YEAROUT ENERGY



Diné College

Investment Grade Audit (IGA) Report

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Proprietary and Confidential

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GLOSSARY OF STANDARD INVESTMENT GRADE AUDIT ACRONYMS

ACRONYM	DEFINITION
BAS:	Building Automation System
BE:	Building Envelope
BTU:	British Thermal Units
BTUh:	British Thermal Units per Hour
CAV:	Constant Air Volume
CBECS:	Commercial Buildings Energy Consumption Survey
CFL:	Compact Fluorescent Lamps
CRAC:	Computer Room Air Conditioner
CMU:	Concrete Masonry Unit
COP:	Coefficient of Performance
DDC:	Direct Digital Controllers
DHW:	Domestic Hot Water
DX:	Direct Expansion
ECI:	Energy Cost Index
EER:	Energy Escalation Rate
EERC:	Energy Escalation Rate Calculator
EIFS:	Exterior Insulated Finish System
ERV:	Energy Recovery Ventilation
EUI:	Energy Utilization Index
FCU:	Fan Coil Unit
FIM:	Facility Improvement Measures
EPC:	Guaranteed Energy Savings Performance Contract
HPS:	High Pressure Sodium
HVAC:	Heating, Ventilation and Air Conditioning
IGA:	Investment Grade Audit
kBTU:	1,000 British Thermal Units
kgal:	1,000 Gallons
KVU:	Kitchen Ventilation Units
kWh:	Kilowatt Hour
LED:	Light Emitting Diodes
MBH:	Million British Thermal Units per Hour
MCOP:	Seasonal Marginal Coefficient of Performance
MH:	Metal Halide
MUA:	Make-up Air Unit
M&V	Measurement & Verification
NG:	Natural Gas
NIST:	National Institute for Standards and Technology
NTUA:	Navajo Tribal Utility Authority
RH:	Radiant Heaters
RTU:	Rooftop Units
SQF:	Square Feet
TPO:	Thermoplastic Polyolefin
UH:	Unit Heater
VAV:	Variable Air Volume
VFD:	Variable Frequency Drive
VRF:	Variable Refrigerant Flow
W:	Watt

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1.0 EXECUTIVE SUMMARY

In September 2020, Diné College engaged Yearout Energy following a competitive selection process to perform an Investment Grade Audit (IGA) of more than 60 buildings located on the Tsaile and Shiprock campuses (North and South). The intent of the IGA was to assess current facility conditions and identify opportunities to improve overall operations and performance through an Energy Performance Contract (EPC).

The primary objectives established for this project include:

- Improve indoor ventilation, air quality, and occupant thermal comfort
- Reduce energy and water consumption
- Reduce utility and operational costs
- Generate clean renewable energy on site to accelerate resiliency
- Replace existing equipment that has surpassed its useful life
- Address significant deferred maintenance issues
- Upgrade critical aging HVAC systems
- Standardize equipment throughout all facilities
- Improve equipment and system reliability
- Leverage available grants, incentives, and utility savings to develop a self-funding project
- Increase pandemic preparedness
- Set a priority on supporting the local community and ensuring responsive ongoing support by hiring qualified Navajo tradesman and local businesses to execute the project scope
- Reduce Dine College's carbon footprint

A fundamental benefit of EPC projects is that they allow for the savings from measures with quicker returns on investment to supplement the funding of critical infrastructure improvements and/or high priority capital intensive measures, such as HVAC upgrades. To accomplish the primary project objectives, the following recommended scope of work has been co-developed by Yearout Energy and Diné College for the facilities on the Tsaile Campus:

- Upgrade ~5,500 existing lighting fixtures to LED technology with lighting controls in select areas
- Install a 1 MW DC solar photovoltaic (PV) system to generate clean renewable energy on site
- Replace aged and inefficient HVAC equipment at high priority facilities
- Add space cooling and increase ventilation at high priority facilities to improve occupant comfort and indoor air quality

- Upgrade ~570 existing domestic water fixtures to reduce water consumption and improve pathogen control through hands-free operation
- Remediate ~130 ft^2 of existing air leakage in building envelope to reduce energy losses
- Install 16 new high efficiency transformers to reduce energy losses
- Hazardous materials testing and abatement

The benefits from those measures are summarized in the following table.

Table 1: Facility Improvement Measures (FIM) Summary

FIM No.	FIM Name	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs	Average Service Life Years
1.00	LED Lighting	$50,775	$7,140	$57,915	$698,458	15.0
2.00	Renewable Energy	$200,337	$0	$200,337	$2,378,419	30.0
3.00	HVAC System Upgrades	($26,720)	$0	($26,720)	$6,749,342	20.0
4.00	Building Envelope	$22,280	$3,342	$25,622	$151,144	20.0
5.00	HE LV Transformers	$16,227	$2,434	$18,661	$198,200	32.0
6.00	Water Conservation	$10,096	$1,514	$11,610	$354,182	20.0
7.00	Hazardous Material Testing and Abatement Allowance	$0	$0	$0	$981,763	-
Total		$272,995	$14,431	$287,425	$11,511,508	20.3

As a result of the comprehensive IGA process, the project team has developed a project that provides Diné College with a tremendous opportunity to leverage available grants and future utility and operational cost savings to self-fund immediate essential capital improvements and make noteworthy advancement towards Diné College's goal to become carbon neutral. Additional phases of work can be explored at Diné College's discretion for the remaining campuses at a later date.

Table 2: Tsaile Campus EPC Project Summary

Turn-Key EPC Project Price	$19,899,603
Up-front Capital Contribution by Diné College	$16,000,000
Approximate Net Financed Amount (Includes CAPI & Cost of Issuance)	$4,136,699
Year 1 Utility Savings	$272,995
Year 1 Operations and Maintenance Savings	$14,431
Project Financing Period	16 Years
Weighted Average Service Life of Proposed Measures	20.3 Years
Percent Reduction in Annual Utility Costs at Tsaile Campus	32.9%
Environmental Impact (Reduction in Annual CO_2 Emissions)	2,142,533 lbs. CO_2
Environmental Impact (Reduction in Annual Water Consumption)	759,600 gallons

Following the independent 3rd party review and acceptance of this report by Diné College, Yearout Energy will develop an Energy Performance Contract (EPC) to implement the final agreed-upon project scope. Yearout Energy anticipates the implementation of this project to commence in Q4, 2021, with an 18-month overall construction period.

2.0 FACILITY DESCRIPTIONS

Diné College is a tribally controlled and accredited collegiate institution that has campuses in three states within the Navajo Nation. Figure 1 shows the approximate location of the Navajo Nation as it sits amongst Arizona, New Mexico, and Utah.

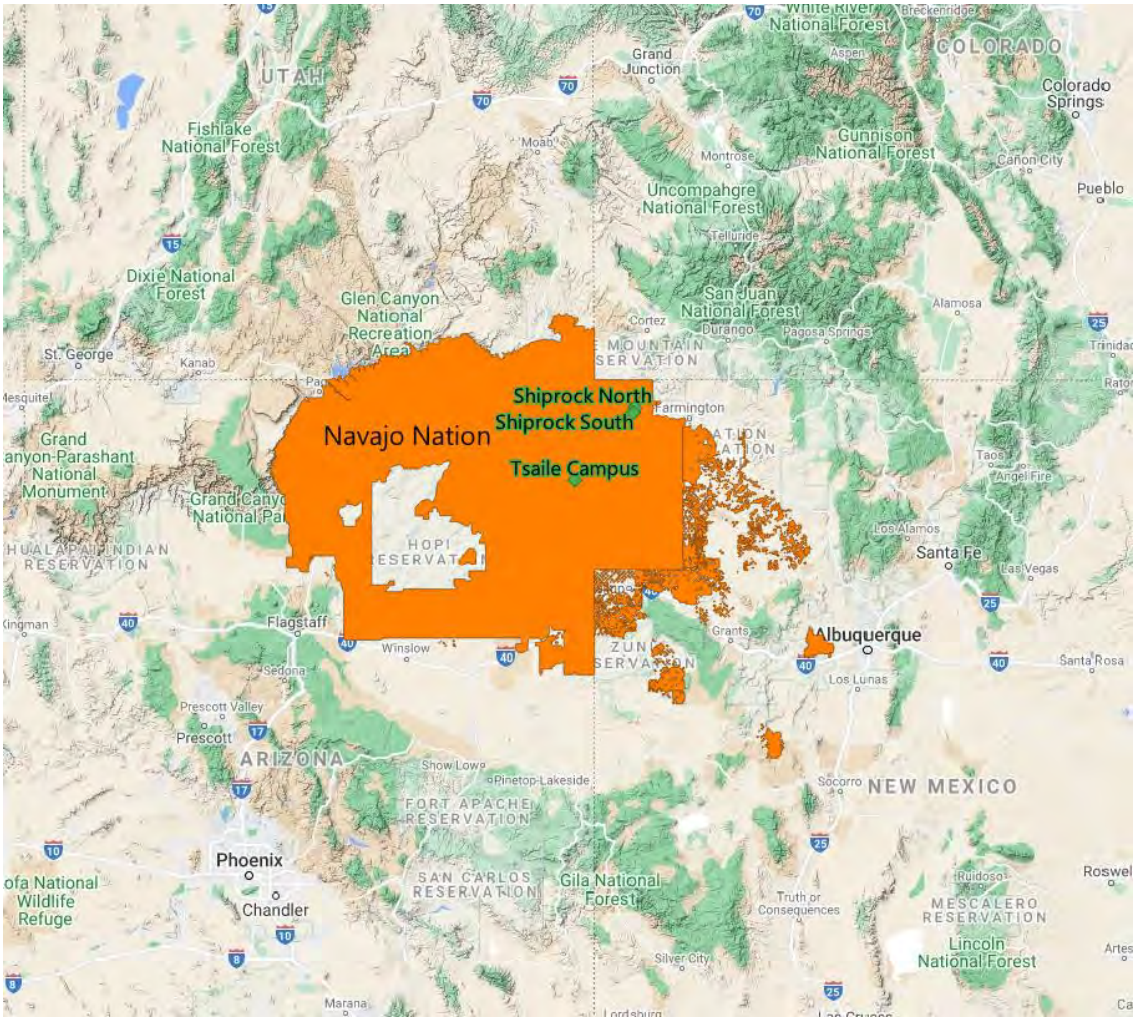


Figure 1: Navajo Nation Map

During the IGA, more than 42 facilities were audited across three campuses in two states (AZ & NM). The largest of these being the main campus in Tsaile, Arizona. There are two smaller campuses in Shiprock, New Mexico. Shiprock South is the newest addition to the school's facilities and Shiprock North was acquired from the Bureau of Indian Affairs. It was not communicated when this transfer took place.



Figure 2: Diné College Tsaile Campus Aerial Image



Figure 3: Diné College Shiprock South Campus Aerial Image



Figure 4: Diné College Shiprock North Campus Aerial Image

To initiate the project, Diné College provided general information for the IGA facilities in the form of the IGA Facility Workbook which can be found in **Appendix A**. The facilities included in the IGA have a total combined gross area of 606,500 ft^2 as shown in Table 3 and Table 4. These facilities have been divided by campus.

Table 3: Tsaile Campus IGA Facility List

Facility No.	Site	Gross Area (ft^2)	Year Built / Renovated
01	Tsaile Day Care	2,705	2007
02	Tsaile North Ceremonial Hogan	508	1971
03	Tsaile Maintenance	16,148	1971
04	Tsaile Silversmith	1,520	1972
05	Tsaile South Ceremonial Hogan	444	1971
06	Tsaile Student Success Center	6,533	2013
07	Tsaile Archival Center	8,002	2012
08	Tsaile Cafeteria	12,611	1971
09	Tsaile Guy Gorman Classroom Building	29,159	1971
10	Tsaile Gym	20,538	1971
11	Tsaile Library	25,434	1972
12	Tsaile Ned Hatathli Center	73,428	1974
13	Tsaile Network Operating Center	6,588	2006
14	Tsaile Head Start	2,688	1980
15	Tsaile Post Office	851	2013
16	Tsaile Oak A Dorm	8,137	1971

Facility No.	Site	Gross Area (ft^2)	Year Built / Renovated
17	Tsaile Pine B Dorm	7,959	1971
18	Tsaile Aspen C Dorm	7,907	1971
19	Tsaile Spruce D Dorm	8,006	1971
20	Tsaile Cottonwood E Dorm	7,956	1971
21	Tsaile Juniper F Dorm	7,944	1971
22	Tsaile Maple G Dorm	7,955	1971
23	Tsaile Cedar H Dorm	7,911	1971
24	Tsaile Willow I Dorm	7,959	1971
25	Tsaile Pinon J Dorm	7,956	1971
26	Tsaile Student Union	30,395	1973
27	Tsaile Student Family Housing	53,313	2014
28	Tsaile Central Hogan	1,150	2007
29	Tsaile Faculty Office Building 1	812	2016
30	Tsaile Faculty Office Building 2	812	2016
31	Tsaile Faculty Office Building 3	4,569	2018
32	Tsaile Land Grant Modular Building	2,070	2006
33	Tsaile Faculty Housing	112,425*	Varies
Total		492,393	-----

** Total sq ft of several complexes estimated.*

Table 4: Shiprock South Campus IGA Facility List

Facility No.	Site	Gross Area (ft^2)	Year Built / Renovated
34	Shiprock South Student Success Center	3,293	2013
35	Shiprock South Classroom Building	15,945	2004
36	Shiprock South Library	23,100	2012
Total		42,338	-----

Table 5: Shiprock North Campus IGA Facility List

Facility No.	Site	Gross Area (ft^2)	Year Built / Renovated
37	Shiprock North Campus	64,817	1952
38	Shiprock North Chemistry Modular	2,161	1998*
39	Shiprock North Biology Modular	2,598	1998*
40	Shiprock North Office Modular	742	1998*
41	Shiprock North HIV Center Modular	604	1998*
42	Shiprock North GIS/GPS Modular	847	1998*
Total		71,769	-----

**Date of build for the modular buildings was not recorded, estimated based on HVAC equipment age.*

IMPORTANT NOTE:

During the IGA, Diné College and Yearout Energy determined that the scope of this initial EPC project phase will be focused on the Tsaile Campus, excluding the housing complexes that exist outside the inner circle.

2.1 Tsaile Campus

2.1.1 Tsaile Day Care



Facility Facts:	
Facility Name	Tsaile Day Care
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	2,705
Year Built	2007
Avg. Daily Occupancy (Staff / Visitors/ Students)	6/6/10

2.1.1.1 Facility Description

This facility is located on the North side of the central circle on the Tsaile campus.



Figure 5: Aerial view of Tsaile Day Care Building

This building serves as a daytime childcare for the surrounding community, including faculty and students. There are two main childcare rooms, one main room with a supporting literacy room. There are three bathrooms, two that serve the childcare rooms and one adult specific restroom. Food is prepared in the kitchen and served in the dining room. There are three storage rooms, including a panty in the kitchen. The utility room is central with entrances off the kitchen. One office serves the staff.

2.1.1.2 Hours of Operation

Monday	7:30 am – 5:30 pm
Tuesday	7:30 am – 5:30 pm
Wednesday	7:30 am – 5:30 pm
Thursday	7:30 am – 5:30 pm
Friday	7:30 am – 5:30 pm

Saturday	Closed
Sunday	Closed

2.1.1.3 Building Envelope

This is a typical single-story building with an open covered ADA entrance way. The roof is a low pitch gable roof, graded to the north and south and covered with white TPO. There is no drainage management installed on the roof edges. The entrance way is covered with a metal roof structure. The walls are typical batt insulated 2x4 stud construction with an adobe exterior and sheetrock interior. The windows throughout the building are double-paned with metal frames. The doors are solid metal doors, with the main entrance having a small, reinforced window.



Figure 6: Window and Exterior wall of Day Care

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Several penetrations and openings are located around the perimeter walls, especially around the exterior wall mounted package units, where air infiltration/exfiltration and energy loss occur.

See Appendices G1 for a detailed report on the building envelope.



Figure 7: Heat infiltration around Day Care wall package unit

2.1.1.4 Lighting

Interior lighting in this building consists of 2'x4' fixtures with four, 32W T8 lamps in most of the spaces. The restroom lighting consists of bath fan type light fixtures, two are fitted with a single 13W LED bulb and the third has a 4W LED. Additionally, in one of the storage closets there is a 6" can light with a 60W incandescent bulb. Mixed with the typical 2'x4' fixtures in the dining room there is a single 6" can light with a 13W CLF bulb. Exit signs consist of 3W LED lamps paired with a 3W emergency wall pack light. The exterior illumination is via two wall pack fixtures with one 13W CFL. There are no existing lighting controls or occupancy sensors in this building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.1.5 HVAC Equipment

The Heating, Ventilation, and Air Conditioning (HVAC) systems are comprised of three wall mounted reversible heat pumps (WMRHP) to provide cooling and heating. Control of the WMRHPs is limited to directly connected digital thermostats that the occupants have had issues with. The kitchen includes a commercial-style hood.



Figure 8: Wall mount package units at the Day Care

A list of equipment is tabulated in **Appendix C1**.

2.1.1.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a daycare center. There are office plug loads such as computers, monitors, and printers located in the office. Additional equipment present in the kitchen are a dishwasher, microwave, hot plates, and a refrigerator. The remainder of the rooms are classrooms, a laundry room, and some office spaces; all have typical plug loads commonly found in these space types.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.1.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the electric DHW unit is in the utility room. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.1.8 Other

None.

2.1.2 Tsaile North and South Ceremonial Hogan



Facility Facts:	
Facility Name	Tsaile North and South Ceremonial Hogan
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	508 & 444
Year Built	1971
Avg. Daily Occupancy (Staff / Visitors/ Students)	Very limited

2.1.2.1 Facility Description

These facilities are located on the West side of the central circle Tsaile campus just to the North and South of the Ned Hatathli Center.



Figure 9: Aerial view of Tsaile North and South-Central Hogan

These buildings serve as ceremonial and meeting spaces for the faculty and students. These spaces are infrequently used and are very low priority for the school. Yearout Energy will not be making recommendations for any upgrades for these buildings due to construction, use time, and priority of Diné College.

2.1.2.2 Hours of Operation

These buildings are used very infrequently throughout the year.

2.1.2.3 Building Envelope

These buildings are constructed from logs with chinking to seal any gaps. They have single pane windows that are old. The entire interior is unfinished, including the dirt floor. The roofs are rolled composite and are past their useful life.

2.1.2.4 Lighting

There is limited interior light and consisting mainly of CFL and incandescent bulbs. Yearout Energy does not have any recommendations for upgrades due to the limited use in this building and they have been excluded from our light inventory.

2.1.2.5 HVAC Equipment and Controls

There is little to no HVAC equipment in these buildings. The heating is mainly accomplished by central fireplaces. There is no inventory of equipment in these buildings.

2.1.2.6 Plug Loads

The plug loads in these buildings are insignificant and will not be included in the inventory.

2.1.2.7 Domestic Hot Water

No domestic hot water is supplied to these buildings.

2.1.2.8 Other

None.

2.1.3 Tsaile Maintenance



Facility Facts:

Facility Name	Tsaile Maintenance
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	16,148
Year Built	1971
Avg. Daily Occupancy (Staff / Visitors)	40/25

2.1.3.1 Facility Description

This facility is located on the south side of the central circle Tsaile campus.



Figure 10: Aerial view of Maintenance Building

This Maintenance building serves as the shop, offices, and storage for all O&M and Projects staff as well as the security personnel at the Tsaile campus. An entryway acts as security checkpoint to the building. Two restrooms serve the entire building, one being a typical, public type of bathroom and the other having shower stalls. There are seven offices to serve the employees, one meeting room, and a break room. Six garage bays exist on the west side of the building, including one extended bus bay. A general shop and electronics shop are located to the North of the building. There are ten storage rooms of differing sizes, to serve the maintenance staff's varied storage needs. The mechanical room is on the west side of the building with access from the exterior.

2.1.3.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.3.3 Building Envelope

This is a single-story building with raised ceilings in the garage bay and shop areas. The roof consists of five different sections with different grades. The flat sections over the office building are covered with white TPO construction. The roof sections over the shops and garage areas are metal roof construction with a white protective paint layer. There are scuppers placed around the roof for drainage, but there is nothing to direct the water away from the building beyond possible landscape grade. The building is mainly brick exterior construction with adobe overhangs and soffits. There is not any interior insulation of the exterior brick walls, and the interior walls are constructed with cinder blocks that are painted white. Most windows throughout the building are double-paned with a metal frame. The main entrance is a metal framed door with a large glass section. There are several other full metal doors and multiple large metal bay doors.



Figure 11: Maintenance building interior wall construction.

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Unsealed

Penetrations, expansion joints, and blank openings are another source of unwanted air and moisture infiltration/ex-filtration leading to energy loss.

See Appendices G1 for a detailed report on the building envelope

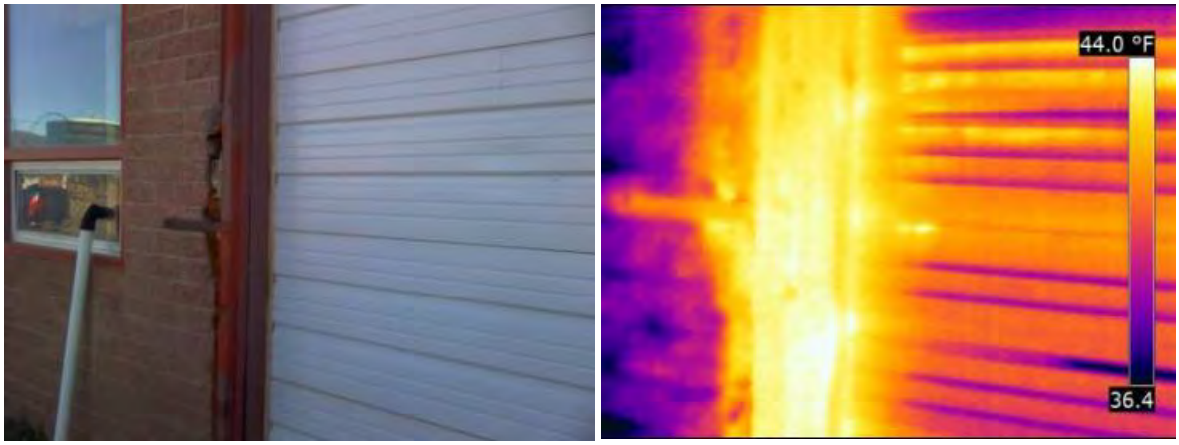


Figure 12: Heat infiltration around Maintenance building bay door.

2.1.3.4 Lighting

Interior lighting for most of the rooms consists of 2'x4' and 1'x4' troffers with either two or four 32W T8s, and a few 40W T12s. About one-quarter of the fixtures are 1'x8' and 1'x4' recessed strip lighting with four or two, respectively, 32W T8s and a hand full of 40W T12s. In the hallways and one storage room there 2'x4' and 1'x4' wrap light with two and four 32W T8s. There are four exit signs, each with two 20W halogen bulbs and one sign with two 20W incandescent bulbs. Currently there are three LED fixtures in two of the offices and one restroom. One restroom has a spiral 13W CFL type fixture. In one garage and storage room, there are 1'x12' high bay suspended fixtures with six 30W T8s. In the maintenance shop, there are two low-bay surface lights with one 100W mercury vapor bulbs each. The exterior illumination consists of a 20W LED and eight 175W metal halide wall packs as well as four 100W metal halide canopy recessed fixture. There are no existing interior lighting controls or occupancy sensors in this building. The exterior lights are controlled by an analog timer and photo sensors on the pole lights.



Figure 13: Maintenance building exterior recessed metal halide fixtures.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.3.5 HVAC Equipment and Controls

Most of the heating load is covered by a hydronics system with a boiler located in the mechanical room. In the office section of the building, the hydronic heat is transferred by radiant heaters and fan coil units. Hydronic unit heaters cover most of the shop and garage sections. The pumps for the hydronics system are old and do not have VFD control. The control of the entire hydronic system is provided by Emerson digital thermostats and this system is only run during heating season. There is no central source of cooling for this building. There are exhaust fans located in some of the shops and garage spaces. Several of the offices do have portable AC and heating units.



Figure 8: Maintenance building hydronic unit heater and exhaust fan

A list of equipment is tabulated in **Appendix C1**.

2.1.3.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a maintenance building. There are office plug loads such as computers, monitors, and printers located in the offices. In the breakroom there is a microwave, coffee machine, toaster, refrigerator, and water cooler. The garage spaces include several wood working, machine shop, and automotive tools. To calculate the garage plug load annual wattage, the square footage of these areas was multiplied 1.5 W/ft^2 average from IEEE table 6.1.2, then by the time of use.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.3.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in a mechanical closet and includes a 40-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.3.8 Other

None.

2.1.4 Tsaile Silversmith



Facility Facts:

Facility Name	Tsaile Silversmith
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	1,520
Year Built	1972
Avg. Daily Occupancy (Staff / Students)	1/11

2.1.4.1 Facility Description

This facility is located on the south side of the central circle Tsaile campus, just south of the Maintenance building.



Figure 14: Aerial view of the Silversmith building

The Silversmith building houses all the equipment and material for Diné College's silversmith program and classes. In this building there is a vestibule and office reception area. Off the reception area, there are two offices to the West. Two main rooms contain most of the equipment necessary for silversmithing, as well as instruction. There is one storage rooms where extra equipment and supplies are stored. One restroom serves the entire building.

2.1.4.2 Hours of Operation

This building is used intermediately during the school year. Typically, one three credit hour course is run out of this building. Yearout Energy estimates its hours of operation to be 12:00 PM to 3:30 PM twice a week.

2.1.4.3 Building Envelope

This is a single-story building. The roof consists of three different sections. There are two flat sections over a large portion of the building and one-half hexagonal cone section. The roof is entirely composed of white TPO construction. There is no drainage management installed on the roof edges. The entrance way is covered with a metal roof structure. The walls are typical bat insulated 2x4 stud construction with an adobe exterior and sheetrock interior. The windows throughout the building are double-paned with metal frames. There are several doors, they are mostly metal with the main entrance having a small, reinforced window.



Figure 15: Typical windows found in the Silversmith building.

A large area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip, door sweeps, and astragals lead to energy waste through outside air infiltration.

Unsealed penetrations and blank openings are another source unwanted air and moisture infiltration/exfiltration leading to energy loss.

See Appendices G1 for a detailed report on the building envelope

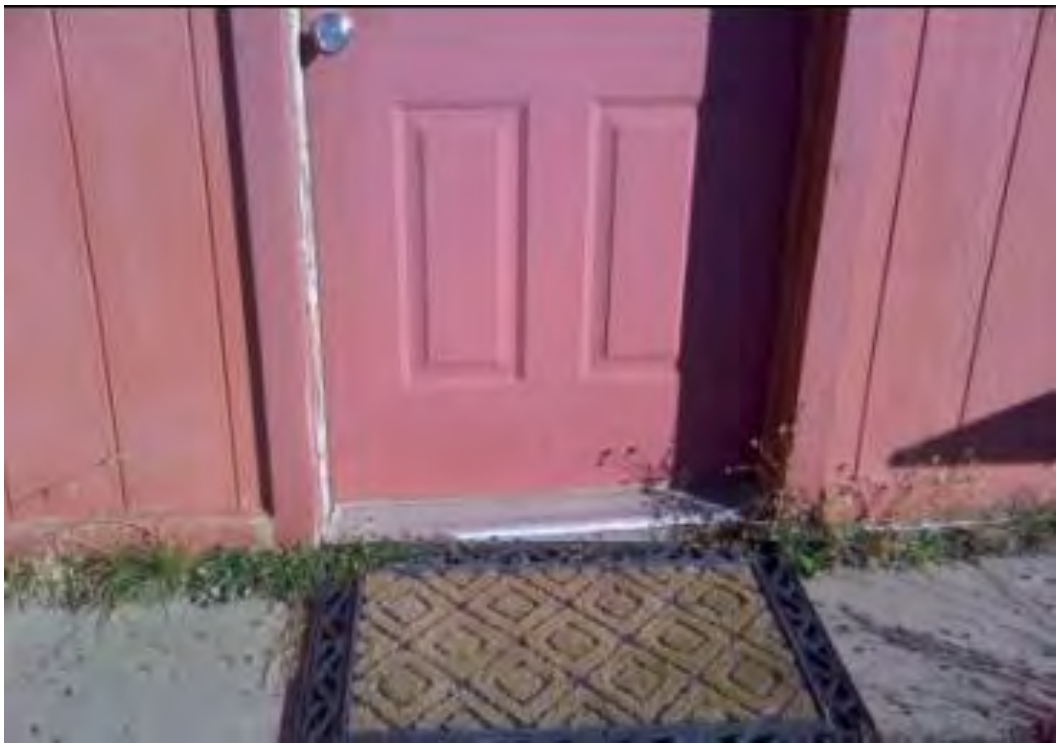


Figure 16: Damage on the door jamb at Silversmith building compromising seals.

2.1.4.4 Lighting

Interior lighting for most of the rooms consists of 2'x4' and 1'x4' troffers with either two or four 32W T8s. There are both recessed and surface mounted troffers. The bathroom has a surface mount vanity fixture with two 20W T12s. There is one exit signs with two 20W halogen bulbs. The exterior illumination consists of a 175W metal halide wall pack and one 75W metal halide 10" recessed can fixture. There are no existing lighting controls or occupancy sensors in this building. Yearout recommends upgrading to LED lights in all the areas that see any more than low use times.



Figure 17: Surface mount troffers found in the Silversmith building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.4.5 HVAC Equipment and Controls

The heating for this building is accomplished by an electric unit heater. This unit is controlled by a wall mounted dial thermostat. For cooling, there is a wall mounted split system which is controlled be a digital thermostat.



Figure 18: The unit heater and split system HVAC units in the Silversmith building.

A list of equipment is tabulated in **Appendix C1**.

