

Multimodal Plan



Circulation is a critical part of experiencing Northern Arizona University's large campus.

The university's population crossing the large campus for daily activities creates an enormous amount of movement both on and off campus.

Circulation systems on campus must harmoniously serve diverse user groups. Students walking or taking the shuttle to class, faculty and staff arriving for work, and service vehicles accessing buildings for deliveries and repairs must each be able to complete their objectives in a safe and convenient manner.

The Master Plan relies on a hierarchical mobility structure focused primarily on pedestrian safety. A dynamic and functional pedestrian environment contributes to the overall campus environment, supports campus sustainability goals, and is cost-effective.

The preferred travel modes at NAU include walking, bicycles, skateboards, scooters, and on-campus transit. These modes have the lowest environmental impact and also support campus wellness initiatives.

The vision to create a pedestrian-focused campus requires a mobility system that relocates vehicles away from the center and uses the recovered areas for the highest and best use of university land. This mobility approach improves the quality of life for campus users by creating more opportunities for the exchange of ideas, chance meetings, and places to collaborate and socialize. For example, a new signature open space at the heart of campus will connect the Library, NACC, Field House, and Union in an area that today faces pedestrian-vehicle conflicts at class change times, congestion, and idling cars waiting for parking spaces. Vehicle parking is encouraged along the campus perimeter by the future construction of structured parking which will serve as transition points to switch travel modes from vehicle to walking, cycling, or transit. A perimeter parking strategy poses little inconvenience to travelers because once on campus, little time is typically lost by walking or cycling compared to driving short distances and parking a vehicle. No net change in parking spaces is planned, however, the University's carbon commitments and goals result in the need to reduce the number of spaces through Transportation Demand Management (TDM) measures.

Through improvements to the Pedway and the additions of east-west connections, the Plan encourages separation or restriction of mixed travel modes in order to emphasize both pedestrian and cycling safety.

The goal of a Pedestrian-Focused Mobility Hierarchy is to create a campus that emphasizes a more urban experience, prioritizing pedestrians, cycling, and then transit, and aligning with the university's commitments and goals around sustainability and carbon emissions. The outcomes will:

- 1. Improve the safety of all users
- 2. Make non-motorized transportation and walking more comfortable and convenient
- 3. Reduce traffic congestion by reducing the number of staff, students, and visitors who drive a vehicle to and around campus
- 4. Reduce the demand for expensive parking and street capacity projects
- 5. Improve storm water management

Climate Action Plan Priorities

The Climate Action Plan (CAP) Transportation Committee recommends the following strategies to transition to a carbon-free campus and to motivate faculty, staff and students to employ non-motorized transit:

- NAU should better locate and design pedestrian walkways and expand micromobility alternatives as well as monitor the impact of these investments in motivating more non-motorized transit on campus.
- Easy availability of on-campus parking undermines efforts to reduce commuting by passenger vehicles. Identify means of dampening demand for on-campus parking with value to ensuring equity.
- The City of Flagstaff is a partner for trip planning and other strategies (educational and operational) to encourage use of electric vehicles and mass transit trip planning as a strategy to reduce emissions. EcoPASS utilization should be improved and encouraged. The City of Flagstaff has a goal of 30% reduction in VMT and conducting a TDM plan.
- The Flagstaff Mountain Campus should continue to offer ride sharing programs. Currently, Northern Arizona Intergovernmental Public Transportation Authority-Mountain Line offers a vanpool program for campus commuters.
- A university policy for remote and hybrid work would help reduce parking demand and congestion.
- NAU should consider the student-proposed carbon tax on all NAU funded and approved air travel to fund carbon offsets for air travel. This is modeled after similar programs at Arizona State University and the University of Washington. This program is most impactful if using a central booking system for all university-sponsored air travel.
- Electric vehicle use for fleet and non-fleet vehicles will be facilitated through university investment. An electrical infrastructure plan and funding is needed to develop the specifics.



RESOURCE EFFICIENCY

The committee urged continued effort to establish university policies and funding to provide and/or promote financial incentives, alternative work arrangements and integration of university activity in support of local and regional infrastructure policies.



CULTURE OF SUSTAINABILITY

The 2018, Northern Arizona University Multimodal Assessment (NAUMA) documented traffic patterns of pedestrians, bicycles, transit and automobiles and offered means of reducing traffic congestion and demand for parking to achieve safety and convenience. The Transportation Committee supports NAUMA's recommendations for travel demand management. These include employer/institutional support actions (such as car-sharing, preferential parking, bicycle and pedestrian education, a bicycle co-op and a bike share), financial incentives/disincentives, alternative work arrangements and local and regional infrastructure and policy. A university program/policy for some employees to work at home/hybrid would reduce demand.



CARBON NEUTRALITY

2025	Downsize fleet and electrify most of the passenger motor pool vehicles
2030	Electrify most of the facility service vehicles
2035	Electrify most of the NAU bus and shuttle fleet
2040 Electrify remaining vehicles in motor pool, facilities, buses and shuttles. Electrify mo NAU owned construction equipment and focus on shifting charging and energy con to nonpeak and low emission periods	
2050	Achieve carbon neutrality as APS achieves 100% renewable energy or purchase renewable power for all fleet vehicles

PROPOSED CIRCULATION RECOMMENDATIONS

KEY POINTS

- Transportation infrastructure elevates the safety of pedestrians above all other modes
- Invest in the Pedway to improve safety and separation of transportation modes
- Strengthen east-west connections
- **Connect** the university with the community
- Increase accessibility for all campus users in all seasons





A Multimodal Campus

Through observation of existing conditions on campus and feedback collected from a variety of key campus groups, three key themes emerged that drive multimodal planning:

IMPROVING ACCESS TO KEY DESTINATIONS

As the campus develops, mobility planning should eliminate barriers to campus services and resources and provide comfortable, safe routes and points of access for academic and student services buildings, no matter one's mode or abilities.

PLANNING FOR EVOLVING COMMUTING PATTERNS

This Master Plan has been developed to optimize campus resources. As users return to campus postpandemic, arrival timing and campus movements are shifting. Accommodating these shifts will require:

- Aligning space management policies to account for increased faculty, staff, and students working or learning from home
- Modifying class schedules to reduce parking peaks
- Planning for mobility mode shifts due to new habits and preferences, including alternate modes of transportation (scooters, bicycles, skateboards, electric vehicles, etc.)

MAINTAINING FLEXIBILITY

Peak demand for roadway space on campus often occurs in a predictable pattern just a few days of the year, such as during move-in, the first few weeks of the fall semester, and in specific areas during special events. This Plan prioritizes maintaining flexibility for the campus to accommodate peak vehicular demand when needed but uses the same space for nonvehicular uses all other times.

NAU has worked to develop and implement policies and recommendations surrounding accessibility in the campus environment, and there is a process in place to continuously improve accessibility through capital improvement projects. Through site and building projects, the Plan addresses campus connections that are not accessible or create barriers for those with mobility limitations. For example, in all new construction and major renovations (where possible) all main entrances should be the accessible entrances. It is a recommendation of this Plan that NAU develops a more detailed, comprehensive, and phased campus accessibility plan, leading to enhanced accessibility over time.

Pedestrian and Bicycle Network Recommendations

STRENGTHENING THE PEDWAY

1. Pedway Improvements: The pedway is needed as a spine for seamless movement along the campus. The Pedway will be strengthened to be consistent throughout campus. Improvements will utilize the center-running bicycle lane with a pedestrian walking area on the outside of the Pedway. This configuration separates users and offers a comfortable, convenient, and accessible facility.

Along the Pedway, a tool kit for open spaces along the spine supports a new role for the pathway as a gathering space. This is discussed further in the Landscape and Open Space Chapter. Bioswales along the spine functionally collect stormwater and provide areas for snow storage during winter months.

EXTENDING THE PEDWAY

Two additions to the Pedway are also proposed:

- 2. Humphreys Street: On the north end of the campus, as NAU acquires property, there is potential to transition Humphreys St. into a pedestrian portal into the campus that will connect into the Pedway south of Dupont Avenue.
- **3. South Village Apartments:** The second addition is proposed at the south end of the Pedway, starting from a newly created eastwest link, and ultimately concluding at the South Village Apartments.



ESTABLISHING A LADDER

The 2018 Placemaking Study discussed a ladder design for circulation that begins branching south of the Union, to include two north-south routes:

- 4. West: Along Knoles Drive
- **5. East:** Between proposed pedestrian route and San Francisco Street to connect to the Skydome

PEDESTRIANIZING KNOLES DRIVE

6. Knoles Drive: Knoles Drive is a main corridor that connects the north, central, and south of campus. Currently, transit and campus shuttles operate in mixed traffic on Knoles Drive. During peak class changes, buses and shuttles are subject to congestion conditions. The Plan proposes to restrict private vehicle access during peak hours on Knoles Drive between Tormey Avenue and Riordan Road, with exceptions to handicapped parking and other needs. Buses, campus shuttles, and bicycles will be allowed to use Knoles Drive, but all other private vehicles will be restricted. In addition to reducing delays for buses and shuttles, this strengthens the connection between the University Union and the Cline Library and improves pedestrian safety. This new pedestrian path can connect into a proposed pedway (4) along Knoles Drive, with streetscape and wayfinding.



Knoles Drive Proposed Limited Access



Proposed Pedway Cross-Section

Proposed Pedway



ESTABLISH NEW EAST-WEST LINKS

Building upon the success of the Pedway, new eastwest mobility links will be established that clearly separate pedestrians from those riding bicycles. The links can also provide external connections for the campus. These east-west links will consist of shared use paths, configured similarly to the Pedway. Major east-west connections are proposed at the following locations:

- 7. Milton Avenue Entry to Liberal Arts (along Tormey Avenue) a similar path location just south of this was proposed in the LMP as "the Seam," south of the Science and Health and Communications buildings, which is still proposed to be enhanced.
- 8. Cline Library to Health and Learning Center
- 9. Performing and Fine Arts to Bookstore
- 10. Runke Drive
- **11. Sinclair Wash:** Compacting or paving the Sinclair Wash Trail would provide an "all weather" pathway that is off-set from McConnell Road. This area will also include lighting and educational elements to celebrate Indigenous Peoples.
- **12. South Quad to Sky Dome:** Currently, a series of sidewalks, plazas, and pathways provide a discontinuous path on the south end of campus between the west edge of campus and the Walkup Skydome. A proposed continuous east-west pedestrian pathway that connects surface lot P62 and Walkup Skydome, as well as other interim destinations, would be configured similarly to the Pedway with separated space for bicycles and pedestrians.

Where width is not available to separate pedestrians from bicyclists, campus paths will be improved to include pedestrian and bicycle-focused pavement markings and traffic calming features to reduce vehicle speeds. **13. Pine Knoll Drive Sidewalks:** Several segments of Pine Knoll Drive have sidewalk gaps. Upon implementation, sidewalks will be continuous between McConnell Drive and San Francisco Street.



BICYCLE AND ALL-WHEEL NETWORK

Given the scale of the campus, bicycling, skateboarding, and scooters are important travel modes that enable students and employees to reach destinations efficiently. A driver of this Master Plan is to encourage and expand the use of alternative transportation methods (bicycles, scooters, skateboards, etc.) within the campus and surrounding neighborhoods. This is critical as NAU strives to become less reliant on vehicular mobility. However, during winter months, alternate modes of transportation availability reduces and become harder to rely on, making it important to improve these networks for pedestrians and accessibility.

It is recommended that on-street alternate transportation lanes be installed on primary campus streets. The preferred minimum width for a bicycle lane is 5 feet when adjacent to a curb. Where sufficient width is not available for these lanes on both sides of the street, as an interim improvement, bicycle lanes are recommended on one side of the road only (in the uphill travel direction) and shared lane markings installed on the downhill side of the road. Over the long-term, bicycle lanes should be constructed on both sides of campus streets, in place of shared lane markings. And the ultimate/long-term cross-section should also include a separated Pedway where feasible.

The following recommendations highlight opportunities for new bicycle and alternate transportation facilities, including lanes, short- and long-term storage, and repairs:

- 14. San Francisco Street
- 15. Pine Knoll Drive
- 16. Knoles Drive

ALTERNATE TRANSPORTATION PARKING

Alternate transportation parking encourages ridership by supporting the final stage of a trip. Throughout campus, both short-term and long-term parking should be accommodated, with a focus on buildings with high numbers of short-term and long-term visitors. This parking should be included in all plans for new and renovated buildings on campus - prioritized for well-lit areas near main building entrances, as well as entrances closest to bicycle paths and on-street facilities. Where possible, these should consider showering facilities to encourage bicycle commuting. All existing and future bike rack locations should be included on online campus maps. A bike parking needs assessment can be conducted for proposed buildings to understand both short-term and long-term bike parking needs based on building use, number of and type of expected visitors, and considerations for special events. Bike parking utilization can be monitored and parking redistributed on an as-needed basis.

Short-term Parking: Bicycle racks are a common form of short-term parking. Short-term bike racks provide both convenience to riders and high levels of security, allowing at least two points of contact, such as the wheel and frame, to provide the most protection against theft and accidental damage. Rack styles should also prioritize ease of access for all riders and types of bicycles, so vertical-style racks or racks that require a rider to lift their bicycle are not recommended. Where possible, covered bike parking is recommended to encourage use.

Long-term Parking: Long-term bicycle parking is intended for students and employees to protect bicycles for extended periods. Long-term facilities are more secure than short-term bicycle parking and should fully protect bicycles from theft and weather. Long-term bicycle parking includes bike lockers, bike cages, and bike rooms.

Near residence halls, the University Union, Health and Learning Center, and Du Bois South Union, are proposed for the installation of a secure highcapacity long-term bike parking, to be provided for both student and employee use. Bicycle rooms are recommended for new residential buildings on campus. These new facilities can help to alleviate current capacity issues at certain short-term bike parking locations.



Vehicular Network Recommendations

The following vehicular network changes are proposed, with the primary aim of increasing safety and comfort for people walking and biking on campus:

NEW CAMPUS GATEWAY AT MILTON ROAD

1. A New Entry to Campus: A new communityfocused entry from Milton Road will provide convenient access to the northwest side of campus. The project will construct a new street and campus intersection from Milton Road, connecting to Riordan Ranch Street and a new parking structure near Cline Library The entry will serve as an alternate route with vehicle access restricted on Knoles Drive, directing traffic to new parking structures, and connecting to Riordan Ranch Street and Riordan Road. The project results in the demolition of several buildings, Roseberry Hall, Geology Annex, as well as the removal of surface lots 3c and 13a. New pedestrian connections from Riordan Ranch Street to Knoles Drive and Tormey Avenue should be explored.



Proposed Rendering of Milton Development



RESTRICT PRIVATE VEHICLE ACCESS

- 2. Knoles Drive: As discussed previously, this project would close Knoles Drive to vehicles during school hours, allowing open access to bicycles, pedestrians, and transit. Service, emergency, delivery, maintenance, transit and accessible vehicles will have full access. Through closure gates, Knoles Drive will have limited access between Riordan Road to McCreary Drive (south of P8). To start, consider limiting access only during peak periods (7:30 am 4:30 pm). This would result in the closure of interior surface parking lots P8, P16 and P16A. These spaces will be replaced in a new parking structure on lot P13.
- McCreary Street: With the addition of the new academic complex, and the removal of surface lots P11 and P12, McCreary Drive can be transitioned into a pedestrianized street.
- **4. Humphreys Street:** On the north end of the campus, as NAU acquires property, there is potential to transition Humphreys Street into a pedestrian portal onto the campus, connecting into the Pedway south of Dupont Avenue.



Knoles Drive Cross-Section



Knoles Drive Proposed Limited Acess

MCCONNELL ROAD ENHANCEMENTS

- 5. McConnell Road Improvements: Identified in the Campus Traffic and Circulation Study (2013), a roundabout provides traffic calming benefits and efficient movement through the busy intersection. This improvement is shown throughout this Master Plan. As a secondary option, a T-intersection would include a traffic signal to control traffic for pedestrian crossings. "Barn dance" signal timing may be considered (includes a pedestrian phase in which all pedestrians cross both legs of the intersection simultaneously). A detailed traffic operations analysis is required. Other suggested ideas are a pedestrian tunnel or roadway bridge under McConnell to eliminate at-grade crossings. The major elements of the improvements are:
 - Realign McConnell Road to the south
 - Construct a single lane roundabout at the intersection of McConnell Dr. and Pine Knoll Dr.
 - Improve the Behavioral Sciences fire access road for pedestrians.
 - Bus stop and pullout improvements.

The 2022 Traffic Impact Analysis determined the roundabout at McConnell and Pine Knoll to require double lanes with slip lanes for rights onto McConnell and onto Pine Knoll. The roundabout would impact the existing entry sign. A raised median along McConnell was necessary to control pedestrian crossings. McConnell also shifts significantly to the south to minimize the impacts on the FEMA regulated Floodway, Sinclair Wash, in order to minimize NEPA impacts.





McConnell Drive and Pine Knoll Drive Intersection Concept Designs (Source: 2018 Multimodal Assessment)



McConnell Drive and Pine Knoll Drive Intersection Concept Designs (Source: 2022 Traffic Impact Analysis)

Entrances and Wayfinding

CAMPUS ENTRANCES

Entrances to campus need improved identity and a sense of having arrived on campus. Particularly at the busiest entrances, using elements such as stone walls, brick walks, landscaped boulevards, etc. may serve to improve the entry points.

Recommended gateway signage and landscape improvements at critical nodes:

- 1. Butler Avenue
- 2. Milton Property
- 3. Riordan Road/Knoles Drive
- 4. University Drive/San Francisco Street
- 5. Pine Knoll Drive and Lone Tree Road
- 6. 1-17 Edge

Digital signage should be used strategically throughout the campus. It is recommended that digital signage is added to three highly public edges of the campus - Butler Avenue, Riordan Road/Knoles Drive, and 1-17 Edge.

CAMPUS BOUNDARIES

7. Boundary Improvements: Landscape improvements along the edges of campus can block visual weaknesses, minimize the look of surface parking, and better define the edge using natural elements.



Proposed Rendering of I-17



Parking and Transportation Demand Management

Proposed changes related to building and other facility locations in the Master Plan will require shifting some existing parking locations. No net change in parking spaces is planned, however, the university's carbon commitments and goals result in the need to reduce the number of spaces through Transportation Demand Management (TDM) measures. Parking demand and location will be considered when adding new and replacement buildings to the campus.

REMOVE INTERIOR PARKING LOTS

1. Removal of Select Interior Surface Lots: Interior surface parking lots are often located near campus destinations and activity centers and are opportunities for new campus buildings, redevelopment, open space, or improving pedestrian connectivity between buildings. Furthermore, interior surface parking lots contribute to congestion during peak periods and class changes. In past planning, NAU has investigated the idea to remove interior surface parking lots and densify perimeter parking facilities. Accordingly, this Master Plan proposes removing interior surface parking lots to enable other campus goals to be achieved.

Surface Lot	# Spaces Removed
1a	11
1c	37
1d	48
Зс	100
11	90
13	357
13a	154
16	149
16a	119
47	55
61	96
66a	139

1355 spaces removed

Parking Structure	# Spaces Added
North Campus + Cline Library	400
South Campus Structure + Transportation Center	680
South Campus Residential	275

1355 spaces added



SOUTH CAMPUS MOBILITY HUB

- 2. Mobility Hub: Mobility hubs are central locations that offer multiple transportation modes - public transit, campus shuttle, bike share, and vehicle parking. When constructed to support frequent transit, mobility hubs offer a safe, comfortable, and convenient facility to help students, faculty, staff, and visitors seamlessly transfer from one transportation mode to another. Mobility hubs may include a variety of elements to support different trip types. The combination and range of elements will vary based on the collection of modes and services available at each mobility hub location. Key elements include shade structures, bicycle parking, sidewalks, pedestrian crossings, bus stop/bus bays, driver restrooms, and water fountains.
- **3.** The South Campus Mobility Hub will be located at 2551 E Pine Knoll Drive (lot P64). This location will provide multimodal connections to the southern end of campus such as Social and Behavioral Science buildings, McConnell residents, and the Walkup Skydome. The mobility hub will replace the existing parking lot. The site will also accommodate covered campus shuttle parking and storage.



Figure 4: South Campus Mobility Hub and Parking Structure Concept

PARKING GARAGES

Two new parking structures will encourage those who drive to campus to park near entry points located on the edges of campus. Each of the proposed parking structures will consist of 5 - 6 flat floors for future building use flexibility.

4. Cline Library Parking Structure:

This new structure adds 400 spaces to the campus. It will primarily serve those entering from the west, either using Riordan Road, or Riordan Ranch Street. The garage project could include a covered walkway connecting to the library. Surface parking east of the parking garage will be converted to plaza space adjacent to the Cline Library.