2.1.4.6 Plug Loads

The plug loads associated with this building vary by space type and include specialized loads for a silversmith. There are office plug loads such as computers, monitors, and printers located in the office. There is a residential sized kitchen. Figuring out a plug load for the silversmith equipment was difficult as there were no classes, students, or teachers on campus, due to COVID-19. To estimate the silversmith equipment, plug load in kwh/yr the square footage of the silversmithing room was multiplied by 1.5 W/ft^2 and then by time of use according to the class schedule.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.4.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in a mechanical closet and includes a propane tank heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.4.8 Other

None.

2.1.5 Tsaile Student Success Center (SSC)



Facility Facts:

Facility Name	Tsaile SSC
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	6,533
Year Built	2013
Avg. Daily Occupancy (Staff / Visitors/ Students)	16/3/14

2.1.5.1 Facility Description

This facility is located to the southeast side of the center point of the circle Tsaile campus just west of the GCB building.



Figure 19: Aerial view of the Tsaile Student Success Center

The Student Success Center is the headquarters for the school's student support services. Two entrance areas open to a reception area. There are eighteen offices for the staff, two conference rooms, and a break room. A west, east, and connecting hallway give access from the reception area. Five storage closets are sprinkled throughout the building, with a larger storage room behind the reception desk. An IT room is also located just behind the reception desk. The building is served by a men's and women's restroom. The copy room is located amongst the offices. There is a janitor's closet to allow the janitorial staff to service the building. A mechanical room is located on the west side of the building and there is an electrical service room to the south; both are accessed from the exterior.

2.1.5.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.5.3 Building Envelope

This is a single-story building with a metal roof. There is a main roof section and two small quarter hexagon sections to the North. The main section is a gable style roof. There is drainage management installed on the roof. The walls are typical bat insulated 2x4 stud construction with sheetrock interior. The exterior is a combination of adobe and stone. The windows throughout the building are double-paned with metal frames. Doors at the entrances are metal frame with large glass sections, and other doors are solid metal doors.

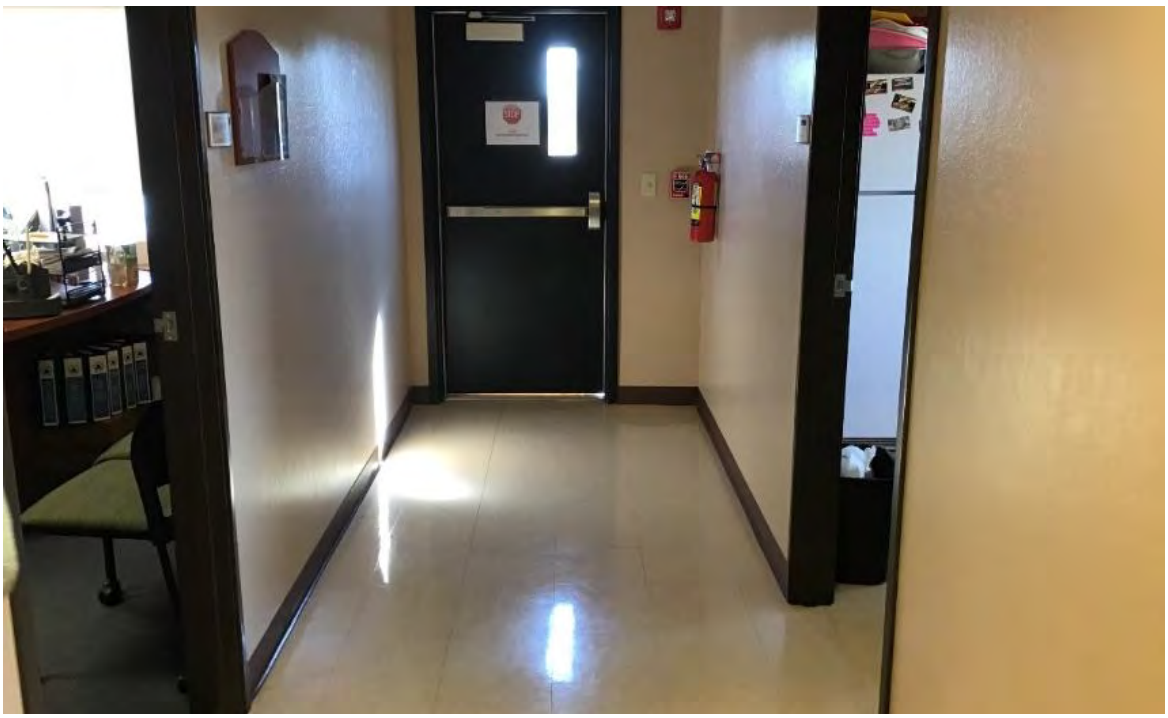


Figure 20: SSC interior construction and exterior door.

The double-paned tinted windows appear to be in good condition; however, several windows have weathered and ineffective sealant that allow air infiltration along the perimeter. Damaged and missing

weather-strip and door sweeps lead to energy waste through outside air infiltration. Unsealed penetrations are another source of unwanted air and moisture infiltration/ex-filtration leading to energy loss and waste.

See Appendices G1 for a detailed report on the building envelope



Figure 21: Gap under exterior door at the SSC allowing air infiltration.

2.1.5.4 Lighting

Interior lighting mainly consists of recessed 2'x2' and 2'x4' troffers with either two or three 32W T8s. There is a single wrap style 1'x4' light in the mechanical room with two 32W T8s. The eight exit signs have 3W LEDs. The exterior illumination consists of two wall packs - one with a 150W HPS bulb and the other with 20W LED bulb. There are no existing interior lighting controls or occupancy sensors in this building and the exterior lights are controlled by a timer and photo sensors on the pole lights.



Figure 22: 2'x2' recessed troffers in the reception area of the SSC.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.5.5 HVAC Equipment and Controls

The main HVAC system is a forced air system with propane furnaces in the mechanical room connected to electric condensers on the exterior of the building. The air is transferred to the spaces with above ceiling duct work with recessed diffusers. There is a dedicated split system for cooling the IT room. Temperature controls are digital thermostats. There are exhaust fans in the restrooms.



Figure 23: The furnaces and condensers found at the SSC.

A list of equipment is tabulated in **Appendix C1**.

2.1.5.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for an office space. There are office plug loads such as computers, monitors, and printers in the offices. Some of the offices have a small UPS for backup purposes. There is a break room with a coffeemaker, microwave, and a refrigerator. The IT room holds a server and several switches. There are several conference rooms with LCD TVs and projectors for display, as well as teleconferencing units exist in the building. There is a copy room that holds a large copy machine and scanner.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.5.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in a mechanical closet and includes a propane tank heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.5.8 Other

None.

2.1.6 Tsaile Archival Center



Facility Facts:

Facility Name	Tsaile Archival
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	8,002
Year Built	2012
Avg. Daily Occupancy (Staff / Visitors/ Students)	8/4/4

2.1.6.1 Facility Description

This facility is located on the south side of the central circle Tsaile campus just east of the Maintenance building.



Figure 24: Aerial view of the Tsaile Archival Center

The Archival Center houses artifact archives as well being used as an office space. Two entrance areas open to a reception area. A vestibule, with a conference room just off to the north, enters a main lobby. The lobby is currently being used as an office space overflow. Off the lobby there is a breakroom, IT room, storage closet, a west exit vestibule, and a men's and women's restroom that serves the entire building. The south side of the building is the archives section. There are two rooms dedicated to media archives like books, videos, film, etc. For all other archives, there are two more rooms. There are dedicated mechanical closets in two of the archive rooms. In between the archive rooms there is a sorting and inspection room. Attached to the sorting room, there is an office and

another vestibule to the south entrance. A larger mechanical room and an electrical room are located on the east side of the building with access from the exterior.

2.1.6.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.6.3 Building Envelope

This is a single-story building with a vertical seem metal roof. The roof is a modified gable style roof with most of the roof being sloped to the west. There is drainage management installed on the roof. The walls are typical bat insulated 2x4 stud construction with sheetrock interior. The exterior is a combination of adobe and stone. The windows throughout the building are double-paned with metal frames. Doors at the entrances are metal framed with large glass sections, and other doors are solid metal doors.



Figure 25: Archival Center west entrance windows.

The sweeps and weather strips around the doors are not in working condition. The double-pane windows appear to be in good condition, however, areas of sealant on four windows are worn,

deteriorated, and no longer effective. Our team also noted unsealed penetrations that allow unwanted air, moisture infiltration/exfiltration, and energy loss.

See Appendices G1 for a detailed report on the building envelope.

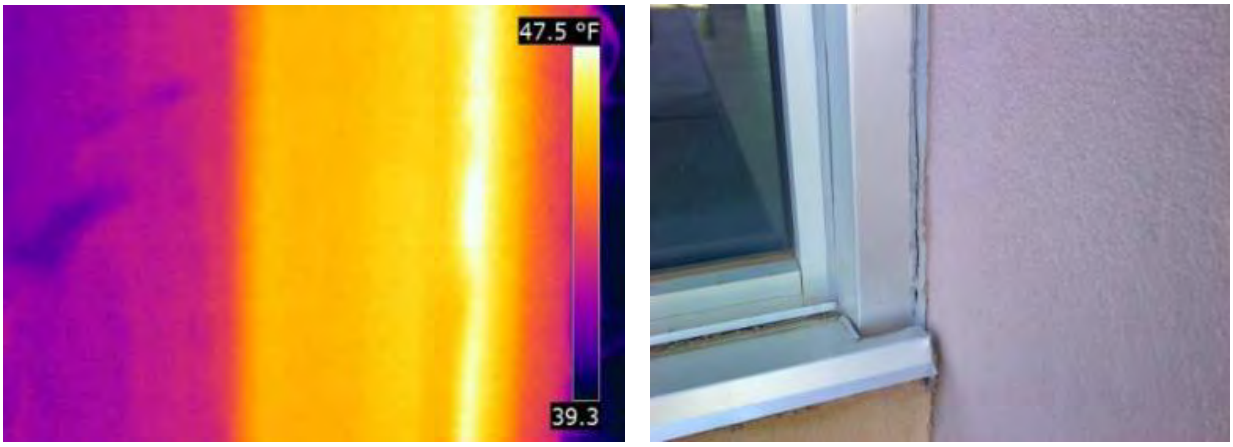


Figure 26: Heat loss due to damaged seal around a window at the Archival Center.

2.1.6.4 Lighting

Interior lighting mainly consists of 1'x4' prismatic cable suspended fixtures with two 32W T8s. In each restroom there is a surface mount wall surface mount'x4' fixture with a single 32W T8, 1'x2' fixture with a single 17W T8s, and three recessed 8" can lights with two 18W CFLs. In the Lobby area there are 3 high bay pendant fixtures with 250W metal halide bulbs, a single high bay pendent with a 42W CFL bulb, four wall wash suspended 1'x4' with 28W T5s, and 2 8" recessed can lights with 18W CFL bulbs. There are two 2'x4' recessed troffer lights, in both the break room and archives office, with two 28W T5s. In the conference room, there are two 2'x4' recessed troffer lights with four 28 T5s. In one of the vestibules, there is one 6" recessed can each with a 23W CFL. The five exit signs have 3W LEDs. The exterior illumination consists of 10 50W high pressure sodium wall packs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer.



Figure 27: High Bay light in lobby and troffers in conference room of the Archival Center.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.6.5 HVAC Equipment and Controls

The main HVAC system is a forced air system with propane furnaces in the mechanical room as well as the dedicated space mechanical closets connected to electric condensers on the exterior of the building. The air is transferred to the spaces with a combination of above ceiling duct work with recessed diffusers and exposed duct with duct mounted diffusers. There is a dedicated split system for cooling the IT room. Temperature controls are direct connection digital thermostats. There are exhaust fans in the restrooms. Also, in the archive rooms there are small exhaust fans with movable tubes for discrete exhaust needs.



Figure 28: Exterior condensers found at the Archival Center.

A list of equipment is tabulated in **Appendix C1**.

2.1.6.6 Plug Loads

The plug loads associated with this building vary by space type. There are office plug loads such as computers, monitors, and printers located in the offices, conference room, and the lobby that was converted to an office. In the archives section of the building, there are specialized tools used for restoration and proper long-term care of the items. To estimate the specialized tools, the shop density of 1.5W/ft^2 times the occupied square footage of this area times the use time percentage. There is a break room with a refrigerator, microwave, coffee machine, and dishwasher.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.6.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the mechanical room and include a 100-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.6.8 Other

None.

2.1.7 Tsaile Cafeteria



Facility Facts:

Facility Name	Tsaile Cafeteria
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	12,611
Year Built	1971
Avg. Daily Occupancy (Staff / Visitors/ Students)	12/9/80

2.1.7.1 Facility Description

This facility is located just north of the midpoint of the central circle Tsaile campus just west of the SUB building.



Figure 29: Aerial view of the Tsaile Cafeteria

The cafeteria serves students as well as staff on campus, and is open for breakfast, lunch, and dinner. Two vestibules open into an entry space on opposite sides of the building. Half the building is made up of a large dining area surrounding a serving area. There are two corridors off the dining room that leads to the two sets of men's and women's restrooms. Off the serving area is the kitchen which is attached to the dishwashing area. To the north of the kitchen is a large storage room with walk in freezers. There are four other smaller storage areas spread out in the north side of this building. Next to the large storage room is a trash room and a kitchen staff's men's and women's restrooms. A much smaller auxiliary dining room is located to the northeast of the building. Four offices sit next to the auxiliary

dining room. A boiler room is located on the west side of the building with access from the exterior. There is a mezzanine above the kitchen that hold the air side of the HVAC system.

2.1.7.2 Hours of Operation

Monday	7:00 am – 7:00 pm
Tuesday	7:00 am – 7:00 pm
Wednesday	7:00 am – 7:00 pm
Thursday	7:00 am – 7:00 pm
Friday	7:00 am – 7:00 pm
Saturday	10:00 am – 6:00 pm
Sunday	10:00 am – 6:00 pm

2.1.7.3 Building Envelope

This is a one and a half story building with a white TPO roof. The roof is a hexagonal roof sloping from the center point. There is no drainage management installed on the roof. The walls are brick construction. The windows take up about ¾ of the wall on the front half of the building and are double paned with metal frames. Doors at the entrances are metal framed with large glass sections, and other doors are solid metal doors.



Figure 30: Back side of the cafeteria kitchen entrance.

A large area of infiltration/ex-filtration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Our team also noted unsealed penetrations that allow unwanted air and moisture infiltration/exfiltration and energy

loss. The roof wall seam was also an area of concern. The seam separation has caused breaks in the thermal and pressure barriers. These are essential components in maintaining the proper pressure within the structure.

See Appendices G1 for a detailed report on the building envelope.

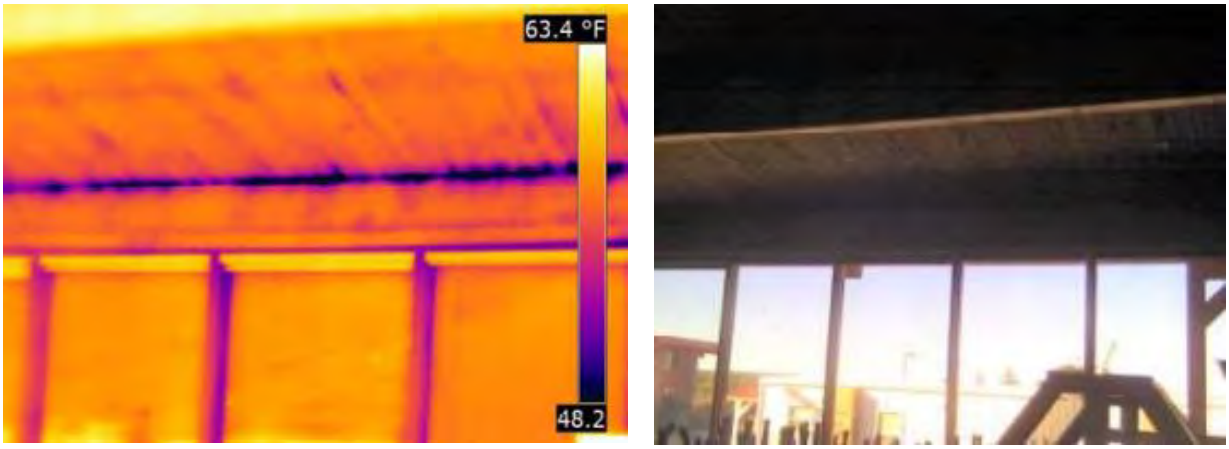


Figure 31: Heat loss due to damaged roof wall seal at the cafeteria.

2.1.7.4 Lighting

Interior lighting mainly consists of 1'x4' surface mount wrap fixtures and 2'x4' recessed troffers with two, three, or four 32W T8s. In the corridor there are two 10" can lights with 9.5W LEDs, as well as two emergency wall fixtures with two 3W LED bulbs each. The vestibules there are four 6"can lights with 13W LEDs. The three exit signs have 3W LEDs. The exterior illumination consists of two 175W metal halide, and two 50W LED wall packs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer.

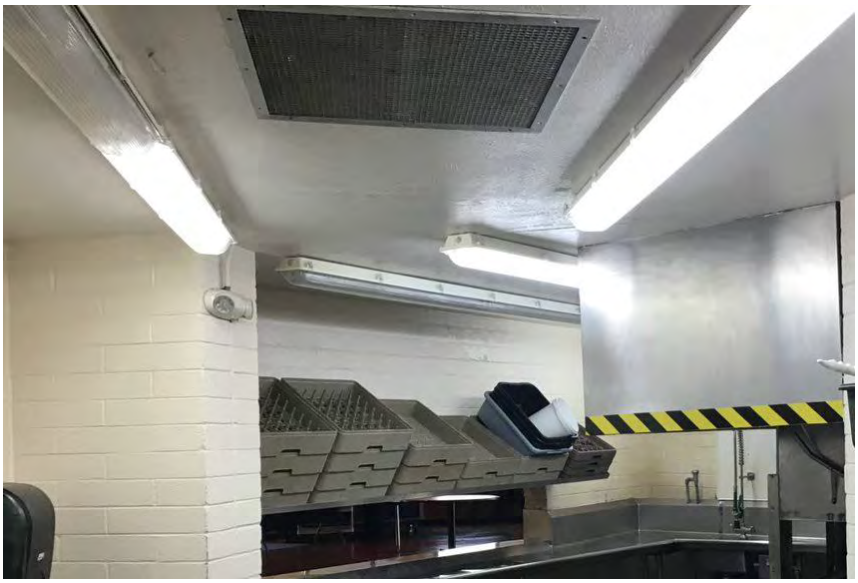


Figure 32: Wrap style fixtures with T8 bulbs found throughout the kitchen area of the cafeteria.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.7.5 HVAC Equipment and Controls

The main source of heating is provided by a hydronic boiler in a dedicated room on the ground floor. The pumps are old and do not have any VFD controls. The hot water is then transferred to radiant hot water coils in the perimeter walls of the dining area. There are AHUs in the mezzanine area that feed ceiling vents in the kitchen section and exterior wall up vents in the dining area, but these are no longer functional. The make-up air (MUA) units and fans for the kitchen also sits in the mezzanine and are not in operational condition. Temperature controls are non-programable dial thermostats, and this system is only operated during the heating season. There is no source of central cooling, but there several window AC and portable evaporative cooling units around the building.



Figure 33: AHUs and kitchen fans in the cafeteria mezzanine.



Figure 34: HW radiant wall units and window evaporative cooling units in dining area of cafeteria.

A list of equipment is tabulated in **Appendix C1**.

2.1.7.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a cafeteria. There are office plug loads such as computers, monitors, and printers located in the offices. There is a commercial grade kitchen that includes fryers, stoves, freezers, refrigerators, and other equipment. The remainder of the rooms are for dining, restrooms, and storage spaces. There are a significant number of fans, portable evaporative units, and space heaters in this building to make up for the HVAC deficiencies.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.7.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the mechanical room and include a 100-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.7.8 Other

None.

2.1.8 Tsaile Guy Gorman Classroom Building (GCB)



Facility Facts:

Facility Name	Tsaile GCB
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	29,159
Year Built	1971
Avg. Daily Occupancy (Staff / Visitors/ Students)	20/10/203

2.1.8.1 Facility Description

This facility is located just to the south of the middle of the central circle Tsaile.



Figure 35: Aerial view of the Tsaile GCB.

The GCB mainly serves as a classroom building but also houses several staff offices. There are twenty-one classroom spaces that include an arts room as well as several traditional rooms and computer laboratories. In between the chemistry and biology labs is a smaller room that houses the larger laboratory equipment. There are twelve offices spread out in the classroom spaces. An office area with a reception space, three offices, and two closets sit in the southeast corner of the building. Two groups of men's and women's restrooms, with a janitors' closets between them, reside in the two different hallways. Behind one janitors' closet is an electrical room and a mechanical room behind the other. There are numerous small storage closets spread out throughout the building.

2.1.8.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.8.3 Building Envelope

This is a single-story building with a white TPO roof. The roof is a low pitch roof split into numerous sections. There is drainage management on the roof with scuppers to move water off the roof, but the water is then dumped right at the foundation of the building. Exterior construction is brick and adobe. The interior walls are typical bat insulated 2x4 stud construction with sheetrock face. The windows throughout the building are double paned with metal frames. Doors at the entrances are metal frame with large glass sections, and other doors are solid metal doors.



Figure 36: GCB south entrance way.

A large area of infiltration/exfiltration exists at the doors on all sides of the building. Damaged and missing weather-strip, door sweeps, and astragals lead to energy waste through outside air infiltration.

Unsealed penetrations and blank openings are another source of unwanted air and moisture infiltration/ex-filtration leading to energy loss. The windows are scheduled for full replacement, therefore not assessed. Several areas of this building were under construction, including new stucco and fresh paint during our visit.

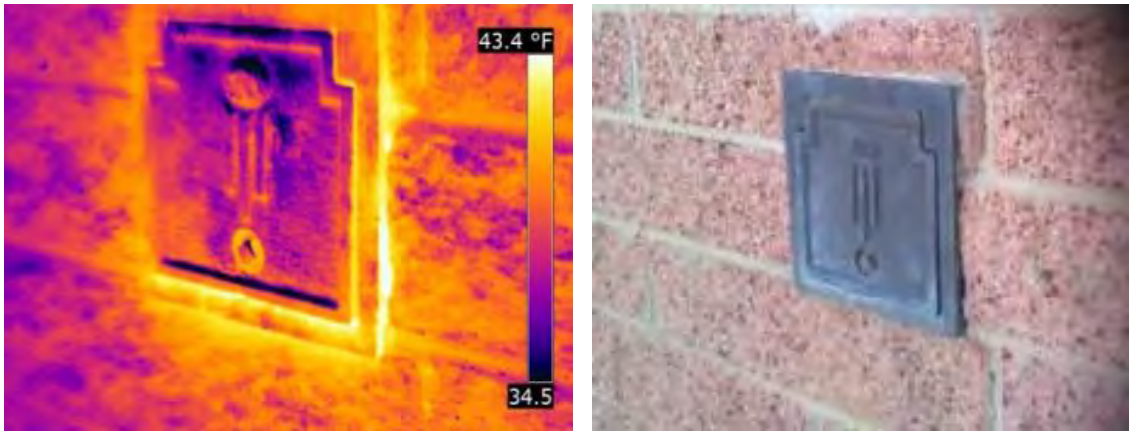


Figure 37: Heat loss through a wall penetration at the GCB.

2.1.8.4 Lighting

About 50% of the interior lighting consists of 2'x4' recessed troffer or surface mount wrap fixtures with three or four 32W T8s. About a third of the troffer lights had been converted to center basket with on 40W LEDs at the time of our audit. Beyond the typical lighting in the classrooms there are 6" cans with 13W LED bulbs. In two separate classrooms there a pair of 1'x4' troffers and a pair of 2'x2' troffers all with two 32W T8 bulbs. There are several one-off light types in a few classrooms including a bare socket with a 13W CFL, an open socket 17W LED, a 1'x4' vapor tight 20W, a six 75W incandescent bulb track light and a 1'x4' wrap with 2 40W T12s. In the restrooms there are a mixture of the typical light types, surface mount 1'x4' fixture with two 14W LEDs, and 1'x3' vanity with two 24W T5s. In the hallways and vestibules there are 1'x1' canopy lights with a 100W mercury vapor bulb. The seven exit signs have 3W LEDs. The exterior illumination consists of five 175W metal halide and six 20W LED wall packs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer and photo sensors on the pole lighting.



Figure 38: 2'x4' troffers and LED exit sign found in the hallway of the GCB.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.8.5 HVAC Equipment and Controls

The main HVAC system is a forced air system supplied by propane/DX rooftop units. The air is transferred to the spaces by above ceiling duct work with recessed diffusers. There is a secondary cooling system with ceiling mounted split system dx units in a couple of classroom areas. Spread around the building are a mixture of window evaporative and ac units. Temperature controls for the RTUs are programmable digital thermostats and nonprogrammable analog thermostats for the secondary system.



Figure 39: Nonprogrammable thermostat at the GCB.



Figure 40: Several rooftop units and a window evaporative cooler at the GCB.

A list of equipment is tabulated in **Appendix C1**.

2.1.8.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a classroom and office building. There are office plug loads such as computers, monitors, and printers located in the office spaces. In the classrooms there are more computers, monitors, and printers as well as large flat screen TVs and overhead projectors used for presenting. The chemistry and biology labs have special equipment including scales, centrifuge, incubators, refrigerators, spectrometer, ice maker, hot plates, and microwave. To calculate the special equipment plug loads the square footage being used was multiplied by 2.27 W/ft^2, published by NREL[1] for laboratories, multiplied by the use time of the spaces based off the school class schedule. There are two computer labs, comprised of 28 computers and monitors as well as four desk top printers and two full-sized printers.



Figure 41: Spectrometer at the GCB.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.8.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the mechanical room and include tank propane heaters. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.8.8 Other

None.

2.1.9 Tsaile Gym



Facility Facts:

Facility Name	Tsaile Gym
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	20,538
Year Built	1971
Avg. Daily Occupancy (Staff / Visitors/ Students)	4/24/24

2.1.9.1 Facility Description

This facility is located on the north side of the Tsaile campus.



Figure 42: Aerial view of the Tsaile Gym.

The Gym houses the courts that serve for basketball, volleyball, and other uses. There are men's and women's locker rooms to the west of building with public restrooms attached to serve the fans. Sandwiched between the locker rooms are Athletics' staff offices and ticket/announcer's booth. Several large storage spaces are peppered throughout the building. The mechanical room is on the southwest side of the building with an exterior entrance.

2.1.9.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm

Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.9.3 Building Envelope

This building has a single-story section to the west with a domed section to the east. The entire building is covered with a white TPO roof. There is no dedicated roof drainage management, and the water is dumped right at the foundation of the building. The exterior construction is mainly brick, with a strip of adobe below the roof plane. The dome section is open ceiling with exposed wood beams and slats. In the west sections there are drop ceilings. The interior walls are typical bat insulated 2'x4' stud construction with sheetrock facade. The windows throughout the building are double-paned with metal frames. Doors at the entrances are metal frame and doors with glass sections around them. The other exterior doors are also metal doors.

A large area of infiltration/ex-filtration exists at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Our team also noted unsealed penetrations, wall cracks, and blank openings that allow unwanted air and moisture infiltration/exfiltration and energy loss. The roof wall seam was also an area of concern. The seam separation has caused breaks in the thermal and pressure barriers. These are essential components in maintaining the proper pressure within the structure.

See Appendices G1 for a detailed report on the building envelope.

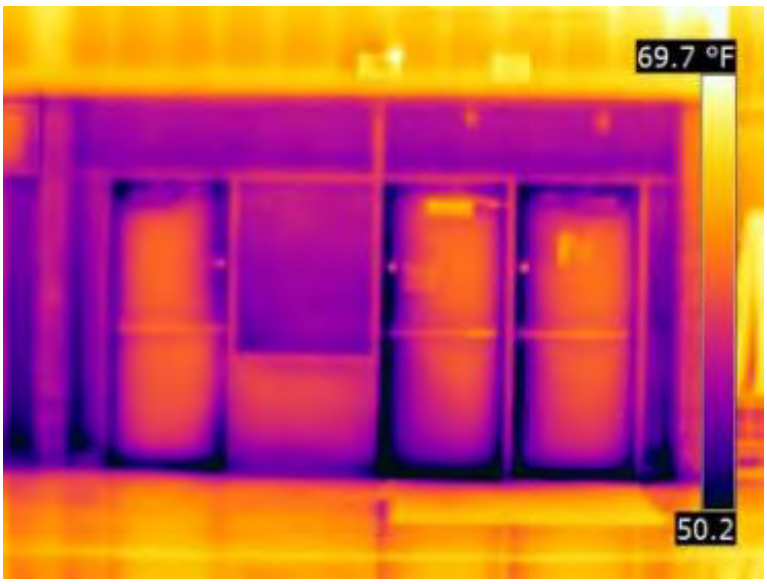


Figure 43: Cold air infiltration through the main entrance doors at the Tsaile Gym.

2.1.9.4 Lighting

The domed court is lit with suspended reflector 2'x4' high bay fixtures and 1'x4' highboys with metal wire guard covers, with six and four 32W T8 bulbs, respectively. A majority of the of the rest of the interior lighting consists of 2'x4' recessed troffer or surface mount wrap fixtures with four 32W T8s. Beyond the typical lighting in the classrooms, there are 6" cans with 13W LED bulbs. In the gym there are two round surface fixtures with two 22W bulbs each and two industrial suspended fixtures with four T12s each. The five exit signs, three have 3W LEDs and two have a pair of 20W halogen bulbs. In combination with exit signs there are four emergency wall lights with two 20W halogen bulbs each. The exterior illumination consists of four 175W metal halide wall pack, one 20W LED wall pack, and 15 canopy lights with a 70W halogen bulb. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer and photo sensors on the pole lighting.