- 5. South Campus Parking Garage: This new structure will be located south of the proposed Transportation Center and Mobility Hub within existing lot P64. This structure will add 400 spaces to the campus. This parking structure will include pedestrian access from the parking structure to the mobility hub. The parking garage rooftop may also be equipped with solar panels.
- 6. South Campus Housing Village: Assumed to be constructed with the apartment complexes, this structure adds 275 spaces to the campus, which is 55% of residents in the new south campus housing complex.



Figure 5: Cline Library Parking Structure Concept

TRANSPORTATION DEMAND MANAGEMENT

Transportation Demand Management (TDM), sometimes referred to as Travel Demand Management, refers to actions that manage the demand for travel by drive-alone private cars, rather than catering for that demand, or managing the road system. The 2018 Multimodal Assessment identified projects and methods to reduce the number of individuals traveling to and from campus in a single-occupant vehicle. In addition to infrastructure-focused investments, non-infrastructure focused investments can help to reduce the number of individuals driving to campus in single-occupancy vehicles. TDM provides people with a variety of mobility options (other than driving alone) to reduce driving and gain environmental, conservation, and sustainability benefits—generally without large infrastructure investments. Measures are directed at increasing vehicle occupancy, shifting travel mode or time of travel, or reducing the need for travel. The following table identifies actions, that may be considered by NAU, aimed at impacting traveler behavior by reducing the number of single-occupant vehicle trips. This study could be completed in conjunction with the City of Flagstaff, Metro Plan and Northern Arizona Intergovernmental Public Transportation Authority (NAIPTA) since many of the issues with multimodal travel rely on city and regional infrastructure. **A full TDM study is a recommendation of this Master Plan.**

TDM Strategy	Description	Propensity to Affect Behavior	Relative Cost to Implements	
Institutional Support Actions				
Alternative Transportation Manager	On-site professional provides personalized trip planning and commuter assistance. Coordinates education and outreach activities and events.	High	Moderate	
Car-Sharing	Car rentals available on-site to facilitate midday travel for individuals that do not drive to work / school. Enterprise or Zip Ride are examples of car-sharing programs. NAIPTA currently offers a van pool service.	High	Moderate	
Bicycle and pedestrian education/ encouragement during new hire and new student orientation	Orientation takes place prior to hiring or starting school to educate employees / students of alternative transportation options and costs. Aimed to influence decision on where to live, how to travel to school/work, and make other travel decisions.	Moderate	Low	
Preferential Parking	Designated to rideshare users (carpool or vanpool), particularly in areas where parking is limited.	Low	Low	
Fairs/Promotions	Periodic events held in public spaces to highlight TDM offerings (e.g. bike fair, bike to work / school week); use student orientation to teach students how to use bike lanes, shared lanes, etc.	Low	Low	
Guaranteed Ride Home	Backup rides are offered to employees / students who do not drive alone to campus. Typically provided through vouchers and/or reimbursement up to a designated number of time per period/semester.	Low	Low	
Bicycle Co-Op	Student-run bicycle co-op that recovers abandoned bikes and repairs / reassembles / repurposes them for incoming students; current bicycle co-op (Bike Hub) provides repairs for bicycles and can be further supported and marketed.	Low	Low	

Mobility Office / Transit Hub / Bike Shop	Centralize the location of a TDM / mobility office and bike shop at an existing transit hub to create a one-stop shop.	Low	Low	
Bike Share	Support installation of bike share that is integrated with the City of Flagstaff. This will build upon the current "Yellow Bike" program on NAU campus. Consider flexibility of a smart bike / station-less system and bundling pricing with a car share membership or in lieu of parking pass.	Moderate	Low	
Alternative Work Arrangemen	its			
Class Scheduling	Normalize travel demand by scheduling classes equally throughout the week and later in the day; consider travel demand when developing class schedules.	Moderate	Low	
Financial Incentives and Disin	centives			
Increase Transit Subsidies	Reduced cost of transit by offering prepaid or discounted transit passes to students who agree to commute primarily by transit. When students purchase a bus pass, they also receive 30-parking days to use as needed. Employees currently are offered an annual Mountain Line Bus Pass at no charge.	High	Moderate	
Restricted Parking	Underclassmen are restricted from using parking to reduce the amount needed. Effective if it is mandatory for on-campus lodging. Waived if proof of off-campus employment is provided.	High	High	
Parking Fees	One of the most effective ways to affect travel behavior. The financial cost of providing parking is high and often not known by users. Passing along the cost of parking can educate users of the true cost of driving and impact their decisions.	High	High	
Pay-as-you-go Passes	Incrementally transition from semester or annual parking passes to pay-as-you-go passes. Students then, when buying a pass don't feel "locked into it" and have more flexibility to select other modes of travel.	High	Low	
Required Bicycle Registration	Bike registration allows for campus police to return recovered stolen bikes and helps TDM managers gather data on the number of bikes on campus.	Low	Low	
30 Day Flex Parking Pass	Provided only to those registered in another program (bike, transit, walk commute) to allow flexibility to drive when necessary.	Moderate	Low	
Financial Incentives and Disincentives				
Permanent Bike Counters	In collaboration with City of Flagstaff, install permanent bike counters to gather data to determine on campus bike usage.	Moderate	Moderate	
Determine TDM goals	Determine program objectives (potential targets and expected outcomes).	Moderate	Low	

Credit: Kimley Horn 2018 Multimodal Assessment

Information compiled from multiple sources, primarily the TCRP Report 95: Chapter 19 "Employer and Institutional TDM Strategies: Traveler Response to Transportation System Changes" (Transportation Research Board 2010).

Previous Plans Summary

Previous plans and studies have evaluated campus mobility and circulation needs. These include:

- Flagstaff Campus Master Plan (2010)
- San Francisco Street Traffic Analysis (2014)
- NAU Campus Multimodal Assessment (2018)
- Transportation Impact Analyses: Milton/Rte 66 Entry and McConnell Gateway
- Zero Emission Bus Fleet Transition Study (2020)

The plans identified issues including congestion during class changes at pedestrian crossings, bicycle and skateboards interfacing and conflicting with foot traffic, lack of east-west connectivity, and sidewalks that are missing or too narrow. Plan recommendations centered around separating users (bicyclists, pedestrians, skateboarders) from operating in the same space by expanding and improving shared use paths and Pedway. Within limited right-of-way, on street bicycle lanes are identified. Improvements also serve to calm traffic. Plans also propose to consolidate and relocate interior parking to parking garages at the exterior of campus.

FLAGSTAFF CAMPUS 2010 MASTER PLAN

This Master Plan aimed to create "a campus that is dynamic and functional, and that balances the needs of faculty, students, drivers, and pedestrian." Organizing concepts prioritize pedestrians, bicycles, and transit, with a unifying central pathway from north to south campus. Improvements include paving, signage, lighting, drainage, and a pedestrian bridge over Sinclair Wash/McConnell Drive. Interweaving the busway creates a new transit spine parallel the Pedway. Relocation of parking to the edges of campus reduces traffic and improves travel time for buses. The improved on-campus bus service makes parking on the perimeter and using the bus system more attractive, resulting in increased ridership.

2014 TRAFFIC ANALYSIS

This study evaluated 2020 traffic conditions at four intersections on San Francisco Street. The study recommended extending the northbound turn lane at Franklin Avenue and converting the intersection at Mountain View Drive from an all-way stop to a two-way stop.

2018 MULTIMODAL ASSESSMENT

This analysis recommended improving multimodal mobility and safety on campus. The assessment integrated multiple studies, campus outreach, and user interviews. The highest-priority issues identified are:

- 1. South Campus; Pine Knoll Drive and McConnell Drive Intersection
- 2. South Campus; San Francisco Street and Pine Knoll Drive
- 3. South Campus; McConnell Drive and San Francisco Street
- 4. Central Campus; Knoles Drive and Runke Drive
- 5. Central Campus; NAU Trail from Ramond Hall to Beaver Street



2020 ZERO EMISSION BUS FLEET TRANSITION STUDY

The study outlines Mountain Line's plan to shift to zero-emission buses starting in 2023 with the replacement of two hybrid-diesel buses with battery-electric ones, aiming for a fully zero-emission fleet by 2034. Various scenarios were examined, including battery-electric and hydrogen fuel cell buses, based on costs, emissions, and goals. The study recommends proactive deployment, considering space limitations for storage. The most cost-effective scenario involves charging both on routes and at depots. The transition represents a significant shift in public transit, requiring continuous advancement for sustainability.



Indigenous Planning



Indigenous Placekeeping drives the cultural interpretive strategy of the Plan.

Northern Arizona University has a long-standing history of honoring Indigenous Peoples in the university strategic plan by dedicating one specific goal to the Commitment to Indigenous Peoples. This goal includes the recognition of the unique sovereign status of Native Nations and the sacred land on which the university was built. It has the mission "to become the leading university serving Indigenous Peoples."

Indigenous design strategies apply a triad as an indicator of outcomes to be achieved in the Indigenous design. There are three levels of meaning in the triad: identity, lifeways, and worldview (ways of knowing). All three ways should be understood in order to fully explain the dynamics of relationships between built environments and human behaviors:

- Identity: How does the Plan reflect the identity of the people?
- Lifeways: How does the Plan offer space for community life ways?
- Ways of Knowing: How does the Plan engage an Indigenous worldview?

The Plan provides opportunities throughout the NAU campus to engage in local narrative, language, story teaching, art, ethnobotany, Indigenous identity, and more to honor the Ancestral presence and deep connection of the Indigenous Peoples to the land in which it is located. Some of these are shown in the Plan as spaces that are welcoming with natural materials, spaces that have a meaningful purpose, and places of outdoor education and native flora and fauna.

Climate Action Plan Priorities

In respect to Indigenous Planning, the Climate Action Plan recommends:

- Consider social equity through the lens of the city and the campus
- Making the campus more resilient means incorporating social equity and resiliency
- Find best practices that will eliminate the possibility of uneven impacts
- The campus should partner with the city to address issues of social equity in the community
- Divest from fossil fuels, address justice and social equity, food and housing insecurity to avoid disproportionate impacts on vulnerable populations
- On-campus parking should be evaluated to both reduce commuting by passenger vehicles and ensure equity
- Promote social equity through university programs; ensure that each policy, program, or practice is free from bias
- Living laboratory activities should better incorporate equitable programming
- Increase use of native and naturalized plants from the campus and surrounding region
- Plant beds with organic, local rock and native grasses to improve the general campus landscape aesthetic and promote the use of Indigenous landscapes
- Focus on preserving native species on campus grounds, such as the Ponderosa Pine and the Gambel Oak
- Work with the landscape management to increase the number of native and adapted plants



PROPOSED INDIGENOUS DESIGN

KEY POINTS:

The engagement process helped to outline three main questions for the Campus Master Plan process.

- How does the Master Plan reflect the identity of the people?
- How does the Master Plan offer space for community life ways?
- How does the Master Plan engage an Indigenous worldview?

In turn, these questions also helped to create three primary drivers in response.

• Indigenous Identity

Cline Library

- Indigenous Lifeways
- Indigenous Ways of Knowing

How does this research contribute to the overall Master Plan? The engagement with Indigenous groups and the drivers created from those conversations allowed the team to target specific areas in the Master Plan.







IDENTITY

- Recognize Indigenous communities' ancestral connections to NAU land and the diverse Indigenous representation on campus.
- Acknowledge the unique geography, topography, archetypes, and seasons as crucial indicators of Indigenous placekeeping that shape diverse experiences.
- Uplift Indigenous communities to shape an inclusive future that goes beyond a land acknowledgment.
- Foster a deep appreciation for Indigenous cultures, traditions, and values
- Work in partnership to support sovereignty and well-being of Indigenous Peoples.

LIFEWAYS

- Embrace traditional Indigenous values to create inclusive spaces that honor their cultural significance to foster deeper relationships.
- Include Indigenous Peoples on campus to express their distinct ways of being, gathering, and ways of relating to community.
- Amplify Indigenous voices by weaving their goals into elements of campus to promote an environment that celebrates their culture as a vital part of its growth.

WAYS OF KNOWING

- Connect to the environment and uplift ecological awareness while creating learning spaces that honor Indigenous knowledge systems.
- Appreciate diversity and learn from divergent cultures demonstrated through an openness to Indigenous modes of learning. Enriching the learning experiences of all students, while building a connection to the wider community.
- Nurture Indigenous teaching practices guided by the wisdom of Elders, Indigenous Traditional Ecological Knowledges, and research agendas led by Indigenous Peoples.

DESIGN

North to South Connection

In response to the concerns uncovered during engagement sessions, improving connectivity between Indigenous assets in the north and south sides of campus became a priority. These assets were integrated into the planning process with guiding principles and suggested design applications as critical features.

North Campus consists of an urban dense area that houses multiple Indigenous departments, including the Native American Cultural Center (NACC). As proposed by TAW, the program space of NACC should be extended into the proposed lawn space surrounding the building. This space should be designed in consideration of year-round weather conditions. It should also have space for ceremonies and teaching, a sweat lodge, a small Indigenous medicine garden, and space to host large gatherings.

Conversely, South Campus is comprised of a pine forest with student housing and the Social and Behavioral Sciences (SBS) building, which contains Indigenous programs and a Hogan. Demolishing four buildings in this southwest area creates an opportunity for a satellite lounge. This gives an opportunity to better utilize the Hogan with a large Indigenous garden, outdoor kitchen, and large multiuse space for hosting events.

There is also an opportunity to connect the North and South Campus with a Tribal Sovereignty Path. This should contain circular resting places, native vegetation, cultural and language opportunities, artwork displays, and a walk of nations through a highly-visibility lighting installation at the Sinclair Wash intersection. Embedding this path with Tribal nation flags will enhance the visibility and prominence of Indigenous culture on campus.

Indigenous Placekeeping on Campus

1	Existing Code Talker Statue
2	Proposed Indigenous Welcome Signage
3	Existing Little Tree Man Trail
4	Proposed Four Seasons gathering space
5	Proposed NACC expansion + Sweat Lodge
6	Existing Native American Cultural Center
7	Proposed Plaza and Gathering Lawn
8	Proposed Indigenous Banners and Signage
9	Enhanced NAU sign with Indigenous Elements
10	Existing International Pavilion
1	Proposed Cemetery Vegetation Visual Barrier
12	Proposed Walk of Nations
13	Proposed Sinclair Wash Enhancements
14	Existing Navajo Nation Archaeology Department
15	Re-imagined SSLUG Garden
16	Satellite Indigenous Lounge at South Campus
Ð	Enhanced Hogan
18	Relocated Institute for Tribal Environmental
	Professionals (ITEP)
19	Existing Grimm Tree Walk
20	Existing Indigenous Peoples Living-Learning
	Community at Mountain View Hall
21	Future Expansion Indigenous Peoples Living-Learning
_	Community and Commons
22	Proposed Cemetery Vegetation Visual Barrier



DESIGN

North Campus



Indigenous Welcome Signage Welcoming signage that faces the community, honoring the diversity of Indigenous Peoples and the university land acknowledgment.



2 NACC Extension Located on the northern end of the existing structure.



3 Four Season Ceremonial Space This ceremonial space will be used year-round for ceremonies, classes, and gatherings.



Gathering LawnTo be used as a venue for the annual Pow Wow.



Seating Along Sovereignty Path Seating area to provide learning opportunities by integrating culture, history, and stories.



• Sovereignty Markers Storytelling through symbolism and teaching opportunities for the community.



 Art Installation
 Collaborative installation with local artists that honors Indigenous Peoples.



Output: Section Visual Barrier
Visual buffer to the cemetery which also prevents students walking through the cemetery.

----- SOVEREIGNTY PATH SECONDARY SOVEREIGNTY PATH - GREEN SPACES **EXISTING ASSETS** PROPOSED SPACES PROPOSED VEGETATION, SEATING, ART, EDUCATIONAL SIGNIFIERS 3 4 8

||||||| MAIN PEDESTRIAN / BIKE PATH

IIIIIIIIII SECONDARY PEDESTRIAN PATH
DESIGN

Central Campus



Seating Along Sovereignty Path Shaded seating pavilion is intended to honor Indigenous heritage, while providing functional space for people of all cultures to enjoy.



 Walkway Design
Designed to teach visitors about Indigenous culture and history.



Central Wayfinding Wayfinding signage that is embedded with NACC branding that can help direct to the diversity of Indigenous centric programming on campus.



6 Meditation Pavilion Meditation space for all students to utilize to reflect and connect to the sky.



Raised Garden Bed SeatingProviding functional seating with raised garden beds surrounding promotes sustainability by encouraging the growth of plants.



6 Vegetation Visual Barrier Visual buffer to mitigate direct vision of cemetery while preventing students from walking through cemetery.



PROPOSED SPACES

• PROPOSED VEGETATION, SEATING, ART, EDUCATIONAL SIGNIFIERS

DESIGN

South Campus



1 Walk of Nations

Representational lighting embedded with highly visible Indigenous motifs.



2 Satellite Lounge

Entrepreneurial resources programming, embedding startup resources such as a creative lab.



3 Creative Lab

Space for sewing, jewelry-making, and various crafts, providing tools and resources.



4 Culinary Lab

Indoor and outdoor cooking area and greenhouse for growing native species and saving seeds.



5 Banners

Promotional banners to highlight and advertise for the NACC and its programs.



Multi-lingual Welcome Signage
Welcome signage that respects and celebrates a
diversity of languages.



Seating Surrounded by landscaped or decorative elements, covered or open to the sky.



8 Patio Design

Patio with elements of the natural environment and traditional Indigenous references.



• PROPOSED VEGETATION, SEATING, ART, EDUCATIONAL SIGNIFIERS

Previous Plans Summary

Previous plans and studies have evaluated different aspects of Indigenous Planning. While no plan has included a comprehensive proposal for incorporating Indigenous Planning as a whole, each plan has touched on key aspects or themes of it. Promoting the use of native plants in the campus landscape and striving for social equity are each key elements of Indigenous Planning, which can be found in the following reports.

- Flagstaff Campus Master Plan (2010)
- Landscape Master Plan (2015)
- Placemaking Workshop Report (2018)
- Landscape Master Plan Report (2022)

FLAGSTAFF CAMPUS 2010 MASTER PLAN

The 2010 Campus Master Plan outlined some key aspects of Indigenous Planning by promoting the use of native plants in the campus landscape. It also introduced the Native American Cultural Center which was constructed in 2011. A key part of this Master Plan was celebrating sustainability by strengthening the connection between the landscape, mountain views, and native landscapes. This Plan also helped to renew efforts to emphasize native landscapes through drought-resistant plants and environmentally-friendly maintenance practices.

2015 LANDSCAPE MASTER PLAN

The 2015 Northern Arizona University Landscape Master Plan also introduced new projects related to Indigenous Planning. The plan called for a landscape expansion surrounding the Native American Cultural Center which would include grass meadows and ornamental grass gardens. A seat wall around the south oval of the NACC was also called for to improve the space. In order to preserve mountain views to the San Francisco Peaks, the plan called for the demolition of the existing Math building and its replacement with another structure.

2018 PLACEMAKING WORKSHOP REPORT

This report called for a more-forested south campus and a greater role of Sinclair Wash in the university.

2022 LANDSCAPE MASTER PLAN REPORT

The 2022 Landscape Master Plan Report also called for more native plantings around the campus.





Sustainability and Smart Campus

Resiliency is important for infrastructure and utilities of Northern Arizona University's campus.

Campus infrastructure aims to digitize, modernize, and decarbonize to align with NAU's goals for smart, efficient, and clean utility infrastructure. The Plan focuses on infrastructure and utilities as the foundation for the effective functioning and support of the educational and operational activities for all of campus. Reliable and well-maintained infrastructure ensures the seamless delivery of essential services throughout the campus. At the core of the recommendations is to revitalize campus infrastructure while tackling deferred maintenance at the building, distribution, and plant levels.

NAU Flagstaff Mountain Campus will realize carbon neutrality by 2030 for Scope 01 (onsite emissions, fleet and natural gas) and Scope 02 (purchased electricity) and the investment in the university's infrastructure will be a critical component to achieving this commitment. At the forefront of the Master Plan, all future buildings and plans must consider the best way to approach planning and implementation through the goals of the Climate Action Plan and the actions outlined in the 2022 Roadmap to Carbon Neutrality. How NAU will get there:

- Maximizing energy and water efficiency to reduce the campus' energy use intensity (EUI) and realize utility savings
- Prioritizing renovation over demolition
- Transitioning to carbon-free electricity through partnerships or a Virtual Power Purchase Agreement
- Converting the district heating system to low temperature hot water, and connecting the north and south plants
- Transitioning to ground source heat pumps (geothermal) and/or a woody biomass system
- Electrifying NAU's fleet
- Creating a culture of sustainability through behavioral change programs, enhanced commuting options, community trainings, and updated policies
- Creating a national model of a living laboratory to ensure it is preparing students, staff, and faculty to meet the climate challenges of the 21st century
- Engaging students to help with implementation of sustainability initiatives – developing student skillsets and advancing university emission reduction goals simutanelously.