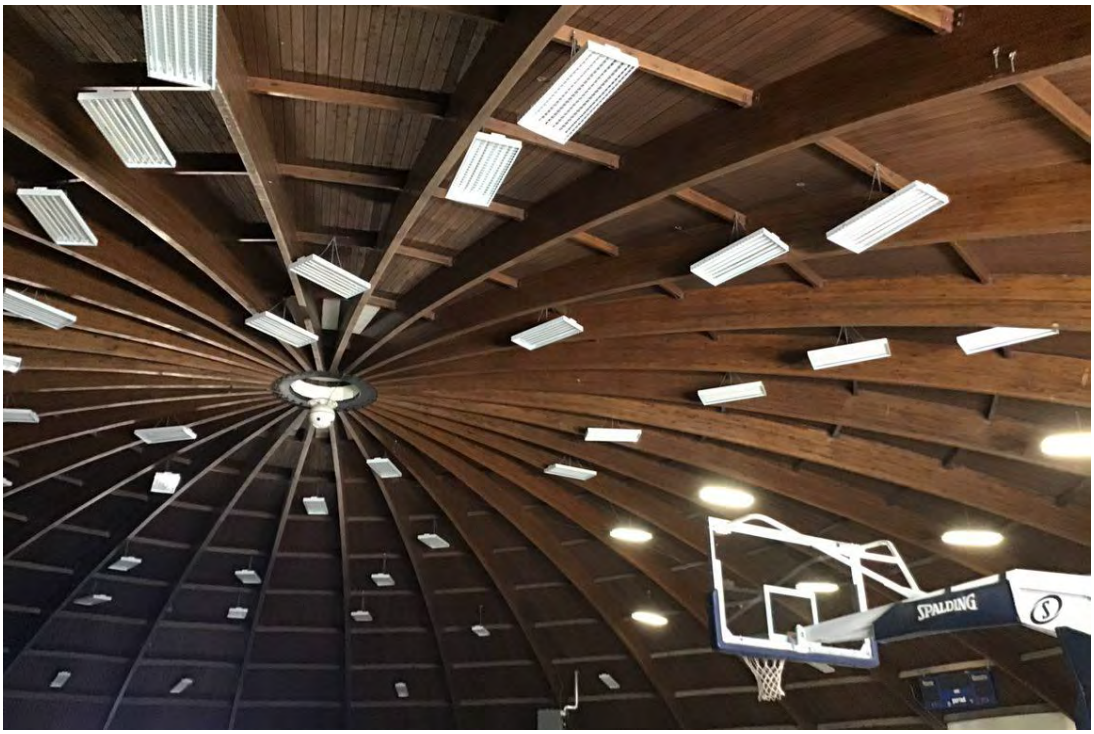


Figure 44: 2'x4' high bay lights in the gym.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.9.5 HVAC Equipment and Controls

The heating for the domed gym space in this building is supplied by four propane unit heaters located in the vaulted ceiling of the gym. There is no cooling in this section of the building currently. Over the office/locker room sections sits a single zone 4-ton dx/propane package unit that serves this area by

ceiling mounted ducts and diffusers. Temperature controls for the unit heaters are non-programmable dial thermostats. There are exhaust fans in the restrooms.



Figure 45: Suspended unit heater in the gym.

A list of equipment is tabulated in **Appendix C1**.

2.1.9.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a gymnasium with lockers and office spaces. There are office plug loads such as computers, monitors, and printers located in the office spaces. The only significant plug loads in the gymnasium space are the portable evaporative units and the score boards. The scoreboard plug loads were calculated taking the wattage times the use time.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.9.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption and the domestic hot water (DHW). The unit is in the mechanical room and includes a 100-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.9.8 Other

None.

2.1.10 Tsaile Library



Facility Facts:

Facility Name	Tsaile Library
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	25,434
Year Built	1972
Avg. Daily Occupancy (Staff / Visitors/ Students)	10/20/224

2.1.10.1 Facility Description

This facility is located very near the midpoint of the central circle Tsaile campus just south of the Head Start building.



Figure 46: Aerial view of the Tsaile Library

The library serves as the main research source and study area on campus. The main vestibule is on the west facing side of the building and opens to the first floor. To the south of the vestibule are men's and women's restrooms with a janitor's closet between them. Next to the restrooms is a computer lab. The main center room takes up most of the space on this floor. It used for study space, book stacks and there is a spiral staircase to the second floor. The east side of this floor is an enclosed space used for book and periodical storage. Next to this space is an AV room and a receiving area. Tucked into this group is one of the two mechanical rooms on this floor. The other mechanical room is on the opposite side of the building next to perimeter staircase. There is a large study room moving clockwise around the perimeter from the north mechanical room.

The second floor also consists of a large center room with study space and many of the book stacks. There are multiple study rooms and an office spread around the perimeter. The two mechanical rooms on the second floor sit directly above the mechanical rooms on the first floor. The bathrooms, janitor's closet, and computer lab replicate the first-floor design directly below them. To the northwest corner of this building is a temperature-controlled archive and display room.

2.1.10.2 Hours of Operation

August-May

Monday	8:00 am – 9:00 pm
Tuesday	8:00 am – 9:00 pm
Wednesday	8:00 am – 9:00 pm
Thursday	8:00 am – 9:00 pm
Friday	8:00 am – 9:00 pm
Saturday	8:00 am – 9:00 pm
Sunday	5:00 pm – 9:00 pm

May-July

Monday	8:00 am – 7:00 pm
Tuesday	8:00 am – 7:00 pm
Wednesday	8:00 am – 7:00 pm
Thursday	8:00 am – 7:00 pm
Friday	8:00 am – 7:00 pm
Saturday	8:00 am – 7:00 pm
Sunday	Closed

Winter, Summer, Spring, Fall Breaks

Monday	8:00 am –5:00 pm
Tuesday	8:00 am –5:00 pm
Wednesday	8:00 am –5:00 pm
Thursday	8:00 am –5:00 pm
Friday	8:00 am –5:00 pm
Saturday	8:00 am –5:00 pm
Sunday	Closed

2.1.10.3 Building Envelope

This is a two-story building with a white TPO roof. The roof is a hexagonal roof sloping from the center point. There is no drainage management installed on the roof. The front entrance is a majority glazing in the form of large windows and doors with large widow sections. The windows are double paned with metal frames. For the rest of the building the walls are brick construction with stucco sections above and below the windows and doors. The two side entrance doors are metal with small windows. Windows and doors take up about ¼ of the wall on each of the sides of the building not including the main entrance.

Figure 47: Library main entrance.



A large area of infiltration/ex-filtration exists at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. The sealant on the interior and exterior perimeters of the windows is separated, deteriorated, weathered, and no longer effective; repairing this will assist in the reduction of air and moisture infiltration and/or

ex-filtration, which causes energy loss. Also, there is noticeable gaps in blank openings, roof wall seam and penetrations that allow air and moisture infiltration/ex-filtration and energy loss.

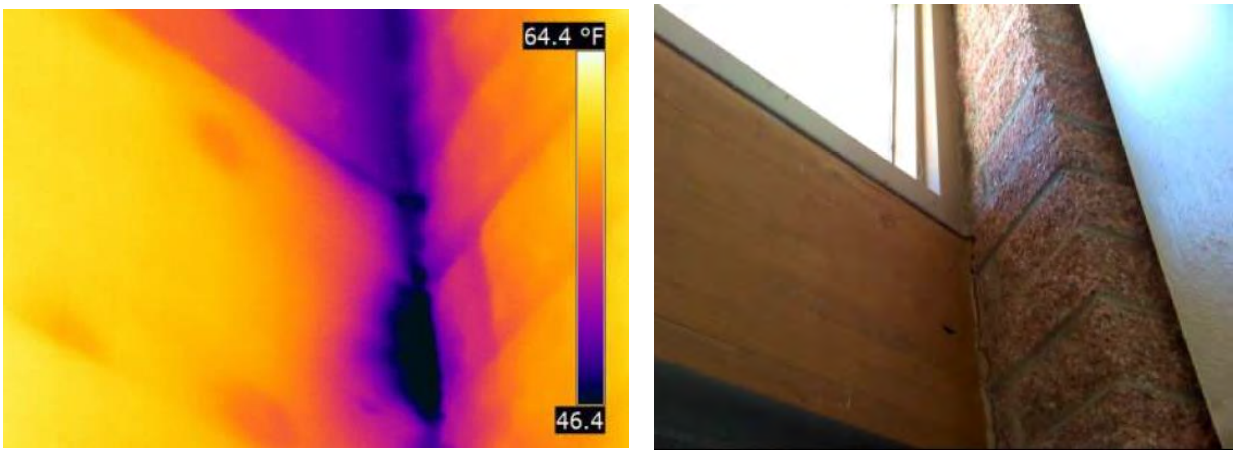


Figure 48: Cold air infiltration around a window in the library.

2.1.10.4 Lighting

Interior lighting on the main floor consists of 2'x4' recessed troffers with three 32W T8s. Two handfuls of these lights have been converted to LED fixtures; for example, in the bathrooms. There are 24 4'x4' surface mount troffers in the open space with eight 28W bulbs each. Also, in the center room there are several track fixtures, one with eight 13W CFLs, one with two 13W CFLs, one with two 50W incandescent bulbs, and another with one 12W LED. There are 47 6" recessed cans spread throughout the floor, with 18 having 12W LEDs and all the others with 13W CFLs. In the perimeter rooms, there are 23 1'x4' surface mount strip lights with two 28W T8 bulbs. Two 1'x4' wrap fixtures also exist in one room with two 32W T8s each. There are open socket fixtures in the mechanical rooms with one 17.5W LED and the other with a 200W incandescent. The two exit signs have 3W LEDs and the other three are two 20W bulb halogen combo lights. There are four ceiling surface mount emergency lights with two 20W halogen bulbs each.



Figure 49: Several lighting types found on the first floor of the library.

On the second floor the lighting in the center space is made up of 2'x4' surface mount troffers with four 28W T8s each. Rounding out this space are 38 recessed 6" can lights with 12W LED bulbs, 26 recessed 6" can lights with 13W CFL bulbs, ten track lights with 13W CFLs, and 26 sconce fixtures with 9W LEDs. The restrooms have been converted to LEDs, like the first floor. The side stairwell is lit with two 23W CFLs in recessed 6" cans. In the office space are six 4'x4' surface mount troffers with eight 28W T8s each. In the archive/display area there are 37 track lights with 50W halogen bulbs, four 1'x4' linear D/I louvers with 4 28W T8s, two 1'x8' linear D/I louvers with 8 28W T8s each, and a glass chandelier with two 26W CFLs. There is one 3W LED exit sign and seven 20W halogen emergency lights on this floor.

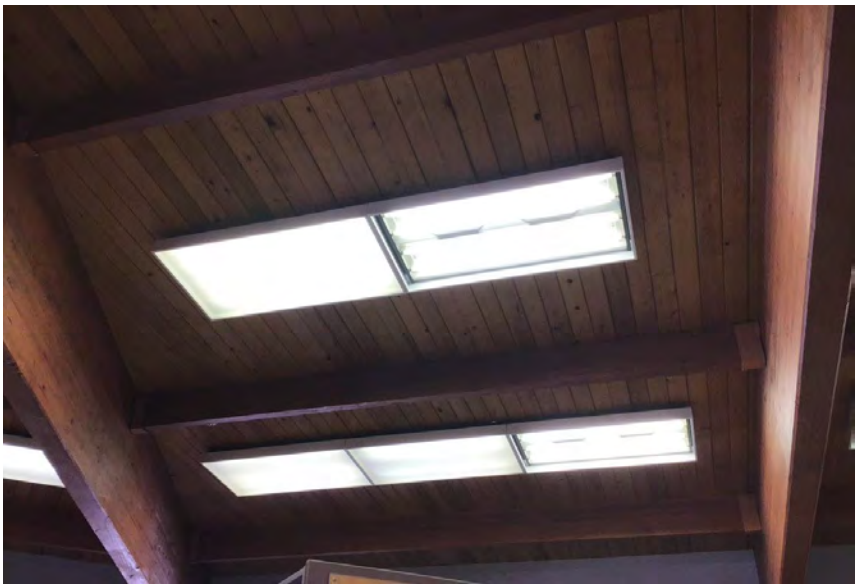


Figure 50: Surface mount troffers on the second floor of the library.

The exterior illumination consists of seven 175W metal halides and two 20W LED wall packs. There are also 18 6" cans in the soffit with 12W LED bulbs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer and photo sensors on the pole lighting.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.10.5 HVAC Equipment and Controls

The heating and cooling for most of this building is provided by four 15-ton reversible heat pumps on the exterior that are connected to four 15-ton air handlers. There are two air handlers on each floor positioned on opposite ends the building. Each air handler is then ducted into the space to provide treated air to roughly half the floor. The archive/display has its own dedicated system consisting of an exterior ground mounted package unit with a heat pump that is then ducted into the space by uninsulated duct running up the exterior wall. Temperature controls are a mix of non-programmable dial and programable digital thermostats for each separate system. Diné College has had issues with this system working correctly, due to both equipment age and control problems.



Figure 51: The heat pumps at the library are approaching their end of life.



Figure 52: Package unit at the library with exterior uninsulated duct.

A list of equipment is tabulated in **Appendix C1**.

2.1.10.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a public library. There are office plug loads such as computers, monitors, and printers located in the offices. In the computer labs and classrooms, you can find computers, printers, UPSs, and projectors. In the library space you can find lamps at personal studying stations as well as students' personal devices.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.10.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the janitor's closets and include a 40-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.10.8 Other

None.

2.1.11 Tsaile Ned Hatathli Center (NHC)



Facility Facts:	
Facility Name	Tsaile NHC
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	73,428
Year Built	1974
Avg. Daily Occupancy (Staff / Visitors/ Students)	118/40/346

2.1.11.1 Facility Description

This facility is located on the east side of the central circle Tsaile campus.



Figure 53: Aerial view of the Tsaile NHC

The NHC is an octagonal seven-story building that serves many functions. There are two stairways and two elevators that serve all the floors. The first floor is partially below ground with an entrance to the west of the building. This level consists of multiple large classrooms, a coffee shop, offices, public restrooms, hallway, as well the main mechanical room that serves the entire building. The west side of the building opens to the main entrance on the second floor of the building. The second floor opens to a vestibule and consists of a central classroom space surrounded by offices, a hallway, dispersed storage space and public restrooms. There is a loading dock and receiving area on the south side of the second floor. The third floor mainly contains a mixture of classrooms and offices. There is a single bathroom with one lavatory and wash sink on this floor. The fourth floor has recently been converted to an open space art display. There are a few classrooms, office spaces, and a small restroom that

remain on this floor. Two air handler rooms also reside on the fourth floor. The fifth-floor perimeter contains mostly classrooms with a few offices interspersed. There are men's and women's public restrooms on the south side of the floor and a hallway that circles the central office spaces. A breakroom has a residential style kitchen. The sixth floor is mostly office space with reception rooms and a few conference/multi-use spaces. Restrooms mirror the fifth-floor layout. There are two breakrooms with residential style kitchens. The seventh floor is unconditioned open storage space sectioned by chain link fence.

2.1.11.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.11.3 Building Envelope

This is a seven-story building with a white TPO roof. The roof is a hexagonal roof sloping from the center point. There appears to be no drainage management installed on the roof edges, but the roof was not easily accessible due to safety concerns. Approximately, the first two levels are a stucco and brick exterior construction. The two entrance points on these levels are a majority glazing in the form of large windows and doors with large widow sections, with the main entrance on the second floor having four large custom wooden doors. The windows are double-paned with metal frames. The five levels above this are high rise glass window construction.



Figure 54: NHC main entrance.

The sweeps and weather strip around the doors are not in working condition. Unsealed Penetrations, expansion joints and blank opening are another source unwanted air and moisture infiltration/ex-

filtration leading to energy loss. The double pane windows are tinted and appear to be in good condition in the areas accessible for inspection.

See Appendices G1 for a detailed report on the building envelope.

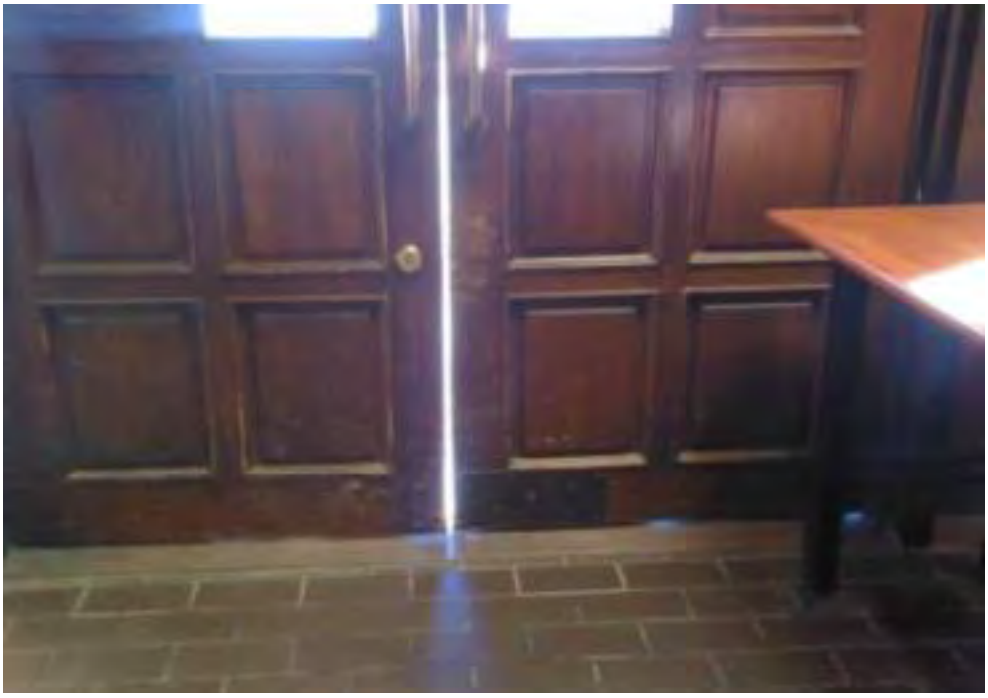


Figure 55: Large gap in the NHC main entrance door where light is clearly visible.

2.1.11.4 Lighting

Around a third of the lighting in this building has been converted to LED lamps. 40% of the building lights are 2'x4' troffers with three or four T8 bulbs. Single lamp 20W and 40W LED center basket troffers fill much of the rest of classroom, office, and general use space on the first and second floors. There remain 2'x4', 2'x2', 1'x4' T8 and T12 fixtures in some areas of the low occupancy spaces on the first and second floor. You can also find these types of fixtures spread throughout the 3rd, 5th, 6th, and 7th floors. There are nine 4'x4' eight 40W T12 fixtures in the fifth-floor classrooms. A mixture of 6" and 8" recessed cans are found on all the floors in a variety of spaces, and have a mixture of 60W incandescent, 13W CFL and 13W LED bulbs. In the Art/Museum installation space on the 4th floor, there are 107 3W LED track lights for highlighting the exhibits. Other lights found in this building in small quantities are Sconces, track, bare socket, and vanity lights, with a mixture of incandescent, CFL and LED bulbs. All the exit signs in this building have been upgraded to 3W LEDs with one or two lamps. Dedicated emergency lights can be found on the 1st, 2nd, 3rd, 6th floors in the form of wall mount two lamp 20W halogen and 3W LEDs.



Figure 56: 2'x2' Troffer lights on the 6th floor of the NHC building.

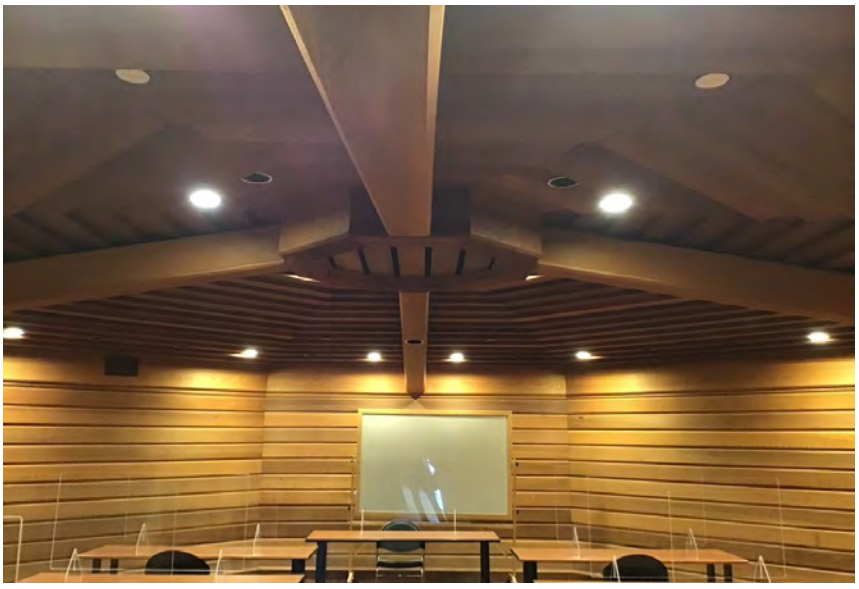


Figure 57: Recessed can fixtures on the 2nd floor of the NHC building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.11.5 HVAC Equipment and Controls

The heating and cooling for this building is accomplished via a hydronic system with forced air distribution. The distribution system is a dual duct system with mixing boxes and automatic dampers to control the zones. There are two condensing boilers in the first-floor mechanical room and two chillers located on the outside the southside of building. The pumps all have VFD control. An AHU in this mechanical room building serves the first and second floors. There are two AHUs on the fourth

floor, one serving the third and fourth floor and the other serving the fifth and sixth floors. The controls in this building are an amalgamation of several rounds of upgrades, consisting of pneumatic nonprogrammable thermostats and digital programmable thermostats that run as separate control systems.



Figure 58: Dual duct mixing boxes on the first and fourth floors of the NHC.



Figure 59: Chiller outside the NHC building.

A list of equipment is tabulated in **Appendix C1**.

2.1.11.6 Plug Loads

The plug loads associated with this building vary by space type. The classrooms have a computer, LCD monitor, projector, desktop printer, portable TV display cart, communication controls, and UPS backup batteries. There are typical office plug loads such as computers, monitors, and printers in the office spaces. Associated with the office spaces there are reception/break rooms that have coffee makers, microwaves, and large copy machines along with typical plug loads. There are multiple residential sized kitchens. The campus radio station airs out of the first floor and has all the required sound and control equipment.



Figure 60: Portable TV display cart that is also used for remote leaning.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.11.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption. The domestic hot water (DHW) unit is in the first-floor maintenance room and includes an 85-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.11.8 Other

None.

2.1.12 Tsaile Network Operating Center (NOC)



Facility Facts:

Facility Name	Tsaile NOC
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	6,588
Year Built	2006
Avg. Daily Occupancy **(Staff / Visitors/ Students)**	14/6/6

2.1.12.1 Facility Description

This facility is located to the southwest side of the center point of the circle Tsaile campus just west of the GCB building.



Figure 61: Aerial view of the Tsaile NOC.

The NOC is the main server center and houses the technology support department for the school. The main entrance opens to a vestibule and then to a reception/lobby area. A hallway runs west from the reception area. A conference room sits to the north of the lobby. There are four offices and two large open flex office areas. Two public restrooms, a break room, loan room, and a copy room serve the staff. A janitor's closet sits in between the restrooms. Next to the restrooms sits a breakroom. There is a larger storage room in northeast section of this building. The server room sits in the southeast corner of the building. Three mechanical rooms serve this building, two are accessible from the interior and the third is accessed south side exterior. Currently only the east section of the building appears to be at full capacity.

2.1.12.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.12.3 Building Envelope

This is a single-story building with a standing seam metal roof. There are two sections that are sloped to the south of the building. There is drainage management installed on the roof. The walls are typical bat insulated 2x4 stud construction with sheetrock interior with a drop ceiling. The exterior is a combination of adobe and brick. The windows throughout the building are double paned with metal frames. Doors at the entrances are metal frame with large glass sections, and the other doors are solid metal doors.



Figure 62: SSC interior construction and exterior door.

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Unsealed

Penetrations, expansion joints, and blank opening are another source of unwanted air and moisture infiltration/ex-filtration leading to energy loss.

See Appendices G1 for a detailed report on the building envelope.

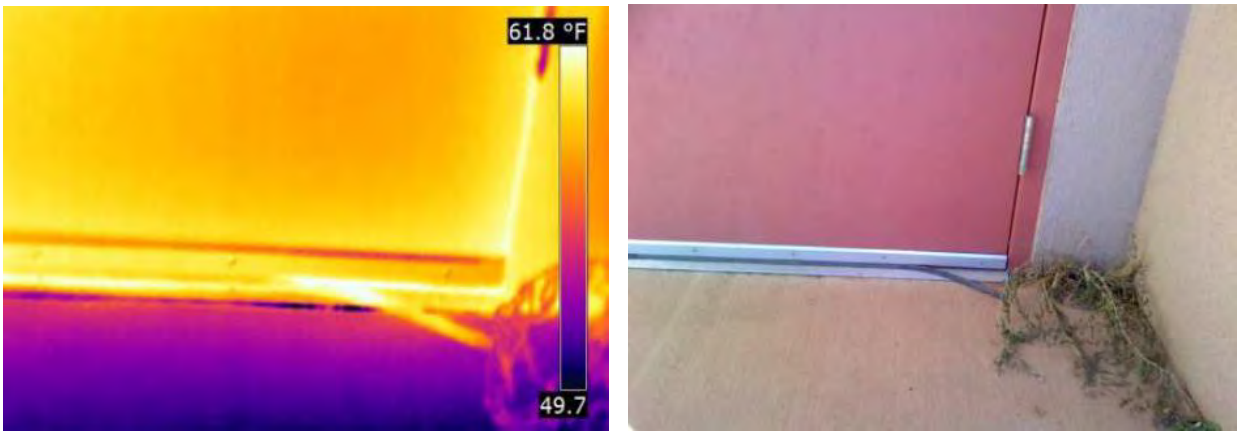


Figure 63: Damaged door sweep at the NOC building allowing energy to escape.

2.1.12.4 Lighting

A third of the interior lighting is 1'x4' suspended strip lighting with two or three 32W T8s. The second third is made up of 1'x8' suspended strip lights with six 32W T8s. Seven 1'X12 suspended strip lights with nine 32W T8s are also found in the flex office areas. The rest of the lighting consists of 6" cans with 13W CFL bulbs, 2'x4' troffers and 1'x4' vanities with two 32W T8s each. The exterior illumination consists of six 20W LED wall packs and one recessed canopy light with a 50W metal halide bulb.



Figure 64: Suspended strip lighting in the reception/lobby area of the NOC.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.12.5 HVAC Equipment and Controls

The main building HVAC system is a forced air system with propane furnaces in the three mechanical rooms connected to refrigerant evaporators on the exterior of the building. The air is transferred to the spaces with above ceiling duct work with recessed diffusers. There is a dedicated CRAC unit for cooling the IT room with the two condensers sitting on the exterior to the south of the IT room. This system is currently in the process of being upgraded by the school. Temperature controls are digital programable thermostats.



Figure 65: The two CRAC condensing units that are being replaced at the NOC building.

A list of equipment is tabulated in **Appendix C1**.

2.1.12.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a server and technology center. There are office plug loads such as computers, monitors, and printers are in the office spaces. The server room is a large percentage of the load in this building. Additional equipment

present are a coffee machine, microwave, water cooler and a refrigerator in the breakroom. Three large LCD TVs are in the conference room.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.12.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in a mechanical closet and include a 40-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.12.8 Other

None.

2.1.13 Tsaile Head Start



Facility Facts:

Facility Name	Tsaile Head Start
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	2,688
Year Built	1980
Avg. Daily Occupancy (Staff / Visitors/ Students)	6/ 6/10

2.1.13.1 Facility Description

This facility is located on the North side of the central circle Tsaile campus just west of the cafeteria.



Figure 66: Aerial view of Tsaile Head Start Building

This building serves as a childcare resource for the surrounding community, providing infant care to faculty and students. There are three main childcare rooms. Spread throughout the building are four bathrooms – three that serve the childcare rooms and an adult restroom of the hallway. There is a kitchen with an attached pantry to serve the occupants. There are two offices as you enter the building. The utility room is central with entrances off the kitchen.

2.1.13.2 Hours of Operation

Monday	7:30 am – 5:30 pm
Tuesday	7:30 am – 5:30 pm
Wednesday	7:30 am – 5:30 pm
Thursday	7:30 am – 5:30 pm
Friday	7:30 am – 5:30 pm
Saturday	Closed

Sunday	Closed

2.1.13.3 Building Envelope

This is a double-wide modular building. The roof is a low pitch gable roof. It is graded to the east and west, with a standing seam metal covering. There is partial drainage management installed on the roof edges. The entrance way is covered with a metal roof awning. The walls are typical bat insulated 2x4 stud construction with a metal siding exterior and sheetrock interior. The windows throughout the building are double-paned with vinyl frames. The two exterior doors are solid metal doors, with a small, reinforced window.



Figure 67: Side of the Head Start building showing roof drainage and windows.

The sweeps and weather strip around the doors are not in working condition. The windows appear to be in good condition; however, areas of sealant are worn, deteriorated, and no longer effective. Several penetrations and openings are located around the perimeter walls, especially around the exterior wall mounted package units, where air infiltration/exfiltration and energy loss occur.

See Appendices G1 for a detailed report on the building envelope.



Figure 68: Damaged seal around the wall HVAC units at the Head Start building

2.1.13.4 Lighting

Interior lighting in this building consists mainly of 2'x4' fixtures with four, 32W T8 lamps in most of the spaces, totaling 33 fixtures. The rest of the interior lighting consist of 6" recessed cans with 75W incandescent bulbs. Exit signs consist of 3W LED lamps paired with an emergency wall pack with two 3W LEDs. There are no existing lighting controls or occupancy sensors in this building.



Figure 69: Emergency wall pack at the Head Start building

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.13.5 HVAC Equipment and Controls

The Heating, Ventilation, and Air Conditioning (HVAC) systems are comprised of four wall mounted reversible heat pumps (WMRHP) to provide cooling and heating. The treated air is then distributed to the spaces by ducting and ceiling mount diffusers. Control of the WMRHPs is limited to directly connected digital programable thermostats. The kitchen includes a commercial grade hood.



Figure 70: Wall mount package units at the Head Start

A list of equipment is tabulated in **Appendix C1**.