PROPOSED INFRASTRUCTURE & UTILITIES RECOMMENDATIONS

KEY POINTS:

- **Energy:** Buildings identified with large, deferred maintenance backlogs and high energy use intensity are prime candidates for deep energy retrofits.
- **Carbon Reduction:** Complete the initiating infrastructure projects that enable NAU to significantly reduce or eliminate the Flagstaff Mountain Campus' reliance of fossil fuels.
- Utilities Overhaul: The campus utility infrastructure requires a comprehensive overhaul to address aging piping and to eliminate the use of fossil fuels to align with the climate action goals.

A Future Focused Campus

The Smart, Sustainable, Comprehensive Campus Master Plan aims to revitalize campus infrastructure while tackling deferred maintenance at the building, distribution, and plant levels.

CAMPUS INFRASTRUCTURE AIMS TO DIGITIZE, MODERNIZE, AND DECARBONIZE TO ALIGN WITH NAU'S GOALS FOR SMART, EFFICIENT, AND CLEAN UTILITY INFRASTRUCTURE.

Among the buildings identified for renovation, several have high energy consumption and significant opportunities for deep energy savings. Several buildings are identified as targets for deep energy retrofits and systematic renovations aiming to achieve energy savings. Deep energy retrofits are typically invasive when conducted on their own but are excellent to pair with major renovations and allow for whole system replacements, energy programming, and occupant engagement to be effective ways to drive energy and carbon savings beyond a traditional energy retrofit.

Food service is one of the largest consumers of fossil fuels on campus after heating and transportation. An older, energy-intensive kitchen is the perfect candidate for a catalyst project to continue to move the campus away from carbonintensive natural gas infrastructure.

The campus utility infrastructure requires a comprehensive overhaul to address aging piping and to eliminate the use of fossil fuels to align with the climate action goals and targets endorsed by faculty, staff, and students. A low-temperature hot water system will enable the campus to transition to electric and carbon-neutral sources of heating energy, such as centralized heat pumps (option 1) or a woody biomass plant reclaiming waste from local forest management (option 2). With either option, a low-temperature system will move NAU away from maintenance-intensive steam systems that have aged to the point of leaking in many older buildings.

Campus heating system interconnection and conversion to low temperature heating water:

With both options, an interconnect of the north and south campus systems allows for consolidation of plant equipment and reduces operational limitations. The campus will also undergo a low temperature hot water conversion to prepare for clean energy heating and cooling plants. The conversion will increase energy efficiency in the interim, provide redundancy by interconnecting the north and south plants, and allow for end-of-life fossil fuel boilers to be retired early by sharing heating capacity between both plants. The low temperature hot water conversions are recommended to occur in phases outlined within this section, and NAU is investigating opportunities for partnerships to upgrade their utility systems.

An updated utility development plan is recommended every 10 years, therefore NAU should update its Utility Plan as a subsequent effort to this Plan.

The advancement of Information Technology (IT) is critical to support the vision and goals of NAU as a sustainable, smart campus. This Master Plan seeks to further leverage technology and services to improve student experiences, improve student success, extend the campus' physical borders, move services into cyberspace, improve efficiencies, and contribute to sustainability.

RECOMMENDATIONS FROM CLIMATE ACTION PLAN

- 1. Complete energy audits, retro-commissioning and automated fault detection and diagnostics systems for the following buildings:
 - Information Technology Services Building
 - High Country Conference Center
 - Science Laboratory
 - Wettaw
 - Performing and Fine Arts
 - Bury Hall
 - Gammage
 - Eastburn Education
 - Cline Library
 - Biological Sciences
 - Health Professions
- 2. Install low-temperature freezers, more efficient equipment and fume hoods and adjusted airflow rates for the following buildings:
 - Science Laboratory
 - Wettaw
- 3. LED lamp or fixture retrofits for common fluorescent and incandescent fixtures in campus buildings constructed prior to 2015:
 - Performing and Fine Arts
- Economizer diagnostics and repairs for buildings with high chilled water climate opportunity scores:
 - Du Bois Union
 - Science Laboratory
 - High Country Conference Center

- 5. Envelope audits for academic, administrative and residential buildings constructed prior to 1970 with high climate opportunity scores related to steam or heating hot water use:
 - Gammage
 - Liberal Arts
 - Eastburn Education
 - Reilly Hall

6. Electrify the Du Bois Student Union Kitchen

Buildings identified with large, deferred maintenance backlogs and high energy use intensity are prime candidates for deep energy retrofits. Additional funding is recommended for these projects to pursue retrofits including HVAC system replacements, envelope upgrades and active occupant engagement.



CLIMATE ACTION STRATEGIES

Summarized from the 2021 Climate Action Plan, credit Affiliated Engineers Inc. (AEI)

NAU is moving forward to reduce and ultimately eliminate the use of fossil fuels on campus as part of a climate action plan to mitigate the ongoing impacts of climate change.

Natural Gas combustion is the largest source of direct emissions across campus.

- 1. Centralized heating accounts for 80% of gas combustion. The following steps will address this 80%:
 - The campus will connect the north and south heating systems and convert both to low carbon, low-temperature heat hot systems. Conversion to low temperature systems will address deferred maintenance of aging distribution systems, improve the efficiency of interim natural gas combustion and allow for decarbonization of the heating plants.
 - Technologically viable options are being pursued through 'energy-as-a-service' arrangement for decarbonization of the heating plants including: woody biomass sustainability harvested from local forest management operations or centralized ground source heat pumps with heat recovery.
- The remaining 20% of gas combustion on campus will include standalone building heating and building uses including cooking, sanitation, and domestic hot water.
 - The remaining uses of natural gas will be electrified or connected to the central heating loop where practical.

Gasoline and Diesel combustion in fleet vehicles is the next largest source of direct greenhouse gas emissions. A campus EV charging and electrical infrastructure plan will be developed alongside an electric vehicle procurement policy. The university is targeting electrifying the campus fleet by 2035 and offsetting interim fleet operations by 2030.

Purchased Electricity is another source of campus emissions. The emissions associated with purchased electricity will be mitigated through a virtual power purchase agreement (VPPA) equivalent to NAU's electric consumption. Local or on-campus solar may be procured as part of a larger VPPA agreement.

Targeted energy and water efficiency retrofits are planned through the use of third party energy service contracts and expansions of the campus sustainability revolving fund.

Education is critical to sustainability on campus.

Behavioral change programs will be expanded including Energy Mentors, Green Office, Green Labs and Sustainable Ambassador programs.

Resiliency will be further developed through the Second Nature's process for resilience planning to identify needs and opportunities. A robust listening and screening process will be utilized to analyze campus planning's impacts on frontline communities and groups put at increased risk due to climate change.

PLANTS

Summarized from 2021 Climate Action Plan, credit Affiliated Engineers Inc. (AEI)

The two campus central heating plants are the major sources of campus natural gas combustion.

North Plant produces steam for distribution to most buildings on the northern part of the Flagstaff Mountain Campus and consumes approximately 70% of campus natural gas. The plant has three 50 kpph steam boilers (installed in 2011-2012), a 48 kpph steam boiler (installed in 1980), and a 45 kpph steam boiler (installed in 1962). The current peak load on this plant is approximately 50-60 kpph. There is sufficient capacity and redundancy to meet loads and accommodate growth even without the two older steam boilers.

South Plant produces high temperature hot water for distribution to most buildings on the southern part of the campus and consumes approximately 15% of the natural gas on the Flagstaff Mountain Campus. The plant includes one 10 MMBH hot water boiler (installed in 1980), one 20 MMBH hot water boiler (installed in 1969) and one 46 MMBH hot water boiler (installed in 1974). The current peak load on this plant is approximately 14-16 MMBH. While there is sufficient capacity and redundancy to meet loads and accommodate growth, all three of these boilers are at least 40 years old. The Climate Action Plan considered a suite of options to significantly reduce or eliminate Flagstaff Mountain Campus reliance of fossil fuels. Two campus energy options proved most appealing and were selected for additional study - biomass and geothermal.

It is recommended the campus district heating system be converted to all hot water. Currently, the south campus is hot water and the north campus is steam. The associated benefits are reduced heat loss, longer economic life, and lower operations and maintenance cost. An interconnect of the north and south campus systems allows for consolidation of plant equipment and reduces operational limitations.

Qualitative Attributes of Energy Options

While this Master Plan does not identify the specific option that NAU will move forward with to decarbonize, the university is currently working with committees and consultants to study the benefits and limitations of both. The table below from the Climate Action Plan represents the benefits and impacts for each option.

Criteria	Option 1 - Woody Biomass Heating Plant										
Financial	-	Price uncertainty - sensitive to the cost of wood feedstock, trucking, and qualified plant operato									
	+	Lower initial capital investment for NAU.									
Community Perception	-	Portions of community may object to new combustion heating systems of any kind.									
	-	Ongoing nuisance condition - a large feedstock stockpile is required on or adjacent to campus (site is on forested land).									
Community Impact	-	Ongoing nuisance condition - approximately 15 tractor-trailer truck deliveries per weekday for 8 months of the year.									
	+	Approximately 5 fte trucking and equipment operator jobs and 12 fte plant operator/maintenance jobs are created for project life.									
Carbon Emissions	/	Carbon Neutral - the emissions of the heating combustion system are equivalent to the otherwise emissions of open burning wood forest management residuals, unless it can be shown that the NAU residual outlet improves the efficiency of the forest restoration initiative.									
	-	Emissions related to diesel fuel for feedstock transportation will need to be offset.									
	-	Risk that forest management emissions will be regulated in the future.									
Access to Fuel	-	Fuel procurement depends on some factors outside of NAU control, including the forest management service and the recovery contractor.									
Resiliency	+	The feedstock pile offers seasonal storage as safeguard for brief interruptions in fuel availability.									
Efficiency	-	Project uses direct combustion boilers (approximately 70% efficient throughout the year).									
	+	Can be procured through a third party contract to build, own, operate and maintain.									
Operations	-	A unique skill set in operations staff is required, which may result in the need to outsource operations.									

Option 2 - Low-Temperature Hot Water Conversion and Central Electric Heat Pumps								
-	Price uncertainty - sensitive to the cost of electricity.							
-	Higher initial capital investment for NAU.							
+	Electrification of heating is commonly accepted and embraced.							
+	Once wells are installed, the surface area can be restored to previous use and limit other land uses.							
+	The geothermal system is underground and unnoticed.							
/	Economic impact is similar in size, but in the form of offsite sustainable electricity generation and larger construction cost.							
+	Carbon Free - electricity can be generated from carbon free sources such as solar, hydro, wind, geothermal, nuclear.							
+	Losses in electric grid distribution and transmission can be overcome with additional off-site sustainable electricity generation.							
+	The electric utility plans to eliminate carbon emissions associated with all grid electricity.							
+	Sustainable electricity generation can be contracted through multiple sources and locations.							
+	Generators could be provided to allow operation of a portion of the system to meet critical heating loads during grid power interruptions.							
+	For one third of the time the heat pumps operate in combined heating and cooling mode at 500% efficiency and for the remaining two thirds of the time, the heat pumps operate in geothermal heating mode at 300% efficiency.							
+	Can be procured through a third party contract to build, own, operate and maintain.							
+	Existing staff (and available local workforce) have skill to operate the system.							

OPTION 01: WOODY BIOMASS

Summarized from 2021 Climate Action Plan, credit Affiliated Engineers Inc. (AEI)

ABOUT BIOMASS TECHNOLOGY

Biomass technologies include heat and/or power generation equipment that directly source their energy from biological matter. Common examples of energy sources are wood, agricultural waste, and livestock waste. A crop can be harvested for the sole purpose of providing biomass energy to an end user. These technologies differ from renewable natural gas in that the biological matter is delivered directly to the end user as a fuel rather than being converted to useful gas in a separate location and transported via natural gas infrastructure.

There are two main categories of biomass: direct combustion and gasification. Direct combustion biomass systems utilize solid fuel boilers to produce steam which can be used for power generation and/or heating. In some cases, existing coal boilers can be converted to direct combustion biomass boilers. Gasification systems utilize equipment that converts the energy in the feedstock to gaseous fuel that is piped to a boiler or an engine. Gasification systems that utilize boilers operate in a very similar manner to direct combustion systems, producing steam that is used for power generation and/or heating. In some cases, existing natural gas boilers can be converted to operate with a biomass gasifier. Gasification systems can also utilize engine generators with exhaust heat recovery to provide combined heat and power.

Woody biomass is biomass derived from trees. It can be classified into construction scrap wood, sawmill residues, and forest residues (such as branches and leaves shed in the mountains). Woody biomass is a renewable energy source, since new forests can be developed through afforestation and appropriate maintenance. If applied at NAU, woody biomass will provide heating only, or a small amount of electricity as a byproduct of heating (such as by use of a back pressure steam turbine generator). A combined heat and power facility was not included in this option because there are lower-cost options for procuring carbon-neutral electricity off-site through power purchase agreements and through the electric utility that serves the Flagstaff Mountain Campus (which plans to decarbonize the electric supply 50% by 2030 and 100% by 2050).

NORTH PLANT

The current analysis is that the existing (relatively new) steam boilers in the North Plant cannot operate on biogas from a gasification system. If that becomes feasible, it could reduce capital cost to this option.

CAMPUS LOCATION

The wood feedstock will be procured, delivered to campus and stockpiled. The schedule for delivery will dictate the space needed for stockpiling feedstock, in colder months when more heating energy is used, the university should arrange for more frequent deliveries to avoid need to store large amounts of feedstock. To limit materials handling, it is assumed that the stockpile and heating facility be proximate with underground piping to distribute the heat.

IMPLEMENTATION

To implement biomass heating, NAU must first interconnect the north and south campus heating systems (Phase 1). This can be achieved by installing a high temperature hot water connection between the plants, and converting the buildings in between to utilize high temperature hot water. During an interim period, the high temperature hot water can be utilized in the North Plant to generate steam in parallel to the plant's natural gas combustion steam boilers. The North Plant can also utilize the natural gas combustion steam boilers to generate hot water and distribute it to the south. This allows the South Plant hot water boilers to be retired at the end of their economic life (approximately 2030).

When the biomass heating plant is constructed and connected to this hot water interconnect it can serve the entire campus load either by direct hot water connection or conversion of hot water to steam at the North Plant. The North Plant natural gas combustion steam boilers can be utilized as a backup for the entire campus heating system. Around 2040, the north campus steam and condensate piping will reach the end of its economic life and can be replaced with hot water (Phases 2 and 3). The North Plant natural gas combustion steam boilers can remain in use as their ability to convert steam generated into hot water has value as a backup to the biomass heating plant.

Around 2050, the remaining south campus hot water distribution will reach the end of its life and be replaced (Phase 4). Phase 5 is a catchall for centralization of heating systems. It is recommended these facilities be connected to the district heating system either at the end of the local heating system's economic life.

OPTION 02: GEOTHERMAL

Summarized from 2021 Climate Action Plan, credit Affiliated Engineers Inc. (AEI)

ABOUT GEOTHERMAL TECHNOLOGY

Geothermal energy is a type of renewable energy taken from the heat of the Earth's core. Lowtemperature geothermal technology involves circulating chilled water or another thermal fluid through closed-loop piping that is buried underground in either horizontal trenches or vertical bores. Stable underground temperatures enable the colder supply entering the loop to gain some heat before returning to the heat recovery chiller evaporators. This system can be used during the summer to reject heat from the conventional cooling system condensers back into the ground rather than using evaporative cooling towers or other heat rejection systems.

This looped piping acts as a heat exchanger where heat is transferred through the surface of the piping that is in contact with the earth. The capacity of the system is dependent on the specific heat and thermal conductivity of the circulating fluid, the thickness and thermal conductivity of the piping, the thermal conductivity of the backfill/grout, and the temperature difference and thermal conductivity of the surrounding earth (noting that the temperature difference to the surrounding earth varies seasonally and is influenced by the piping system effect). The total capacity of the system is a product of the specific capacity and the total surfa ce area of the piping. The horizontal trench method significantly limits the amount of surface area that is possible per land area, and is therefore only utilized for small buildings or residential systems. The vertical bore method is higher cost, but is necessary to consolidate larger systems into reasonably sized land areas.

NAU's large campus offers an opportunity to use horizonal trench geothermal energy through low temperature heating water conversion with central heat pumps. Before such a system can be implemented, NAU must first replace the campuswide central steam and high temperature heating water distribution with a low temperature heating water distribution. It may be advantageous to first convert steam within the North Plant to lowtemperature heating water and distribute it to the campus in a phased manner in combination with retiring and removing steam and high temperature heating water distribution.

Initially, this should focus on providing a source of heat to the southern part of campus from the North Plant, allowing retirement of the aged high temperature hot water boilers. This will allow the South Plant to be repurposed for the heat pump facility, which can eventually operate in parallel to the North Plant converters and replace the need for boiler operation at the North Plant.

IMPLEMENTATION

Phase 0 of the conversion replaces legacy south campus hot water piping (installed around 1970) and modifications necessary within south campus buildings to allow a year-round heating water supply temperature of 160°F (or less).

In Phase 1, low temperature hot water is distributed north from the South Plant, back feeding the steam distribution along the west side of north campus and converting those buildings to utilize 160°F hot water. Eventually, the hot water is back fed to the North Plant. At this point the steam-to-hot water converters can be installed and the south campus hot water boilers can be retired. Then, the South Plant will be repurposed as a heat pump plant.



OPTION 02: GEOTHERMAL (CONTINUED)

Phases 2 and 3 see the remainder of north campus steam and condensate distribution replaced with hot water distribution.

In Phase 4, the balance of the south campus hot water piping is replaced at the end of its economic life (approximately 2050).

Phase 5 is a catch-all for centralization of heating systems. It is recommended these facilities be connected to the district heating system either at the end of the local heating system's economic life or as desired to eliminate the small fraction of remaining local combustion of natural gas.

Phase 6 (which need not occur in sequence with the other phases) is installation of a low-temperature geothermal system and connection of it to the heat pump plant with north and south campus chilled water distribution systems interconnection. This enables combined heating and cooling when loads overlap. It allows the evaporators of the heat pumps to circulate closed loop cooling water through bores in the earth and extract low-grade heat that can be converted to low-temperature heating water.

It is estimated that one third of the heat required annually can be recovered from existing cooling processes and two thirds will need to be extracted from the geothermal heating and cooling system. An equivalent quantity of heat will be rejected into the geothermal heating and cooling system during summer to balance the array and eliminate the need to reject heat to the environment.

Pathway to Carbon Neutrality

A detailed plan is essential for NAU to meet its sustainability commitments. The roadmap below illustrates the steps that the university must complete to move toward carbon neutrality. A full gantt chart is located in the appendix.

	Comprehensive Sustainable Smart Campus Master Plan Phase 01															Pha	_												
Task		2023			2024				2025				2026				2027				2028				2029				
Hire Consultant				O(A	ct. 2023 pr. 202	4 - 4																							
Create Virtual Power Purchase Agreement								Aŗ	or. 20)24 -	Jul. 2	2026																	
Heating Distribution Decarbonization		Apr. 2024 - Mar. 2029																											
Plant Design												Au	g. 20	25 -	Mar.	2027													
Distribution Construction (Climate Action Plan Phases 1+2+4)																		0	ct. 20	026 -	Feb.	2029)						
Plant Construction																			Γ	Mar. 2	2026	- Ma	r. 20	29					
fficiency With Heating ecarbonization - Phase 01 Climate Action Plan Phases 1+2)																													
Efficiency With Heating Decarbonization - Phase 02 (Climate Action Plan Phase 3)														Feb. 2				026 - Apr. 2028											
Efficiency With Heating Decarbonization - Phase 03 (Climate Action Plan Phase 4)																				C)ct. 2	027 -	- Mai	r. 202	29				
Efficiency Parallel To Heating Decarbonization - Phase 01 (South Campus)								Apr.	2024	4 - Fe	eb. 20	026																	
Efficiency Parallel To Heating Decarbonization - Phase 02 (North Campus)															Feb.	2026	6 - Ja	ın. 20)28										
Efficiency Parallel To Heating Decarbonization - Phase 03 (Remote Buildings)																	July	y. 20:	26 - \$	Sep. 3	2028								

A smart campus leverages technology and data to enhance the experience and optimize operations.

The future campus is centered around creating outstanding student engagement and anticipates new perspectives on human interactions and experiences in both the physical and virtual world. NAU is planning for the possibilities of technological influences on our physical world, by thoughtfully considering a future defined by new interactions among humans and cyber sentient entities, redefining the sense of place, and projecting the impact of innovations of nanotechnology, autonomous vehicles, self-repairing infrastructure, augmented realities, and immersive virtual learning space to create a unique working and learning experiences.

Smart Campus Elements

Digital Twin: NAU is investigating the creation of a Digital Twin of the Flagstaff Mountain Campus and other campuses to effectively manage design, planning, and construction. This tool will enhance building performance, operations and predictive maintenance through simulations, optimize and measure realized energy efficiencies, improve space utilization, enhance safety, and capture facilities lifecycle insights to inform renovation and retrofitting priorities that address legacy deferred maintenance.

Paths of Travels: In alignment with the circulation recommendations in this plan, the university will implement technology that provides information and connected experiences along the Pedway. Smart sidewalks also measure the traffic flow of people and can provide critical planning information to campus safety programs and future campus master planning. NAU's Pedway and sidewalks are already used for small food delivery robots. In the future, autonomous delivery applications will include the movement of larger items, goods, and supplies, and pathways and roadways should be planned to ensure there is adequate space.

Smart Signage: Through touch-screen overlays or Bluetooth network connections, smart signage drives heightened engagement and communications with campus users and can help market events held in and around campus. In alignment with the Digital Signage recommendations and with existing mobile and digital sign technologies, NAU is investigating implementing Smart Signage, primarily along the Pedway and at community engagement sites.

Robots: Artificial intelligence, machine learning, robotics, nanotechnology, 3D printing, genetics, space sciences, and biotechnology are expected to dominate in the coming decades. At NAU, there are opportunities to explore robotic autonomous devices to conduct labor-intensive work like traffic control, mowing, window washing, snow plowing, etc. In addition, smart warehouses to centralize and optimize receiving on campus, and smart library storage.

Smart Learning Environments: Traditional classrooms are transforming with the adoption of virtual reality environments and through flexible learning environments that support active teaching and learning. Outside the classroom, learning evolves through the presence of experiential learning throughout the campus such as maker labs, virtual reality, multimedia studios, etc. It is important to note that faculty must be engaged in how to best leverage advanced learning technologies.

Smart Buildings: A smart building collects actionable data from user devices, sensors, systems, and services on the premises. Applying that data using artificial intelligence and machine learning makes the building both programmable and responsive to the needs of the users and the building manager. A smart building converges various building-wide systems - such as HVAC, lighting, alarms, conveyance, and security capabilities - into a managed network infrastructure.

Specifically, NAU can leverage an enterprise building information system to:

- 1. Optimize energy management and building operations.
- 2. Improve space management and design
- 3. Enhance occupant experience and productivity.
- 4. Enhance safety and promote healthy buildings.

NAU will integrate Smart Building standards and components into new construction and major renovation projects such as automated building scheduling, space utilization measurement through sensoring, predictive maintenance indicators, and real-time water and energy use data.

Internet of Things (IoT): Integrating everything under the management umbrella of campus facilities operations, operational technology (OT) in utilities, and internet-of-things (IoT) technologies can secure and enable "smart campus" efficiencies beyond utilities management. NAU's ITS IoT Lab has been working on the development of new ideas such as Collaboration with Facilities Services. As a pilot project, "Smart Restrooms" help NAU monitor the use of restrooms throughout the campus in order to deploy custodial resources where there is the most need. In addition, the expansion occupancy opportunities to measure utilization of space, and smart outdoor lighting.



PROPOSED INFORMATION TECHNOLOGY RECOMMENDATIONS

KEY POINTS:

- Continue to invest in network infrastructure. NAU will continue to strengthen its network through the replacement of cabling in alignment with tunnel and infrastructure work, upgrades and addition of wireless access points, and working with partners to fill in cell coverage.
- Amplify outdoor Wi-Fi. In alignment with the activation of the outdoors, specifically around the Pedway, primary open spaces, and parking lots, outdoor Wi-Fi points should be added to allow for connectivity within the outdoors seating and study areas.
- Prioritize building access management. NAU should continue to create consistency for smart egress campus-wide.
- Integrate experiential learning. In partnership with Academic Affairs and the Faculty Resource Center, NAU should continue to integrate experiential learning throughout the campus and statewide sites, including maker labs, virtual reality, production studios, and one button studios.
- Implement Smart Campus technology. Within the Master Plan recommendations, there are several opportunities to implement new technologies to campus circulation, gathering spaces, wayfinding, information sharing and collection, learning and working spaces, and building automation, management and materials.



Information Technology

Northern Arizona University's Information Technology (IT) infrastructure environment, or "digital utilities," consists of a variety of information, computing, and telecommunication systems designed to meet the needs of a complex higher education institution. The advancement of Information Technology is critical to support the vision and goals of NAU. The Plan seeks to further leverage technology and services to improve student experiences, and success, extend the campus' physical borders, move services into cyberspace, improve efficiencies, and contribute to sustainability. IT Services is in the process of developing its own strategic plan, due to release in January 2024. This plan will be deeply connected to the university's own strategic road map "Elevating Excellence." With foundations in technology, infrastructure, and services, this plan aims to provide higher quality services to the university and its surrounding community.

USER EXPERIENCE

Many campus users reported a lack of connectivity both within campus buildings and outdoors. Several members of the campus community stated their desire for stronger, better Internet services on campus. NAU ITS is in the process of upgrading approximately 3,000 legacy access points around campus to improve the wireless connectivity for faculty, staff, and students. These changes will make the wireless network more resilient, secure, and intelligent while providing faster speeds for users. The upgrades are both within the buildings, and out of doors - increasing the number of access points and improving connectivity while moving between buildings.

NETWORK INFRASTRUCTURE

NAU is continuously investing in its core network infrastructure.

- 1. Continuing to build out the campus-wide fiber optic backbone to increase resilience and create a robust BACnet network for facilities management.
- 2. Upgrading over wireless access points to Wi-Fi 6 capabilities, focusing on student spaces
- 3. Working to fill in cell coverage
- 4. Implementing network architecture that supports modern security best practices

NAU has several partnerships that are critical to connectivity across campuses:

- **Commercial 5G partnerships.** The university partners with several cell carriers, including Verizon, AT&T, and T-Mobile, and is putting in a significant amount of fiber.
- Citizens Broadband Radio Service (CBRS) wireless infrastructure. NAU is currently deploying CBRS, private LTE, in alignment with state initiatives, to create equitable access in alignment with our 2025 Elevating Excellence strategic plan. It also supports research such as the a NATO Communications and Information Agency (NCIA) grant, located at Hat Ranch.
- LoraWan. There are currently seven (7) sites on campus for providing connectivity to IoT devices in support of facilities management and other Smart campus applications.

Community partners: The university is continuously working to find opportunities for shared paths, which impacts diversity and redundancy. This occurs with several community and regional partners, including the City of Flagstaff, Coconino County, Coconino Community College, and Sun Corridor.

NAU currently has several electronic safety and security initiatives:

- Power over Ethernet (PoE) cameras. NAU has created a standard for camera systems across the Flagstaff Mountain Campus, with a collaboration between Public Safety and IT. The cameras are connected directly to NAU's network.
- Prioritize smart ingress and egress access controls. NAU is working to create consistency for smart egress campus-wide. In addition to the ongoing work to install smart access controls systems into existing buildings, all major renovations and new construction projects will include this system. Lenel is the continuing campus standard for smart ingress and egress access controls for exterior and interior doors.
- **Digital credentials.** Using cellphones for credentialing. The success of this initiative is dependent on the dependent upon the ubiquitous implementation of door access and other IoT technology standards.

Connectivity across the state. In the state-wide locations, the goal is to deliver the NAU network and experience to the 20+ sites. NAU is working to remove legacy circuits and provide a more universal on-campus experience for all sites. As NAU determines long-term plans for statewide locations, IT should consider how to best expand access to these locations.

Digital signage. In alignment with the Master Plan's recommendations to create consistent branding across all state-wide sites, and to add exterior digital signage on the Flagstaff Mountain Campus at key campus gateways, leveraging established institutional standards for digital signage.

COMPUTER CENTER INFRASTRUCTURE

Data Center: Currently, there are three Data Center locations - North, which is also the campus' disaster center; South, within the basement of Du Bois Union; and Central within the ITS building. Required server space is trending down in size as technologies improve and as cloud services are more prevalent. Geographic separation between the North node and the Central node is critical. They are currently a 1/4 mile apart and within the same flood plane. NAU is exploring a secondary node located in a data center in Phoenix or the cloud.

Hyper Converged Infrastructure: As a stepping stone to migrating infrastructure to the cloud, the Hyper Converged Infrastructure (HCI) is a highly virtualized environment where centralized file sharing and back up information is stored. The university should continue to upgrade and improve performance and capacity for on-premise smart campus applications while evaluating workloads appropriate to transition to the cloud.

High Performance Computing: Monsoon is a valuable asset to the research community and should be leveraged to model and analyze smart-campus data and foster research in sustainability and related sciences. Cluster resources are generally free to faculty, staff, and students (with a sponsor). Initially acquired as part of the development of the campus-wide Informatics and Computing Program, the HPC cluster can be utilized to address complex research questions across many disciplines, including biology, climate science, behavioral sciences, humanities, education, genetics, and astronomy.

CLOUD STRATEGY

Improving the resiliency and performance of internet access provides the opportunity to explore additional cloud applications in support of a sustainable smart campus. The goals of NAU's cloud strategy are to reduce the technical debt of on-premises systems and reduce workloads on IT technical staff while creating secure access to state-ofthe-art applications. Migration to the cloud also serves to reduce NAU's carbon footprint, through the reduction of power consumption at the data center - the single highest consumer of energy. Today, NAU has dozens of critical applications in the cloud and is continuing to migrate systems to the cloud when prudent. It is important that the university continue to leverage cloud technology capabilities to advance the objectives of this Sustainable Smart Campus Master Plan.



Creating a Smart Campus

Summarized from Considering The Smart Campus, a working document by Dr. Steven Burrell, VP IT and Chief Information Officer.

With the disruption to higher education over the past several years, and with NAU's new strategic vision in place, there is no better time to consider the campus of the future and ways of differentiating NAU. A key requirement to improving the student journey through higher education is to have the technological infrastructure and capabilities that can support 24/7 access to personalized, digital experiences both inside and outside of the classroom. Embedding technology in every aspect of campus life to meet students' expectations and enrich their campus experience is one piece of a larger digital transformation strategy that NAU must undertake to increase student success, research prowess, and institutional prestige.

SMART CAMPUS FRAMEWORK

Microsoft's Smart Campus research outlines a framework to implement Smart Campus capabilities. The most achievable are those at the bottom of the framework, or facilities-centric capabilities – optimizing and maintaining buildings more effectively. These elements tend to be easier to measure, and most organizations tend to start with these. As organizations obtain more data and monitor their facilities, they move into the middle section, focusing efforts on safety and total usage of resources. At the top of the framework, it's about people – enabling them to be more efficient, effective, and productive. These elements are more difficult to measure.



DIGITAL TWINS / PLANNING TOOLS

It is no longer good enough to tell someone how an individual asset performs within a building. Asset owners want to know how the environment or ecosystem is functioning. A connected ecosystem brings together all the disparate technologies into a single environment.

Digital twins enable the ability to fuse the physical world that is happening right now into a digital one to measure performance and run simulations on the environments. It is the construct of how you enrich the physical world together – the spaces, the people, the actions that take place in a single environment. A recent study has determined that up to 60% of all assets will be digital twin enabled.

An exploration of digital twins was completed as part of this Master Plan, however, the direction at the time was to create a digital twin "lite" utilizing NAU's GIS data and building a scenario planning tool on top of this data. Current challenges that need to be solved for NAU to implement a digital twin of its campus and assets are:

- Siloed systems. Currently there are several applications and systems across the university that create and store data and information. Because these systems are disconnected from one another, it is difficult to analyze the complexity of the data across all systems. Coordination of applications and systems should be completed prior to the creation of a digital twin.
- **2. Reactive data.** Currently, NAU is in the process of automating processes across campus. As automation continues, it will be important to ensure the data can be captured real-time within the digital twin environment.
- **3. Centralization of data.** A centralized data warehouse should be in place prior to the creation of a digital twin.



NAU PLANNING TOOL

NAU Smart Campus Planner

Smart Campus Retreat

In July of 2022, participants from NAU and the university's technology partners gathered for a full-day retreat to explore inspiring ideas, opportunities, aspirations, critical questions, and potential solutions for creating a smart campus plan for NAU. The retreat's purpose wasn't to solve the problems but to discover what is possible. The following themes were covered at the Retreat and are summarized below.

Infrastructure Evolution and Climate Responsiveness

- **Understanding our carbon footprint.** What is my individual, departmental carbon footprint? This increases accountability and can be a catalyst for action.
- Education and awareness. Communicating impact to the larger community Improve, measure, report, and verify on-campus resource usage.
- Scalability, elasticity, and reliability of infrastructure. Scale as the number of users and devices increase.
- Transportation infrastructure and climatefriendly transportation.
- How do we pay for this?

A Connected Campus Experience with Smart Buildings, Data, and Automation

- Dynamic parking aligned with schedules.
- Dashboards monitor everything and provide access to everyone.
- Using data to improve healthy buildings and air.
- Identified redundancies.
- Do we need "tech-free" spaces for disconnecting?

Effective Administration, Business Practices, and Robotics

- Just in time. Using occupancy and utilization information to provide things (transit, deliveries, services, etc.) Where do the drones and robots go?
- **Staffing.** Do we have the staff to do this? Are we planning on things we don't have the staff to do?
- **Ease of use.** There are a lot of apps. How are we focusing on a better and more seamless experience for all campus users?
- **Create and show value.** What is in it for me? If I'm opting to share data, what is coming back to be? How are we planning for reinvestment of this benefit that NAU is getting?

Teaching, Learning, Research and its Intersection with Technology

- Access and equity. How does everybody experience these tools? (on-campus, off-campus, virtual learners, rural areas, partners, out of state, etc.)
- **AR/VR.** How can everyone access these digital spaces as this is being distributed across the curriculum?
- Who is an instructor? Community partners, alums, students, etc. How do these initiatives align with the goals of diversifying faculty and staff and honoring and embracing indigenous wisdom and voices?
- **The Data.** There is going to be and already is a lot of data. Is the data being analyzed to see patterns that help connect rather than reinforce existing silos?



Smart Campus Recommendations

The consideration of a future campus is centered around creating outstanding student engagement and anticipates new perspectives on human interactions and experiences in both the physical and virtual world. NAU is considering the possibilities of technological influences on our physical world, by thoughtfully considering a future defined by new interactions among humans and cyber sentient entities, redefining the sense of place, and projecting the impact of innovations of nanotechnology, autonomous vehicles, self-repairing infrastructure, augmented realities, and immersive virtual learning spaces to create unique working and learning experiences.

PATHS OF TRAVEL

Implement smart technology along the Pedway. In alignment with the Pedway improvements outlined in the Open Space and Landscape Chapter, the Pedway improvement projects should implement technology that provides information and connected experiences. For example, smart benches can provide a Wi-Fi hotspot, digital signage, and charging ports, among other features. Smart lamp posts and wayfinding applications can utilize smartphones and augmented reality to provide the campus community and visitors with accurate and timely information about available services and their location on campus. They can also facilitate virtual engagements, appointment making, and information sharing that enriches the campus experience.

Measure utilization of campus pathways. Smart sidewalks also measure the traffic flow of people and can provide critical planning information to campus safety programs and future campus master planning.

Ensure paths are ready for robots. NAU's Pedway and sidewalks are already used for small food delivery robots. In the future, autonomous delivery applications will include the movement of larger items, goods, and supplies. Therefore, pathways and roadways should be planned to ensure there is adequate space. Personal assistive robots provide support services to disabled individuals or provide "errand" services for individuals, the co-existence of humans and autonomous devices must be considered for pathways for robotic devices at NAU.

SMART LIGHTING

NAU has already begun to plan for smart lighting initiatives across the campus:

- Adaptive LED and induction luminaires with occupancy sensors in parking structures and lots.
- Adaptive post-tops near residence halls.
- Adaptive corridor luminaires and open digital communications protocols for lighting systems.
- Wireless lighting controls with occupancy sensors, daylight sensors, personal controls, and LED task lights inside buildings.
- Adaptive stairwell lighting, as well as daylighting and occupancy sensors such as in the book stacks in libraries.
- Tubular daylighting devices and occupancy controls.
- Hybrid bathroom luminaires that combine LED night-lights with conventional lamps and occupancy sensors in residence halls.
- Reflective surfaces and photosensitive controls that maximize daylight and reduce the need for electric light in laboratories.

SMART SIGNAGE

Through touch-screen overlays or Bluetooth network connections, smart signage drives heightened engagement and communications with campus users and can help market events held in and around campus. The technology can yield significant analytics about kiosk visitors that can inform communications and marketing strategies. In alignment with the digital signage recommendations and with existing mobile and digital sign technologies, NAU will pilot Smart Signage, primarily along the Pedway and at community engagement sites.

AUTONOMOUS VEHICLES

The transportation sector is experiencing rapid changes in technology, driven by three major trends: electrification, automation, and servitization.

Electrify the university's fleet. In alignment with NAU's carbon commitment, the campus fleet will become electrified.

Plan for less parking. Although this Plan identifies no loss nor gain in parking, as autonomous vehicles become more prevalent on the campus, the demand for parking will decrease. Driverless vehicles will be able to drop users at their destination and return to pick them up upon their request. As the university plans and designs new parking structures, flat floors that can be converted to inhabited space should be investigated.

Prepare campus roadways. Driverless cars require dramatic changes to streetscape, including new traffic management strategies and an evaluation of curb and parking spaces. Autonomous vehicles require less space on the road, freeing up dedicated lanes for robots, bikes, and buses.

Reduce vehicles on campus. Mobility-as-a-service (Maas) is mobility on demand that promotes access to mobility rather than ownership. Maas operators offer customers multiple mobility options (borrow a car, rent an e-scooter, ride public transportation) through a single interface. Campuses located adjacent to cities, like NAU, are perfect opportunities to adopt Maas.

ROBOTS

Artificial Intelligence, machine learning, robotics, nanotechnology, 3D printing, genetics, space sciences, and biotechnology are expected to dominate in the coming decades. At NAU, there are opportunities to explore robotic autonomous devices to conduct labor-intensive work like traffic control, mowing, window washing, snow plowing, etc. As educational programs will shift toward innovation, academic settings will require the adoption of robots to collaborate with both instructors and students.

Explore smart warehouse technology within the Facilities Services renovation and addition.

As part of the Facilities Services renovation and addition, the exploration of smart technology should be included in the pre-design of the project. NAU manages a large amount of surplus items, mechanical parts, construction materials, etc. NAU could benefit from the same concepts employed by industrial warehouses, to manage and control inventories more effectively. Benefits of smart warehousing include:

- Improved labor and space efficiency and effectiveness.
- Centralized receiving, reduced campus traffic, and faster turnaround times.
- Increased security and lower operational costs.
- Greater accuracy in warehouse operations.
- Improved accuracy of managing assets and inventory.

When paired with autonomous delivery vehicles, just-in-time deliveries reduce the space required to store products in buildings and delivery traffic on campus could be reduced significantly.
Smart library and archival storage. Some

universities have been using robotics to warehouse library and archive materials that are securely stored while optimizing floor space for other student learning experiences and services. The Cline Library renovation and addition project should explore opportunities for off-site storage and smart warehousing of the collection and archiving of materials.

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universities have been using robotics to warehouse library and archive materials that are securely stored while optimizing floor space for other student learning experiences and services. The Cline Library renovation and addition project should explore opportunities for off-site storage and smart warehousing of the collection and archiving of materials.

LEARNING ENVIRONMENTS

Classrooms across campus are centralized and standardized in terms of technology and support including standard interfaces, projection, cameras, streaming, and lecture-capture for hybrid instruction. Most of NAU's nearly 400 classrooms employ remote management capabilities using Crestron Fusion cloud technology. Nearly all of these facilities provide NAU Flex Plus two-way remote interactive participation technology.

Flexible learning environments. The university has been investing in upgrading the learning environment post-pandemic to support new ways of teaching and learning. Mobile hybrid stations turn any space into a hybrid learning environment or meeting and active learning set ups are becoming more prevalent across campus.

Integrate experiential learning. In partnership with Academic Affairs and the Faculty Resource Center, NAU should continue to integrate experiential learning throughout the campus and statewide sites, including maker labs, virtual reality, production studios, and one button studios.