2.1.13.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a daycare center. There are office plug loads such as computers, monitors, and printers located in the office. There is a commercial grade kitchen. Additional equipment present in the kitchen are a dishwasher, microwave, and refrigerators.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.13.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the electric domestic hot water (DHW) unit is in the utility room and consists of two 40-gallon tank heaters. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.13.8 Other

None.

2.1.14 Tsaile Post Office



Facility Facts:

Facility Name	Tsaile Post Office
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	851
Year Built	2013
Avg. Daily Occupancy (Staff / Visitors)	2/15

2.1.14.1 Facility Description

This facility is located on the North side of the central circle Tsaile campus south of the Day Care building.



Figure 71: Aerial view of Tsaile Head Start Building

This building serves the entire surrounding community providing them access to the US Postal Service. The entrance is into a front customer service area. In the back is an office with a closet and a restroom.

2.1.14.2 Hours of Operation

Monday	9:00 am – 6:00 pm
Tuesday	9:00 am – 6:00 pm
Wednesday	9:00 am – 6:00 pm
Thursday	9:00 am – 6:00 pm
Friday	9:00 am – 6:00 pm
Saturday	Closed
Sunday	Closed

2.1.14.3 Building Envelope

This is a typical single-story building with an open covered ADA entrance ramp. The roof is a low pitch gable roof, graded to the east and west with a standing seam metal covering. There is no drainage management installed on the roof edges. The entrance way is covered with a small metal awning. The walls are typical bat insulated 2x4 stud construction with an adobe exterior and sheetrock interior. The windows throughout the building are double paned with metal frames. The doors are solid metal doors, with the main entrance having a small, reinforced window.

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Several penetrations and openings are located around the perimeter walls, especially around the exterior wall mounted package units, where air infiltration/exfiltration and energy loss occur.

See Appendices G1 for a detailed report on the building envelope.

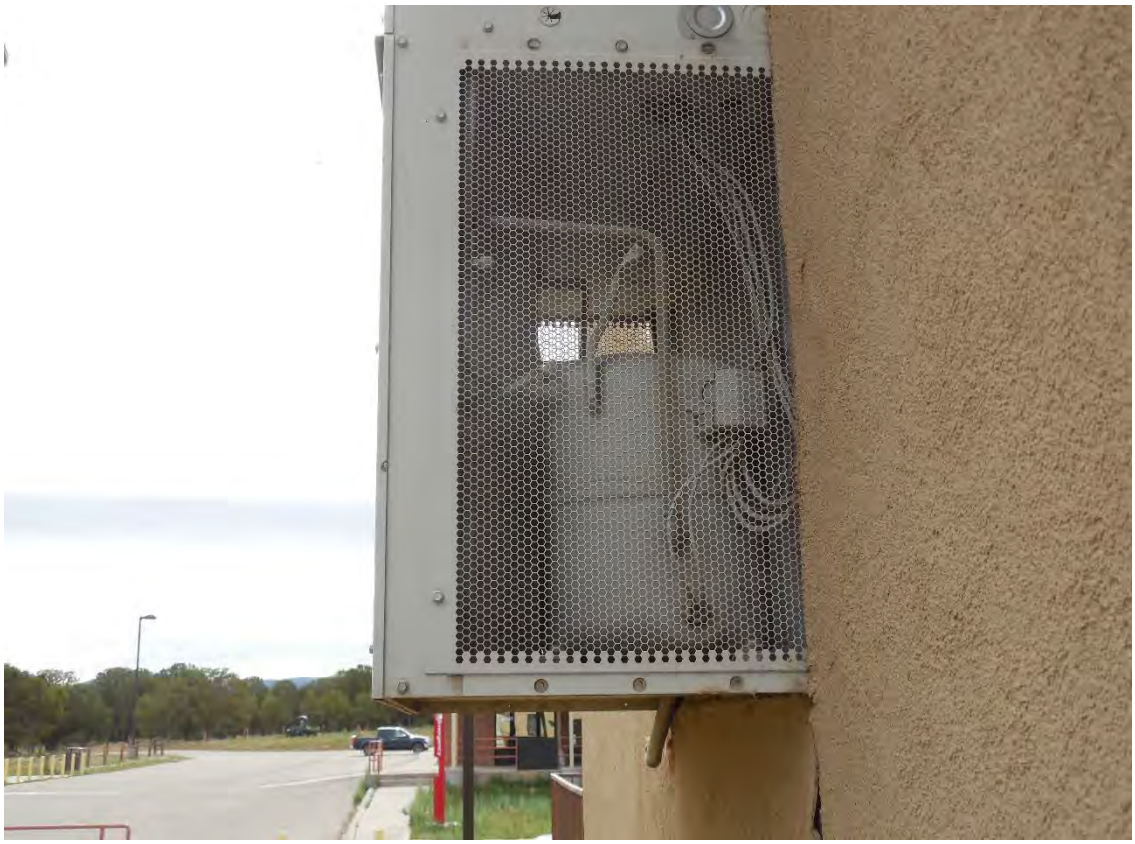


Figure 72: Damaged seal around the wall HVAC units at the Post Office building

2.1.14.4 Lighting

Interior lighting in this building consists mainly of 2'x4' fixtures with four, 32W T8 lamps in most of the spaces, totaling 12 fixtures. The rest of the interior lighting consist of 6" recessed cans with 75W incandescent bulbs. Exit signs consist of 3W LED lamps paired with an emergency wall pack with two

3W LEDs. Exterior lighting is 20W and 70W LED There are no existing lighting controls or occupancy sensors in this building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.14.5 HVAC Equipment and Controls

The Heating, Ventilation, and Air Conditioning (HVAC) systems are comprised of two wall mounted reversible heat pumps (WMRHP) to provide cooling and heating. The treated air is then ducted to the spaces and distributed by ceiling diffusers. Control of the WMRHPs is limited to directly connected digital programable thermostats.

A list of equipment is tabulated in **Appendix C1**.

2.1.14.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for customer service. There are office plug loads such as computers, monitors, and printers located in the office. There is a POS system in the customer service area consisting of a computer, LCD monitor, scanner, and digital scale.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.14.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the 6-gallon electric domestic hot water (DHW) unit is in the utility room. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.14.8 Other

None.

2.1.15 Tsaile Dorms



Facility Facts:	
Facility Name	Tsaile Dorms
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	79,690 Total
Year Built	1971
Avg. Daily Occupancy (Visitors/ Students)	20/300

2.1.15.1 Facility Description

These facilities are located on the west side of the central circle Tsaile campus.



Figure 73: Aerial view of the Tsaile Dorms

There are ten dorm buildings that were all built at the same time and are identical in design and construction. There are 15 perimeter dorm rooms, and historically there have been two students per dorm room but as a response to covid the school has elected to put a single student per room. For 14 of the rooms each two rooms shares a bathroom. The Last room share the bathroom with the shared kitchen. There is a corridor that separates the perimeter space from the central lounge area that then extends to the two entrances. The lounge area has a large wood fireplace in the center of the room. On one side of the building sits a laundry room and opposite that is the janitor's closet, storage room and boiler room.

2.1.15.2 Hours of Operation

During the regular school year, August through May, the dorms are at full capacity and are occupied 24/7. The remainder of the year, only a portion of dorms are occupied.

2.1.15.3 Building Envelope

These are one story buildings with a vaulted center section. The roof has a white TPO covering. The roof is a hexagonal roof sloping from the center point. There is no drainage management installed on the roof. The walls are brick construction. The windows take up about a fourth of the walls and are double paned with metal frames. Doors at the entrances are solid metal doors with small, reinforced windows.



Figure 74: Entrance and windows at one of the dorms.

A large area of infiltration/ex-filtration exists at the doors on all sides of the buildings. These doors would benefit from new sweeps and weather strip. At the bottom & sides of the windows the sealant is deteriorated, weathered and no longer effective; this allows air and moisture infiltration and/or ex-

filtration, which causes energy loss. There are noticeable gaps in the soffit seams, wall cracks and penetrations that allow air and moisture infiltration/ex-filtration and energy loss.

See Appendices G1 for a detailed report on the building envelope.



Figure 75: Heat loss at the soffit joints and edges at the Tsaile Dorms.

2.1.15.4 Lighting

Interior lighting in these buildings consists of a mixture of lighting fixture types and models. Residential style surface mount ceiling fixtures with one or two 13W CFL bulbs can be found in the Dorm rooms, Restrooms, and corridor space. Wall sconces with one or two 13W CFL bulb are found in the dorm rooms, kitchen, and common area. A vanity light with 2 13W CFL bulbs can be found in all the dorms. There are 6" and 10" recessed cans in the corridor with 13W CFL bulb. In the laundry room there are 1'x4' surface mount wrap fixtures with two 32W T8s. A bare socket light fixture with a 13W CFL provides light to the storage room. Exit signs consist of 3W LED lamps paired with emergency wall pack light with two 20W halogen bulbs. There are no existing lighting controls or occupancy sensors in this building.



Figure 76: Residential style ceiling lights and two types of sconces in a Tsaile Dorm common area.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.15.5 HVAC Equipment and Controls

The main source of heating is provided by a hydronic boiler in a dedicated room. The boilers in each dorm are not the same type and ages as they are replaced as they break down. The hot water is then transferred to radiant hot water coils in the perimeter walls under the windows of the dorm rooms and kitchen as well as interior wall mounted radiant units in the entrance corridors. Most of the pumps are old and do not have VFD control. There are hydronic fan coil units located in the walkway attic space, but it is not clear if any of these units are functional. One fan coil is meant to serves each perimeter room pulling return air from the attic space and transfer air grills that lead to the center common area. There is a duct with dampers going through the roof that was intended to bring in fresh air, but this appears to be nonfunctional. In the laundry room there is a hydronic unit heater mounted at ceiling height. In the middle of the common area is a wood fireplace which is consistently used for heating during the evening and nighttime. There is no source of central cooling. Temperature controls are non-programable pneumatic thermostats and this system is only run during the heating season.



Figure 77: Three different boiler types in separate dorms.



Figure 78: The two types of wall radiant units in the corridor and dorm room.

A list of equipment is tabulated in **Appendix C1**.

2.1.15.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a residential area. There are plug loads such as computers, monitors, laptops, TVs, game consoles, stereos, phone chargers, lamps and fans located in the rooms. There is a residential sized kitchen that includes a dishwasher, microwave, and two refrigerators. In the common space there is a vending machine and TVs. The bathrooms have plug loads like hair treatment tools and hair dryers.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.15.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the boiler room of each dorm and includes a 100-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.15.8 Other

None.

2.1.16 Tsaile Student Union Building (SUB)



Facility Facts:	
Facility Name	Tsaile SUB
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	30,395
Year Built	1973
Avg. Daily Occupancy (Staff / Visitors/ Students)	25/10/208

2.1.16.1 Facility Description

This facility is located just to the northwest of the middle of the central circle Tsaile very near the cafeteria.

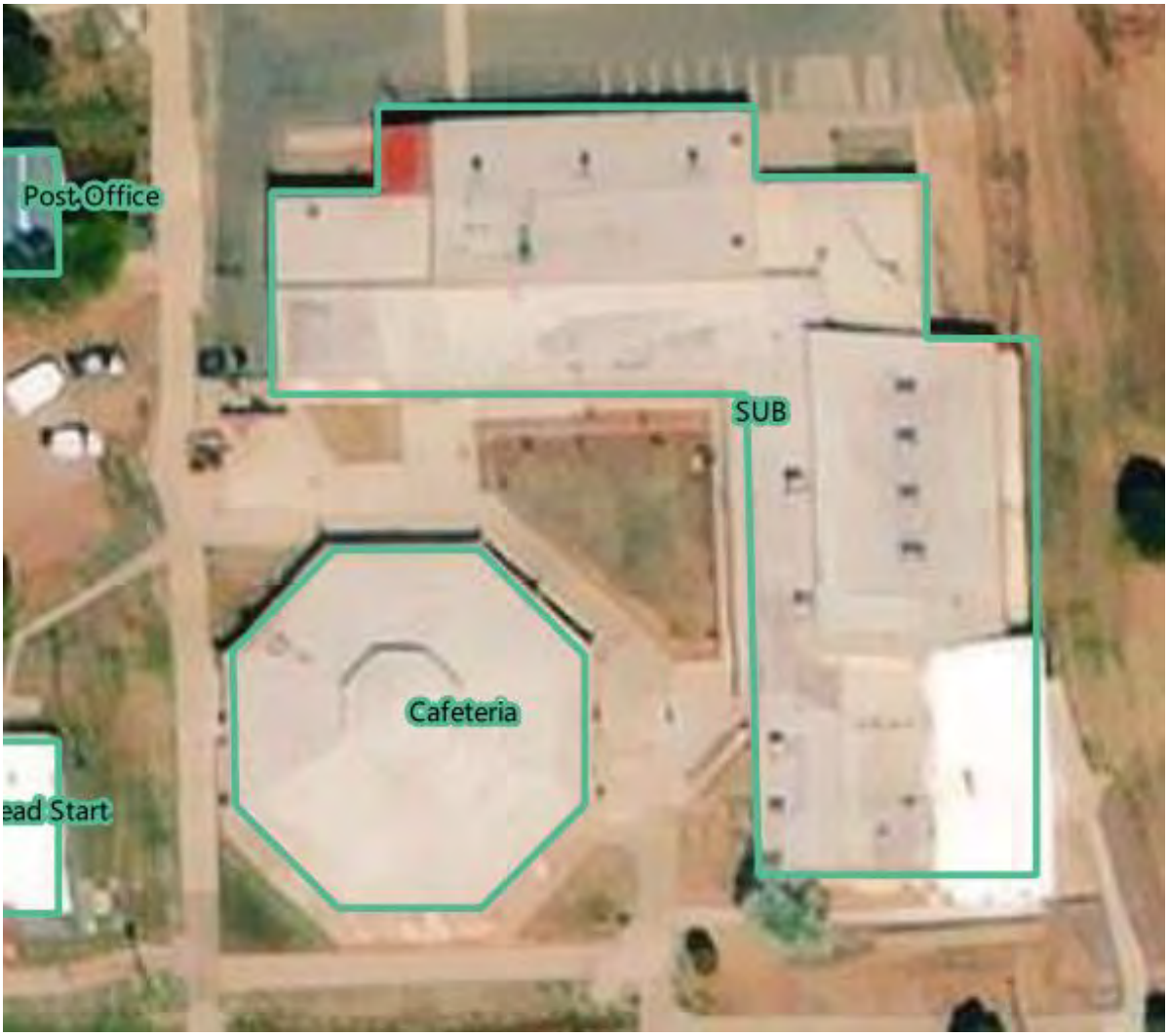


Figure 79: Aerial view of the Tsaile Archival Center

The SUB serves as a multipurpose building. This building went through a partial renovation about four years ago. There are offices, student services, restrooms, IT room and a multipurpose room on the south end of the building. A lecture hall sits just to the north of this area with a display area outside its entrance. In the northeast corner where the building turns west are more offices, mechanical/electrical room, and janitor's closet. Stepping in the west wing is a student recreation area with billiard hall and concession stand. On the west side of this space are a mechanical/electrical room, janitor's closet, and public restrooms. To the north of the billiard space is the workout center. In the far west side of this building is the school bookstore. There are numerous small storage closets spread

out through the building. Corridors run the length of the building. Most of the main entrances to this building have vestibules.

2.1.16.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.16.3 Building Envelope

This is a single-story building with a mixture of white TPO and rolled composite roofs. The roof is a low pitch roof split into numerous sections. There is drainage management on the roof with scuppers and roof drains to move water off the roof, but the water is then dumped right at the foundation of the building. Exterior construction is brick and adobe. The interior walls are typical bat insulated 2x4 stud construction with sheetrock face. The ceilings are a mixture of drop ceilings and vaulted ceilings with ceiling tiles or sheet rock depending on if they have been renovated or not. The windows throughout the building are double paned with metal frames. Doors at the entrances are metal frame with large glass sections, and other doors are solid metal doors.



Figure 80: Scupper drainage at the SUB.

A large area of infiltration/exfiltration exists at the doors on all sides of the building. Damaged and missing weather-strip, door sweeps, and astragals lead to energy waste through outside air infiltration. Unsealed Penetrations, expansion joints and blank opening are another source unwanted air and

moisture infiltration/ex-filtration leading to energy loss. In a few areas, the window sealant is weathered and deteriorated and no longer effective.

See Appendices G1 for a detailed report on the building envelope.



Figure 81: An expansion joint at the SUB that needs to be resealed to prevent energy loss.

2.1.16.4 Lighting

Around 40% of the interior lighting consists of 2'x4' and 1'x4' recessed troffers or surface mount wrap fixtures with two, three or four 32W T8s. Nearly 50 of the troffers and wraps have been converted to 20W and 40W fixtures. About a fourth of the interior lighting is 10",8", 6" or 4" recessed can fixtures with one or two 13W CFL, 13W LED, 65W incandescent or 75W incandescent bulbs. There are 1'x3' vanity lights with two 24W T5s in the restrooms. The recently renovated multipurpose room is all LED fixtures and has 15W sconces and track lights as well as 12W flood lights and 4W step lights. In the student services area, there are 12' and 8' suspended lights with six and four 32W T8s respectively. There is a track light located in the corridor with 12 50W halogen bulbs. In the student recreation area, there are 44 6" pendant lights with a mixture of 15W/17.5W LEDs and 75W incandescent bulbs in addition to the 1'x4' troffers. Bare socket fixtures with 13W CFLs can be found in electrical/mechanical and storage rooms. The exit signs have mostly been converted to 3W LEDs with a few 20W halogens remaining. Five of the 18 emergency light wall packs have been converted to 3W LEDs from 20W halogen fixtures. The exterior illumination consists of six 175W metal halide wall packs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer.



Figure 82: 1’x4’ troffers and 6” pendant fixtures in the SUB student recreation room.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.16.5 HVAC Equipment and Controls

The main HVAC system is a forced air system supplied by propane/DX rooftop units, which a majority were upgraded during the renovation of this building. The treated air is transferred to the spaces by above ceiling duct work with recessed diffusers. Temperature controls for the RTUs are programmable digital thermostats. The IT room has a dedicated spilt system for cooling. There are small electric unit heaters in some of the vestibules. The concession stand has a hood with fans on the roof and a MAU mounted in the mezzanine, but this system is not currently functioning correctly. The MAU has hydronic heat provided by a boiler which also serves radiant heat units in the northwest branch of the SUB.



Figure 83: RTUs on the SUB rolled composite roof.



Figure 84: Vestibule unit heater in the SUB.

A list of equipment is tabulated in **Appendix C1**.

2.1.16.6 Plug Loads

The plug loads associated with this building vary by space type. There are typical plugs loads for a classroom and office building. There are office plug loads such as computers, monitors, and printers located in the office spaces. In the classrooms there are more computers, monitors, and printers as well as large flat screen TVs and overhead projectors used for presenting. The concession stand has multiple refrigerators, several fryers, coffeemaker, soda dispensers, and a propane range. The workout center has treadmills, ellipticals, stationary bike, other workout equipment, TVs, cold drink vending machine and a computer and monitor at the reception desk. The bookstore has desktops, LCD monitors, laptop, printers, and a cold drink vending machine.



Figure 85: Plug loads in the concession stand at the SUB.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.16.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) units are in the mechanical rooms spread throughout the building and include 40-gallon tank propane heaters. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.16.8 Other

None.

2.1.17 Tsaile Student Family Housing (SFH)



Facility Facts:

Facility Name	Tsaile SFH
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	53,313 Total
Year Built	2004
Avg. Daily Occupancy (Visitors/ Students)	15/115

2.1.17.1 Facility Description

These facilities are located on the southwest corner of the Tsaile central circle campus.



Figure 86: Aerial view of the Tsaile SFH

There are ten dorm 21 buildings on this complex separated into 31 units that were all built at the around the same time and are based on six floor plans. The construction is identical from unit to unit as they are prefabricated. All the units have an entrance that opens into the living room connected to an open layout dining room and kitchen. The living room is attached to a corridor with a utility/laundry closet. There are two bedroom and three-bedroom units. The three-bedrooms units have two bathrooms whereas the rest only have a single bathroom. There are ADA units, and the only layout difference is gaining a larger bathroom by taking over the space used as a coat closet in the other units. There are other closets in all the units attached to each one of the bedrooms. Each unit has a

mechanical room with exterior access. One of buildings has server room that provides internet to the entire complex.

2.1.17.2 Hours of Operation

These buildings are occupied at near capacity year-round. One unit is used as an office for the property management staff.

2.1.17.3 Building Envelope

These are single story prefabricated construction residential style buildings. The roof is a low pitch gable roof. The roofs have a standing seam metal covering. There is partial drainage management installed on the roof edges over the doorways. The walls are insulated 2x4 stud construction with stucco and brick exterior and sheetrock interior. The windows throughout the building are double paned with vinyl frames. The two exterior doors are metal doors.



Figure 87: Exterior construction and roof drainage of a SFH unit.

The sweeps and weather strip around the doors are not in working condition. The double pane windows appear to be in good condition, however areas of sealant on four windows are worn,

deteriorated and no longer effective. Our team also noted unsealed penetrations that allow unwanted air and moisture infiltration/exfiltration and energy loss.

See Appendices G1 for a detailed report on the building envelope.



Figure 88: Heat loss through the front door of a SFH unit.

2.1.17.4 Lighting

Interior lighting in these buildings consists of a mixture of lighting fixture types and models. Residential style surface mount ceiling fixtures with one or two bulbs, which are a mixture of 13W CFLs and 9W LEDs, can be found in most of the room. There are two chandelier lights in the kitchen and dining room with two 9W LEDs each. Pendant lights with two 9W LEDs are also in the kitchen. A ceiling fan fixture with two 13W CFL bulbs can be found in the living room and bedrooms. A vanity light with 3 13W CFL bulbs can be found in the bathrooms. Two LED wall packs with a 15W bulbs illuminate the exterior of each unit. There are no existing lighting controls or occupancy sensors in this building.



Figure 89: Pendant and chandelier lights in the kitchen of a SFH unit.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.17.5 HVAC Equipment and Controls

The main source of heating for each unit is provided by a propane furnace in the mechanical room. The treated air is transferred to the spaces by diffusers mounted high up on the walls. Temperature controls for the RTUs are programmable digital thermostats. Ceiling fans are used for air movement in the living room and bedroom. There is no source of central cooling in the units. The server room does have a dedicated split system for cooling.



Figure 90: SFH unit furnace with the cover off.



Figure 91: Programmable thermostat in SFH unit.

A list of equipment is tabulated in **Appendix C1**.

2.1.17.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a residential area. There are plug loads such as computers, monitors, laptops, TVs, game consoles, stereos, phone chargers, lamps and fans located in the rooms. In the kitchens there is a dishwasher, microwave, coffeemaker, and a refrigerator. The living rooms contains loads like TVs, computer, monitor, game console, DVD player, and a stereo. The bathrooms have plug loads like hair treatment tools and hair dryers.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.17.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the mechanical room of each unit and includes a 40-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.17.8 Other

None.

2.1.18 Tsaile Central Hogan



Facility Facts:

Facility Name	Tsaile Central Hogan
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft^2)	1,150
Year Built	2007
Avg. Daily Occupancy (Visitors/ Students)	3/6

2.1.18.1 Facility Description

This facility is in the center of the Student Family Housing complex.



Figure 92: Aerial view of the Tsaile Central Hogan

This building is used as a community gathering site for principally the residences of the Student Family Housing. About 2/3rds of the floor area is an open entertainment room. The rest of the floor space is an open porch area. There are plans to upgrade and redesign this building as a project separate of the IGA project.

2.1.18.2 Hours of Operation

This building is used intermittently for group gatherings.

2.1.18.3 Building Envelope

This is a one-story building with a standing seem metal roof. The roof is a hexagonal roof sloping from the center point. There is no drainage management installed on the roof. The walls are stucco and brick construction. The windows take up about a half of the walls and are double paned with metal frames. Doors at the entrances are metal frames with large window section.



Figure 93: Double pane metal frame windows at the Central Hogan.

2.1.18.4 Lighting

Interior lighting in this building consists of ceiling fan lights with 9W LED bulbs. The Exit sign is a 3W LED. Exterior lighting consists of three 30W LED wall packs and two 15W LED wall packs. There are no existing lighting controls or occupancy sensors in this building.



Figure 94: Ceiling fan lights and exit sign in the Central Hogan.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.18.5 HVAC Equipment and Controls

There are no central HVAC system or controls in this building. A fireplace with a pellet stove retrofit sits in the middle of the building. There are ceilings fans to move air around the interior space.



Figure 95: Pellet stove retrofitted to the fireplace in the Central Hogan.

A list of equipment is tabulated in **Appendix C1**.

2.1.18.6 Plug Loads

The plug loads associated with this building vary and are hard to predict as it dependent on the purpose of the gathering. There were no visible plug loads identified during the site visits.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.18.7 Domestic Hot Water

There is no domestic water in this building. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.18.8 Other

None.

2.1.19 Tsaile Faculty Office Building 1 and 2 (FOB1 and FOB2)



Facility Facts:	
Facility Name	Tsaile FOB1 and FOB2
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	1,624 total
Year Built	2016
Avg. Daily Occupancy (Staff / Visitors/ Students)	10/2/2

2.1.19.1 Facility Description

These facilities are located on the southeast side of the central circle Tsaile campus between the GCB and Archival building.



Figure 96: Aerial view of Tsaile FOB1 and FOB2.

These buildings serve as office space for the Diné College staff. The entrance leads to a corridor to access the rest of the spaces in the building. Four office spaces can be found in each building. There is one bathroom per building.

2.1.19.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.19.3 Building Envelope

These are small, 812 sq. ft. each, single-story modular buildings that has been converted to a permanent structure. The roofs are low pitch gable roof with a standing seam metal covering. There is no drainage management installed on the roof edges. The walls are typical bat insulated 2x4 stud construction with an adobe exterior and sheetrock interior. The windows throughout the building are double paned with metal frames. The doors are solid metal doors, with small, reinforced windows.

The sweeps and weather strip around the doors are not in working condition. The double pane windows appear to be in good condition, however areas of sealant on the windows are worn, deteriorated and no longer effective. Our team also noted unsealed penetrations that allow unwanted air and moisture infiltration/exfiltration and energy loss.

See Appendices G1 for a detailed report on the building envelope.



Figure 97: Heat loss around the door and seams of FOB2

2.1.19.4 Lighting

Interior lighting in these buildings consists of 2’x4’ recessed troffer fixtures with three or four, 32W T8 lamps in most of the spaces. In the restrooms there are 6” recessed cans with 13W LED bulbs. Exit signs consist of 3W LED combo fixtures. The exterior illumination is source two 100W metal halide wall packs per building.



Figure 98: Walpack on the exterior of FOB1.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.19.5 HVAC Equipment and Controls

The HVAC system is comprised of a three-ton package unit mounted to a stand on the side of each building. The treated air is transferred to space by ducts that serve recessed ceiling mount diffusers. Control of these units are by programable digital thermostats. There are exhaust fans in the restrooms.



Figure 99: Stand mounted package units at FOB1 and FOB2.

A list of equipment is tabulated in **Appendix C1**.

2.1.19.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for an office space. There are office plug loads such as computers, monitors, and printers in the offices. Some of the offices have a small UPS for backup purposes. Other plug loads found in the space are LCD TV, shredder, coffeemaker, microwave, and a refrigerator.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.19.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption and consists of an electric domestic hot water (DHW) unit. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.19.8 Other

None.

2.1.20 Tsaile Faculty Office Building 3 (FOB3)



Facility Facts:	
Facility Name	Tsaile FOB3
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	4,569
Year Built	2018
Avg. Daily Occupancy (Staff / Visitors/ Students)	21/6/6

2.1.20.1 Facility Description

This facility is located just southwest side of the central circle Tsaile campus, North of the NOC.



Figure 100: Aerial view of Tsaile FOB1 and FOB2.

This building serves as office space for the Diné College staff. The entrance leads to a corridor to access the rest of the spaces in the building. There are 21 office spaces in this building. A kitchen with attached dinning/general purpose room are available for staff use. A conference room is used as a communal meeting space. Four bathrooms serve the occupants. A utility room sits next to the bathrooms.

2.1.20.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.1.20.3 Building Envelope

This is a typical double wide single-story modular building that has been converted to a permanent structure. The roofs are low pitch gable roof with a white TPO covering. There is drainage management installed on the roof edges but is only directed about a foot away from the base of the building. The walls are typical bat insulated 2x4 stud construction with a wood siding exterior and sheetrock interior. The windows throughout the building are double paned with metal frames. The doors are solid metal doors, with small, reinforced windows.

The sweeps and weather strip around the doors are not in working condition. The double pane windows appear to be in good condition, however areas of sealant on the windows are worn, deteriorated and no longer effective. Our team also noted unsealed penetrations that allow unwanted air and moisture infiltration/exfiltration and energy loss.

See Appendices G1 for a detailed report on the building envelope.

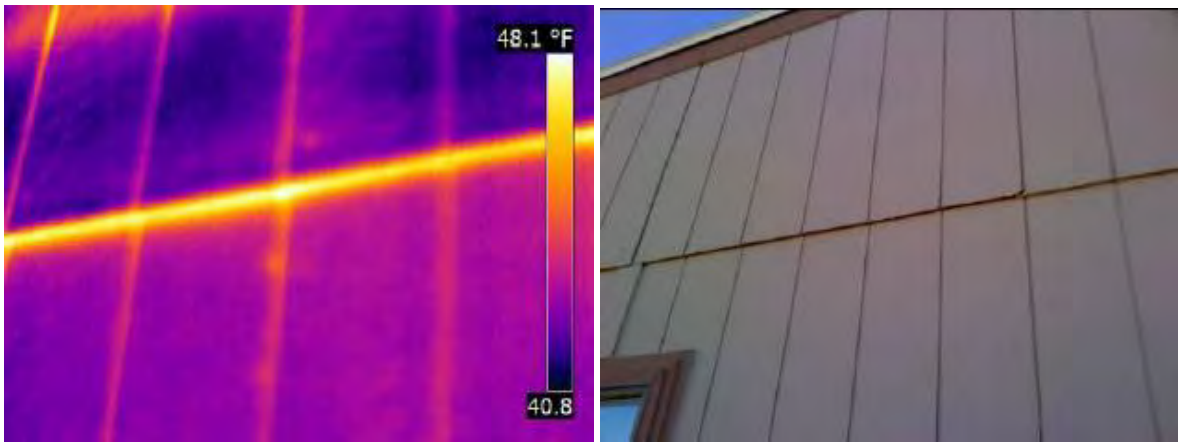


Figure 101: Heat loss through the exterior panel seam at the FOB3.