Educate faculty. It is important to note that faculty must be trained in how to best use these active learning set-ups, and the university should provide support for faculty to transition traditional curriculum to project or problem based curriculum which is more appropriate for active learning spaces.

Foster interdisciplinary collaboration.

Collaboration stations foster active and collaborative learning experiences that extend learning outside of the formal classroom and lab time. NAU is developing its third generation of collaboration stations. Collaboration stations provide convenient areas for the campus community to gather in small groups and exchange information.

Measure utilization. Use occupancy sensors to measure utilization of classrooms and class labs, and integrate power-down abilities for classrooms not in use to save energy and costs.

SMART BUILDINGS

A smart building uses its intelligence to collect actionable data from user devices, sensors, systems, and services on the premises. Applying that data using artificial intelligence and machine learning makes the building both programmable and responsive to the needs of the users and the building manager. A smart building converges various building-wide systems-such as HVAC, lighting, alarms, and security into a managed network infrastructure.

Microsoft's identified opportunities of smart buildings:

- 1. Optimize energy management and building operations.
- 2. Improve space management and design.
- 3. Enhance occupant experience and productivity.
- 4. Safe and healthy buildings.

Integrate Smart Building Elements Into New Construction and Major Renovation Projects.

As the Master Plan is implemented over the next decade, NAU should explore adding smart building elements into major capital projects:

- Automated building scheduling.
- Measure space utilization for instructional spaces and workspaces through sensors.
- Connect lighting, shading, and mechanical systems to enable the automatic adjustment of temperature and lighting based on occupancy.
- Smart building materials including smart paint, advanced insulating materials, etc.
- Predictive maintenance technology to reduce service calls.
- Measure water and energy use in real time using dashboards.

Integrate Intelligent Building Management Into New Construction and Major Renovation

Projects. Smart or intelligent building management enables a building to function efficiently through automation. Improvements result in higher performing buildings, often energy-related. Smart systems yield cost savings at substantial levels and impact NAU's sustainability goals.



Space & Program Needs



SPACE AND PROGRAM NEEDS

This appendix chapter will cover the existing space use, analysis, and general recommendations. It will also discuss the previous master plans and space studies.

CLASSROOM UTILIZATION ANALYSIS

Using the Fall 2022 course schedule, classrooms were analyzed using two metrics: total hours a room is scheduled with courses, and the average occupancy of seats in the room. The below chart includes a circle for every classroom on campus scaled in size based on how many courses occur in the room. The 2019 Space study did a similar comparison and included a target of 65% occupancy and 23.5 schedule room hours (highlighted in gray on the chart). This Master Plan increases the target room hours for classrooms to 30 hours a week and the target seat fill occupancy to 80% which is more aligned with NAU's desire to optimize space.

The 2022 data revealed that classrooms across campus already have a fairly high occupancy with the majority averaging above 80%. This target aligns with the current course schedule and supports the classroom policy recommendations such as verification that historic enrollment of rooms aligns with the size of the spaces. The increase in target hours supports NAU's goal to increase utilization across campus. There are sufficient available room hours to support projects identified in the Plan that will impact academic spaces.



The goal of an even distribution of course offerings will greatly increase space utilization at NAU. There is a Tuesday/Thursday overload of classroom use and parking lots as a consequence of courses being scheduled preferentially on these two days.

A strategy discussed as part of this process is to increase instructional hours and teaching lab hours by expanding the scheduling envelope to include Fridays, weekends, and evenings. The current data shows very few classrooms are utilized Fridays or weekday late afternoons, or early evenings. While this was discussed, it must be important to note that students typically do not select Friday/weekend courses, and student success and completion can be compromised. A student-centered lens should be applied to the decision-making process as NAU weighs options around classroom scheduling.





Class Lab Utilization Map: The utilization map represents the combined average room hours by building. Many buildings with higher utilization are located on the north end of campus in high science buildings.

Academic Space Discussions

The square footage review of space needs was developed as part of the 2019 Space Study. The Plan further progressed this effort by working with each college to discuss goals each college has for future programs, and how their current facilities supports or limits that work. A survey to obtain feedback was also completed, followed by detailed focus groups to review each college's ten year outlook. Several consistent future goal themes were identified throughout the focus groups including:

Where possible, consolidate colleges that are spread across multiple buildings on campus to facilitate in-person interactions and make interdisciplinary work common in the day-to-day.

Develop spaces that create inner-college community dialogue, such as academic living rooms, adaptable meeting space, and collaborative breakout rooms.

Colleges desire to develop partnerships with Flagstaff and global NAU communities.

Redesign teaching spaces to support a more active learning environment and provide training or incentives to guide that transition.

COLLEGE OF ARTS AND LETTERS

Update Instructional Spaces. Overall, instructional space within the College of Arts and Letters (CAL) is outdated, requiring updated lighting (with dimmers), window coverings, furniture, and technology. Within classrooms, the college identified the desire to complete more active learning within their instructional space. Current classrooms and studio spaces do not have a large enough square foot per station for breakout groups or problembased learning that are common in the college's coursework. As academic buildings are renovated overtime, specific attention should be paid to updating classrooms.

Address small-scale needs. Specific space solutions that can occur in the short-term are:

 Update Art History instructional space by ensuring the spaces have approximately 40 seats, blackout curtains, microphones, dimmers, high-definition projection, and custom lighting controls to best project content onto a screen, and allow for student note-taking.

- Update the Black Box theater to be accessible which will allow for more community partnership opportunities.
- Relocate Beasley Gallery to be more accessible to the community.
- Locate dedicated space for the Martin Springer Institute. The current space does not allow for growth or easy access for the community. Potential locations are within the Cline Library addition, or with a communityengagement building along the campus perimeter.
- There is a growing program for media technology needs including 3D printing and high resolution imaging that is growing but will need space and further equipment support.
- Ardrey Auditorium needs upkeep, specifically within the orchestra pit.

Relocate Interior Design. There have been major changes to what types of spaces fine arts and design needs over time and they have outgrown their current spaces. Facility layouts no longer serve fine arts. The growing Interior Design program needs larger studio spaces to best serve students. Today the studio spaces are cramped and inadequate. The master plan recommends that Interior Design relocate into a new CAL-focused building in Phase 02.

Build Interdisciplinary Community. Because the college is spread across several buildings, it is important to build community spaces throughout the college for students and faculty to interact. Two recommendations will allow for expanded collaboration - (1) the addition of faculty studio space, so their work can be completed on campus instead of at home, providing more face-time with students, and (2) as renovations occur in CAL-occupied building, spaces and opportunities for interdisciplinary and student/faculty discussion should be created within ground floor "academic living rooms."

Invite the Community in. Extend services to benefit greater Flagstaff community. Use galleries and performance space to interact with Flagstaff. In addition, CAL is working to develop a system to support the rental of arts and letters spaces to outside entities creating a revenue stream. For example, Ashurst Auditorium has become a general use facility but could be set up to become an outside use facility with some work and staffing support.

Split Fine and Performing Arts. The Performing and Fine Arts building is increasingly becoming more cramped, and fine arts are becoming impacted. In the long-term, the entirety of Fine Arts could relocate out of the Performing and Fine Arts Center to allow for the right-sizing of the fine arts, and the consolidation of fine arts, design, and museums, and the expansion of the performing arts.



Arts and Letters Buildings

COLLEGE OF EDUCATION

Currently located in the Eastburn Education Center and the Institute of Human Development, the College of Education (COE) has stated several needs to update their facilities:

Expand Space for Counseling. The counseling program has seen growth specifically in the need for clinic and research space. This portion of the college's work is community facing and the college would like to establish additional meeting spaces that allow for community participation.

Additional Collaborative Student Space. The pedagogy drives group work within the classroom, therefore additional group study and collaboration must be present within the academic buildings.

Plan for Early Childhood Development Center.

Although separate organizationally from the College of Education, space for an Early Childhood Development Center (ECDC) is also necessary to meet the growing difficulties in finding childcare resources for the NAU and Flagstaff community. Today, the newly formed ECDC is located within a Flagstaff Unified School District building has a short-term lease, however, NAU is currently in discussions and as identified several locations to relocate the program permanently.



College of Education Buildings

COLLEGE OF HEALTH AND HUMAN SERVICES

The College of Health and Human Services (CHHS) is primarily located in the Health Professions Building and Nursing Building with functions also located in SAS and a new Simulation Center in the Du Bois Union.

Create a Health Complex. On the Flagstaff campus, the current buildings do not represent what the college stands for in innovative learning and health care goals. The Health Professions building and Nursing building are both outdated and do not functionally operate to best serve students. For example, elevators are not large enough for cadavers in order to transfer them to the labs and WiFi issues are consistently occurring in the buildings which constricts the college in being able to provide hybrid courses. The college would like to focus on facilities that represent their goals of advanced healthcare and innovative learning with a functional stateof-the-art medical facility. The master plan recommends a new replacement building for Nursing that is connected to a renovated Health Professions building, creating a Health Complex. NAU Health was primarily at the end of this planning effort so more study is needed surrounding that initiative and its impacts on the College.

State-wide Presence. CHHS has a large programmatic footprint across the state of Arizona. The college has seen a lot of growth in their state-wide programs and has accommodated this growth by expanding into leased spaces or partnership agreements. The Occupational Therapy program is expanding to a weekend cohort, the Physical Therapy program is expanding within the Phoenix Biosciences Core (PBC), Nursing is expanding in Tucson (Pima Community College), Yuma, and Prescott, and the Physicians Assistant program is expanding in Tucson and Yuma. These programs expanding throughout the state forces the college to use space they do not oversee or control, which results in uncertainty of scheduling and long-term use of the space. As the university seeks opportunities to expand their physical presence across the state, CHHS programs would benefit from being in NAU-owned spaces.



College of Health and Human Services Buildings

COLLEGE OF ENVIRONMENT, FORESTRY, AND NATURAL SCIENCES

The College of Environment, Forestry, and Natural Science (CEFNS) is currently located in multiple buildings across campus.

Update Instructional Spaces. The college feels limited by instructional setup where options for active learning classrooms are limited. The college is looking for academic space where the design does not limit the changing learning and work approaches of the future. Throughout the college there are several areas that are not highly utilized including the Science Annex and specific teaching laboratories that were designed for a previous way of teaching and learning and have been outgrown in their design leading to a lack of use.

Consolidate Earth and Sustainability. A major issue within CEFNS is the dispersed programs, specifically within the School of Earth and Sustainability (SES) which is located across eleven (11) buildings today. This dispersement results in redundancies, inefficiencies, and a lack of community building within the school. In addition, SES has seen significant growth and desire from students to expand but spaces do not necessarily support this ideal learning experience. The Plan recommends a consolidation of the school into a new Science and Research building in Phase 01.

Purpose-Built Research Space. There are several research initiatives occurring within aging facilities that need to be addressed to provide a setting that is aligned with the caliber of NAU's research. Buildings 19 and 21 have been identified as poor condition buildings, and there are several research functions within those buildings that do not have adequate space. The Plan recommends the relocation of specialized science research across all disciplines into a new Science and Research building in Phase 01.

Make Space for Hands-on Learning. Many existing laboratories and student spaces do not represent a collaborative or modern work environment that a student would see in the real world. The college is interested in spaces that are academically-minded and supportive of innovative student learning. Teaching laboratories should be designed to mimic the future workplaces. Makerspace rooms with current technology should be planned to encourage creativity and innovation within spaces that are modern and align with student's future workplace expectations. A specific program need is a lab and teaching space for work in GIS, LiDar, Informatics, and Geography.

Embrace community-driven programs. Much of CEFNS's work extends into the community, and with that work comes the opportunity for students and faculty to be in the community, but also invite the community onto campus. Where community-focused programs exist, accessible parking and signage to create a comfortable and intuitive visitor experience is critical. A current request of the College is to relocate Collections into the Science Annex to allow for more public access into the space.



The College of Social and Behavioral Sciences (SBS) is NAU's largest college, and every student at NAU must take a course from SBS and those courses are an opportunity to bring students to the college, share what their college is about and represent the brand of NAU.

Address poor condition space. The SBS West and the Raul H. Castro ("Castro") buildings are in poor condition, outdated and do not functionally operate to best serve students. The Plan recommends a full demolition of the SBS West building, and a full renovation of Castro.

Consolidate and build community. SBS is currently dispersed throughout campus which makes the inner-college community difficult to establish. Community building is necessary especially for newer and younger faculty. These faculty have desire to interact with colleagues and collaborate in their work.

The college would like to consolidate and reevaluate what units should be co-located. A portion of this work is tied to recommendations of the Plan to renovate Castro and replace SBS West into a new building. These projects provide the ability to move disparate programs form IHD and SAS into the new structures, re-uniting them with a majority of the college. It is important to note that the School of Communication will remain within its North Campus facility.

Even though some programs and courses are online, there is often still a desire for students to interact on campus and create their own community in person. This trend for group space will remain as the learning model continues to shift over time with lectures online with on campus/in person group work.



College of Environment, Forestry, and Natural Sciences Buildings

SBS as entry. Today, there are interdisciplinary programs and faculty research that are not showcased to the community. With reimagined facilities, there is an opportunity to showcase current and expand faculty collaborations around research/teaching as well as the community space/ collaboration. The location of SBS as an entry point to the community could be a useful way to both showcase and engage community partnerships.

Expand space for growing programs. The Social Work program is new over the last few years and is growing. The program now needs additional space for students to get together and collaborate, study, interact at a deeper level. In addition, Psychological Sciences needs expanded laboratory space.

Modernize SBS work spaces. SBS would like to embrace the hybrid workplace seen in more corporate environments, but also create a deep community in person for staff and faculty to interact. These spaces can accommodate hybrid faculty, adjunct faculty, graduate students, student workers and faculty who are working outside of their private office. In addition, the college has many departments that have a wider community reach in Flagstaff, but a lack of flexible space to support visitors. Establishing flexible hoteling desks and modern meeting space is necessary to continue growing the college's community partnership work.

Collection Space. Anthropology has many archives throughout campus, and currently these spaces struggle to meet compliance standards because the resource needed to take care of these collections do not exist. The Plan recommends a renovated space for collections that is centralized outside of the colleges and allow for the collections to be cared for and displayed to the community-at-large. In addition, the university should be considering a decision on how collections should be acquired, so that the university is taking on what it can support.



College of Social and Behavioral Sciences Buildings

COLLEGE OF ENGINEERING, INFORMATICS, AND APPLIED SCIENCES

The College of Engineering, Informatics, and Applied Science (CEIAS) is current located across seven buildings. CEIAS is working to prepare for lesstraditional students in the future and expanding their presence throughout the state.

Consolidation and modernization. The College of Engineering has the potential to consolidate underutilized and outdated lab space, while creating new student space and modern laboratories that drive collaboration, innovation, and research. A prime example of an opportunity is within existing space is the ROTC building. The Plan recommends an addition for CEIAS within phase 03. This expansion space would aid in the ability to move the program out of the Engineer Research Building (located within an Operations Complex - Emerald Village) to a more central location to the rest of the CEIAS programs. In addition, creating space for academic advising is critical to student success, and should be located centrally to the majority of CEIAS students on south campus.

Instructional + Technology. As CEIAS programs continue to innovate in its teaching and research, instructional spaces and technology infrastructure must be in place to prepare students for jobs of the future. This includes introducing new technologies to the campus such as metaverse and quantum computing. Monsoon, the current high-performance computer for interdisciplinary research needs should be expanded to meet the growing need for computing-based research.

Encourage interdisciplinary work. Students and faculty/staff in the college would benefit from increased interdisciplinary collaboration space, particularly around research teams, as well as traditional lab types. In addition, a new gaming program creates interdisciplinary work between CAL and CEIAS. In the future, more programs like this are likely, and shared space should be available to house innovative and interdisciplinary programs.



College of Engineering, Informatics, and Applied Sciences Buildings

W.A. FRANKE COLLEGE OF BUSINESS

The College of Business is currently located in both the Business building and buildings of the Hospitality Complex. The college recently split into two departments and there is still an extensive process trying to designate what the future is for both of those departments and how it ties in to the future of the College of Business as a whole. Much of the student-focused spaces in the college should be reevaluated to ensure they meet student's needs, especially as space may be renovated to accommodate organizational and program changes.

Provide more study space. The college's primary space needs include flexible study spaces for graduate and undergraduate students that facilitate both heads-down and collaborative based work. The addition of a graduate lounge would give students a touch down space between courses. Group study spaces is a large need for the college. Though the library currently serves many study needs, there is a desire for students to have designated social, relaxation, and study spaces within the college's most used or active buildings.

Preparing for new programming. A new Data and Business Analytics program will require an additional need for space in the college such as a large (~72 seats) computer laboratory for teaching and open laboratory work. In addition, graduate programs are expecting to grow and may require additional space in the future.

HONORS COLLEGE

The current facility for the Honors College is well designed, but there is limited room for future growth, and a lack of 24-hour spaces for students.

The opportunity to collaborate with the Cline Library renovation to develop more diverse study spaces would benefit all of NAU, including students from the college.



W.A. Frank College of Business Buildings

Transitioning from a Culture of Ownership to a Culture of Sharing

A successfully planned interdisciplinary space creates a vibrant environment where students and faculty gather to generate knowledge, increasing engagement and productivity.

Understanding the culture and behavior in how space management has been engrained into higher education is critical. The ownership of space has been embedded into policy and operations for decades, and now there is a great desire to flip this. A key component of NAU's academic mission is to provide opportunities for interdisciplinary learning and connecting programs. However, when all space is "owned" there can be a perceived lack of space for these programs to use. As a subsequent planning effort, NAU will work to identify the right policies, metrics, and guidelines to build a space culture that connects programs and embraces collaboration.

THE KEY TO SUCCESS IS TWO-FOLD:

Educate Users on the Positives of Collaborative Environments

Collaborative environments provide the necessary flexibility to adapt to rapidly changing needs and enable workers and students to control their space and create what they need. They also increase opportunities for informal, spur of the moment collaboration and information sharing, resulting in new ideas that cross boundaries and link together previously independent perspectives. Collaboration encourages critical thinking, sharing of methodologies, and creativity, but every discipline or college has different traditions and ways of working. NAU must plan for spaces that meet these diverse needs and can adapt to ensure people of multiple backgrounds feel comfortable and welcome in shared spaces.

Enact Administrative Policies In Place:

In order to align the university's policies and standards with this focus, there must be an institutional shift to focus on long-term adaptable design, resulting in the highest and best use of the space. NAU will review current procedures that impact space and update policies for the best most efficient use of space. Development of flexible, adaptive spaces that eveolve with diverse users will improve space utilization at NAU.

Building Manager Program

Building managers serve a vital role at NAU, overseeing the various buildings and connecting building occupants to maintenance and building support. As part of the Master Planning process, engagement was conducted to better understand the building manager role and how individuals assigned to a building are serving NAU. Engagement included an online survey to all building managers as well as two focus groups, the first to better understand the intentions behind the program's development and the second to hear from building managers directly on what the experience has been for those in the position.

The Building Manager position at NAU is primarily selected out of necessity and in addition to an individual's active position duties. In some cases, the building manager is a standing position defined as part of their official job description. However, for most building managers, the role is an add-on to their workload and assigned out of necessity due to an individual's location in a building or primary position work. The inconsistency in how this position is established and compensated leads to a variance in the types of work the individual does and their job performance. There is also a lack of oversight, leadership and accountability that leads to the lack of clarity in the Building Manager position.

The Building Manager's position duties vary with the primary obligation being work order submittal and building access control. They often serve as the point of contact for maintenance and the gobetween of the building occupants, facility services, and the faculty. The focus group with building managers highlighted the difficulty in knowing what the role's expectations are and the pressures associated with keeping a building running. The majority of the focus group centered around the lack of a clear definition of the role's responsibilities and the difficulty in finding information or solutions when building issues arise.

Building Hours: One task assigned to many building managers is access control. Many building managers are on site during standard working hours though their building may be open earlier or later in the day. This limits their ability to be present after hours and after-hour contacts are not always established. The added role of building access makes it difficult to assign the role to an individual that practices a hybrid work schedule and often leads to assigning the role to someone who is always on site regardless of whether their primary position intersects with the various units in the building. The common building hours of 8 a.m. to 8 p.m. also make it impractical for a building manager to be on site at all times. True Blue Fridays will also affect building hours during the summer months.

Building Manager Support and Training: A

manual for building managers has been developed that primarily focuses on how to submit work orders, building construction and maintenance, and the role of custodial staff. While this manual provides for the more logistical steps around the role it should be extended to set clear guidelines and define the responsibilities of the role. Training for building managers must also support their role in implementing and communicating environmental programs and reporting any related issues. Among others, these programs include conservation and efficiency goals of building energy use, waste streams and occupant comfort as well as proper use of windows and blinds to manage thermal loads.

Processes: There are several processes that building managers perform or work within that need review for effectiveness, including work order requests, event approvals, and card door access.

BUILDING MANAGER SURVEY RESPONSES

The overarching issue is that no specific program/expectation exists for building managers. It is different from building to building. It's awkward because there are folks within academic departments who are assigned the building manager title - but at the same time, they are told by facilities that they "don't own" their building or their space. So it's hard to encourage someone to feel a sense of ownership over a building.

A building manager should have access to all rooms and areas of the building they manage. If the reason they won't provide keys to those areas is really for "safety" or "liability" excuses, then give us training for those secure areas.

I would like the building manager program to be inclusive of statewide campuses.

Something helpful would be a clear guide on who to contact for what needs. Most things go directly to facilities, but there are times where the roof is leaking and I need someone more urgent. It would be nice to know which sub departments can be contacted when.

Building Managers often feel isolated and beset with a relentless list of faculty/ administrator complaints and requests. Structure in process is often made without full information.

The building manager meeting addresses a lot of issues which is helpful and appreciated but could be expanded.

Placing building manger with others who have similar work area/building spaces would be helpful. I could go to them with issues that they may have experience with or who can trouble shoot with me about how & who can fix the issue.

A more user-friendly system to submit, inquire and follow-up of work orders is needed.

It would be helpful if finished work orders include a statement of what was actually done, rather than only that it WAS done. Example: When we report a heat pump is not working, we get a report that the job is "complete," but not what was done. Did they replace a fan? Clear out the pipes? Replace a transformer? It would be helpful to know without having to ask.

BUILDING MANAGER INSTITUTIONAL EXAMPLES

There are many institutional examples of Building Manager programs that can be used to refine the program at NAU. Each program establishes an individual that helps communicate building issues with facilities. However, every institution approaches the program slightly differently in how that process is carried out. Some institutions place a greater emphasis on the emergency management part of the role and others simply ask the person to submit work orders. NAU will need to lean on other institutions as a guide for their Building Manager positions.

ARIZONA STATE UNIVERSITY

Building Managers at Arizona State University are the primary contact for facility issues, building access, and communication with building occupants. The ASU program includes an emergency and safety element of the position that integrates with the police department and emergency response team for emergency situations, fire safety issues, and building emergency plans. ASU provides regular training for Building Managers that is focused on how to respond to facility and emergency issues. This training includes a detailed facility staffing overview to familiarize Building Managers with the technicians that may interact in their building and the services they provide.

UNIVERSITY OF SOUTHERN MISSISSIPPI

The Building Liaison Program at University of Southern Mississippi, like many building manager programs, focuses responsibilities on the facility upkeep of the building. What makes this program unique is the requirement for all work orders to be submitted by only the Building Liaison. This helps develop a communication loop where the Building Liaison is aware of any facility issues and regularly works with building occupants. The program further requires Building Liaisons to interact with their entire building by participating in regular walk-throughs of the building.

UNIVERSITY OF NEW MEXICO

The University of New Mexico building coordinator program is fairly robust with an established communication schedule and responsibilities. The Building Coordinators have a list of responsibilities including serving as the primary communication between occupants and facilities as well as serving as the emergency response representative for the building. The Building Coordinators are intimately involved in renovation or construction work and coordinate with the Fire Marshall and Accessibility Services for annual building reviews. The program at UNM further develops an extensive communication process between coordinators and facilities. Building Coordinators meet regularly with facility management to discuss their building and are required to attend building coordinator meetings held bi-annually to provide regular feedback on the program.

PROPOSED POLICIES

The Building Manager's role should be designated to an individual who has a broad understanding of the activities taking place in the building and the units allocated space within the building. If the building includes specialty equipment such as research laboratory equipment, the Building Manager should have knowledge around the unique facility needs associated with the specialty equipment or share the role with an individual that has such knowledge.

A Building Manager Coordinator position should be established. This position will be dedicated to overseeing the Building Manager Program and addressing the current gaps in communication and training. This individual should work in coordination with facility services to communicate the Building Manager process and serve as a guide to Building Managers.

An onboarding process should be established on a regular basis for new building managers overseen by the dedicated Building Manager Coordinator. Additionally, a yearly session should be required for all building managers before the Fall Term to review building management resources, changes to procedure, and updates to facilities request protocols.

The Building Manager coordinator should establish a working group made up of Building Managers and Facility Services personnel to define the role of Building Manager and propose a set of guidelines for the expected responsibilities of the role. This working group should also establish a plan for the disparity in individuals that have the role added to their primary position versus those where the role is designated in their job description and propose a type of compensation for the added duties such as a monetary stipend or other benefit such as free parking space.

If a Building Manager oversees a building with multiple departments, they should have knowledge of each department or share the role with additional individuals to encompass all building units.

Previous Studies 2010 Campus Master Plan



KEY POINTS

FOCUS ON GROWTH -

- Increase to 35,000 students by 2020
- Physical growth from 3.25M GSF (excludes housing) to 4.65M GSF + 600K GSF of renovations/ replacement
- 2,000 new beds

2010 Campus Master Plan Illustrative Plan, Ayers Saint Gross

2016 Campus Master Plan Refresh



KEY POINTS

UPDATED NEEDS -

- Updated site plan to reflect completed work
- Added new projects such as Honors Community, Convocation Center, Softball Complex

2016 Campus Master Plan Refresh Illustrative Plan, Ayers Saint Gross

Previous Studies Review of 2019 Space Study

A Strategic Space Utilization Study was completed in 2019 by design firm, Sasaki. This study evaluated the existing space portfolio and facility conditions, developed strategies for program accommodation due to current and future projects, and established strategies and recommendations for the management of NAU's space resources. As the study was completed prior to the COVID-19 Pandemic, the Master Plan revisits NAU's space policies and use through the context of post pandemic needs, expanding on the previous recommendations. This additional context was completed by re-engaging Colleges to reflect on their future space needs and refine the suggested policies to encompass the more adaptive learning and work style that NAU has embraced.

LEARNING SPACE

The 2019 Space Utilization Study identified several opportunities to better utilize and develop learning spaces by conducting focus groups with each College including questions about ideal classroom layouts. A need for active learning based classrooms was emphasized both in the space study and throughout the Master Plan process. The study further found a discrepancy in room sizes with an imbalance in the supply of smaller seminar rooms, specifically rooms with less than 40 seats. Without many rooms in this range, courses are routinely scheduled in larger rooms resulting in low seat fill percentages for certain rooms. Future academic projects should align classroom sizing with course type needs to fill this gap. Teaching laboratories were primarily located in suitable facilities but lacked adaptability to be functional for multiple courses. The recommended teaching laboratory policy includes the need for future teaching laboratories to serve multiple course needs when possible.

WORKSPACE

The space study found an excess of office space, referring to office size rather than quantity, but noted an anticipated need in office space for the future. Due to the timing of this study, it did not take into consideration how hybrid work would impact office space needs, this is a current trend that may or may not continue in the future. The Master Plan stays flexible and adapts workspace recommendations to fall more in line with multimodality arrangements and encourage flexible or hybrid workspaces when possible. There is a need to seek balance of collaborative and community work environments with spaces that support individual focus and productivity, while understanding the many different types of environments to support differing work. Another opportunity would be to include more multimodality work space for graduate students versus the current graduate teaching and research workspaces, which would improve space utilization.

STUDY SPACE

Study space was shown in the Space Utilization Study as being in a deficit. This is further exasperated by the spread of the Campus, making it difficult for students to access the academic core, where study space is more prevalent. The Library Study also identified needs for diverse study space types, depending on the time of day. The Plan confirms the need to develop additional study space throughout campus to support the modern learning experience.

RESEARCH OPPORTUNITIES

A significant portion of the space study focuses on the need to build out the science corridor and develop opportunities for Science, Technology, Engineering and Math (STEM) as a driver for research initiatives. The Master Plan expands on the STEM components to encompass two additional research opportunities that will require re-envisioned space. The first category is the communitybased research (both on and off campus). A greater emphasis in social equity, educational, and counseling-based grants has established a growing sector of research. The second additional research focus is undergraduate research. Many Colleges spoke about an increased need to provide undergraduates with research opportunities as part of the engagement process. Ideas also arose beyond just research, but also space for scholarship and creative work of students. Research space was reexamined using this wider approach as part of the Master Plan process.





Buildings and Facilities



EXISTING BUILDING ANALYSIS

KEY POINTS

- Deferred Maintenance costs have continued to escalate, the condition of buildings are well below average, and many buildings are beyond their return on investment and lifespan.
- Need to Prioritize Suitability there are many buildings on campus that were not purpose built or are no longer serving planned programmatic needs.
- Carbon Footprint the most sustainable buildings are ones that already exist on campus today, prioritizing renovation over demolition where possible.

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BUILDINGS BY USE



ADMIN + STUDENT SERVICES SUPPORT RESIDENTIAL RECREATIONAL STUDIO + RESEARCH LAB THEATER + AUDITORIUM CAMPUS OPERATIONS PARTNERSHIP The current arrangement of buildings on campus reflects a historical need for space, resulting in a somewhat scattered layout. While areas like central campus are primarily dedicated to housing, there are instances where the allocation of buildings by use have become more scattered. For instance, there is a noticeable absence of services on the south campus, despite the presence of student housing, which increases

> the need for support in that area. This disparity highlights the need for a more strategic approach to building and program placement and ensuring that necessary resources are accessible to all students throughout the campus.

SECONDARY USE

ACADEMIC

AUXILIARY

Primary Building Use

BUILDINGS BY COLLEGE



To address the issue of colleges being spread out in multiple buildings across campus, hindering interdisciplinary collaboration, efforts should be made to consolidate colleges and create a stronger sense of community. This involves fostering inter and intra-college dialogue and developing dedicated spaces like academic living rooms, lounges, and study spaces to facilitate interaction. Teaching spaces are in need of redesign to support active learning environments.

Buildings by College



Buildings by Year of Construction

NAU experienced a significant period of growth in terms of building expansion during the late 20th century. This development saw a surge in buildings for the growing student population and expanding programs. From the 1960s-1990s, numerous buildings were added including academic buildings, residence halls, recreational facilities, and administrative centers, which continued to transform the campus. These additions provided infrastructure and a dynamic environment for learning and living.

NAU's oldest buildings sit on north campus and other building ages become scattered throughout the campus. There are currently eight buildings on campus that are listed on the National Register of Historic Places that include: Old Main (1894), Morton Hall (1914), Cambell (1916), Blome (1919), Riles, (1926), Gammage (1930), North Hall (1935), and South Beaver School (1935). These buildings account for \$6M in deferred maintenance, with Gammage and South Beaver Street requiring over \$2M each, and Old Main at over \$1M. Any renovation of these buildings, whether systems replacement or programmatic changes, requires extra consideration as they must align with the guidelines of the State Historic Preservation Office. Additional buildings on campus may be eligible for the National Register of Historic Places.



Energy Use Intensity (EUI) by Building, 2018-2019

The Energy Use Intensity (EUI) plays a vital role in monitoring and evaluating the energy efficiency of buildings on campus. The larger numbers indicate a higher use of energy, although there are several targets depending on the building type. EUI serves as a valuable metric for assessing and comparing the energy performance of individual buildings, guiding the setting of energy efficiency goals and tracking progress over time. The EUI is instrumental in fostering a sustainable campus and promoting a culture of environmental responsibility in line with the university's Climate Action Plan. Although some buildings on campus may currently have unexpectedly high rankings, there is potential for improvement through specific changes, such as updates to mechanical systems and building envelopes. It is important to consider all factors, but a target EUI for the building type should be regarded as a high standard to strive for, ensuring energy efficiency is prioritized throughout the campus.



Deferred Maintenance Cost per Square Foot by Building



campus buildings and systems age. To address this challenge, the Master Plan has identified and prioritized deferred maintenance. Implementing a system of measurable metrics becomes necessary to assess the ongoing changes in buildings and track their lifespan. By emphasizing a forward-thinking approach and implementing effective tracking and assessment mechanisms, the university can better address deferred maintenance and ensure the long-term sustainability of infrastructure. This tracking will also address building energy management, a key strategy in the roadmap for carbon neutrality.

Building	Gross Square Footage	Building Condition	2023 Total Deferred Maintenance
[023A] ACADEMIC ANNEX	3600	Critical	\$419,436
[026] ADEL MATHEMATICS	43488	Poor	\$4,187,290
[046] ALLEN HALL	90315	Poor	\$6,532,686
[049] ANTHROPOLOGY LABORATORY	3400	Poor	\$301,661
[056] APPLIED RESEARCH AND DEVELOPMENT	60500	Good	\$32,683
[086] AQUATICS AND TENNIS COMPLEX	123,341	Good	\$438,482
[037A] ARDREY AUDITORIUM	37,635	Good	\$88,559
[011] ASHURST	18,390	Good	\$439,935
[047] ATMOSPHERIC RESEARCH OBSERVATORY/LUTZ TELESCOPE	2,175	Poor	\$249,585
[076] AVIAN COGNITION LABORATORY	5,402	Poor	\$643,442
[023] BABBITT ACADEMIC ANNEX	39,033	Good	\$655,872
[051] BABBITT ADMINISTRATIVE CENTER	29,423	Poor	\$2,753,620
[07A] BEAVER STREET HOUSE	1,714	Poor	\$245,519
[052] BILBY RESEARCH CENTER	19,174	Good	\$92,087
[021] BIOLOGICAL SCIENCES	86,964	Fair	\$4,150,705
[021B] BIOLOGICAL SCIENCES ANNEX	8,551	Poor	\$679,088
[018A] BIOLOGY GREENHOUSE	4,004	Good	\$69,497
[002] BLOME	18,817	Good	\$510,642
[035] BOOKSTORE	47,804	Good	\$4,709
[008] BURY	17,470	Poor	\$2,388,232
[07C] BUTLER OFFICE BUILDING	9,195	Critical	\$947,293
[006] CAMPBELL HALL	17,186	Poor	\$2,144,961
[050] CAMPUS HEIGHTS APARTMENTS	56,541	Poor	\$2,488,324
[097] CECMEE FIELD STATION	1,547	Good	\$62,290
[091] CENTENNIAL	10,997	Fair	\$547,310
[080B] CERAMICS CLAY MIXING	1,262	Good	\$6,434
[080] CERAMICS COMPLEX	9,009	Poor	\$797,031
[078] CHEMICAL STORAGE	1,788	Good	\$2,977
[028] CLINE LIBRARY	211,312	Poor	\$15,420,040
[016] COMMUNICATION	94,365	Fair	\$4,918,402
[098B] CONTRACTING AND PURCHASING SERVICES	9,624	Good	\$5,026
[038] COWDEN LEARNING COMMUNITY	87,049	Poor	\$6,359,379
[064] DU BOIS SOUTH UNION	92,946	Good	\$1,664,385
[027] EASTBURN EDUCATION CENTER	78,047	Good	\$890,408
[069] ENGINEERING AND TECHNOLOGY	89,460	Good	\$2,387,178
[098C] ENGINEERING RESEARCH	9,665	Good	\$5,026
[029] ERNEST CALDERON LEARNING COMMUNITY	108,808	Fair	\$4,756,253
[033] EUGENE M. HUGHES HOTEL & RESTAURANT MANAGEMENT BUILDING - I	17,817	Good	\$39,154
[033A] EUGENE M. HUGHES HOTEL & RESTAURANT MANAGEMENT BUILDING - II	13,695	Good	\$14,555
[098D] EXTENDED CAMPUS OPERATIONS CENTER	9,624	Good	\$61,474

Building	Gross Square Footage	Building Condition	2023 Total Deferred Maintenance
[077] FACILITY SERVICES	127,981	Poor	\$7,762,226
[077A] FACILITY SERVICES ANNEX	8,970	Poor	\$310,656
[089] FOUNTAINE APARTMENT	1,638	Poor	\$205,553
[053] GABALDON HALL	3400	Poor	\$301,661
[001] GAMMAGE	43,684	Fair	\$2,557,152
[043] GATEWAY STUDENT SUCCESS CENTER	16,662	Poor	\$818,876
[012] GEOLOGY	22,559	Poor	\$3,130,445
[013] GEOLOGY ANNEX	7,904	Poor	\$895,411
[031] GILLENWATER HALL	46,775	Poor	\$5,727,012
[079] GREENHOUSE COMPLEX	17,009	Good	\$38,434
[066] HEALTH PROFESSIONS	59,826	Poor	\$5,769,417
[058] HIGH COUNTRY CONFERENCE CENTER AND PARKING STRUCTURE	167,563	Good	\$655,618
[082B] HOGAN	480	Good	\$2,928
[032] HOSPITALITY RESOURCE & RESEARCH CENTER	2,762	Poor	\$216,479
[096] HUFFER LANE FACILITY	5220	Fair	\$149,801
[07B] HUMPHREYS OFFICE BUILIDING	2,177	Fair	\$56,635
[054B] INFORMATION TECHNOLOGY ANNEX	2,985	Poor	\$225,506
[054] INFORMATION TECHNOLOGY SERVICES	5,444	Poor	\$700,478
[054A] INFORMATION TECHNOLOGY TELECOM	22,702		\$3,085,289
[027A] INSTITUTE FOR HUMAN DEVELOPMENT	12,642	Good	\$16,951
[050A] INTERNATIONAL PAVILION	10410	Good	\$0
[073] J. LAWRENCE WALKUP SKYDOME	254,360	Fair	\$11,729,757
[025] JOHN HAEGER HEALTH AND LEARNING CENTER		Good	\$1,071,472
[083] KNAU / MOUNTAIN CAMPUS TRANSIT	11,893	Good	\$263,852
[096A] KNOLES PARKING STRUCTURE	293,485	Good	\$0
[061] LEARNING RESOURCE CENTER	19,648	Good	\$263,592
[018] LIBERAL ARTS	58,433	Good	\$10,388
[062] MCCONNELL HALL	160,132	Poor	\$10,073,746
[040] MCDONALD HALL	33,402	Poor	\$3,215,646
[050B] MCKAY VILLAGE	161,897	Poor	\$8,674,197
[094] MILTON PROPERTY	16,304	Critical	\$10,677,789
[004] MORTON HALL	22,534	Poor	\$2,426,727
[055] MOUNTAIN VIEW HALL	148,867	Poor	\$13,429,022
[096C] MOUNTAIN VIEW STRUCTURE	82,800	Good	\$0
[014] NATIVE AMERICAN CULTURAL CENTER	12,849	Good	\$430,901
[005] NORTH HALL	22,724	Poor	\$2,492,175
[024] NORTH HEATING AND COOLING PLANT	46,811	Fair	\$3,578,619
[003] NORTH UNION	31,277	Good	\$62,755
[072] NURSING	19,696	Poor	\$2,362,649
[010] OLD MAIN	31,259	Good	\$1,311,576
[037] PERFORMING AND FINE ARTS	150,493	Good	\$3,250,175
[] PETERSON	39,648	Poor	\$3,035,618

Building	Gross Square Footage	Building Condition	2023 Total Deferred Maintenance
[019] PHYSICAL SCIENCES	51,318	Good	\$1,357,845
[095] PINE RIDGE VILLAGE	124,094	Fair	\$4,212,088
[098A] POLICE DEPARTMENT	9,665	Good	\$12,662
[092] PONDEROSA	10,464	Poor	\$1,566,723
[057] PRINTING SERVICES	5,111	Poor	\$621,551
[03A] PROCHNOW AUDITORIUM	18,227	Good	\$7,390
[065] RAUL H. CASTRO SOCIAL AND BEHAVIORAL SCIENCES	63,321	Good	\$1,356,634
[039] RAYMOND HALL	61,467	Poor	\$3,043,754
[048] REILLY HALL	114,512	Poor	\$13,943,671
[074] RENEWABLE ENERGY TEST FACILITY	622	Poor	\$82,652
[015] RILES	28,211		\$395,568
[098F] RLSS WAREHOUSE	17,203	Good	\$17,350
[068] ROLLE ACTIVITY CENTER	47,697	Poor	\$4,451,801
[013A] ROSEBERRY APARTMENTS	34,558	Poor	\$3,720,374
[047A] ROTC	25,182	Fair	\$1,407,886
[096B] SAN FRANCISCO PARKING GARAGE	474,120	Good	\$0
[070] SBS WEST	71,312	Poor	\$9,593,755
[090] SCHOOL OF INFORMATICS, COMPUTING, AND CYBER SECURITY	46,565	Good	\$45,548
[036] SCIENCE AND HEALTH BUILDING	140430	Good	\$838,154
[020] SCIENCE ANNEX	73,168		\$280,495
[017] SCIENCE LAB FACILITY	107,358	Good	\$52,836
[084] SCULPTURE STUDIO	4,200	Good	\$6,127
[042] SECHRIST HALL	121,754	Poor	\$8,588,858
[099] SEISMIC OBSERVATORY	372		\$32,234
[093] SOUTH BEAVER SCHOOL	30721	Critical	\$2,752,609
[067] SOUTH HEATING AND COOLING PLANT	16,168	Fair	\$1,238,188
[085] SOUTH REC FIELDS COMPLEX	4666	Poor	\$280,368
[071] SOUTH VILLAGE	102,371	Poor	\$8,619,746
[082] SOUTHWEST FOREST SCIENCE COMPLEX	72,137	Good	\$2,043,642
[060] STUDENT AND ACADEMIC SERVICES	111,915	Good	\$0
[073A] STUDENT ATHLETE HIGH PERFORMANCE CENTER		Good	\$0
[009] TAYLOR HALL	31,603	Poor	\$2,510,468
[080A] TEA HOUSE	425	Good	\$6,817
[044] TINSLEY HALL	89,475	Good	\$1,352,264
[016A] UNIVERSITY MARKETING AND OPERATIONS	23,103	Good	\$357,234
[030D] UNIVERSITY UNION DINING EXPANSION	11,888	Good	\$22,712
[030A] UNIVERSITY UNION DINING SERVICES	66,566	Poor	\$5,623,798
[030] UNIVERSITY UNION FIELDHOUSE	88,019	Good	\$938,607
[030C] UNIVERSITY UNION FOOD COURT	24,767	Good	\$265,239

Building	Gross Square Footage	Building Condition	2023 Total Deferred Maintenance
[030B] UNIVERSITY UNION STUDENT SERVICES	24,354	Poor	\$1,699,800
[081] W.A. FRANKE COLLEGE OF BUSINESS	120,308	Good	\$74,895
[088] WETTAW	80,221	Good	\$809,048
[045] WILSON HALL	89,825	Fair	\$2,382,029
[099B] GRANNYS	9,327	Critical	\$978,451
[HAT] HAT RANCH			\$1,474,335
[PHXB1] HEALTH SCIENCES EDUCATION BUILDING	13,620		\$321,080
[KINGMAN1] NAU MOJAVE KINGMAN	8,100		\$566,615
[YUMA1] NAU YUMA ACADEMIC FACILITY	52,434		\$133,456
[YUMA2] NAU YUMA RESEARCH FACIL- ITY	12,225		\$0


Student Life



Student Housing Today

Northern Arizona University operates an on-campus student housing program consisting of 8,178 beds located in 22 residential complexes. The smallest complex, Campbell Hall, has a capacity of 45 beds while the largest, McConnell Hall, offers 820 beds. Honors College, included in the on-campus stock, is owned by American Campus Communities ("ACC"), a private housing provider, and master-leased by NAU. In addition to the NAU-owned or master-leased properties, students have access to three (3) on-campus complexes through a co-marketing agreement with ACC. These complexes provide 2,096 beds. Overall, NAU has the capacity to house approximately 49% of its student enrollment, a very high number for a comprehensive public institution.