2.1.20.4 Lighting

Most of the interior lighting in this building consists of 2’x4’ recessed troffer fixtures with one 40W LED lamp. In the restrooms there are 2’X2’ recessed troffers with one 20W LED lamp. Exit signs consist of 3W LED combo fixtures. The exterior illumination source is four metal wall packs with a 13W CFL bulb. There are no lighting controls at this building.



Figure 102: Interior lighting at the FOB3.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.20.5 HVAC Equipment and Controls

The Heating, Ventilation, and Air Conditioning (HVAC) systems are comprised of six wall mounted reversible heat pumps (WMRHP) to provide cooling and heating. The treated air is then distributed to

the spaces by ducting and ceiling mount diffusers. Control of the WMRHPs is limited to directly connected digital programable thermostats. The bathrooms and utility have small exhaust fans.



Figure 103: Wall mounted heat pumps at the FOB3.

A list of equipment is tabulated in **Appendix C1**.

2.1.20.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for an office space. There are office plug loads such as computers, monitors, and printers in the offices. Some of the offices have a small UPS for backup purposes. There is a break room and attached kitchen with a coffeemaker, propane stove, dishwasher, microwave, and a refrigerator. In the conference room are LCD TVs and projectors for display as well as teleconferencing units.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.20.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the utility room and includes a 40-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.20.8 Other

None.

2.1.21 Tsaile Land Grant Management Building (LGM)



Facility Facts:

Facility Name	Tsaile LGM
Street Address	1 Circle Dr.
City, State, Zip	Tsaile, AZ 86556
Gross Area (ft²)	2,070
Year Built	2016
Avg. Daily Occupancy (Staff / Visitors/ Students)	4/6/13

2.1.21.1 Facility Description

This facility is located outside of the central circle Tsaile campus, northwest of the dorms.



Figure 104: Aerial view of Tsaile Land Grant Building.

This building serves as a resource for rangeland, farming, and livestock management education programs and community outreach. The entrance leads to a corridor to access the rest of the spaces in the building. There are seven office spaces in this structure. A breakroom is on the south side of the building. A conference room is used as a communal meeting space. One bathroom serves the occupants. A utility room sits next to the bathrooms.

2.1.21.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed

Sunday	Closed

2.1.21.3 Building Envelope

This is a typical double wide single-story modular building that has been converted to a permanent structure. The roofs are low pitch gable roof with a standing seam metal covering. There is drainage management installed on the roof that is collected for agricultural use. The walls are typical bat insulated 2x4 stud construction with a wood siding exterior and sheetrock interior. The windows throughout the building are double paned with metal frames and metal security bars. The exterior doors are solid metal doors.

A large area of infiltration/exfiltration exists at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Unsealed Penetrations and blank opening are another source unwanted air and moisture infiltration/ex-filtration leading to energy loss.

See Appendices G1 for a detailed report on the building envelope.

2.1.21.4 Lighting

Interior lighting in this building consists of 2'x4' fixtures with four, 32W T8 lamps in most of the spaces. In the restrooms exist bath fan type light fixtures, two are fitted with a single 13W bulb and the third has a 4W LED. Additionally, in one of the storage closets there is a 6" can light with a 60W incandescent bulb. Mixed with the typical 2'x4' fixtures in the cafeteria there is a single 6" can light with a 13W CLF bulb. Exit signs consist of 3W LED lamps paired with a 3W emergency wall pack light. The exterior illumination is via two wall pack fixtures with one 13W CFL. There are no existing lighting controls or occupancy sensors in this building.



Figure 105: Interior lighting at the Land Grant building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.1.21.5 HVAC Equipment and Controls

The Heating, Ventilation, and Air Conditioning (HVAC) systems are comprised of two RTUs. The treated air is then distributed to the spaces by ducting and ceiling mount diffusers. Control of the RTUs is limited to directly connected digital programable thermostats.



Figure 106: RTU at the Land Grant Management building.

A list of equipment is tabulated in **Appendix C1**.

2.1.21.6 Plug Loads

The plug loads associated with this building vary by space type. There are office plug loads such as computers, monitors, and printers located in the office. There is a break room and attached kitchen with a coffeemaker, propane stove, microwave, refrigerator and some other not often used appliances. In the conference room are LCD TVs and projectors for display as well as teleconferencing units.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.1.21.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the utility room and includes a tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.1.21.8 Other

None.

2.1.22 Tsaile Faculty Housing



2.1.22.1 Facility Description

These facilities are spread out over the area north of the central circle Tsaile campus.



Figure 107: Aerial view of Tsaile Faculty Housing.

These facilities are comprised of trailers, Hogan buildings, and multi-story apartment buildings. These buildings were excluded from the scope of this IGA because they are low priority for upgrades for the college. Also, the residents pay all the utility bills for these buildings meaning they are not a good fit for the EPC program. Yearout Energy recommends the school use the suggestions for other buildings in this IGA as upgrades are planned for these facilities.

2.2 Shiprock South Campus

2.2.1 Shiprock South Student Success Center (SSC)



Facility Facts:	
Facility Name	Shiprock South SSC
Street Address	Hwy 64 & N570
City, State, Zip	Shiprock, NM 87420
Gross Area (ft²)	3,293
Year Built	2013
Avg. Daily Occupancy (Staff / Visitors/ Students)	10/3/13

2.2.1.1 Facility Description

This facility is located to the south side of the Shiprock South campus, between the south parking lot and the classroom building.



Figure 108: Aerial view of the Shiprock Student Success Center

The Student Success center is the headquarters for the Shiprock campus's student support services. An entry area is attached to a reception office. A corridor runs from the entry through the rest of the space. Two storage closets are surrounding the entry and reception. Next to the entry is a conference room with a folding dividing wall. There are 8 offices and a break room for the staff. There are two restrooms with a utility room next to them. An IT room sits amongst the offices.

2.2.1.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.2.1.3 Building Envelope

This is a single-story building with a flat roof with parapet wall around the perimeter. The roof is a white TPO. Roof drainage is accomplished by roof drains on the south side of the roof. The walls are typical bat insulated 2x4 stud construction with sheetrock interior. The ceiling is a drop ceiling. The exterior is stucco. The windows throughout the building are double paned with metal frames. Doors at the entrances are metal frame with large glass sections, and other doors are solid metal doors.



Figure 109: SSC roof, roof drain, and parapet wall.

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Unsealed Penetrations, expansion joints and blank opening are another source unwanted air and moisture

infiltration/ex-filtration leading to energy loss. The windows are double pane, tinted and in good condition.

See Appendices G1 for a detailed report on the building envelope.



Figure 110: Damaged bottom door seals the SSC.

2.2.1.4 Lighting

Interior lighting mainly consists of recessed 2'x4' troffers with either two or three 32W T8s. There is a single wrap style 1'x4' light in the utility room with two 32W T8s. The four exit signs have 3W LEDs. The exterior illumination consists of three 70W metal halide wall pack. Surrounding the Shiprock South buildings there are 27 pole lights, with 25 400W and two 250W metal halide bulbs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer and photo sensors on the pole lights.



Figure 111: Exterior light at the SSC and exterior light control timeclock in the SSC.

Refer to **Appendix D1** for a lighting fixture inventory.

2.2.1.5 HVAC Equipment and Controls

The main HVAC system is a forced air system with three Natural Gas/DX package units. The air is transferred to the spaces with above ceiling duct work with recessed diffusers. There is a dedicated split system for cooling the IT room. Temperature controls are digital thermostats for each of the three zones. There are exhaust fans in the restrooms. There is no source of outside air in this building, and this issue should be addressed. Also, the RTUs appear to be capable for economizer cooling but not currently configured for it.



Figure 112: RTUs at the SSC building.

A list of equipment is tabulated in **Appendix C1**.

2.2.1.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for an office space. There are office plug loads such as computers, monitors, and printers in the offices. Some of the offices have a small UPS for backup purposes. There is a break room with a coffeemaker, microwave, and a refrigerator. The IT room holds a server and several switches. There is a conference room/computer lab with LCD TVs, computers, printers, copy machines, a projector, and telecommunication equipment.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.2.1.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in a utility closet and includes a 20-gallon tank electric heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.2.1.8 Other

None.

2.2.2 Shiprock South Classroom Building



Facility Facts:	
Facility Name	Shiprock South Classroom
Street Address	Hwy 64 & N570
City, State, Zip	Shiprock, NM 87420
Gross Area (ft²)	15,945
Year Built	2004
Avg. Daily Occupancy (Staff / Visitors/ Students)	17/6/105

2.2.2.1 Facility Description

This facility is located to the south side of the Shiprock South campus, just west of the Shiprock SSC.



Figure 113: Aerial view of the Shiprock Classroom Building.

The Classroom Building is a two-story structure that mainly serves as an instructional building but also houses several staff offices. There are nine classroom spaces that include a computer laboratory. There are 17 offices spread out on the southeast side of the building. Attached to these offices are four work areas and a conference room. Storage closets are spread throughout the building. There are three restrooms on each floor. Two janitor's closet serves each floor. An IT room sits on each floor. The mechanical and electrical rooms sit on the first floor and is accessible from the exterior central walkway. There is a PV solar installation on the roof of this building.

2.2.2.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.2.2.3 Building Envelope

This is a two-story building with a white TPO flat roof. There is drainage management on the roof with roof drains and scuppers to move water off the roof, but the water is then dumped right at the foundation of the building. Exterior construction is cmu block, formed concrete, metal siding and architectural panels. The interior walls are typical bat insulated 2x4 stud construction with sheetrock face. The windows throughout the building are double paned with metal frames. Doors at the entrances are metal frame with large glass sections, and other doors are solid metal doors.



Figure 114: Exterior of classroom building showing construction materials

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Unsealed

Penetrations, expansion joints and blank opening are another source unwanted air and moisture infiltration/ex-filtration leading to energy loss.

See Appendices G1 for a detailed report on the building envelope.

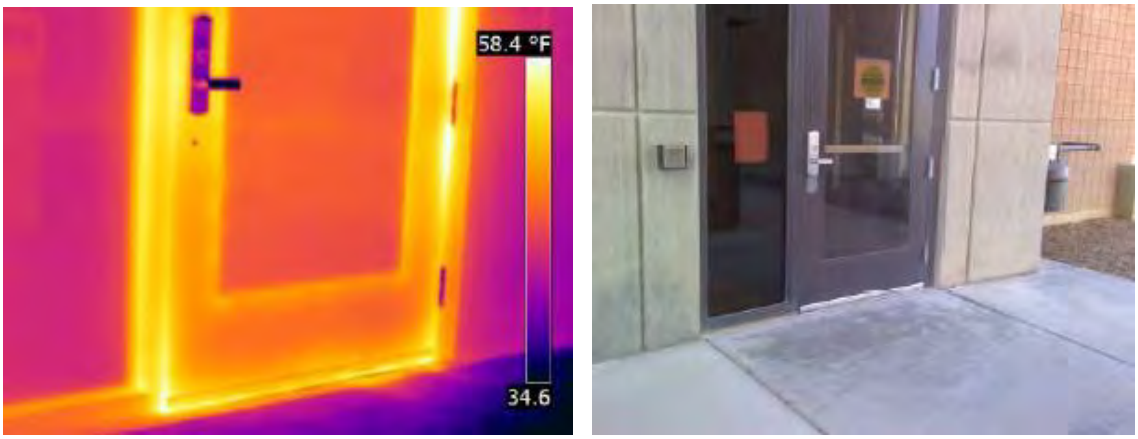


Figure 115: Energy loss through exterior door at classroom building.

2.2.2.4 Lighting

About 30% of the lighting count is made up of 6” and 8” pendant can lights with a 32W CFL bulb. A little over 20% of the interior lighting consists of 1’x4’ recessed strip, ceiling surface mount, wall surface mount or suspended fixtures with one or two 32W T8s. Around one sixth of the lighting in this building is provided by 1’x8’ and 1’x12’ suspended fixtures with six or nine 32W T8s, respectively. Yet another 15% of the lighting is provided by 1’x3’ recessed strip lighting with a 25W T8. Only a few handfuls of lights have been converted to LEDs in this building. There are some less common fixture types like 2’x4’ recessed troffers in the electrical/mechanical rooms, as well as Scones 6” recessed cans, flood lights in the hallways and stairwells. The ten exit signs have 3W LEDs and the five emergency wall packs have two 20W halogens. The exterior illumination consists of sconces, surface mount canopy, and 10” recessed can lights with 70W, 250W and 100W metal halide bulbs, respectively. There are also a few 70W and 40W LED wall packs on the exterior. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer and photo sensors on the pole lighting.

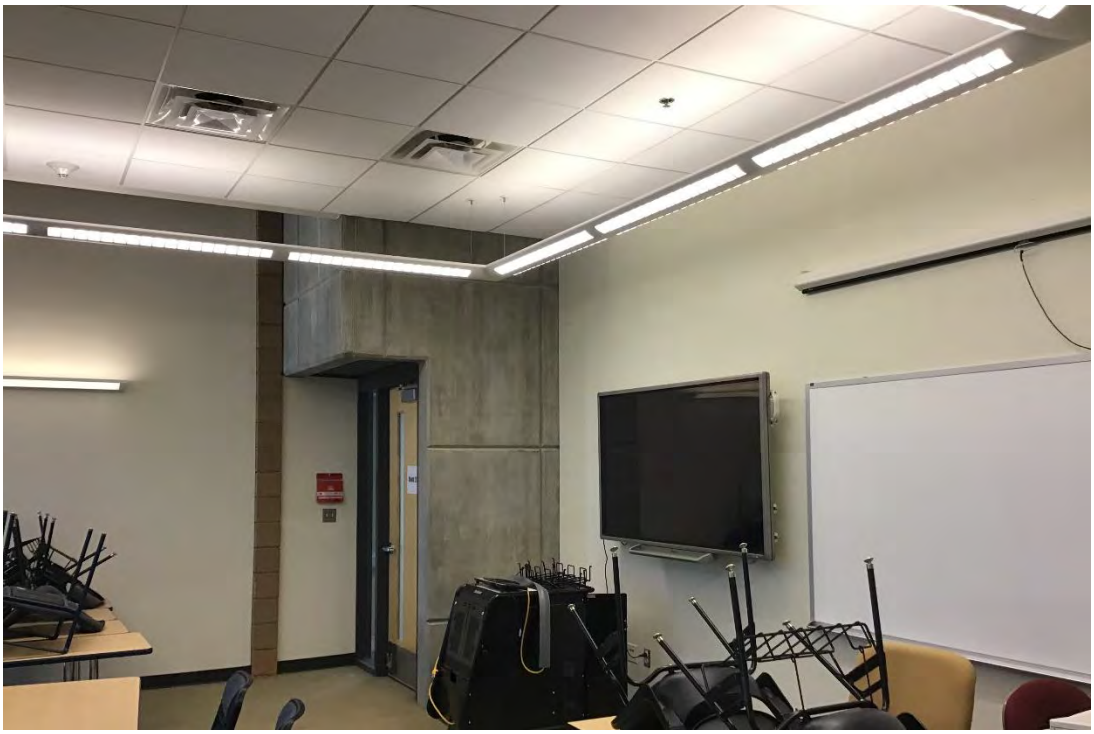


Figure 116: Suspended lighting at classroom building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.2.2.5 HVAC Equipment and Controls

The main HVAC system is a forced air system supplied by natural gas/DX rooftop units. The air is transferred to the spaces by above ceiling duct work with recessed diffusers. Temperature controls for the RTUs are programmable digital thermostats and nonprogrammable thermostats. There is Trane front end controls, but the maintenance staff does not have access to it. The IT rooms have a dedicated CRAC system with an outdoor condenser and ceiling mount interior units with dedicated control units.



Figure 117: RTU at the Classroom building.



Figure 118: Classroom building IT room interior unit and control module.

A list of equipment is tabulated in **Appendix C1**.

2.2.2.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a classroom and office building. There are office plug loads such as computers, monitors, and printers located in the office spaces. In the classrooms there are more computers, monitors, and printers as well as large flat screen TVs and overhead projectors used for presenting. There is a computer lab with several computers and monitors as well as desk top printers and full-sized printers.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.2.2.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the mechanical room and include a 71-gallon tank natural gas heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.2.2.8 Other

None.

2.2.3 Shiprock South Pinto Library



Facility Facts:

Facility Name	Shiprock South Library
Street Address	Hwy 64 & N570
City, State, Zip	Shiprock, NM 87420
Gross Area (ft²)	23,100
Year Built	2012
Avg. Daily Occupancy (Staff / Visitors/ Students)	10/20/201

2.2.3.1 Facility Description

This facility is located on the north side of the Shiprock South campus, just north of the Shiprock Classroom building.



Figure 119: Aerial view of the Tsaile Library

The library serves as the main research source and study area on campus. The main vestibule is on the southeast facing side of the building. A lobby sits to the north of the vestibule attached a men's and woman's restrooms. The lobby leads to a lecture hall. As one enters the library from the vestibule there is a break room and storytelling room to the left. This leads to the main Library space with a circulation desk area, conference room and four study rooms. To the north of this space is a classroom and a computer lab. Behind the circulation desk two open office areas, the branch librarian office, break room and a restroom. The IT room is attached to the break room. A corridor leads to back of the building with an electrical and storage rooms attached. A mechanical room is accessed by the exterior through the back of the building.

2.2.3.2 Hours of Operation

August-May

Monday	8:00 am – 8:00 pm
Tuesday	8:00 am – 8:00 pm
Wednesday	8:00 am – 8:00 pm
Thursday	8:00 am – 8:00 pm
Friday	8:00 am – 8:00 pm
Saturday	8:00 am – 8:00 pm
Sunday	8:00 am – 8:00 pm

May-July

Monday	8:00 am – 7:00 pm
Tuesday	8:00 am – 7:00 pm
Wednesday	8:00 am – 7:00 pm
Thursday	8:00 am – 7:00 pm
Friday	8:00 am – 5:00 pm
Saturday	8:00 am – 5:00 pm
Sunday	Closed

Winter, Summer, Spring, Fall Breaks

Monday	8:00 am –5:00 pm
Tuesday	8:00 am –5:00 pm
Wednesday	8:00 am –5:00 pm
Thursday	8:00 am –5:00 pm
Friday	8:00 am –5:00 pm
Saturday	8:00 am –5:00 pm
Sunday	Closed

2.2.3.3 Building Envelope

This is a single-story building with a white TPO flat roof. There is a large architectural skylight that sits over the story room. There is drainage management installed on the roof in the form of roof drains. There are large sections of glazing at the entrance and on the southwest side of the building. The windows are double paned with metal frames. Much of the rest of the building exterior is stucco construction. The main entrance doors are metal frame with large windows and the rest of the exterior doors are solid metal.



Figure 120: The southwest side of the library with large glazing section.

The building has double pane, tinted windows, in good condition. However, a few of the windows have sealant that has separated from the frame. The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Several penetrations and openings are located around the perimeter walls where air infiltration/exfiltration and energy loss occur.

See Appendices G1 for a detailed report on the building envelope.



Figure 121: A wall penetration at the library that was never properly sealed or has lost its seal.

2.2.3.4 Lighting

Around a third of the lighting count in this building is 4", 6", or 8" recessed can lighting with one or two 50W halogen, 18W CFL, 26W CFL, 42W CFL, or 50W CFL bulbs. The next third is made up of 2'x4' and 1'x4' recessed troffers and surface mount fixtures with one two or three 32W T8 bulbs. The main source of lighting in the open library space is 1'x8' suspended fixtures with two 54W T5s. Elsewhere there are other 1'x4' and 1'x8' suspended fixtures with one 54W T5 or four 32W T8s, respectively. In the classroom there are 8" pendant cans with 32W CFL bulbs. There are open socket fixtures in the mechanical rooms with one 17.5W LED and the other with a 200W incandescent. The ten exit signs have 3W LEDs. Exterior lights consist of 70W metal halide wall packs and flood lights, and 100W metal halide recessed well lights. To light the exterior pathways there are recessed path lights with 42W CFLs and bollards with 70W metal halide bulbs. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer.

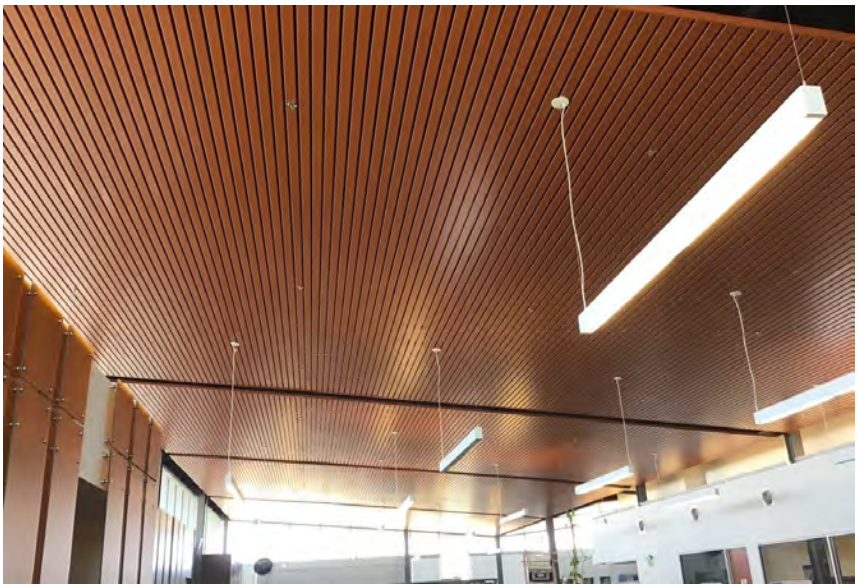


Figure 122: Suspended lighting in the open space at the library.

Refer to **Appendix D1** for a lighting fixture inventory.

2.2.3.5 HVAC Equipment and Controls

The main source of heating and cooling for this building is provided by an 80-ton package unit that has natural gas heating and DX cooling. This unit is pad mounted on the northwest exterior of the building. The package unit is then ducted into the interior space and out to VAV boxes to control the separate zones. There are two condensing boilers and VFD controlled pumps to supply reheat to the VAV boxes. The air is then supplied to the space using recessed ceiling diffusers or jet diffusers in the case of the open library space. The IT room has its own dedicated split system for cooling. Temperature controls are a front-end system run from a computer in the IT room. The college has had issues with this system working correctly due to control problems. The restrooms and IT room have small exhaust fans



Figure 123: The package unit that serves the library.



Figure 124: The boiler system that serves the library with reheat.

A list of equipment is tabulated in **Appendix C1**.

2.2.3.6 Plug Loads

The plug loads associated with this building vary by space type and are typical for a public library. There are office plug loads such as computers, monitors, and printers located in the offices. In the computer labs and classrooms, you can find computers, printers, UPSs, and projectors. In the library space you can find lamps at personal studying stations as well as student's personal devices.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.2.3.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) unit is in the mechanical room and include a 50-gallon tank propane heater. The available data collected during the field survey are tabulated in **Appendix C1**.

2.2.3.8 Other

None.

2.3 Shiprock North Campus

2.3.1 Shiprock North Main Building



Facility Facts:	
Facility Name	Shiprock North Main Building
Street Address	1228 Yucca Street
City, State, Zip	Shiprock, NM 87420
Gross Area (ft²)	64,817
Year Built	1952
Avg. Daily Occupancy (Staff / Visitors/ Students)	17/10/180

2.3.1.1 Facility Description

This facility is most of the square footage of the Shiprock North Campus.



Figure 125: Aerial view of the Shiprock North Main building.

The Shiprock North Main building serves as a multipurpose structure. This building was initial built by the Bureau of Indian Affairs as a boarding school and subsequently bought and converted by Diné College to serve as its initial Shiprock campus. There have been several rounds of renovations on this building since Diné took control and it is only partially being used currently. Due to the age of the building and the infrastructure growth at the Shiprock South campus, the future of the building is uncertain. The south section of this building is a gymnasium. The rest of the first floor is filled with classrooms, computer labs, office space for the staff, office work areas, conference rooms, restrooms, janitor's closets, nonfunctional kitchen space, lobbies, vestibules, and study areas. The second-floor area over the west wing is office space that is currently being rented out to other unassociated organizations. The basement houses a mechanical room.

2.3.1.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm
Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.3.1.3 Building Envelope

This is for the most part a single-story building with a second story on the vaulted gym and a raised area above the west wing. The roof is a mixture of white TPO and rolled composite roofs that have been covered with a white paint on material. The roof is a low pitch roof split into numerous sections. There is only partial drainage management on the roof, generally only over entrance points. Exterior construction is stone and stucco. The interior walls are typical bat insulated 2x4 stud construction with sheetrock face. The ceilings are a mixture of sheetrock hard ceilings, wood slat, drop ceilings and vaulted ceilings. The windows throughout the building are a mixture of double paned and single paned with wood or aluminum frames. Exterior doors at some entrances are metal frame with large glass sections, and other doors are solid metal doors.



Figure 126: Composite roof with white coating at the Shiprock North Main building.

A large area of infiltration/exfiltration exists at the doors on all sides of the building. Damaged and missing weather-strip, door sweeps, and astragals lead to energy waste through outside air infiltration. Several of the doors also required sealant around the frames. Unsealed penetrations, expansion joints and blank opening are another source unwanted air and moisture infiltration/ex-filtration leading to energy loss. The windows are double pane with wood and aluminum frames. The wood frames are

varying condition from good to poor. The windows sealant is deteriorated, weathered and no longer effective leading to air and moisture infiltration and/or ex-filtration, which causes energy loss.

See Appendices G1 for a detailed report on the building envelope.



Figure 127: Energy loss around an exterior door seal at the Shiprock North Main building.

2.3.1.4 Lighting

Over 40% of the interior lighting consists of 2'x4' recessed troffers or surface mount wrap fixtures with three or four 32W T8 bulbs. Around a fourth of the lighting count in this building is 1'x4' recessed troffer, surface mount wrap, wall mount vanity, and suspended fixtures with one or two 32W T8 or 40W T12 bulbs. In multiple spaces are 6" recessed can lighting with one 13W LED or 65W incandescent bulbs. Bare socket fixtures can be found in the basement and spread out in the rest of the building with anywhere from 300W incandescent to 13W CFL bulbs. The gym is lit with 400W metal halides in pendent fixtures. There are a small number of other fixtures like 1'x3' vanities with two 24W T5s, RLM fixtures with 300W incandescent bulbs, as well as ceiling fan and bath lights with 60W incandescent bulbs. The exit signs have mostly been converted to 3W LEDs with a few 20W incandescent bulbs remaining. Thirteen of the 28 emergency light wall packs have been converted to 3W LEDs from 20W halogen fixtures. The exterior illumination consists of 150W HPS canopy, 70W HPS canopy, 70W HPS wall pack, 70W LED wall pack, 70W MH wall pack, and 70W LED shoebox lights. There are no existing interior lighting controls or occupancy sensors in this building, and the exterior lights are controlled by a timer.



Figure 128: Surface mount fixtures at Shiprock North main building classroom.

Refer to **Appendix D1** for a lighting fixture inventory.

2.3.1.5 HVAC Equipment and Controls

The main HVAC system a hydronic system with the main heat plant being two aged boilers in the basement. The hot water is supplied to radiant heat units on the perimeter of the building. The gym has its own dedicated package unit that sits on a platform in the rafters with distribution ducts and duct mounted diffusers. The west wing ground floor has a ground mounted 4-ton package unit that is ducted in and supplies treated air through ceiling mounted diffusers. Temperature controls for the hydronics and package units are nonprogrammable thermostats. There are several rooms with dedicated split systems for cooling, including the IT room and classrooms. There are many window-mounted AC units throughout the building.

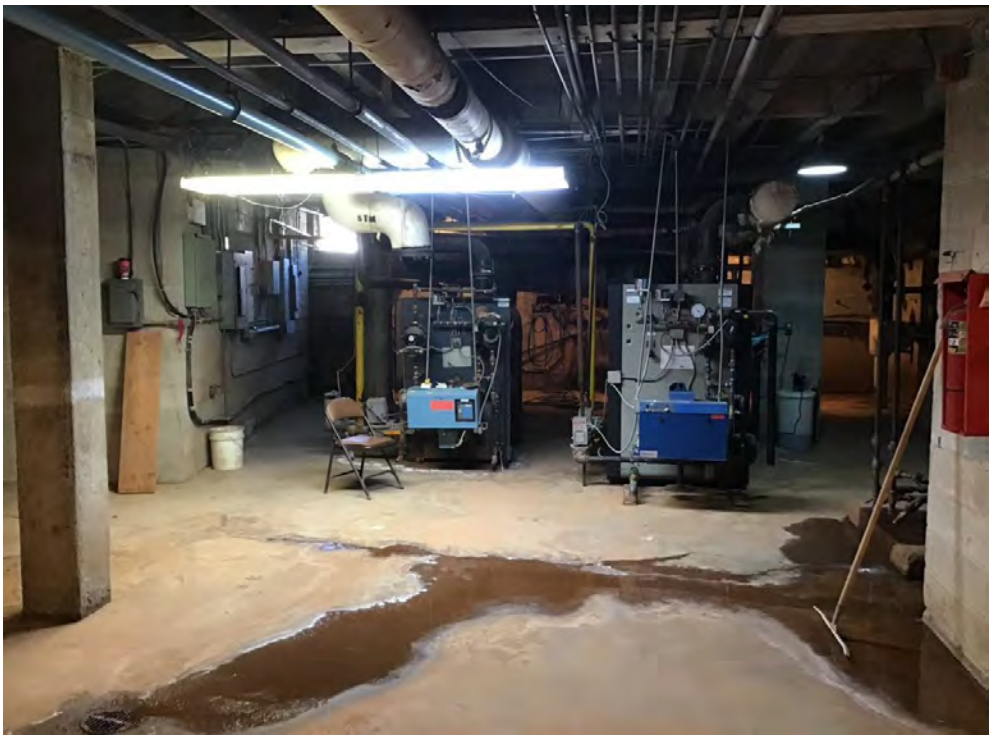


Figure 129: Boilers in the Shiprock North Main building basement.