NAU's housing variety offers a good mix of building and unit types desired by all levels of undergraduate students as well as graduate students seeking on-campus options.

The bed breakdown of NAU managed housing properties is as follows:



Numbers above do not include ACC owned and operated housing



Overall, NAU's housing stock is in good physical condition. Based on the facility condition assessment report provided by NAU, buildings with the highest deferred maintenance cost per bed include:

- Mountain View : \$65,000/bed
- Campbell Hall: \$61,000/bed
- Gillenwater Hall: \$53,000/bed
- McDonald Hall: \$52,000/bed

Campus Living has been a very popular residential option. Despite the absence of any live-on requirement, over the last five years, the system has functioned at nearly 100% occupancy with the exception of Fall 2020 when the occupancy was lower due to COVID-19.

The fall occupancies over the course of the last five years are as follows:



CAMPUS LIVING OCCUPANCY

STUDENT INPUT

During a campus visit, students were interviewed in a series of focus groups. The discussion covered student housing and other student life facilities. Participants raised the following key points related to on-campus living:

- The reasons for living on campus include safety, simplicity of transaction, proximity to academic resources, and proximity to work (on-campus jobs).
- The key amenities mentioned by students were kitchens, private bathrooms, free laundry, high-speed Internet, air conditioning/ ventilation, and location (proximity to academic buildings and parking). Participants also spoke about the importance of maintenance services, especially in the bathrooms.
- Cost is a very significant factor some students cut costs by having a roommate (double-occupancy bedroom). Looking for affordable off-campus housing may be complicated and requires a "game plan." In the context of cost sensitivity, an academicyear lease term on campus is attractive compared to 12-month leases off-campus, which are considered to be expensive.
- On-campus apartments are very popular among students as they offer the desired amenities in favorable locations.
- Graduate students are very interested in campus living but one to two roommates is the maximum they would accept.

OFF-CAMPUS MARKET

As part of the off-campus market research, the planning team spoke with the City of Flagstaff representatives, reviewed Flagstaff's 10-year Housing Plan, and examined housing data for offcampus, purpose-built student housing properties.

The key findings are listed below:

- The City of Flagstaff has a significant shortage of housing in the majority of income categories including low-income and low-tomoderate income. Since 2000, Flagstaff's population has grown by 77,590 residents (47% growth) while the market underproduced nearly 8,000 units.
- The factors contributing to the community housing shortage include second homes (approximately 3,900 units) and short-term rentals (approximately 535 units).
- Single-family homes, are unaffordable and do not contribute to addressing the affordable housing crisis.
- Flagstaff is planning on constructing 254 affordable units in the next 10 years, but NAU students typically do not qualify for affordable housing.
- Flagstaff is very respectful of NAU's oncampus housing strategy and supportive of expanding offerings.
- The Flagstaff market offers a large quantity of housing (approximately 5,880 beds) in purpose-built student housing properties. These include The Jack, Yugo Grove Flagstaff, The Standard, and Fremont Station, among others. Due to the shortage of other, more affordable options, these student-oriented facilities enjoy very high occupancies ranging from 92% to 100%.

UNIONS AND DINING TODAY

NAU's food service program provides comprehensive community dining and retail options. There are two community dining venues on campus:

- <u>The Hot Spot</u> Located in the University Union. The Hot Spot offers eight concepts in an all-you-care-to-eat arrangement.
- <u>The DüB Dining District (Du Bois Center)</u>
 This recently renovated dining hall offers seven concepts serving south campus in Du Bois South Union. The DüB is also arranged as an all-you-care-to-eat venue.

The community dining options are supplemented by retail options in various campus buildings including:

- Eight offerings in the University Union: Chickfil-A, Pizza Hut Express, Starbucks, Wild Blue Sushi, and others.
- Five offerings at the Union Point (University Union expansion): Cabrizio, Einstein's Bagels, Jamba Juice, Lemon Grass, and Star Ginger.
- Three offerings in Du Bois South Union: Einstein's Bagels, Subway, and Qdoba Mexican Eats.
- Other retail locations include the Cline Library (Scholars Café), Science Laboratory (Bean and Beaker), Health & Learning Center (Essential Blends and Green Scene), The Suites (Starbucks and The Coupe), North Union (1899 Bar and Grill), and Skyview (EAT Food Market).

NAU also provides students with two mobile dining options:

- Where's the Food Truck: lunch and late-night options served out of a food truck in different locations across campus.
- Starship Late Night: pick-up and robotic delivery options from the Wedge, the Coupe, and Burger ConFusion.

The University Unions at NAU provide services in two distinct locations/facilities: University Union serving the north campus and Du Bois South Union serving the south campus.

<u>University Union:</u> the facility is approximately 216,000 gross square feet (Buildings 30, 30A, 30B, 30C, and 30D). This square footage includes approximately 88,000 gross square feet in the Fieldhouse. While the offices within the Fieldhouse are currently occupied by various NAU departments, the open multi-story arena space (approximately 45,000 gross square feet) remains vacant. The University Union offers the following programs, service, and spaces:

- Office of Inclusion: Multicultural and LGBTQIA Student Services,
- Veteran Success Center,
- SUN Entertainment,
- Student Affairs,
- First Generation Programs,
- Transfer and Online Connections,
- North Academic Success Center,
- Peer Jacks,
- EMSA Financial Services,
- Food service (detailed above),
- Conference / multipurpose rooms, and
- Study and lounge spaces.

<u>Du Bois South Union</u>: the facility is approximately 93,000 gross square feet and the programmatic offerings include:

- Academic Success Centers,
- Testing Center,
- Meeting Rooms,
- Ballroom,
- Study and lounge spaces,
- Classrooms/multipurpose rooms, and
- Food service (detailed above).



STUDENT INPUT

Students provided additional input related to campus dining and the University Unions, which to a large degree consistent with the views of the administration:

- Students generally believe that there is a good balance of community dining and retail options across the campus.
- Renovation of the Du Bois Center was successful from the student perspective and the variety and quality of food meet student expectations. The offerings at the Hot Spot are perceived as of lesser quality.
- With respect to ideas for improvements, students mentioned longer operating hours, as well as Kosher and Halal meal options.
- Graduate students asked for more dedicated spaces, such as a coffee shop, in which they could socialize and study.
- Students believe that the University Union serves as a hub of student life on north campus, but is used primarily for food service with limited offerings of "purpose-built" hangout spaces.
- Many requests were received for more dining options near housing on central campus, especially touch-less convenience kiosks and quick grab options.



HEALTH AND WELLNESS TODAY

The Health & Learning Center is the main comprehensive wellness asset on campus. This is a mixed-use facility accommodating Campus Recreation Services, NAU Athletics, Medical/Counseling Services (both students and employees), classrooms, conference rooms, informal study areas, and food service. The building is approximately 283,000 gross square feet and its major program elements include:

Campus Recreational Services (approximately 116,000 GSF):

- 4 basketball courts
- 6 racquetball courts
- 2 squash courts (non-regulation)
- 5 volleyball courts
- 3 multipurpose fitness studios
- Indoor jogging track
- Wellness Suite
- Climbing wall
- Weight & fitness areas (cardio machines, free weights, and selective machines)
- TRX/Functional Fitness areas
- Outdoor courtyard
- Multipurpose gym used for indoor soccer, basketball, and volleyball
- Fitness Assessment room
- Locker rooms

Medical/Counseling Services (approximately 23,000 GSF):

- Physical and mental health services,
- Urgent Care clinic,
- Pharmacy,
- Counseling services,
- Disability Resources, and
- Employee Assistance and Wellness.

Other building components (approximately 144,000 GSF):

- General classrooms,
- Social lounges,
- Study areas (individual and group),
- Food service (The Green Scene Café and Essential Blends Juice Bar), and
- Locker rooms facilities for University Athletics (soccer, tennis, track and field).

STUDENT INPUT

NAU students shared their thoughts related to recreation, health, and counseling services during focus groups:

- Participants expressed appreciation of the counseling services: "Counseling is great," and added that having more distributed locations of the services would increase convenience – locations such as student housing, and south campus were both mentioned multiple times.
- Counseling services are in high demand among students: "Hard to get an appointment." Those without health insurance raised the issue of affordability (\$60/visit).
- Students view telehealth as a positive development in how services are delivered but still prefer face-to-face appointments.
- Numerous students brought up their desire for NAU to bring a pharmacy back to the Wellness Center to assist those living on campus and avoid the struggle of finding transportation especially when ill.
- Students generally enjoy the recreational facilities but indicated they can be intimidating to some. One student indicated she always waits to "go with a friend."



Students participating in a swim class



Students stretching with the San Francisco Peaks in the background



Students exercising outdoors



Students outside the Recreation Center



Open Space and Landscape



EXISTING OPEN SPACE ANALYSIS

KEY POINTS:

- Implement Landscape Strategies: enhance the landscape with native vegetation and soil management, snow storage, and ice removal.
- Integrate Sustainability into the following functions water management with stormwater and reclaimed water from the city, analysis of areas considered for turf reduction, and further integration of solar and composting programs.
- **Utilize Open Spaces:** allow the entire campus to become a classroom for learning experiences.
- Incorporate Clear Circulation: connecting all pathways to multimodal circulation in a safe manner with clear signage.
- **Design for Flexibility** including accessibility, social spaces, individual and group activities throughout campus spaces.

VEGETATION AND SOIL

The type and management of vegetation and soils throughout the NAU Campus is a key component of sustainable open spaces. Sustainability could be increased across campus with the following methods:

- Reduction of turf with no programmed purpose
- Detailed mapping of the campus forest and canopy trees
- Use of compost and/or reclaimed water for irrigation

The 2015 Landscape Master Plan (LMP) defines a native and adaptive plant list as well as practices to reduce outdoor water use. NAU can further manage the use of water, reduce its carbon footprint, and increase environmental benefits through the reduction of turf. Locations such as athletic and recreation fields, and quad spaces should keep turf for programmatic use, but broader areas of campus which are not often utilized do not need to remain maintenance-heavy and water-requiring turf. Areas such as roadway medians and tertiary spaces adjacent to buildings should be replaced with lowwater native and adapted vegetation.

The LMP also identifies a change in ecosystem type, resulting from a change in the tree canopy. The university should consider a Campus Tree Care Plan which becomes a comprehensive guide to the campus trees and be used as a resource for NAU. The purpose of the Plan would be to identify and establish regulated policies and procedures committed to proper planting, maintaining, protection, conservation, and removal of trees on campus.

WATER

Water is a critical aspect of sustainable outdoor spaces. While currently already utilizing some conservation efforts, NAU should look to the continued use and expansion of reclaimed water for all outdoor water use and potentially partner with the City of Flagstaff reclaimed water line expansion. Stormwater and snow storage areas can both be used as amenities and educational opportunities by utilizing green infrastructure techniques throughout the campus.

Strategies NAU can consider for water conservation:

- Localized filtration planters
- Permeable hardscape surfaces
- Consider expansion of the urban forest
- Evolve landscape maintenance practices
- Evaluate the benefits of existing water-efficient landscapes

EXISTING CAMPUS OPEN SPACE



Existing Landscape Types

OPPORTUNITIES FOR TURN REDUCTION





The campus is comprised of many landscape types as shown above in types of ground cover. While portions of the campus (gathering spaces, recreational, or athletic fields) make sense to remain turf grass, many areas would benefit from a change to native and natural vegetation, requiring less maintenance, and diversifying the ecology of the campus. In turf conservation efforts, the areas of remaining turf should consider a selection of type, or if recreation, the use of artificial as an alternative. Areas that make the most sense to eliminate turf include along roadways, in medians, and the tertiary spaces adjacent to buildings. Turf elimination aligns with the sustainability plans and Climate Action Plan goals of the university.

SHADE STUDY / URBAN HEAT ISLAND



Shaded Areas on Campus

LEGEND LOW HEAT ISLAND EFFECT

HIGH HEAT ISLAND EFFECT

SHADED AREA

There is a need for an in-depth shade study to understand the impacts of the urban heat island effects on the campus. For areas along existing pedestrian circulation routes, it is possible to better understand the location where additional trees or structured shade would be beneficial for increased comfort. Minimizing urban heat island helps in temperature regulation of the sites, health and comfort of the users, and ecological balance for the flora and fauna of the campus. This heat severity map was derived from Landsat 8 band 10 imagery, from the summer of 2022 (source: Heat Severity - USA 2022, ArcGIS Living Atlas). Landsat 8 is part of a series of satellites that take imagery of Earth. Specifically, band 10 provides accurate surface temperature data. Shading of buildings was analyzed using ArcGIS Pro.

TREE MAPPING



Tree Map of the Campus with Deciduous vs Pine Trees

LEGEND TREE CANOPY

DECIDUOUS TREE PRIMARY

PINE TREE FOCUS PRIMARY



EXAMPLE OF A PINE TREE -PONDEROSA PINE



EXAMPLE OF A DECIDUOUS TREE -LONDON PLANE TREE

The NAU Campus exists in the world's largest Ponderosa Pine-Arizona Fescue forest. This forest has differing plant communities, drainage, and soil types. Historically, North and Central campus areas exist as open grassland meadows, though have been the most built up over the years. These areas should remain as large deciduous shade and coniferous trees. The South campus should remain to reflect the historic vegetation of the Ponderosa Pine forest. While there is currently some information, it would be helpful to have more data surrounding tree mapping that would allow for analytical data to be collected over time and tracking of the campus canopy's overall health.



OUTDOOR CLASSROOM AND SOCIAL SPACE OPPORTUNITIES

Existing Ground Cover

Utilizing the campus as a learning environment, NAU benefits by using areas that already act as outdoor classrooms and include natural or structured shade, outdoor seating or sloping, and spaces located around housing or academic settings. Previous plans placed outdoor learning on the Central Innovation Campus, however, South Quad and North Historic Quad would also be good assets for learning.

Outdoor social spaces also provide a space for social connection, physical activity, and mental restoration. Both the 2010 Campus Master Plan and the LMP identified such spaces. Similarly, this Plan also identifies these projects, specifically gathering spaces near housing clusters. Outdoor spaces should be designed for flexibility so they can be scheduled for formal learning or informal clubs, studying, and socializing. The spaces should have ample and reliable Wi-Fi and sustainable power sources. The spaces should be accessible for all, including barrier-free design methods and protection from climates such as the sun and wind. These spaces should be sited so that they enhance circulation, defining the relationship between the open space network and adjacent buildings.

MULTIMODAL NETWORK



Existing Pedestrian and Vehicular Circulation

LEGEND PEDESTRIAN SIDEWALK

PEDWAY AND MULTIMODAL PATH

Clear circulation encourages multimodal transit such as walking, biking, and mass transit. These connections should be holistic in their approach and include stormwater management, dark sky lighting, places to rest, providing trees for shade, including necessary accessibility elements, encouraging recycling, and using native and adapted landscaping and regional materials. Many of these elements are outlined in the LMP as priority projects that would connect key areas in the NAU campus. Future planning should also consider broader multi-modal transit networks such as the Flagstaff Urban Trails System, Mountain Line bus routes, and access to key resources such as healthcare, affordable food, and housing.





SOLAR GROUND MOUNTED ROOF MOUNTED ROOF MOUNTED (NON-OPERATIONAL) SOLAR WALL SOLAR AIR HEATERS

> Open spaces with tree canopy support building energy efficiency. Open areas such as parking lots or lawns on campus can also provide lane area for solar arrays on top of car ports or shade structires. Additionally, an expansion of the composting program would reduce waste and fertilizer consumption for oncampus landscape maintenance. As the campus environment becomes more sustainable in operations, it will be important to continue sustainability strategies and put them on display to create places for users to experience and learn. This Plan should take into consideration multimodal accessibility and sustainable charging for e-mobility in order to follow the Climate Action Plan goals.

Green Energy Locations on Campus

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Multimodal Plan



EXISTING CIRCULATION ANALYSIS

KEY POINTS:

10 00

- **People walking:** improve connectivity with a focus on eastwest connections, improve ADA compliance
- People using alternative modes of transportation: improve alternate transportation facilities with a focus on connections to the Pedway
- **People riding transit:** reduce impact of congestion on shuttles
- Vehicle parking: Utilize existing parking locations through policy, permit, and policing

EXISTING PEDESTRIAN FACILITIES



Existing Pedestrian Circulation

The campus has a robust pedestrian network, with primary pedestrian pathways and a network of sidewalks, paths, and trails that connect academic buildings, housing, services, support, and surrounding community.

Pedway: The Pedway is the backbone of pedestrian and bicycling infrastructure on campus. It is a shared use path that runs north-south and connects the north campus to the south campus. The Pedway begins at DuPont Avenue, and extends south to McConnell Drive. The character of the Pedway (width, elements, materials, etc.) varies throughout the campus. Portions of the Pedway are defined with a center bicycle lane and tactile strips on either side, while other portions are comprised of former roadways and old brick paver sections that are in poor condition. To better manage bicycle and pedestrian traffic, the recent extensions of the Pedway introduced a new design, featuring a dark gray bicycle lane running between two lighter gray pedestrian pathways. Two tactile strips will alert pedestrians that they are encroaching into the bicycle space.

East-West Connections: Past planning studies highlighted a lack of east-west connections throughout the campus, especially tying together high traffic areas and south campus. Incomplete sidewalk networks and pathways with areas that are not universally accessible have also continued to be a concern for the campus. Additional east-west connections are needed for bicycles and pedestrians. Currently, east-west travel is dependent upon Pine Knoll Drive in the south and Butler Avenue in the north. Campus interviews revealed that outside

EXISTING BICYCLE FACILITIES



Existing Bicycle Circulation

of the Pedway, it is confusing where bicycles must merge with foot traffic. While bicycle parking, racks, and lockers are plentiful in some places, it is not in other areas. If there are sufficient places, they might not be suitable in terms of sheltered alternative transportation parking and security. The perception is that bicycle parking, including racks and enclosed lockers on campus is plentiful, yet underutilized. Students choose not to use bicycle parking that is located far from building entrances. The NAU Yellow Bike Program provides free bicycle rentals on campus. NAU has expressed a desire for a formal campus bike share program; however, insufficient funding and limited vendor interest has inhibited progress. There is also a need to address conflicts with high speeds of e-mobility devices on the Pedways, bike paths, and sidewalks.

EXISTING TRANSIT FACILITIES



MOUNTAIN LINE ROUTE 10
 LOUIE
 JACKS
 TRANSIT STOPS
 AXELITE
 ROUTE DIRECTION
 TRANSIT SPINE: BUSES AND BICYCLES ONLY

Northern Arizona Intergovernmental Public Transportation Authority's Mountain Line (Route 10) runs through the NAU Campus connecting downtown Flagstaff to Woodlands Village. NAU provides employees NAIPTA's ecoPASS at no charge to use Mountain Lion. NAU operates two campus shuttle routes that operate in mixed traffic; and therefore, are subjected to congested conditions during class changes. Potential ideas to reduce the impact of congestion on buses is to consolidate transit hubs to serve the north and south campuses individually, while providing a route connecting the two hubs. Another opportunity is to close interior roads to private vehicles during class change times to enable shuttles to efficiently travel across campus.

EXISTING ENTRY AND EDGES



Existing Campus Edges

Some campus boundaries are well-defined and others are not. The campus boundaries on the west side are very poor. Campus edges need to be welcoming and open to the community. In addition, entrances to campus need improved identity and a sense of having arrived on campus. Entrance points lack identity and the feeling of entering a special place. Branding needs to be improved at gateways, particularly at the busiest entrances, using elements such as stone walls, brick walks, landscaped boulevards, etc. may serve to improve the intuitiveness of entering the campus.

EXISTING PARKING FACILITIES



Existing Parking Locations



Interior lots naturally attract vehicles to the interior of campus. However, perimeter facilities lack strong multimodal connections to the interior of campus. NAU has made a policy decision to remove interior parking lots and densify and strengthen perimeter facilities. Recommendation of changes to permits, pricing, and enforcement would help reduce utilization of interior lots and increase utilization of perimeter lots. Visitor sentiment is that wayfinding to available parking can be confusing, so if simplified, is another opportunity to enhance community engagement on campus. South Commuter, Dome, Health Learning Center, and Cline parking lots, as well as Knoles and San Francisco parking garages are all located within a block of a shuttle stop, which would be strong multimodal connections in the future.



Indigenous Planning



EXISTING INDIGENOUS DESIGN

KEY POINTS:

Located in a region with many Indigenous cultures, NAU has a long history of honoring these cultures and peoples with specific goals outlined in the university's strategic plan. Adopted in 2017, the university has created a land acknowledgment to recognize the influence that its Indigenous peoples have had on the campus and in the Flagstaff region. In addition to this land acknowledgment, the university has also established an Office of Native American Initiatives, or ONAI, to contribute to its Indigenous student population. To do this, ONAI has charged its mission with four strategic values, including:

- "Partnering with Native American / Indigenous communities."
- "Collaborating with tribal colleges and universities."
- "Contributing to a culture of support for Native American / Indigenous students."
- "Building bridges to and from Indigenous-serving institutions across the globe."

Cline Library

CORE VALUES

In addition to those four strategic values, ONAI also includes four core values of relationships, responsibility, respect, and resilience. These additional four values help represent shared principles found throughout the many local Indigenous communities.



"The Relationships graphic was inspired by the staple imagery of the four cardinal directions that are considered sacred in Native American cultures. The feathers represent the trust, honor, wisdom, and strength that is necessary in establishing and cultivating relationships."

"The Responsibility value is a sun that illustrates responsibility by showing the effect that it has by reaching out with its rays. It also signifies the beginning of a new day as it rises from the east. Both of these express dependability and accountability which are essential parts of responsibility."

"The Respect value is represented by a water graphic that uses a droplet shape often utilized in Native American jewelry and other inspired circular designs. Water is used here to visually express the importance of respect and the value of community approval and honor."

"The Resilience value is represented as a corn stalk that is found in many Native American images. Corn is a resilient crop which ties directly to the concept of resilience. It also symbolizes the growth students experience through support in their education."

PROGRAMS

- Native American Advisory Board
- Office of Native American Initiatives:
 - Seventh Generation Indigenous Knowledge
 Center
 - Institute for Tribal Environmental
 Professionals
 - Seventh Generation Research and Service Program
 - Institute for Native-Serving Educators
 - Tribal Leadership Initiative
 - NAU Native American Cultural Center
 - NAU Elders Program
- NAU The Office of Native American Initiatives
- Office of Indigenous Student Success
- Commission for Indigenous Peoples
- American Indian Nursing Program
- Applied Indigenous Studies
- Native American Cancer Prevention
- College of Health and Human Services Native
 Journey to Academic Success
- Department of Global Languages and Cultures
- Office of Inclusion and Multicultural Services
- Center of American Indian Economic Development
- Southwest Health Equity Research Collaborative
- IHD Culturally Appropriate Research in American
 Indian Employment

STUDENT ORGANIZATIONS

- Abaya Yala University Association
- American Indian Science and Engineering Society
- Generations
- HAPA Club
- Council of Indigenous Ambassadors
- Indigenous Rodeo Club
- Indigenous Business Club
ENGAGEMENT

NAU's commitment to including Indigenous voices in the Campus Master Plan led to the hiring of Tawaw Architecture Collective (TAW) to assist in focus groups and engagement sessions for local Indigenous groups. Working alongside DLR Group, TAW—an Indigenous consultant—conducted workshop sessions and focus groups with multiple Indigenous organizations. This included groups of students, staff, faculty, and Elders that later helped to define the Indigenous design principles for the Campus Master Plan. Through their efforts, TAW developed a strategic work plan and goals with three main steps. These goals are also included as part of their full report in the appendix.

- Utilizing visuals, such as images or maps, to start conversations and to clarify accuracy and representation.
- Scheduling time for "deep-dive sessions" with Elders or culture bearers to ensure culturallysignificant spaces are identified including gathering and knowledge spaces and ensuring cultural storytelling features are honored.
- Ensuring connections to vital markers including directionality, land forms, sacred landscapes, cosmology, and biophilia to increase ancestral connections for the campus.

During the engagement process, we heard from many different groups about what they would want to have included on campus. The following are a small selection of quotes from students:

- "A collage of nation flags or a collage of languages for one word. Universal symbols, not one symbol is one nation's"
- "All languages should be prioritized but in order for people to see the languages having sentences and quotes around campus will help that, but with those quotes you have to include the meanings to balance out diversity"
- "Using the walkways to incorporate nature (designs in the concrete, art along the walkway)"
- "Tribal art made by Indigenous artists"
- "We can recognize all Tribes by a flag walk"
- "Having an area where Indigenous herbs surround you, reminding you that you are in a safe place like home"
- "A mural of the landmarks with the stories or history, i.e. peaks on wall"

Engagement	Attendees/Type	Date
Charrette #1	Faculty and Staff	1/12/2023
Workshop #1	Students	2/2/2023
Workshop#2	Faculty and Staff	2/3/2023
Focus Group #1	Student Group - Ethnobotany / Food Sovereignty	4/20/2023
Focus Group #2	Sovereignty Walk / Run + Art	5/4/2023
Focus Group #3	Elders + Signage, Naming and Language	5/11/2023
Focus Group #4	Review	6/13/2023
Deep Dive #1	Review	7/5/2023





ENGAGEMENT RESULTS

The engagement results from all of the groups involved were broken into the categories:

- Visual preference survey
- Indigenous references in cultural landscapes
- Strategies for inclusivity
- Traditional Indigenous structures
- Outdoor learning spaces
- Space for Indigenous Elders
- Cultural activities on campus
- Medicine garden flora



Based on feedback and responses from workshops and engagement sessions conducted with the local Indigenous groups, these were some of the most frequent responses.

ENGAGEMENT RESULTS

From the many engagement sessions conducted on campus, these were some of the responses to questions asked.

Visual Preference Survey

- Connecting to nature through: native flora/fauna; creating soundscapes (ex: water); organic/ circular spaces; spaces that open up to nature;
- Creating spaces that are welcoming: natural materials (wood); home/ cozy feeling; color (earth tones, native colors); familiar geometry (ex: hogan);
- Providing spaces with a meaningful propose: ceremony; gathering; meditating; bring the community together; personal space options; harvesting traditional foods

Indigenous References in Cultural Landscapes

- More use of Native Language
- People should also hear how these words are said
- Art work of the Peaks but perhaps more importantly why they are sacred. (keep people off peaks)
- I would like to see the importance of the traditional aspect of the sacred 4 elements, colors, mountains and tie it into the emerging science of today like physics/ mechanics and bio geometry
- They are similar to our creation stories.

Strategies for Inclusivity

- Community engagement
- It would be hard to recognize them all maybe providing a survey every semester to students asking which Tribe from and now they want to be recognized
- We can display maps, art, and languages on campus. we can make an interactive map and students can learn about different Tribes
- Embedding Native Languages

- We should prioritize local Native languages and have meaningful translations of university mission statement
- Voice recordings of native languages to welcome the 22 Tribes in Arizona
- Online video showcase for Indigenous native languages arts etc.

Traditional Indigenous Structures

- Hogan closer to NACC
- Tents or Teepees/ Tipis
- Outdoor fire place
- Teepee/ Tipis on campus
- Shade structure
- Hogan and education purposes to be done by native teacher
- Move hogan "easy" for student/groups to access, cultural teachings, tee-pee and blessings or educational ceremonies
- Fireplace, circular, similar to fireplace but more culturally representative, ground level

Outdoor Learning Spaces

- Cooking class/ events
- Student poetry, story reading
- Ways of knowing, gardens with medicinal plants and flowers, sculptures from local artists, outdoor theater for native artists
- Native plant garden
- Outdoor gathering space
- Mini amphitheater
- Garden of traditional foods could be a greenhouse
- Fireplace at Center, circular, accessible, adoptable to weather, grounded, made with elements, integrated with tribes
- Multi functional altar learning and ceremony with native plants and gardens incorporated
- Importance of bring any "physical activity" space, running pause with place keeping images and Indigenous plants

• Sovereignty run group during Native American Heritage Month

Space for Indigenous Elders

- There is at the NACC but may be worth having Elders come into other spaces not just the NACC
- There is no designated space except story room, gathering room, etc. They need a space to put their stuff and cultural items. They also need a space to conduct ceremony.
- Move closer
- Yes, here the gathering room and story room
- Dedicated space/room on South campus for spiritual - Current and AU policy prohibits emerging in classroom

Cultural Activities on Campus

- Indigenous Convocation
- Staff Appreciation Events
- Graduate/Undergraduate Presentations
- Language celebrations
- Change policies to tipi/Indigenous structures « They have trouble with regulations each time they put up a tipi (i.e. fire regulations)
- Massive prayer before school begins
- Restorative justice practices
- Need for more collaboration among Indigenous in an Indigenous programs
- Indigenous visit day
- Faculty of color honors luncheon and talk

Medicine Garden Flora

- Juniper, piñon Sage, tobacco, wild onion, yucca, sumac
- Milton tobacco, sage, juniper, sumac (berries) bush, sweetgrass
- Sage, sweet grass, engage experts in the design, NAU peyote garden, teas
- Boxwoods with traditional plants in front Wild (Navajo) tea, wild onion

- A native garden that allows the plants to grow healthy, that does not negatively impact the ecosystem
- Corn
- More moss walls! Or a succulent wall
- Water feature
- Visual buffer: plant trees, bushes: bougainvillae type of bush
- Worth talking to families that have loved ones buried there
- What I want to see is sage and cedar. Also sweetgrass because it signifies healing
- Sage, bunnies, deer, palo santo
- Lavendar, roses, dandelions
- Cedar, yucca, sage!
- Sage, cedar, yucca, ask native professor
- Moss or flower wall
- I would like to see more sage, cedar, sweetgrass and yucca on campus
- Aspen trees
- Native floral and fauna. Buffer for the cemetery would be nice
- Traditional medicines
- Juniper trees
- Tobacco, corn, juniper, sweet grass



Sustainability and Smart Campus

EXISTING INFRASTRUCTURE & UTILITIES ANALYSIS

KEY POINTS:

- Water: focus areas include overall water use, irrigation, stormwater management, and resiliency.
- Waste Management: how can the total volume of waste be minimized and diverted from landfill?
- Energy and Carbon Reduction: all future projects should consider the Climate Action Plan, where previous projects did not.
- **Energy:** Buildings identified with large, deferred maintenance backlogs and high energy use intensity are prime candidates for deep energy retrofits.
- **Carbon Reduction:** Complete the initiating infrastructure projects that enable NAU to significantly reduce or eliminate the Flagstaff Mountain Campus' reliance of fossil fuels.
- Utilities Overhaul: The campus utility infrastructure requires a comprehensive overhaul to address aging piping and to eliminate the use of fossil fuels to align with the climate action goals.

EXISTING UTILITIES

The last utility development plan for the Flagstaff Mountain Campus was completed in 2013 and included an assessment of the chilled water, steam, high temperature hot water, natural gas, water, and medium voltage distribution systems.

Electrical

- North Campus Medium Voltage System: The north campus electrical system was refreshed in 2011 from the APS service to the distribution switches and is anticipated to have another 15 years of useful life. The system includes one primary 12.47 kV feed to the Building 24 Plateau Center with a manual backup feed and an Automatic Throw-Over system for the Drury feeder. A monitoring system was installed as part of the medium voltage electrical system in 2011 to evaluate failures during unplanned outages. The system is currently nearing the end of its useful life and requires updates for reliable reporting.
- South Campus Medium Voltage System: The south campus electrical system is at 12.47 kV with the APS service at the Heating Plant Annex (building 67), including a manual backup feeder. The system was installed in 2003. The south campus system is metered separately from the normal campus and totalized for billing. No monitoring system is installed on the south campus system.

Heating

• North Campus Heating System: The north campus utilizes manifolded steam water tube gas boilers distributes steam at 60 psig. Steam and condensate return piping is distributed through utility tunnels in major corridors with direct buried branches. Nodal steam loops provide redundancy in areas of the north campus. Sufficient steam capacity exists to serve both the north and south campus. Three (3) new boilers were installed in 2011 supporting a 40-year old boiler and one (1) 60-year old boiler. Condensate return installed in the 1980s has begun to fail and is expected to require replacement.

• South Campus Heating System: A high temperature hot water system serves the south campus heating needs. Distribution piping is located in tunnels and shallow trenches. The system was originally designed for 400°F and 400 psig however has been reset to lower temperatures below 250°F and 150 psig. The three (3) existing gas boilers feeding the system are over 40 years old.

Chilled Water

- North Campus Chilled Water System: The north campus cooling needs are provided by centralized, water-cooled centrifugal chillers. Four (4) chillers are manifolded together to provide 3,000 tons of cooling. Chilled water supply and return is distributed throughout the north campus at 42°F through direct buried piping. Chilled water production is expected to group to 4,000 tons by 2027 requiring three (3) new chillers. The two (2) oldest chillers are at the end of their useful life and may be considered for replacement to increase capacity and efficiency or a rebuild.
- South Campus Chilled Water System: The south campus cooling needs are provided by centralized, water-cooled centrifugal chillers. Two (2) chillers are manifolded together to provide 1,250 tons of cooling. Chilled water supply and return is distributed throughout the south campus at 42°F through direct buried piping. Chilled water production is expected to group to 1,550 tons by 2027 and require two (2) new chillers to maintain redundancy.





ENERGY USE TODAY

Summarized from 2021 Climate Action Plan, credit Affiliated Engineers Inc. (AEI)

The Flagstaff Mountain Campus expends about \$4 million dollars per year in annual energy costs equating to approximately 65 cents per square foot. The Climate Action Plan employed a utility meter data-driven virtual energy audit to identify the most impactful opportunities for detailed audits and gauge the potential for reductions in energy demand. The virtual energy audit of the campus considered building use, building age and the building's ability to respond to seasonal weather conditions for analysis. Through review and analysis of these attributes, the energy consumption of buildings can be ranked and prioritized by the potential for energy, water, carbon, and cost reductions.



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Energy Use Intensity by building. The energy use intensity (EUI) was calculated for each building with metered, monthly utility data except for 3rd party-owned residential buildings, the central utility plants, and the data center. A NAU target EUI was calculated for each building representing the 75% lowest EUIs among that building type on campus. As illustrated in the figures on the following pages, a net-zero energy target was calculated for each building based on the AIA 2030 challenge. The larger umbers indicate a higher use of energy, alothough there are several targets depending on the building type.





Climate Opportunity Score: Each building's ability to respond to seasonal weather changes was analyzed through statistical analysis of historic weather data and utility energy consumption. Then, each was assigned a climate-opportunity score representing how much energy the building uses in response to changing weather and climate conditions.

Equipment Opportunity Score: An equipment opportunity score was calculated, indicating the extent of each building's energy use that is unrelated to weather and climate conditions.

The highest scoring buildings with equipment opportunity have the most potential for energy savings. The university should first consider reducing and/or replacing their energy-intensive equipment such as lighting, ventilation fans, pumps, and kitchen and scientific equipment.

- Older buildings will benefit most from repairs and technology upgrades, while new building technologies may need calibration, repair or adjustment.
- Newer buildings with digital controls that have high equipment (or climate opportunity scores) are the best candidates for automated fault detection and diagnostics systems and likely already have compatible controls.





NAU CLIMATE AUDIT PRIORITY BUILDINGS

Utility	Building	Equipment Score	Year Built
Electric	[008] Bury	0.841	1908
	[019] Physical Sciences	0.958	1960
	[020] Chemistry	0.916	1968
	[021] Biological Sciences	0.891	1967
	[021b] Biological Sciences Annex	0.966	1989
	[030] Fieldhouse	0.8	1965
	[035] Bookstore	0.925	1967
	[043] Gateway Student Success Center	0.975	1967
	[058] High Country Conference Center	0.758	2008
	[070] Social and Behavioral Sciences West	0.941	1972
	[074] Renewable Energy Test Facility	0.766	1972
	[080] Ceramics Complex	0.85	1989
	[082] Southwest Forest Science Complex	0.933	1992
	[082usfs] United States Forest Service	0.991	1992
	[088] Wettaw	0.9	2000
	[089] Fountaine Apartment	0.783	1940
	[099] Seismic Observatory	0.866	1977
	[099b] Granny's Closet	0.858	1968
	[001] Gammage	0.757	1930
	[017] Science Laboratory	0.969	2007
Steam	[018] Liberal Arts	0.833	1963
	[027] Eastburn Education	0.893	1958
	[037] Performing and Fine Arts	0.924	1969
	[037a] Ardrey Auditorium	0.787	1972
	[048] Reilly Hall	0.803	1969
	[088] Wettaw	0.954	2000
Chilled Water	[017] Science Laboratory	0.913	2007
	[058] High Country Conference Center	0.826	2008
	[064] Du Bois Center	0.804	1971
Hot Water	[073] Walkup Skydome	0.818	1977

NAU EQUIPMENT AUDIT PRIORITY BUILDINGS

Utility	Building	Equipment Score	Year Built
	[017] Science Laboratory	0.975	2007
	[069] Engineering	0.958	1972
	[016] Communication	0.933	1960
	[082] Southwest Forest Science Complex	0.908	1992
	[088] Wettaw	0.891	2000
	[070] Social and Behavioral Sciences West	0.883	1972
Electric	[073] Walkup Skydome	0.858	1977
	[037] Performing and Fine Arts	0.85	1969
	[053] Gabaldon Hall	0.833	1984
	[063] South Dining	0.816	1970
	[082usfs] United States Forest Service	0.808	1992
	[066] Health Professions	0.8	1970
	[062] McConnell Hall	0.791	1971
	[028] Cline Library	0.766	1965
	[027] Eastburn Education	0.758	1958
	[020] Chemistry	0.954	1968
Steam	[030c] University Union Food Court 30c	0.878	2009
	[003] North Union 1899	0.848	1952
	[037a] Ardrey Auditorium	0.833	1972
	[017] Science Laboratory	0.787	2007
	[003a] Prochnow	0.772	1914
	[058] High Country Conference Center	0.934	2008
Chilled Water	[037] Performing and Fine Arts	0.869	1969
	[088] Wettaw	0.804	2000
	[028] Cline Library	0.782	1965
Hot Water	[081] W.A. Franke College of Business	0.909	2005
	[072] Nursing	0.818	1978