Figure 130: Two types of radiant units at the Shiprock North Main building.

A list of equipment is tabulated in **Appendix C1**.

2.3.1.6 Plug Loads

Only a portion of this building is currently in use. The plug loads associated with it vary by space type. There are typical plugs loads for a classroom and office building. There are office plug loads such as computers, monitors, and printers located in the office spaces. In the classrooms there are more computers, monitors, and printers as well as large flat screen TVs and overhead projectors used for presenting. The there are several specialized teaching rooms, like a geology lab. To calculate the

special equipment plug loads the square footage being used was multiplied by 2.27 W/ft2 multiplied by the use time of the spaces based off the school class schedule.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.3.1.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the domestic hot water (DHW) units are in utility rooms spread throughout the building. The available data collected during the field survey are tabulated in **Appendix C1**.

2.3.1.8 Other

None.

2.3.2 Shiprock North Modular Buildings



Facility Facts:	
Facility Name	Shiprock North Modular Buildings
Street Address	1228 Yucca Street
City, State, Zip	Shiprock, NM 87420
Gross Area (ft²)	6,952 total
Year Built	1998
Avg. Daily Occupancy (Staff / Visitors/ Students)	8/2/70

2.3.2.1 Facility Description

These facilities are spread-out around the perimeter of the Shiprock North Main building.



Figure 131: Aerial view of Shiprock North Modular units.

There are currently five modular units on the Shiprock North campus. The HIV and Office modulars see infrequent use currently. The Biology, Chemistry and GIS modulars see frequent use as there are academic programs currently being conducted in them. The biology building is one main room separated into to two teaching spaces by a central functional laboratory space. The Chemistry building is a large main teaching space with a smaller office space and a mechanical closet. The GIS building is one main room with a small mechanical closet.

2.3.2.2 Hours of Operation

Monday	8:00 am – 5:00 pm
Tuesday	8:00 am – 5:00 pm
Wednesday	8:00 am – 5:00 pm
Thursday	8:00 am – 5:00 pm

Friday	8:00 am – 5:00 pm
Saturday	Closed
Sunday	Closed

2.3.2.3 Building Envelope

These buildings, which range from 605 to 2,598 sq. ft. each, are single-story modular buildings that have been converted to a permanent structure. The roofs are low pitch gable roof with a standing seam metal covering or curved roof with rolled composite. There is no drainage management installed on the roof edges. The walls are typical bat insulated 2x4 stud construction with a metal or wood siding exterior and sheetrock interior. The windows throughout the building are double paned with metal frames. The doors are solid metal doors, with small, reinforced windows.



Figure 132: Entrance of the Biology modular building.

The largest area of infiltration/exfiltration is at the doors on all sides of the building. Damaged and missing weather-strip and door sweeps lead to energy waste through outside air infiltration. Several penetrations and openings are located around the perimeter walls, especially around the exterior wall mounted package units, where air infiltration/exfiltration and energy loss occur.

See Appendices G1 for a detailed report on the building envelope.

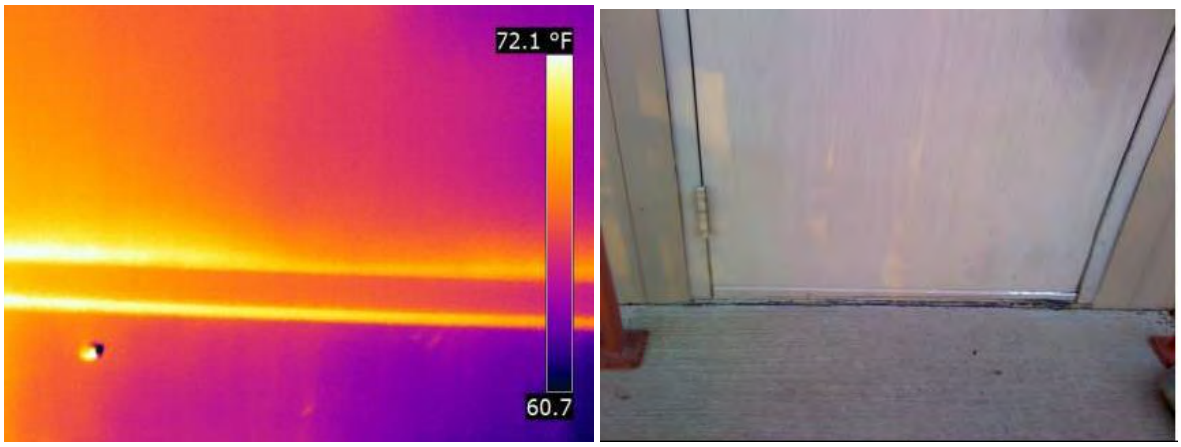


Figure 133: Heat loss under the door at the Chemistry modular building.

2.3.2.4 Lighting

Interior lighting in these buildings consists of 2'x4' recessed troffer fixtures with three or four, 32W T8 lamps in most of the spaces. Exit signs consist of 3W LED combo fixtures. The exterior illumination source is 70W HPS wall packs.



Figure 134: 2'x4' troffers at the biology modular building.

Refer to **Appendix D1** for a lighting fixture inventory.

2.3.2.5 HVAC Equipment and Controls

The HVAC in the Chemistry and GIS building is a typical residential furnace located in the mechanical closet. The biology building is served by two exterior pad mounted package units. Both the HIV and

office modulars are served by wall mounted heat pumps. The treated air is then ducted to the space and served through ceiling mounted diffusers in all the buildings. The Controls in these buildings are non-programable thermostats. There are laboratory grade exhaust fans in the Biology and Chemistry buildings.



Figure 135: Package units at the biology modular.



Figure 136: Furnace at the Chemistry modular.

A list of equipment is tabulated in **Appendix C1**.

2.3.2.6 Plug Loads

In all three buildings there are typical classroom equipment like computers, monitors, TVs, and printers. The GIS building has a few plotters and other specific equipment. The chemistry and biology labs have special equipment including scales, centrifuge, incubators, refrigerators, spectrometer, ice maker, hot plates, and microwave. To calculate the special equipment plug loads the square footage being used was multiplied by 2.27 W/ft^2 multiplied by the use time of the spaces based off the school class schedule.

Refer to **Appendix C2** for detailed plug load inventory and plug load power densities.

2.3.2.7 Domestic Hot Water

The domestic hot water (DHW) system is a small portion of the energy consumption, and the electric domestic hot water (DHW) unit is in the utility room. The available data collected during the field survey are tabulated in **Appendix C1**.

2.3.2.8 Other

None.

3.0 BASELINE UTILITY ANALYSIS

The baseline utility analysis was performed by evaluating utility records from 2018 through 2020 for all three campuses included in the IGA report. The baseline period selected for Electricity, Natural Gas (Shiprock North and South Campuses only), and Water/Sewer was from January 2018 through December 2019, which represents 24 months of data. Data from 2020 and after has been excluded to avoid any inconsistencies related to the COVID19 pandemic.

Baseline propane data for the Tsaile campus covers a period from Oct. 2019 to June 2021, due to limited access to historic billing data. Propane for the Tsaile campus is bought in bulk on an as-needed basis to fill multiple large propane tanks from the lowest cost provider. To account for this data, Yearout Energy collected delivery bills from Diné College staff and summed the total usage and cost. The data was then split into 80% of the consumption for heating, 15% domestic hot water and 5% kitchen use for the 22-month period.

To calculate the monthly use based on weather conditions, the difference of the average temperature of that month from 2019 hourly weather data was subtracted from a balance point temp of 65 degrees. The total consumption attributed to heating was then multiplied by this difference divided by the sum of the differences. Next the water consumption data was used to calculate a per month percentage of water consumption then applied to calculate a per month domestic hot water propane consumption, assuming that the two consumptions are linearly related. Lastly, the kitchen use was assumed to remain constant through the year, so the consumption was divided by eight months and then multiplied by 12 months to calculate the yearly consumption. These numbers were added together monthly to establish the propane baseline. To calculate a monthly and annual baseline spend on propane a weighted average rate was taken of the rates and amount delivered for each delivery and then multiplied by the months estimated consumption. The equations used to calculate propane consumption include:

$$.8 * C_H + .15 * C_D + .05 * C_k = C_Y$$

And

$$(C_H * \Delta T/\Sigma\Delta T_M) + (C_D * W/\Sigma W_m) + C_K = C_M$$

Where:

C_H= Heating Consumption

C_D= DHW Consumption

C_k= Kitchen Consumption

C_Y= Total Yearly Consumption

C_M=Total Monthly Consumption

ΔT= Temp. Balance Point minus the Avg. Outside Temp

ΔT_M= Monthly Temp. Balance Point minus the Avg. Outside Temp

W= Water Consumption

W_M= Monthly Water Consumption

The utility records consisted of electricity, propane, natural gas, and water/sewer data from 24 meters and propane billing data. Refer to the following sections for information on all utilities and meters, and to **Appendix B1** for more detailed baseline utility information.

The following table and pie chart depict the baseline annual cost by utility type for all facilities included in the IGA.

Table 6: Baseline Annual Utility Costs by Type ($/year) – All IGA Facilities

Utility	$/Year
Electricity	$606,846
Propane	$307,774
Natural Gas	$60,025
Water & Sewer	$68,296
Total	**$1,042,941**

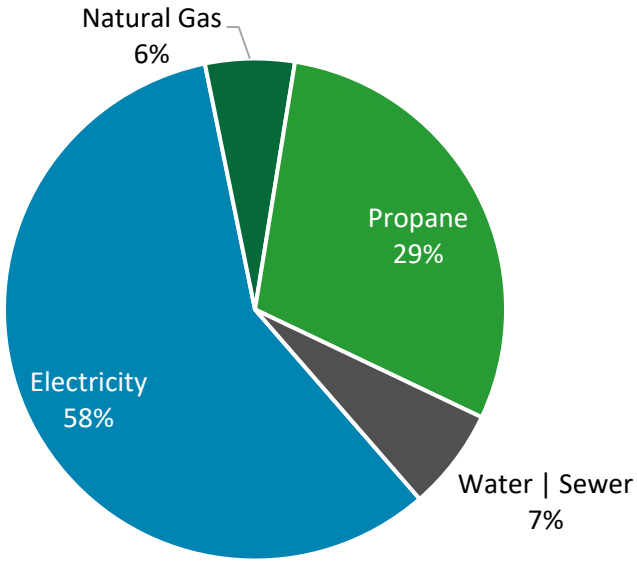


Figure 137: Baseline Annual Utility Costs Type ($/year) – All IGA Facilities

The following table and pie chart depict the baseline annual energy consumption by utility type for all the facilities included in the IGA.

Table 7: Baseline Annual Energy Consumption by Utility Type (kBTU/year) – All IGA Facilities

Utility	kBTU/Year
Electricity	15,696,633
Propane	28,852,913
Natural Gas	8,231,768
Total	52,781,314

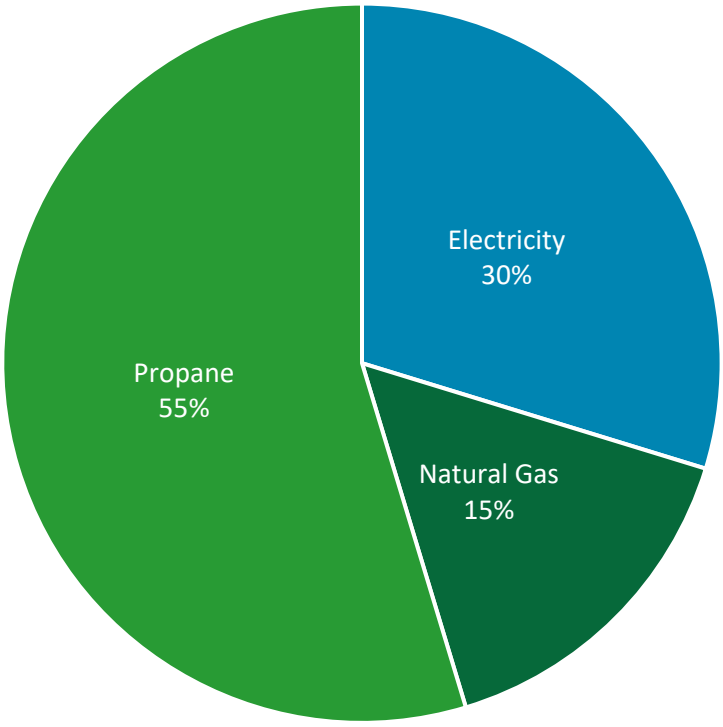


Figure 138: Baseline Annual Energy Consumption by Utility Type (kBTU/year) – All IGA Facilities

3.1 Diné College Campuses

Due to how each campus is master metered with limited to no existing submetering, the most practical approach towards establishing the baseline and benchmarking of the facilities is by campus. On the Tsaile campus, there is a single electric meter for most of the campus and one additional meter that serves the land grant management building. The propane for the Tsaile campus is unmetered and only tracked by delivery amount, which makes it difficult to breakout consumption down to the facility level. At the Shiprock South and North Campuses, there is a single water meter that serves both according NTUA.

The Table 8 depicts the baseline annual utility cost and consumption for each campus included in the IGA.

Table 8: Baseline Annual Utility Cost Summary by Campus

Campus	Electric	Natural Gas	Propane	Water & Sewer	Total Cost
Tsaile Campus	$459,534	$0	$307,774	$60,489	$827,797
Shiprock North & South Campuses	$147,312	$60,025	$0	$7,807	$215,144
Total	$606,846	$60,025	$307,774	$68,296	$1,042,941

3.2 Benchmarking

Benchmarking is the process of comparing performance indices from “typical” buildings to those of the same type and function. This provides a better understanding which of the buildings have the greatest potential for savings.

3.2.1 Baseline Energy Utilization Index (EUI) and Comparison

A common approach to benchmarking a facility is through the comparison of the facility’s Energy Utilization Index (EUI) against that of similar facilities in similar climates. The EUI is determined by dividing the total annual energy consumption, disregarding on-site renewable production, by the area of the facility (kBTU/ft²/yr). The lower the EUI, the better the energy performance of the facility.

The following table and chart depict the EUI for each campus. The baseline EUI of each campus is benchmarked against similar type facilities located in a similar climate region using the Commercial Buildings Energy Consumption Survey (CBECS) 2012, a national sample survey that collects energy-related information on the stock of U.S. commercial buildings.

Table 9: Baseline EUI Summary (kBTU/ft²/Year) by Campus

Facility	EUI kBTU/ft²/Yr.
Tsaile Campus	106.33
Shiprock North & South Campuses	104.76
CBEC median EUI for Education in Cold/Very Cold Region	74.7

Based on the EUI Benchmarking analysis above:

- There is the opportunity for significant improvement across all three campuses due to aging equipment and infrastructure.
- Diné College has taken steps in the right direction, but a large-scale project will do much more to move the needle towards energy efficiency and equaling or surpassing other similar facilities.

3.2.2 Baseline Energy Cost Index (ECI)

Another common method for benchmarking a facility is through the comparison of the facility's Energy Cost Index (ECI) against that of similar facilities. The ECI is determined by dividing the total annual energy utility cost by the square footage of the facility ($/ft²/Year). The lower the ECI, the better the energy cost performance of the facility.

Table 10: Baseline ECI Summary ($/ft²/Year) by Campus

Facility	ECI $/ft²/Yr.
Tsaile Campus	$2.01
Shiprock North & South Campus	$1.88

3.3 Baseline Utility Rates

Refer to **Appendix B2** for more detailed baseline utility rate analysis information.

3.3.1 Electricity

Navajo Tribal Utility Authority (NTUA) is the electric utility provider for all sites. The billing demand is determined by the maximum 15-minute integrated, or kilowatt demand established by the customer during the month for which the bill is rendered. There is a minimum monthly billing charge of $16.20 which includes the monthly service charge. All the sites are under the same rate listed below:

Table 11: Electric Rates Tariff Summary

Rate No.	Provider	Rate Description	Service Charge	Demand	Energy Use
				$/kW	$/kWh
COME45_3	NTUA	General Service	$11.45	First 25 kW $0.00 Next 175 kW $6.00 Additional kW $4.00	First 200 kWh $0.1100 Next 800 kWh $0.0920 Next 6000 kWh $0.0900 Additional kWh $0.0840

After an assessment of the current electric rates and baseline utility data, it was determined that the proposed savings would occur at the $4.00/kW and $0.0840/kwh tiers with an added energy cost adjustments and taxes to arrive at the rates outlined in the table below. For more information refer to Appendices B2.

Table 12: Year 1 Electric Rates

Rate No.	Provider	Rate Description	Demand	Energy
			$/kW	$/kWh
COME45_3	NTUA	General Service	$4.24	$0.129041

3.3.2 Natural Gas

Navajo Tribal Utility Authority (NTUA) is the natural gas utility provider for the Shiprock North and South Campuses which are on the rate listed below.

Table 13: Year 1 Natural Gas Rates

Rate No.	Provider	Rate Description	Monthly Service Charge	Average $/therm
CTHG82_33	NTUA	Institutional & Public Buildings/Authorities Gas Service	$37.00	$0.5639

3.3.3 Water and Sewer

Navajo Tribal Utility Authority (NTUA) is the water and sewer utility provider for all the campuses which are on the rates listed below.

Table 14: Year 1 Water and Sewer Gas Rates

Rate No.	Provider	Rate Description	Service Charge	Water	Sewer
				$/kgal	$/kgal
COMWT64_69	NTUA	General Water Service 6” meter	$519.84	$7.95	-
COMWT64_89	NTUA	General Wastewater Service w/ Water Service, 6” meter	$273.27	-	$1.95
COMWT64_67	NTUA	General Water Service 4” meter	$255.34	$7.95	-
COMWT64_87	NTUA	General Wastewater Service w/ Water Service, 4” meter	$165.10	-	$1.95
COMWT64_65	NTUA	General Water Service 2” meter	$70.33	$7.95	-
COMWT64_85	NTUA	General Wastewater Service w/ Water Service, 2” meter	$45.05	-	$1.95

The rate used to calculate saving is $7.95/kgal for water and $1.95/kgal for sewer because it is the same across the entire rate structure. See Section 3.4.1 for more clarification to which rate applies to each meter.

3.3.4 Propane

Propane for the Tsaile Campus is bought in bulk on an as-needed basis from several providers who bid out the cost to Diné College. Propane is delivered by truck load to fill the three large tanks that serve the main Tsaile campus and a fourth tank that serves the Faculty Housing. The number of deliveries varies with weather and demand for heating. A weighted average rate relative to the amount of gallons purchased was used to calculate a cost per gallon of propane used. See **Appendix B4** for more information.

Table 15: Year 1 Propane Rates

Rate No.	Provider	Rate Description	Avg Rate $/gal
None	Varies	Weighted Average Rate	$0.981

3.4 Baseline Utility meters

When discussing the utility meters, the following acronyms have been applied for the utility types:

ELEC: Electricity
NG: Natural Gas
WATER: Water

3.4.1 City Facilities

3.4.1.1 Tsaile Campus Meters

Table 16: Tsaile Campus utility meters that were included in the IGA

Utility Type	Area Served	Account #	Meter #	Rate
ELEC	DINE COLLEGE MASTER	60134449	17207048	COME45_3
ELEC	DC LAND GRANT DEPT BLD	60298209	17393642	COME45_3
WTR/SWR	DC CULTURAL CTR*	60023171	70632648	COMWT64_69/ COMWW64_89
WTR/SWR	DC DORMITORIES*	60134471	63253169	COMWT64_67/ COMWW64_87
WTR/SWR	DC SPECIALIZED CLRM TS*	60134477	10243618	COMWT64_65/ COMWW64_85

Utility Type	Area Served	Account #	Meter #	Rate
WTR/SWR	DC S GEN CLRM*	60134479	45516048	COMWT64_65/ COMWW64_85
WTR/SWR	DC N GEN CLRM*	60134480	45516046	COMWT64_65/ COMWW64_85
WTR/SWR	DC LIBRARY*	60134482	26493271	COMWT64_65/ COMWW64_85
WTR/SWR	DC CAFETERIA*	60134484	45516049	COMWT64_65/ COMWW64_85
WTR/SWR	DC STUDENT UNION*	60134486	42697343	COMWT64_65/ COMWW64_85
WTR/SWR	DC GYMNASIUM*	60134488	8168618	COMWT64_65/ COMWW64_85
WTR/SWR	DINE COLLEGE*	60230035	15795610	COMWT64_65/ COMWW64_85

*In discussions with Diné and NTUA it is unclear which meters serve buildings not listed in the area served description. Yearout Energy did not pursue this further as the baseline is for the entire campus due to a single meter for electricity.

3.4.1.2 Shiprock South and North Campus Meters

Table 17: Shiprock South and North Campus utility meters that were included in the IGA

Utility Type	Area Served	Account #	Meter #	Rate
ELEC	SR South Campus Classroom	60131197	13408474	COME45_3
ELEC	SR South Campus Library	60308239	13407641	COME45_3
ELEC	SR South Campus SSC	60344530	13584901	COME45_3
NG	SR South Campus Classroom	60131197	9972234	CTHG82_33
NG	SR South Campus Library	60308239	15581844	CTHG82_33
NG	SR South Campus SSC	60344530	12R530994	CTHG82_33
WTR/SWR	SR South and North Campus*	60193205	14314017	COMWT64_69
ELEC	SR North Campus Main	60001994	13408488	COME45_3

ELEC	SR Science Buildings	60040357	17461100	COME45_3
ELEC	SR North Trailers**	60040915	16857988	COME45_3
NG	SR North Campus Main	60001994	1642180	CTHG82_33
NG	SR Science Buildings	60040357	19219010	CTHG82_33

* There is a single meter located north side of the South campus that has been verified with NTUA to be the only meter on either Shiprock campuses. According to NTUA this meter serves both campuses. There is no wastewater associated with this account.

** This account was associated with two modular buildings that have been relocated. The meter is not currently in use.

4.0 FACILITY IMPROVEMENT MEASURES

The two fundamental factors contributing to energy savings are performance and duration. Performance describes how much energy is being used to accomplish a task, while duration describes how much time the task operates.

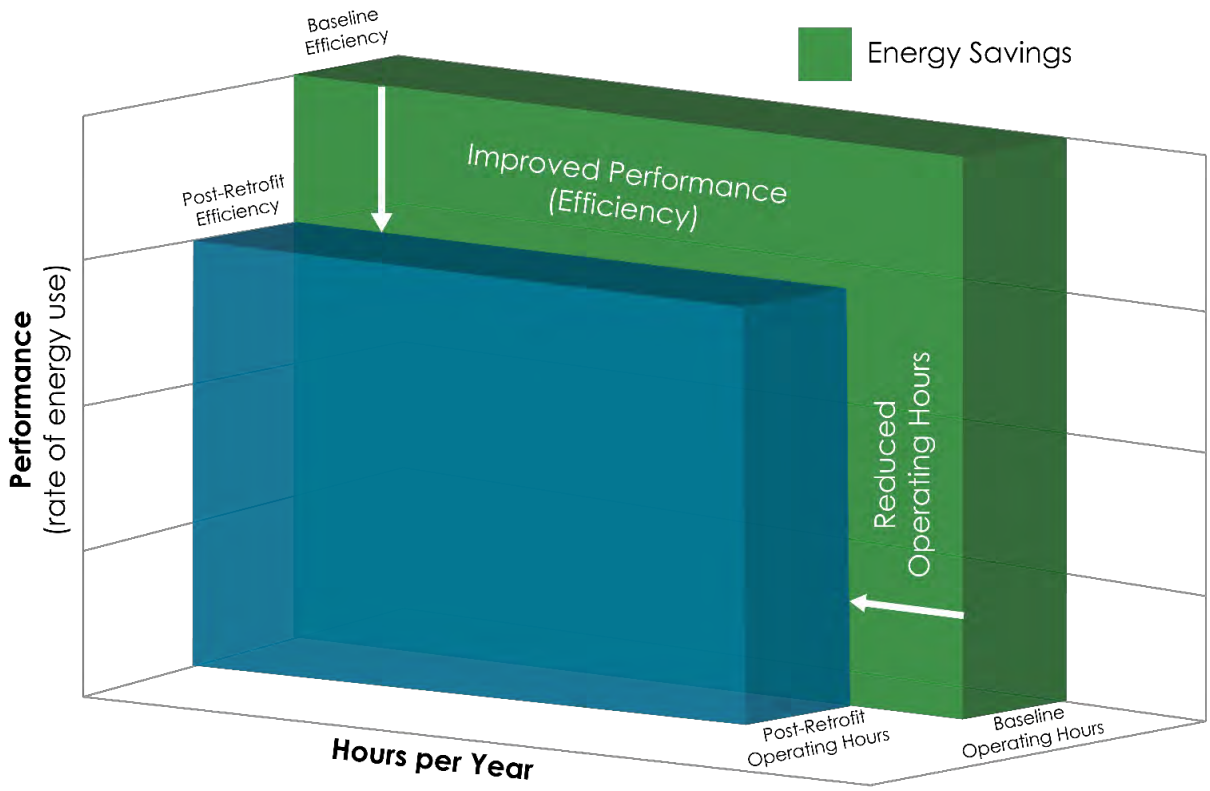


Figure 139: Facility Improvement Measures Diagram

A fundamental benefit of EPC projects is that they allow for measures of varying financial returns to be bundled together to form a combined project that meets Diné College's financial and operational objectives. This process places Diné College at the project helm in terms of selecting which measures will be implemented as part of the final project scope within a targeted financing term.

A comprehensive Investment Grade Audit (IGA) was performed to establish the baseline condition and performance of each facility, and to identify and co-develop the following recommended FIMs. Not every FIM is applicable to each IGA building and only data and information for impacted buildings will be presented in the subsequent FIM sections of this report. In discussions with Diné College it was decided that the focus of the initial EPC project would be the Tsaile campus due to need and available funding. Table 18: FIM Matrix clearly identifies where FIMs are applied.

Table 18: FIM Matrix

Site		1.00	2.00	3.00	4.00	5.00	6.00	7.00
		LED Lighting	Renewable Energy	HVAC System	Building Envelope	HE LV XFMR	Water Conserve	Hazardous Materials
Tsaile Day Care	01	●			●			
Tsaile Maintenance	02	●			●		●	●
Tsaile Silversmith	03	●			●		●	●
Tsaile Student Success Center	04	●			●	●	●	
Tsaile Archival Center	05	●			●		●	
Tsaile Cafeteria	06	●		●	●	●	●	●
Tsaile Guy Gorman Classroom Building	07	●			●	●	●	
Tsaile Gym	08	●		●	●	●	●	●
Tsaile Library	09	●		●	●		●	●
Tsaile Ned Hatathli Center	10	●		●	●	●	●	●
Tsaile Network Operating Center	11	●			●	●	●	
Tsaile Head Start	12	●			●			●

Site		1.00	2.00	3.00	4.00	5.00	6.00	7.00
		LED Lighting	Renewable Energy	HVAC System	Building Envelope	HE LV XFMR	Water Conserve	Hazardous Materials
Tsaile Post Office	13	●			●			●
Tsaile Dorms	14	●		●	●		●	●
Tsaile Student Union	15	●		●	●	●	●	●
Tsaile Student Family Housing	16	●			●	●	●	
Tsaile Faculty Office Building 1	17	●			●		●	
Tsaile Faculty Office Building 2	18	●			●		●	
Tsaile Faculty Office Building 3	19	●			●		●	
Tsaile Land Grant Modular Building	20	●			●		●	●
Tsaile Campus	21	●	●					
Total		21	1	6	20	8	17	11

4.1 FIM 1.00 LED Lighting

4.1.1 Existing Conditions

The existing lighting system consists primarily of T8 fluorescent, compact fluorescent, and LED lamps as depicted in the table below. Across this entire campus there are limited interior lighting controls. Most of the exterior lighting has lighting controls in the form of timeclocks and photosensors.

Refer to **Appendix D1** for a detailed baseline lighting inventory including lighting controls.

Table 19: FIM 1 LED Lighting – Existing Tsaile Campus Lighting Inventory

Lamp Type	Existing Fixture Qty	% Of Existing
Compact Fluorescent Lamp (CFL)	1,202	21.96%
Halogen Lamp	164	3.00%
High-Pressure Sodium Lamp (HPS)	11	0.20%
Incandescent Lamp	176	3.22%
Light Emitting Diode (LED)	1,838	33.58%
Metal Halide Lamp (MHL)	152	2.78%
Mercury Vapor (MV)	14	0.26%
T12 Fluorescent Lamp	132	2.41%
T5 Fluorescent Lamp	20	0.37%
T8 Fluorescent Lamp	1,763	32.21%
T9 Fluorescent Lamp	2	0.04%
Total	5,474	100%

T8 Fluorescent Troffers

T8 fluorescent troffers, shown here with a prismatic lens, are the most common light fixture at the Tsaile campus. They are found in most office, classroom, hallway, and multiuse areas. On average, each of these fixtures consumes 96 watts of power.



LED Conversions

LED troffers, shown here with a center backet lens, and bulb are the second most common light lamp type on the Tsaile campus. They are found in renovated spaces across the campus. This is a testament to the project and maintenance departments' commitment to energy efficiency.



CFLs

The third most common lamp type on campus is CFL bulbs. These are found throughout the campus is a variety of fixture types.



4.1.2 Proposed Modifications

This measure will retrofit and/or replace the existing interior and exterior incandescent, fluorescent, metal-halide, and other lighting equipment with new Light Emitting Diode (LED) technology. This will significantly reduce the energy consumption of the lighting system while also improving security and the working environment. In addition, the proposed solution would standardize the lighting system

throughout the facilities, resulting in simplified inventory requirements and reduced maintenance costs and work.

The following table depicts the lighting fixture post retrofit upgrade. Refer to **Appendix D1** for a detailed proposed baseline lighting inventory.

Table 20: FIM 1 LED Lighting – Proposed Tsaile Campus Lighting Inventory

Lamp Type	Proposed Fixture Qty	% Of Proposed
Compact Fluorescent Lamp (CFL)	0	0.00%
Halogen Lamp	0	0.00%
High-Pressure Sodium Lamp (HPS)	0	0.00%
Incandescent Lamp	0	0.00%
Light Emitting Diode (LED)	5,474	100.00%
Metal Halide Lamp (MHL)	0	0.00%
Mercury Vapor (MV)	0	0.00%
T12 Fluorescent Lamp	0	0.00%
T5 Fluorescent Lamp	0	0.00%
T8 Fluorescent Lamp	0	0.00%
T9 Fluorescent Lamp	0	0.00%
Total	5,474	100%

Refer to **Appendix D2** for new equipment specifications.

Dimming controls will be added to classrooms, private offices and conference rooms where recessed troffers are being installed. Adding controls will help drive down energy costs and improve occupant comfort. Lighting levels will be commissioned during project implementation to IESNA recommendations in each perspective space. Dimming will allow users to reduce/increase light levels to their preference.

The following table depicts the significant reductions in the lighting power density at each facility through the implementation of the proposed scope.

Table 21: FIM 1 LED Lighting – Existing vs. Proposed Lighting Power Densities

Facility	Existing	Proposed	Reduction	Reduction
	W/ft^2	W/ft^2	W/ft^2	%
Tsaile Day Care	1.1039	0.2950	0.8089	73%
Tsaile Maintenance	1.1231	0.4604	0.6627	59%
Tsaile Silversmith	2.1624	0.6552	1.5072	70%
Tsaile Student Success Center	1.5141	0.5725	0.9416	62%
Tsaile Archival Center	0.8093	0.4261	0.3832	47%
Tsaile Cafeteria	0.7289	0.2914	0.4375	60%
Tsaile Guy Gorman Classroom Building	1.4000	0.4445	0.9555	68%
Tsaile Gym	0.6978	0.2428	0.4550	65%
Tsaile Library	1.2936	0.5369	0.7568	59%
Tsaile Ned Hatathli Center	0.7891	0.3343	0.4548	58%
Tsaile Network Operating Center	1.8969	0.8718	1.0251	54%
Tsaile Head Start	1.7112	0.4171	1.2941	76%
Tsaile Post Office	2.0744	0.6038	1.4707	71%
Tsaile Dorms	0.3560	0.1725	0.1835	52%
Tsaile Student Union	1.0900	0.4605	0.6295	58%
Tsaile Student Family Housing	0.3610	0.2324	0.1287	36%
Tsaile Faculty Office Building 1	1.6693	0.5220	1.1473	69%
Tsaile Faculty Office Building 2	1.6693	0.5220	1.1473	69%
Tsaile Faculty Office Building 3	0.5122	0.4885	0.0236	5%
Tsaile Land Grant Modular Building	1.4425	0.3855	1.0570	73%
AVERAGE	**1.2203**	**0.4468**	**0.7735**	**59%**

4.1.3 Savings Methodology

Energy and demand savings for this FIM were calculated using the following equations.

Demand

The existing and proposed fixture/lamp wattage was calculated as follows:

[Existing Demand (kW) = Lamp QTY x Lamp Wattage (W) x Burnout Factor x Ballast Factor / 1,000]*

[Proposed Demand (kW) = Lamp QTY x Lamp Wattage (W) x Ballast Factor / 1,000]*

* Due to the wide variety of existing fixtures throughout the IGA facilities a ballast factor of 1 was assumed for all areas to average out the range of low, normal, and high ballast factors.

Demand Savings

The demand savings was calculated using the following equation:

[Demand Savings (kW) = (Existing Demand (kW) – Proposed Demand (kW)) x Diversity Factor (%)]

Energy

Energy Savings

The energy reduction was calculated using the calculated demand savings and stipulated burn hours and the diversity factors which can be found in **Appendices D5 and D6**.

[Energy Savings (kWh) = Demand Savings (kW) x Burn Hours (Hrs. /Year) x Occupancy Sensor Factor]

Additional detailed information regarding the Methodology is available in in **Appendix D1**.

Based on field data, interviews, and industry best practices annual burn hours have been established for each space type per facility. These are available in **Appendix D5.**

HVAC Interactions

Additional analysis was performed to account for the cooling credit and heating penalty associated with the reduction in internal heat gain from the proposed lower lamp wattage. The method used to determine the impact was based on ASHRAE article “Calculating Lighting and HVAC Interactions” (see **Appendix D4**).

Cooling Savings

[Cooling Energy Savings (kWh) = A X B / C]

where:

A – Lighting Energy Savings (kWh)
B – Fraction to Cooling- Tabulated value base on climate zone
C – Cooling System MCOP- estimated depending on new building or retrofit

Heating Penalty

*[Heating Energy Penalty (therm) = A X B X C / D*E]*

where:

A – Lighting Energy Savings (kWh)
B – Fraction to Heating- Tabulated value base on climate zone
C – Fraction building area within 15' of exterior walls to the total building area
D – Heating System COP
E – Fuel Fraction

4.1.4 FIM Guaranteed Year 1 Utility Savings

Table 22: FIM 1 LED Lighting – Year 1 Guaranteed Utility Savings

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	kgal
1.01	Tsaile Day Care	19	3,915	(4)	0
1.02	Tsaile Maintenance	76	13,240	(33)	0
1.03	Tsaile Silversmith	14	3,092	(11)	0
1.04	Tsaile Student Success Center	47	10,580	(7)	0
1.05	Tsaile Archival Center	24	5,478	(21)	0
1.06	Tsaile Cafeteria	40	7,034	(18)	0
1.07	Tsaile Guy Gorman Classroom Building	244	58,773	(131)	0
1.08	Tsaile Gym	70	7,961	(20)	0
1.09	Tsaile Library	165	53,612	(32)	0

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	kgal
1.10	Tsaile Ned Hatathli Center	277	62,845	(141)	0
1.11	Tsaile Network Operating Center	52	10,746	(36)	0
1.12	Tsaile Head Start	31	7,240	(26)	0
1.13	Tsaile Post Office	10	2,271	(8)	0
1.14	Tsaile Dorms	123	37,297	(92)	0
1.15	Tsaile Student Union	160	38,696	(87)	0
1.16	Tsaile Student Family Housing	51	15,204	(75)	0
1.17	Tsaile Faculty Office Building 1	6	1,516	(2)	0
1.18	Tsaile Faculty Office Building 2	6	1,516	(2)	0
1.19	Tsaile Faculty Office Building 3	0	49	(0)	0
1.20	Tsaile Land Grant Modular Building	19	3,915	(4)	0
1.21	Tsaile Campus Pole Lighting	18	6,154	0	0
Total		1,455	351,133	(750)	0

4.1.5 O&M Savings

O&M savings for lighting are related to the cost of replacement of bulbs and other parts such as ballasts in T5, T8, and T12 troffers. LED lights are composed of few parts and last significantly longer than the lights they are proposed to replace. Not only is there savings in the replacement materials but also the paid time of the maintenance to complete the work.

No data was available from the Diné College's maintenance department for a proper analysis of O&M cost and savings. Yearout Energy took 15% of the calculated utility savings for this FIM as a conservative estimate of O&M savings. The savings are then multiplied by the ration of the average service life for this FIM to the finance term for the project if the service life is less than the finance term.

See section 6.2 for more information.

4.1.6 Financial Summary

Table 23: FIM 1 LED Lighting – Financial Summary

FIM No.	Facility	Year 1 Total Annual Savings	Year 1 Total O&M Savings	Year 1 Total Savings	Labor, Equip & Material Costs
1.01	Tsaile Day Care	$583	$82	$664	$8,105
1.02	Tsaile Maintenance	$2,000	$281	$2,281	$36,684
1.03	Tsaile Silversmith	$449	$63	$512	$9,537
1.04	Tsaile Student Success Center	$1,560	$219	$1,779	$35,912
1.05	Tsaile Archival Center	$787	$111	$898	$26,102
1.06	Tsaile Cafeteria	$1,058	$149	$1,207	$21,493
1.07	Tsaile Guy Gorman Classroom Building	$8,492	$1,194	$9,686	$79,877
1.08	Tsaile Gym	$1,305	$184	$1,488	$20,178
1.09	Tsaile Library	$7,616	$1,071	$8,688	$69,782
1.10	Tsaile Ned Hatathli Center	$9,147	$1,286	$10,433	$132,362
1.11	Tsaile Network Operating Center	$1,573	$221	$1,794	$14,239
1.12	Tsaile Head Start	$1,039	$146	$1,186	$9,880
1.13	Tsaile Post Office	$329	$46	$375	$4,301
1.14	Tsaile Dorms	$5,245	$738	$5,983	$63,303
1.15	Tsaile Student Union	$5,588	$786	$6,373	$100,215
1.16	Tsaile Student Family Housing	$2,106	$296	$2,402	$12,314

FIM No.	Facility	Year 1 Total Annual Savings	Year 1 Total O&M Savings	Year 1 Total Savings	Labor, Equip & Material Costs
1.17	Tsaile Faculty Office Building 1	$220	$31	$251	$4,868
1.18	Tsaile Faculty Office Building 2	$220	$31	$251	$4,868
1.19	Tsaile Faculty Office Building 3	$8	$1	$9	$727
1.20	Tsaile Land Grant Modular Building	$583	$82	$664	$8,105
1.21	Tsaile Campus Pole Lighting	$869	$122	$991	$35,605
Total		$50,775	$7,140	$57,915	$698,458

4.1.7 Scope of Work

Please refer **Appendix D1** for a detailed baseline and proposed room-by-room lighting inventory.

CLARIFICATIONS

1. Recycling of lamps will be executed in compliance with appropriate governmental regulations.
2. Disposal of PCB-laden ballasts will be executed in compliance with appropriate governmental regulations.
3. The installation will be executed in accordance with industry-standard safety practices and with the care, skill, and diligence provided by a contractor skilled in the performance of lighting retrofit services.
4. Installation of all equipment will be executed per manufacturer's recommendations.
5. Any conditions not meeting current codes, and any system deficiencies will be brought to the attention of the Owner. Any work required to remedy these situations is excluded.

EXCLUSIONS

1. Removal of asbestos-containing materials, lead-containing materials or any other hazardous/suspect materials above the scope covered by allowance amount described in the hazardous material and testing included in FIM 7. No work will be performed in areas containing hazardous materials.
2. All fixtures not outlined for replacement or retrofit in **Appendix D**.
3. Grounding of new and existing luminaires that are not currently grounded in which the luminaire will be retrofitted (not replaced).
4. Seismic bracing of new and existing luminaries that are not currently braced.

5. Replacement of existing LED exit signs and fixtures.
6. Lighting controls unless noted otherwise in **Appendix D**.
7. Yearout Energy has accounted for battery backups where existing. In the event additional battery backups are required, Yearout Energy will charge $400 per unit installed.
8. In-board, out-board double switching of existing fixtures (unless noted otherwise).
9. All existing LED fixtures and bulbs will not be upgraded or replaced.

4.1.8 Equipment Service Life

The estimated service life for this FIM is as follows:

Table 24: FIM 1 LED Lighting – Estimated Service Life

FIM Component	% Of FIM Total Cost	Median Service Life
LED Lighting & Controls	100%	15 Years
FIM Weighted Average Service Life		15 Years

4.1.9 Preliminary Commissioning Plan

The following preliminary commissioning plan is intended to serve as the outline from which the final commissioning plan will be developed during the pre-construction / design phase. The final commissioning plan will be primarily focused on validating the functionality of the proposed equipment/ strategies and are implemented in accordance with the savings methodology associated with each measure. All relevant Facility Improvement Measures will be included and tracked in one commissioning planned and one commissioning issues log.

1. Develop and issue construction phase commissioning plan
2. Review equipment submittals to validate the specified performance criteria is in alignment with the proposed savings methodology
3. Review sequences of operation and controls strategies to validate alignment with proposed savings methodology
4. Develop equipment Pre-Functional Checklists (PFCs)
5. Perform a random inspection to validate the implemented lighting improvements align with the proposed scope of work (lamp, fixture, control device, etc.)
6. Perform light level measurements on a sampling of spaces.
7. Create and maintain a commissioning issues log
8. Participate in staff training activities

4.1.10 Preliminary Measurement & Verification Plan

M&V Option A – Retrofit Isolation

Guarantee Factor: 90%

Refer to SECTION 5 for a detailed preliminary M&V Plan.

4.1.11 Warranty

An industry standard 1-year materials and workmanship warranty is provided by Yearout Energy. Any material warranties that extend beyond this period will be transferred to the Owner upon project closeout. All available warranty information can be found in **Appendix D2**.

The warranty period information for the major pieces of equipment associated with this measure is summarized in the table below.

Table 25: FIM 1 LED Lighting – Warranty Information

Equipment Description	Warranty Period
LED Luminaires	10 years
LED Tubes and Lamps	5 years

4.1.12 Training

Yearout Energy will co-develop a training plan with the Owner that is tailored to the needs and skill level of the building operators. Training sessions will be conducted during the project implementation phase. These sessions will be recorded and provided in electronic format to the Owner for future reference. Topics commonly covered during these training sessions include:

1. Equipment start-up, proper operation, shutdown, power failure, etc.
2. Sequences of operation
3. Operations and maintenance (O&M) manuals
4. Diagnosing and troubleshooting common equipment issues
5. Preventative maintenance and required documentation
6. Health and safety considerations
7. Warranty information
8. Identified system deficiencies
9. Measurement and Verification (M&V) plan and KPIs which directly impact savings

4.2 FIM 2.00 Renewable Energy

4.2.1 Existing Conditions

There are no existing solar photovoltaic (PV) systems installed on the Tsaile Campus.

4.2.2 Proposed Modifications

This measure will install a new 1 MW solar PV system that will generate clean, renewable energy onsite for the next 25 to 50 years and reduce the amount of power purchased from the utility grid. This measure will provide complete turnkey installation, interconnection, startup, and commissioning of the solar PV system.

See **Appendix E** for additional information.

Table 26: FIM 2 Renewable Energy – Proposed Solar PV Systems

College Facilities	NTUA Account #	Meter No	PV System Size MW (DC)	Mounting	Landowner
Tsaile Campus	60134449	17207048	1.01	Ground Fixed-Tilt	Diné College

Additional information including calculations and system renderings are available in **Appendix E1**.

4.2.3 Savings Methodology

Energy savings for this FIM are based on an offset of energy delivered by the electric utility grid.

A monthly basis for system design was provided to the solar provider as follows:

$$S = (E_B - F_s) \times D_f$$

where:

E_B = energy baseline (kWh)
F_s = FIM savings (kWh)
D_f = design factor

The system will offset approximately 45% of post-retrofit annual electricity consumption for the Tsaile Campus. The system was designed to maximize production while not overproducing in any given month, as it is not financially viable to do so based on the NTUA interconnection program.

Energy production from the proposed solar PV systems were estimated using NREL's PVWatts modeling methodology. The tool simulates production with a high degree of accuracy based on specific inputs which include:

1. Location, solar resource, weather
2. System design including orientation, losses, module type, inverter efficiency, etc.

Although likely to occur, Yearout Energy has not accounted for any monthly demand savings due to the installation of solar PV. These additional savings will go directly to benefit Diné College.

Detailed bases for calculations, output from the simulation, and additional information at each facility is provided in **Appendix E**.

4.2.4 Guaranteed Year 1 Utility Savings

Table 27: FIM 2 Renewable Energy – Year 1 Guaranteed Utility Savings

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	kgal
2.01	Tsaile Campus	0	1,552,510	0	0
Total		0	1,552,510	0	0

4.2.5 Financial Summary

Table 28: FIM 2 Renewable Energy – Financial Summary

FIM No.	Facility	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs	Estimated Utility Rebate	Net Cost
2.01	Tsaile Campus	$200,337	$0	$200,337	$2,378,419	$0	$2,378,419
Total		$200,337	$0	$200,337	$2,378,419	$0	$2,378,419

4.2.6 Scope of Work

Please refer **Appendix E** for a detailed explanation of the proposed solar PV systems including product specifications and production calculations.

1. Provide and install LG 440N2T-E6 bifacial modules (or equivalent)

2. Provide and install Unirac GFT ground mounted solar racking
3. Complete and submit interconnection applications for required metering
4. Obtain building and electrical permits as required
5. Provide stamped engineered electrical and structural drawings by a Professional Engineer as required
6. Provide and install SMA Core1-62 photovoltaic inverters (or equivalent)
7. Provide and install conduit between PV panels and inverter, inverter and Combiner, Combiner and Recombiner, Recombiner and AC disconnect, AC disconnect and back-feed location
8. Provide and install all electrical components associated with interconnection, including, but not limited to, Combiner Panels, set-up transformer, DC and AC disconnects, Combiner, Combiner and Recombiner, Recombiner and AC disconnect, AC disconnect and back-feed location
9. Provide and install XHHW-2 and TWHN-2 wire sized per NEC 2017 for DC and AC voltage runs
10. Provide and install eGauge monitoring system
11. Installation by NABCEP certified professionals
12. Commissioning and performance testing of installed systems

Clarifications

1. Installation will be executed in accordance with industry-standard safety practices and with the care, skill, and diligence provided by a contractor skilled in PV systems.
2. Installation of all materials will be executed per manufacturer's recommendations.
3. The Owner is to provide Yearout Energy with internet connectivity at each site for remote monitoring. Connectivity can be provided through either hard-wired or wireless communication.
4. Any conditions not meeting current codes, and any system deficiencies will be brought to the attention of the Owner. Any work required to remedy these situations is excluded.

Exclusions

1. Removal of asbestos-containing materials, lead-containing materials or any other hazardous/suspect materials above the scope covered by allowance amount described in the hazardous material and testing included in FIM 7. No work will be performed in areas containing hazardous materials.
2. Saw cutting, removal, patching, and replacement of landscaping, gravel ground cover, concrete, and asphalt.
3. Formed concrete, including equipment pads, leveling channels, conduit curbs, and pole bases other than defined for racking structure above.

4. Cutting, patching, and painting and all other miscellaneous coatings not explicitly defined in the scope of work.
5. Tree removal and trimming.
6. Cathodic protection, snow melt and heat trace.
7. Independent testing laboratory services including concrete and compaction/density testing.
8. Surveying, dust control, seeding, erosion control and dewatering.
9. Repair or installation of any structural systems.
10. Cellular monitoring or infrastructure upgrades to support remote monitoring.

4.2.7 Equipment Service Life

The estimated service life for this FIM is as follows:

Table 29: FIM 2 Renewable Energy – Estimated Service Life

FIM Component	% Of FIM Total Equipment Cost	Median Service Life
PV modules	70%	30 years
Inverters	10%	15 years
Racking	20%	40 years
FIM Weighted Average Service Life	100%	30 years

4.2.8 Preliminary Commissioning Plan

The following preliminary commissioning plan is intended to serve as the outline from which the final commissioning plan will be developed during the pre-construction / design phase. The final commissioning plan will be primarily focused on validating the functionality of the proposed equipment/ strategies and are implemented in accordance with the savings methodology associated with each measure. All relevant Facility Improvement Measures will be included and tracked in one commissioning planned and one commissioning issues log.

1. Develop and issue construction phase commissioning plan
2. Review equipment submittals to validate the specified performance criteria is in alignment with the proposed savings methodology
3. Review manufacturer's startup documentation

4. Develop equipment Pre-Functional Checklists (PFCs)
5. Review monitoring system to validate proper operation.
6. Create and maintain a commissioning issues log
7. Establish trends as required to validate system operation
8. Coordinate Owner participation as required during commissioning and equipment startup efforts

4.2.9 Preliminary Measurement & Verification Plan

M&V Option B – Multiple Parameter Measurement
Guarantee Factor: 90%

Refer to SECTION 5 for a detailed preliminary M&V Plan.

4.2.10 Warranty

An industry standard 1-year materials and workmanship warranty is provided by Yearout Energy. Any material warranties that extend beyond this period will be transferred to the Owner upon project closeout. All available warranty information can be found in **Appendix E2**.

The warranty period information for the major pieces of equipment associated with this measure is summarized in the table below.

Table 30: FIM 2 Renewable Energy – Warranty Information

Equipment Description	Warranty Period
PV Modules	25-Year limited Product
String Inverters	10 years

4.2.11 Training

Yearout Energy will co-develop a training plan with the Owner that is tailored to the needs and skill level of the building operators. Training sessions will be conducted during the project implementation phase. These sessions will be recorded and provided in electronic format to the Owner for future reference. Topics commonly covered during these training sessions include:

1. Equipment start-up, proper operation, shutdown, power failure, etc.
2. Sequences of operation
3. Operations and maintenance (O&M) manuals

4. Diagnosing and troubleshooting common equipment issues
5. Preventative maintenance and required documentation
6. Health and safety considerations
7. Warranty information
8. Identified system deficiencies
9. Measurement and Verification (M&V) plan and KPIs which directly impact savings

4.3 FIM 3.00 HVAC System Upgrades

4.3.1 Existing Conditions

This measure will upgrade the HVAC Equipment and Controls at selected IGA facilities. The existing HVAC systems at these facilities vary, but generally fall into one of the categories described below. Existing controls are a mixture of different building automation systems and digital standalone thermostats.

4.3.1.1 HVAC Equipment

There are several types of HVAC systems on the Tsaile campus. This section will focus on the systems that are being upgraded as part of the EPC project. A summary of these systems is provided below.

Air Handling Unit (AHU)

These units serve several buildings, including NHC and library. They consist of a fan that blows outside air across a chilled-water cooling coil and a hydronic hot-water heating coil into the space, via an extensive network of distribution ductwork.



Single-Zone DX Rooftop Unit (RTU)

These units serve many of the larger buildings on campus, like the SUB building. They consist of a fan that blows outside air across a DX cooling coil and an indirect natural-gas-fired furnace section into the space, usually via distribution ductwork.



DX Heat Pump/Mini Split

These units serve the library and smaller mini split units serve miscellaneous spaces at several buildings, including computer rooms. They consist of an outdoor condenser unit that feeds one or more indoor fan coil units that blow conditioned air into the space.



Hydronic Hot Water Heating

Some older buildings on campus are heated by hydronic hot water boilers that feed radiant and/or convective heaters throughout the building. These units can be found in the dorms and the cafeteria.



Propane unit heaters

Propane unit heaters can be found in the more open spaces around campus like in the gymnasium.



4.3.1.2 Tsaile Dorms

The Tsaile dorms are Hydronic systems with heating only. There are boilers ageing from older than around 40 years old to condensing boilers that are less than five years old spread throughout the dorms. The hydronic system auxiliary pieces like piping, valves, radiant heaters, and fan coils are likely

all original to the building, vintage 1971. The Diné maintenance team says the radiant system works well excluding having to replace boilers as they break down. The fan coils and associated attic forced air system appear to be nonfunctional. The controls are the original pneumatic controls.

4.3.1.3 Tsaile Cafeteria

The cafeteria is also at present a hydronic heating system. The boiler plant for this system is 17 years old. In the initial design the system was split into two heat distribution system. The first being radiant heat around the perimeter of the dining room and a few other perimeter spaces. This system appears to be functional, but the components, besides the boiler and pumps, are likely all original to the building built in 1971. There is a mezzanine system above the kitchen area where the hydronic forced air equipment resides. There are AHUs with hot water coils that were disconnected from the water supply years ago. This system served the kitchen and other auxiliary spaces, but these spaces have had no HVAC service since the system was decommissioned. The kitchen fan and associated MAU also sit in this space. The fans turn on but are very near the end of their life and the MAU has been decommissioned and abandoned in place. The controls are the original pneumatic controls.

4.3.1.4 Tsaile Ned Hatathli Center

The NHC is a hydronic system with two boilers and two chillers. The boilers are less than four years old, and the chillers are less than 12 years old. The heated/chilled water is supplied to three large custom AHUs that serve two floors each. The equipment for system appears to be in good shape which was confirmed by the Diné staff. The distribution is by duct with VAV mixing boxes and ceiling mounted diffusers and returns. The distribution seems to be in good working order besides the second and fourth floors. The second floor has spaces that are heated/cooled very unevenly which has led to many complaints from the occupants as well as frozen pipes in the main entrance vestibule. The fourth floor was recently converted to an open floor plan art/museum display space. There are concerns about the ability to control the temperature in this space, especially with consideration for the priceless contents of the space. There is a mixture of controls in this building from remote accessible front end, programable thermostats, to the original pneumatic controls.

4.3.1.5 Tsaile Library

The library is mainly heated and cooled by four 15-ton dx/heat pump systems. There are four condenser/heat pump units on the exterior slab of the building and four AHUs surrounded by a built-up insulated space located in the interior mechanical rooms. The insulated space is used as a plenum to pull in return and fresh air. These units are all around 15 years old and are starting to give the maintenance staff problems. There is a museum display area on the second floor that is served by a dedicated 7.5-ton dx/heat pump package unit mounted on the exterior slab. This unit is 17 years old and approaching the end of its life cycle. The controls a mixture of digital programable and pneumatic thermostats.

4.3.1.6 Tsaile Student Union Building

There are single zone RTUs spread throughout the roof of this building. A majority, 8 units, of these were replaced during a remodel that happened around 2016. There are four units on the northwest section that are approaching ten years old that the project's staff has expressed interest in replacing. Above the concession stand in this building there is an industrial kitchen fan with MAU served by hydronic heating, this system has not been functioning correctly. The boiler for the hydronics is less than 20 years old and serves radiant heaters in the northwest section of the building. A mini split serves the IT room and was also upgraded during the remodel. There is a mixture of controls for the different systems, but the main controls are programable thermostats for the RTUs.

4.3.1.7 Tsaile Gym

The Gym has two separate HVAC systems. In the gymnasium space there are (4) unit heaters that are approaching 20 years old. There is no cooling in this space. The heating in the office and locker room areas is covered by a 4-ton dx/propane unit that is 11 years old. The heat is transferred to the space by ceiling mounted duct and recessed diffusers and returns.

4.3.2 Proposed Modifications

When considering the proposed HVAC modifications for the highest priority buildings several considerations lead the charge. Yearout Energy and Diné both agreed on the importance of the most modern high efficiency equipment. As there is the proposal for a large solar installation on campus it was understood that there should be electrification whenever possible, so that the school can fully take advantage of the clean solar energy produced on site. Finally, that any upgrade we made increased the filtration and airflow in the space to reduce the chances of pathogen transmission and to meet the required funding mechanisms. For any major equipment replacement there will be MERV13 filters included in the price if they are made for the equipment.

4.3.2.1 Tsaile Dorms

There were multiple requirements taken into consideration when devising a solution at these buildings. A few of the leading requests were to add cooling, fresh air, and filtration to the spaces, especially the dorm rooms, with as few pieces of equipment for the maintenance team to maintain. After several iterations of proposed design, and site visits to confirm information the recommended solution is to put one or two Daikin VRF heat pumps outside each dorm that would supply a fan coil unit that will replace the existing hydronic units in the attic space. There will also be a fresh air supply in combination with the ducted fan coils. The radiant heat system will remain functional with an upgrade to the boiler plant. Both systems will be integrated into a single newly installed building automation system, so that the boiler will only be used as supplemental heat on very cold days and emergency heat in case of a blackout. Finally, the Mechanical insulation for this building will be repaired where it is accessible and necessary.

4.3.2.2 Tsaile Cafeteria

The main objective for this building was to supply cooling and heating to entire building, when only a portion of the spaces have had even heating for several years. Like the dorms, the radiant heating system will be kept functional with a boiler replacement to provide supplemental and emergency heat. Most of the heating and cooling load will be handled by a one or two pad mounted dx/ heat pump package units on the northwest exterior of the building. The treated air will then be ducted into the building and up into the mezzanine space where it will be integrated into the existing duct work to supply the kitchen and auxiliary areas. There will be added diffusers mounted high on the mezzanine wall with the required new ducting to serve the cafeteria space. In the dining room air destratification fans will be installed to increase the air movement which in turns increase the heating and cooling effectiveness. This way of supplying air negates the need to have to install duct work on the architectural wood ceiling. The kitchen exhaust fan and MAU will be replaced, the new MAU being a DX unit. All the major HVAC equipment will be controlled by the newly installed building automation system. Finally, the Mechanical insulation for this building will be repaired where it is accessible and necessary.

4.3.2.3 Tsaile Ned Hatathli Center

Yearout Energy believes that addressing the concerns of the staff at this building has more to do with system design than issues with the major equipment. To solve the airflow issues on the second and fourth floors, there needs to some system testing to nail down the problem areas. The solution being proposed is for the ducting to have minor redesign and for nonfunctional VAV mixing boxes to be repaired or replaced on these two floors. The controls for the entire building will be integrated into a single newly installed building automation system. To address the issue of pipes freezing in the main entrance vestibule Yearout Energy proposes adding an electric unit heater to the space. Finally, the Mechanical insulation for this building will be repaired where it is accessible and necessary.

4.3.2.4 Tsaile Library

The main concern at the library is system age as it is already entirely electric HVAC system and there are no other major complaints. For this system, the solution being proposed is a one for one replacement of the package unit, heat pumps and AHUs, for more efficient modern equipment. The interior distribution system will remain the same. The exterior duct going from the pack unit up the wall will be inspected and replaced with insulated duct if needed. The controls for all the equipment will be upgraded to a newly installed building automation system.

4.3.2.5 Tsaile Student Union Building

Here the four RTUs on the northwest section of the building are proposed to be replaced one for one with dx/heat pump units at the request of the Projects team. The concession stand kitchen exhaust fan and MAU are also going to be replaced with a fan and DX MAU pair. The new equipment will be tied into the newly installed building automation system associated with this project.

4.3.2.6 Tsaile Gym

To supply cooling and heating to the gymnasium section of this building there will be two ground pad mounted dx/propane package units installed and ducted inside the building around the perimeter of the space near where the wall meets the ceiling. It was decided to continue to use propane for this building due to the high cost of large heat pump package units and that this building is not used at full capacity on a consistent basis. A new building automation system will be installed to control the new package units.

4.3.3 Savings Methodology

Isolated Excel based calculations were developed to calculate the impacts for this measure. There are primarily four factors considered when estimating savings and penalties. The first is adding cooling to spaces that currently do not have cooling. Second, is converting space heating fuel sources (propane to electric). Third, increased ventilation for improved indoor air quality. Lastly, increased efficiency due to upgrading to modern high efficiency equipment. Overall, this measure results in a net increase to energy consumption and cost due to the significant amount of added cooling and increased ventilation.

4.3.3.1 Tsaile Dorms

The following savings methodology applies to all (10) identical dorm facilities. The scope of this measure will convert the primary heating source from HW radiant heating to VRF. The HW radiant heating system will remain in place and provide supplemental heating below freezing temperatures. The design intent is for the VRF system to provide most of the heating for these facilities. This measure will also add cooling and ventilation to this facility, increasing energy consumption. The following table outlines the key differences driving savings and penalties for this measure.

Table 31: FIM 3 HVAC Upgrades – Key Parameters – Dorms

Variable	Baseline	Proposed	Notes
Cooling Diversity Factor	0%	80%	No Cooling in Baseline, Proposed Estimate
Heating Diversity Factor	40%	60%	Estimate / Central Fireplace Supplemental
HW Radiant System OAT Enable (°F)	60	30	Base Primary, Proposed Supplemental Heating Below Freezing
Heat Pump Cooling Capacity (tons)	0	270	(10) Dorms * (18) Units * 1.5-Ton
Heat Pump Cooling Efficiency (kW/ton)	0	1.03	12/EER - Conservative Estimate
Heat Pump Heating Capacity (btu/h)	0	3,600,000	(10) Dorms * (18) Units * 20 kBtu/h
Heat Pump Heating Efficiency (COP)	0	2.00	Conservative Estimate

See **Appendix F2** for more detail on setpoints and assumptions used to calculate the savings and penalties for this building.

4.3.3.2 Tsaile Cafeteria

The scope of this measure will convert the primary heating source from HW radiant heating to packaged heat pumps. The HW radiant heating system will remain in place and provide supplemental heating below freezing temperatures. The design intent is for the packaged heat pumps to provide most of the heating for these facilities. This measure will also add cooling and ventilation to this facility, increasing energy consumption. The following table outlines the key differences driving savings and penalties for this measure.

Table 32: FIM 3 HVAC Upgrades – Key Parameters – Cafeteria

Variable	Baseline	Proposed	Notes
Economizer Max % OA	0%	100%	No Existing, Economizer Proposed
HW Radiant System OAT Enable (°F)	60	30	Base Primary, Proposed Supplemental Heating Below Freezing
Heat Pump Cooling Capacity (tons)	0	25	Manufacturer's Data
Heat Pump Cooling Efficiency (kW/ton)	0	1.09	12/EER - Conservative Estimate
Heat Pump Heating Capacity (btu/h)	0	760,000	Manufacturer's Data
Heat Pump Heating Efficiency (COP)	0.00	2.00	Conservative Estimate

See **Appendix F1** for more detail on setpoints and assumptions used to calculate the savings and penalties for this building.

4.3.3.3 Tsaile Gym

The Gym does not currently have cooling or ventilation in the main area. This measure will add both cooling and ventilation to this area increasing energy consumption. We are also upgrading the heating system from propane unit heaters to forced air from propane fired packaged units. An upsize in equipment was integrated into the calculation to allow for increased air flow for pathogen mitigation. See the table below for the key differences in the calcs that are driving the savings and penalties:

Table 33: FIM 3 HVAC Upgrades – Key Parameters – Gym

Variable	Baseline	Proposed	Notes
Cooling Diversity Factor	0%	90%	Estimate
Economizer Max % OA	0%	100%	Economizer Proposed
Heating System Capacity (btu/h)	600,000	1,297,000	Baseline Estimated | Proposed Manufacturer's Data
Cooling System Capacity (tons)	0	70	Manufacturer's Data
Cooling System Efficiency (kW/ton)	0	1.09	12/(Weighted Avg EER)

See **Appendix F3** for the setpoints and assumptions used to calculate the savings and penalties for this building.

4.3.3.4 Tsaile Ned Hatathli Center

No savings are proposed for this facility.

4.3.3.5 Tsaile Library

In the Library Yearout Energy is proposing like for like equipment. The factors considered here were equipment age and efficiency as well as adding economizer cooling. An upsize in equipment was integrated into the calculation to allow for increased air flow for pathogen mitigation. See the table below for the key differences in the calcs that are driving the savings and penalties:

Table 34: FIM 3 HVAC Upgrades – Key Parameters – Library

Variable	Baseline	Proposed	Notes
Economizer Max % OA	20%	100%	Based on Site Survey
Avg Cooling Efficiency (kW/ton)	1.42*	1.00	12/(Weighted Avg EER)
Avg Heating Efficiency (COP)	1.90*	2.00	Manufacturer's Data

*Degraded based on age of equipment

See **Appendix F4** for the setpoints and assumptions used to calculate the savings and penalties for this building.

4.3.3.6 Tsaile Student Union Building (SUB)

Yearout Energy is proposing the replacement of four propane RTU units with one for one heat pump packaged units. An upsize in equipment was integrated into the calculation to allow for increased air flow for pathogen mitigation. See the table below for the key differences in the calcs that are driving the savings and penalties:

Table 35: FIM 3 HVAC Upgrades – Key Parameters – SUB

Variable	Baseline	Proposed	Notes
Propane Heat System Capacity (btu/h)	372,000	0	Existing Equipment Nameplate
Propane Heat System Efficiency	80%	0%	Estimate
Propane Heat System OAT Enable (°F)	60	0	Design Intent
DX Cooling Capacity (tons)	20	24	Manufacturer's Data
Heat Pump Heating Capacity (btu/h)	0	400,000	Manufacturer's Data
Heat Pump Heating Efficiency (COP)	0.00	2.00	Conservative Estimate

See **Appendix F5** for the setpoints and assumptions used to calculate the savings and penalties for this building.

4.3.4 Guaranteed Year 1 Utility Savings

Table 36: FIM 3 HVAC Upgrades – Year 1 Guaranteed Utility Savings

FIM No.	Facility	Electricity		Propane
		kW	Total kWh	gal
3.06	Tsaile Cafeteria	(320)	(30,692)	14,154
3.08	Tsaile Gym	(422)	(66,372)	(7,724)
3.09	Tsaile Library	87	21,279	0
3.14	Tsaile Dorms	(2,022)	(256,512)	18,472
3.15	Tsaile Student Union	(406)	(8,786)	6,041
Total		(3,083)	(341,083)	30,943

The guaranteed savings from this FIM represent the following utility savings in relative to current utility usage for the entire Tsaile campus.

Table 37: FIM 3 HVAC Upgrades - Percent Reduction in Baseline Usage

Facility	Percent Reduction (As Percent of Campus Total)
Electricity -Demand	(43%)
Electricity –Energy	(10%)
Propane	10%
Water	0.0%
Sewer	0.0%

4.3.5 Financial Summary

Table 38: FIM 3 HVAC Upgrades – Financial Summary

FIM No.	Facility	Year 1 Total Annual Savings	Labor, Equip & Material Costs
3.06	Tsaile Cafeteria	$8,573	$584,805
3.08	Tsaile Gym	($17,936)	$581,018
3.09	Tsaile Library	$3,115	$584,522
3.10	Tsaile Ned Hatathli Center	$0	$810,658
3.14	Tsaile Dorms	($23,546)	$3,813,880
3.15	Tsaile Student Union	$3,074	$374,460
Total		($26,720)	$6,749,343

4.3.6 Scope of Work

The scope of work and quantities shown below are preliminary.

4.3.6.1 Tsaile Dorms

Scope Item	Quantity
Demo existing Boiler and HW Pumps	10
Furnish and install new Boiler and HW Pumps (Similar Capacity)	10
Repair mechanical insulation	-

Scope Item	Quantity
Furnish and install new VRF condenser	10
Furnish and install new indoor fan coils and OSA equipment	180
Furnish and install new automated controls system	1
Integrate new installed equipment into new automated controls system	-----

4.3.6.2 Tsaile Cafeteria

Scope Item	Quantity
Demo existing boiler	1
Furnish and install new Boiler and HW Pumps (Similar Capacity)	1
Repair mechanical insulation	-
Furnish and install new package unit	2
Furnish and install and integrate duct work and diffusers	-
Furnish and install new dining room ceiling fan	2
Furnish and install new kitchen exhaust fan	1
Furnish and install new MAU	1
Furnish and install new automated controls system	1
Integrate new installed equipment into new automated controls system	-----

4.3.6.3 Tsaile Ned Hatathli Center

Scope Item	Quantity
Testing and balancing of existing system on floors 2 and 4	-
Duct and mixing box VAV repair/replace on floors 2 and 4	-
Repair mechanical insulation	-
Furnish and install new electric unit heater	1

Scope Item	Quantity
Furnish and install new automated controls system	1
Integrate existing equipment into new automated controls system	-----

4.3.6.4 Tsaile Library

Scope Item	Quantity
Demo existing AHUs	4
Demo existing Heat Pumps	4
Demo existing package unit	1
Furnish and install new AHUs	4
Furnish and install new Heat Pumps	4
Furnish and install new Package Unit	1
Furnish and install new automated controls system	1
Integrate new installed equipment into new automated controls system	-----

4.3.6.5 Tsaile Student Union Building

Scope Item	Quantity
Demo existing RTUs	4
Demo existing kitchen exhaust fan	1
Demo existing MAU	1
Furnish and install new RTUs	4
Furnish and install new kitchen exhaust fan	1

Scope Item	Quantity
Furnish and install new MAU	1
Furnish and install new automated controls system	1
Integrate new installed equipment into new automated controls system	-----

4.3.6.6 Tsaile Gym

Scope Item	Quantity
Demo existing unit heaters	10
Furnish and install new packaged units	10
Furnish and install new duct work and diffusers	-
Furnish and install new automated controls system	1
Integrate new installed equipment into new automated controls system	---------

Clarifications

1. Owner should anticipate planned outages required to complete the scope of work. Yearout Energy will work diligently with the Owner to determine the best plan and schedule for these impacts.
2. Pricing includes LOTO procedures, de-energization and re-energization of electrical panels, and installation of new branch panels and circuit breakers required to establish power to equipment.
3. Where necessary to complete work, 4'x4' sections of existing ceiling grid will be removed and reinstalled to facilitate removal of old systems and installation of new equipment.
4. Owner shall provide network connections and IT Support as required for a complete and working system. This includes access to a suitable wireless network with internet access for all controls devices.

Exclusions

1. Removal of asbestos-containing materials, lead-containing materials or any other hazardous/suspect materials above the scope covered by allowance amount described in the hazardous material and testing included in FIM 7. No work will be performed in areas containing hazardous materials.

2. Removal of all equipment noted "decommission" above, including but not limited to, boilers, pumps, and hydronic piping

3. Removal and abatement of asbestos-containing materials
4. Structural and seismic upgrades associated with replacement of HVAC equipment
5. Temporary heating and cooling

4.3.7 Equipment Service Life

The estimated service life for this FIM is as follows:

Table 39: FIM 3 HVAC Upgrades – Estimated Service Life

FIM Component	% Of FIM Total Cost	Median Service Life
HVAC Equipment & Controls	100%	20 Years
FIM Weighted Average Service Life		20 Years

4.3.8 Preliminary Commissioning Plan

The following preliminary commissioning plan is intended to serve as the outline from which the final commissioning plan will be developed during the pre-construction / design phase. The final commissioning plan will be primarily focused on validating the functionality of the proposed equipment/ strategies and are implemented in accordance with the savings methodology associated with each measure. All relevant Facility Improvement Measures will be included and tracked in one commissioning planned and one commissioning issues log.

1. Develop and issue construction phase commissioning plan
2. Review equipment submittals to validate the specified performance criteria is in alignment with the proposed savings methodology
3. Review sequences of operation and controls strategies to validate alignment with proposed savings methodology
4. Review manufacturer's startup documentation
5. Develop equipment Pre-Functional Checklists (PFCs)
6. Develop and conduct Functional Performance Testing (FPT) procedures on equipment and sequences of operation to ensure proper operation
7. Create and maintain a commissioning issues log
8. Establish trends as required to validate system operation
9. Coordinate Owner participation as required during commissioning and equipment startup efforts
10. Participate in staff training activities

4.3.9 Preliminary Measurement & Verification Plan

M&V Option A – Retrofit Isolation
Guarantee Factor: 90%

Refer to SECTION 5 for a detailed preliminary M&V Plan.

4.3.10 Warranty

An industry-standard 1-year materials and workmanship warranty is provided by Yearout Energy. Any material warranties that extend beyond this period will be transferred to the Owner upon project closeout.

The warranty period information is depicted in the following table for the major equipment related to this FIM.

Table 40: FIM 3 HVAC Upgrades – Warranty Information

Equipment Description	Warranty Period
Rooftop Units (Compressor / Heat Exchanger)	5 years / 10 years
Mini splits/ Split systems/VRF	5 years

4.3.11 Training

Yearout Energy will co-develop a training plan with the Owner that is tailored to the needs and skill level of the building operators. Training sessions will be conducted during the project implementation phase. These sessions will be recorded and provided in electronic format to the Owner for future reference. Topics commonly covered during these training sessions include:

1. Equipment start-up, proper operation, shutdown, power failure, etc.
2. Sequences of operation
3. Operations and maintenance (O&M) manuals
4. Diagnosing and troubleshooting common equipment issues
5. Preventative maintenance and required documentation
6. Health & safety considerations
7. Warranty information

8. Identified system deficiencies
9. Measurement and Verification (M&V) plan and KPIs which drive savings

4.4 FIM 4.00 Building Envelope

4.4.1 Existing Conditions

Significant quantities of air infiltration into the buildings were discovered during the envelope survey period. The facilities were found to be in a mixed set of conditions regarding infiltration losses, mostly due to age and maintenance issues.

Most buildings are in good condition but could use improvements to stop air infiltration/exfiltration and energy loss. Door systems were found to be the largest areas of air infiltration/exfiltration. Most entrance doors needed one of the following: weather stripping or sweeps. In most buildings of this age the door seals are either original or have been replaced. Often the replacement seals are of poor quality and are degraded by ultraviolet solar rays. Over time they lose their flexibility and ability to function reliably. Care should be taken to replace seals with products having extensive long-term testing (higher cycle count). Sealant is recommended around the perimeter of several windows. Numerous penetrations were observed that need to be sealed.

Recommended improvements are tabulated and available in **Appendix G1**.

Air Leakage – Building Envelope

Air leakage through the building envelope most often occurs where building envelope elements are connected. Leakage is typically a result of either improper design or construction, lack of maintenance, or normal degradation over the life of the building. The audit identified penetrations in the building envelope that consist mainly of cracks or openings at building connection points, holes, and pipe/mechanical penetrations. These openings in the building envelope need to be sealed to stop significant amounts of air leakage and energy loss.

Weather Stripping – Exterior Doors

The weather stripping, door sweeps, vertical sweeps on exterior doors, and overhead doors are damaged and in disrepair allowing air infiltration into the space between the door and the frame. Over time this weather stripping develops gaps due to normal wear and tear. By replacing worn out weather stripping, energy savings can be realized due to reduced infiltration and thus, reduced load on the building HVAC equipment. In some instances, the weather stripping appears to be in good condition, but it is still not preventing air leakage as it is intended.

Air Leakage – Windows

Windows throughout the campus, both single and double paned, both have issues that impact energy efficiency. The window glazing and seals are generally in good condition overall; however, air leakage between the window frames and walls was observed in several locations, as well as failed seals.

Windows

Gaps at window / wall junction should be sealed as shown at the Siler Complex.



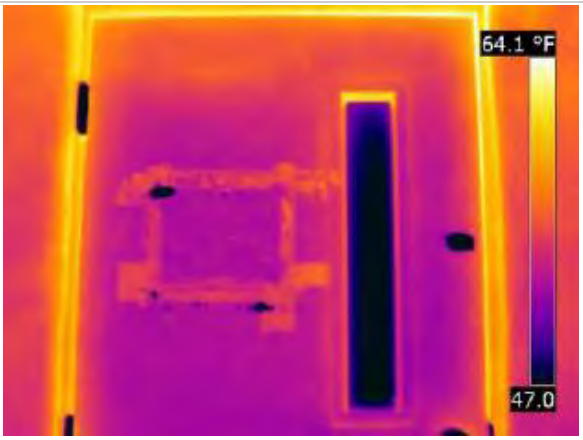
Air Leakage

We recommend sealing penetrations and electrical boxes openings to reduce air and moisture infiltration and exfiltration leading to energy loss



Exterior Doors

The thermal image at right shows a typical example of failed weather-stripping at exterior doors. Here bright yellow at the edges of the door signifies a large temperature differential is apparent, signaling severe leakage.



4.4.2 Proposed Modifications

Recommended improvements are tabulated and available in **Appendix G1**.

Air Leakage – Building Envelope

The proposed modifications include insulating and sealing all identified penetrations and openings with the appropriate polyurethane spray foam product and premium urethanized elastomeric sealants to minimize or eliminate these sources of air leakage.

Weather Stripping – Exterior Doors

This scope will repair or replace the weather stripping, door sweeps, and vertical sweeps as identified to minimize the amount of air leakage at identified locations.

Air Leakage – Windows

Interiors of windows and frames where they meet interior finishes will be caulked using premium urethanized elastomeric sealants to mitigate air leakage where necessary.

Implementing the proposed modifications will reduce the heating and cooling loads by reducing the amount of air entering and leaving through the building envelope and will also improve space comfort.

4.4.3 Savings Methodology

Infiltration Reduction (Air Leakage, Weather Stripping, Exterior Doors, and Windows)

Heat loss, q, in BTU/h, is determined by the following equation:

$$[\, q = H_l \times Q \times \Delta T \,]$$

Where:

H_l = Heat Loss Coefficient ($\frac{BTU*Min}{ft^3*°F*Hr}$) is calculated as follows:

$$[H_l = \text{Cp x } \rho \text{ x } 60\ (\tfrac{Min}{Hr})] = 0.864\ \tfrac{BTU*Min}{ft^3*°F*Hr}$$

Where:

Cp = Specific Heat ($\frac{BTU}{Lb*°F}$)

P = Air density at site elevation ($\frac{lb}{ft^3}$)

Conversion factor = 60 ($\frac{Min}{Hr}$)

where:

Q represents the airflow in cubic feet per minute (CFM) and is calculated in the following manner:

$$[\, Q = A_{crack} \times \sqrt{C_s \Delta T + C_w V^2}\,]$$

where:

A_{crack} = crack area reduction (in²)

C_s = stack coefficient

C_w = wind coefficient

V = wind speed = 8.8 mph
[ΔT = temperature difference = $T_{out} - T_{in}$ (deg F)]

ΔT is calculated by subtracting the average outdoor air temperature per hour from the indoor temperature, using 24 data points per month to accurately account for weather variances, and subsequently calculating airflow and heat loss for each set of data. In total, 288 data points are used, and Δt is the number of hours each data point represents. The total heat loss is calculated as follows:

$$[q = \sum_{x=1}^{288} H_l \times A_{crack} \times \sqrt{C_s(T_{out} - T_{in}) + C_w V^2} \times (T_{out} - T_{in}) \times \Delta t\ ]$$

Conduction/Insulation

Steady-state one-dimensional heat loss, q, in BTU/h, is given by Fourier's law:

$$[\ q = -kA\frac{dT}{dx} \times \frac{hrs}{MMBTU}\ ]$$

where:

A = cross-sectional area normal to heat flow (ft^2)
K = thermal conductivity of the insulation material (BTU-in/h-ft^2-°F)
dT/dx = temperature gradient (°F/in)

The proposed modifications would provide a reduction in leakage area at the facilities as shown in the following tables.

Table 41: FIM 4 Building Envelope – Proposed Air Leakage Area Remediation (ft^2)

Facility	Remediated Air Leakage Area (ft^2)
Tsaile Day Care	1.21
Tsaile Maintenance	14.69
Tsaile Silversmith	0.94
Tsaile Student Success Center	3.53
Tsaile Archival Center	2.78
Tsaile Cafeteria	6.53

Facility	Remediated Air Leakage Area (ft^2)
Tsaile Guy Gorman Classroom Building	4.32
Tsaile Gym	7.49
Tsaile Library	5.00
Tsaile Ned Hatathli Center	4.12
Tsaile Network Operating Center	1.89
Tsaile Head Start	1.80
Tsaile Post Office	0.42
Tsaile Dorms	45.69
Tsaile Student Union	9.62
Tsaile Student Family Housing	14.81
Tsaile Faculty Office Building 1	0.42
Tsaile Faculty Office Building 2	0.43
Tsaile Faculty Office Building 3	3.38
Tsaile Land Grant Modular Building	0.56
Total	129.63

4.4.4 Guaranteed Year 1 Utility Savings

Table 42: FIM 4 Building Envelope – Year 1 Guaranteed Utility Savings

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	Kgal
4.01	Tsaile Day Care	0	45	138	0
4.02	Tsaile Maintenance	0	0	1,898	0
4.03	Tsaile Silversmith	0	2,903	0	0
4.04	Tsaile Student Success Center	0	105	452	0
4.05	Tsaile Archival Center	0	7,779	0	0
4.06	Tsaile Cafeteria	0	0	777	0
4.07	Tsaile Guy Gorman Classroom Building	0	104	502	0
4.08	Tsaile Gym	0	0	934	0
4.09	Tsaile Library	0	16,628	0	0
4.10	Tsaile Ned Hatathli Center	0	200	964	0
4.11	Tsaile Network Operating Center	0	4,831	0	0
4.12	Tsaile Head Start	0	68	216	0
4.13	Tsaile Post Office	0	18	49	0
4.14	Tsaile Dorms	0	0	8,223	0
4.15	Tsaile Student Union	0	231	1,121	0
4.16	Tsaile Student Family Housing	0	0	2,498	0
4.17	Tsaile Faculty Office Building 1	0	18	49	0

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	Kgal
4.18	Tsaile Faculty Office Building 2	0	18	59	0
4.19	Tsaile Faculty Office Building 3	0	126	403	0
4.20	Tsaile Land Grant Modular Building	0	0	69	0
Total		0	33,072	18,354	0

4.4.5 O&M Savings

The building envelope FIM includes upgrades to multiple items includes under the overall building envelope. The first and biggest upgrades are to exterior doors, walls, and foundation. Not only does sealing these keep out cold air but also moisture that could lead to expensive repairs should it be allowed to penetrate the interior. Further a well-sealed building should lead to less maintenance complaints from the occupants, especially those near exterior doors. The O&M savings for this FIM consider savings from avoided repairs related to these items.

No data was available from the Diné College's maintenance department for a proper analysis of O&M cost and savings. Yearout Energy took 15% of the calculated utility savings for this FIM as a conservative estimate of O&M savings then multiplied by the ration of the average service life for this FIM to the finance term for the project if the service life is less than the finance term.

See section 6.2 for more information.

4.4.6 Financial Summary

Table 43: FIM 4 Building Envelope – Financial Summary

FIM No.	Facility	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs
4.01	Tsaile Day Care	$141	$21	$162	$1,025
4.02	Tsaile Maintenance	$1,863	$279	$2,142	$14,503
4.03	Tsaile Silversmith	$375	$56	$431	$1,503

FIM No.	Facility	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs
4.04	Tsaile Student Success Center	$458	$69	$526	$3,687
4.05	Tsaile Archival Center	$1,004	$151	$1,154	$4,064
4.06	Tsaile Cafeteria	$763	$114	$877	$7,741
4.07	Tsaile Guy Gorman Classroom Building	$506	$76	$581	$6,189
4.08	Tsaile Gym	$917	$138	$1,055	$10,765
4.09	Tsaile Library	$2,146	$322	$2,467	$6,099
4.10	Tsaile Ned Hatathli Center	$972	$146	$1,118	$5,291
4.11	Tsaile Network Operating Center	$623	$94	$717	$2,794
4.12	Tsaile Head Start	$221	$33	$254	$1,367
4.13	Tsaile Post Office	$51	$8	$58	$661
4.14	Tsaile Dorms	$8,070	$1,210	$9,280	$47,845
4.15	Tsaile Student Union	$1,130	$170	$1,300	$14,415
4.16	Tsaile Student Family Housing	$2,452	$368	$2,820	$18,227
4.17	Tsaile Faculty Office Building 1	$51	$8	$58	$661
4.18	Tsaile Faculty Office Building 2	$60	$9	$69	$664
4.19	Tsaile Faculty Office Building 3	$412	$62	$474	$2,951
4.20	Tsaile Land Grant Modular Building	$68	$10	$78	$690
Total		$22,280	$3,342	$25,622	$151,144

4.4.7 Scope of Work

Please refer **Appendix G1** for a detailed baseline and proposed envelope remediation.

Table 44: FIM 4 Building Envelope – Proposed Scope of Work

Facility	*Penetrations	*Wall cracks, window/door frames and vents	Sets of Weather-strip DF	Door Sweeps	**Astragals	Sets of weather-strip DF (OH Door)	Door sweeps (OH Door)
	ft^2	Linear Ft	Sets	Qty	Qty	Qty	Qty
Tsaile Day Care	0.31	40	2	2	0	0	0
Tsaile Maintenance	0.40	73	6	6	1	11	11
Tsaile Silversmith	0.04	21	3	3	1	0	0
Tsaile Student Success Center	0.17	370	6	6	0	0	0
Tsaile Archival Center	0.27	199	6	6	3	0	0
Tsaile Cafeteria	0.05	690	12	12	5	0	0
Tsaile Guy Gorman Classroom Building	0.19	0	17	17	3	0	0
Tsaile Gym	0.21	652	16	16	2	0	0
Tsaile Library	0.09	567	8	8	0	0	0
Tsaile Ned Hatathli Center	0.42	16	11	11	3	1	0
Tsaile Network Operating Center	0.24	15	7	7	2	0	0
Tsaile Head Start	0.92	82	2	2	0	0	0
Tsaile Post Office	0.03	28	1	1	0	0	0
Tsaile Dorms	1.24	6862	40	40	0	0	0

Facility	*Penetrations	*Wall cracks, window/door frames and vents	Sets of Weather-strip DF	Door Sweeps	**Astragals	Sets of weather-strip DF (OH Door)	Door sweeps (OH Door)
	ft^2	Linear Ft	Sets	Qty	Qty	Qty	Qty
Tsaile Student Union	0.22	405	32	32	14	0	0
Tsaile Student Family Housing	0.56	1220	34	34	0	0	0
Tsaile Faculty Office Building 1	0.03	28	1	1	0	0	0
Tsaile Faculty Office Building 2	0.04	28	1	1	0	0	0
Tsaile Faculty Office Building 3	0.66	286	5	5	0	0	0
Tsaile Land Grant Modular Building	0.09	2	2	0	0	0	0
Total	6.18	11584	212	210	34	12	11

*Sealed w/ polyurethane sealant
**weather-strip for center of double door

Clarifications

1. Installation will be executed in accordance with industry-standard safety practices and with the care, skill, and diligence provided by a contractor skilled in building envelope services.
2. Installation of all materials will be executed per manufacturer's recommendations.
3. Any conditions not meeting current codes, and any system deficiencies will be brought to the attention of the Owner. Any work required to remedy these situations is excluded.

Exclusions

1. Removal of asbestos-containing materials, lead-containing materials or any other hazardous/suspect materials above the scope covered by allowance amount described in the hazardous material and testing included in FIM 7. No work will be performed in areas containing hazardous materials.

2. Removal of caulking, coatings, mastics, flashings, insulation, or any other materials unless clearly specified.
3. Repair or installation of brick or other masonry materials or systems.
4. Repair or installation of window or door systems unless clearly identified.
5. Repair or installation of any structural systems.

4.4.8 Equipment Service Life

The estimated service life for this FIM is as follows:

Table 45: FIM 4 Building Envelope – Estimated Service Life

FIM Component	% Of FIM Total Cost	Median Service Life
Building Envelope Materials	100%	20 Years
FIM Weighted Average Service Life		20 Years

4.4.9 Preliminary Commissioning Plan

The following preliminary commissioning plan is intended to serve as the outline from which the final commissioning plan will be developed during the pre-construction / design phase. The final commissioning plan will be primarily focused on validating the functionality of the proposed equipment/ strategies and are implemented in accordance with the savings methodology associated with each measure. All relevant Facility Improvement Measures will be included and tracked in one commissioning planned and one commissioning issues log.

1. Develop and issue construction phase commissioning plan
2. Review equipment submittals to validate the specified performance criteria is in alignment with the proposed savings methodology
3. Perform a random inspection to validate the implemented building envelope improvements align with the proposed scope of work (door sweeps, penetrations, etc.)
4. Create and maintain a commissioning issues log

4.4.10 Preliminary Measurement & Verification Plan

M&V Option A – Retrofit Isolation
Guarantee Factor: 90%

Refer to SECTION 5 for a detailed preliminary M&V Plan.

4.4.11 Warranty

An industry standard 1-year materials and workmanship warranty is provided by Yearout Energy. Any material warranties that extend beyond this period will be transferred to the Owner upon project closeout. All available warranty information can be found in **Appendix G1**.

The warranty period information for the major pieces of equipment associated with this measure is summarized in the table below.

Table 46: FIM 4 Building Envelope – Warranty Information

Equipment Description	Warranty Period
DAP & Dow Corning Sealants	50 years
Other sealants	1 year
Door sweeps and astragals	N/A

4.4.12 Training

Yearout Energy will co-develop a training plan with the Owner that is tailored to the needs and skill level of the building operators. Training sessions will be conducted during the project implementation phase. These sessions will be recorded and provided in electronic format to the Owner for future reference. Topics commonly covered during these training sessions include:

5. Equipment start-up, proper operation, shutdown, power failure, etc.
6. Sequences of operation
7. Operations and maintenance (O&M) manuals
8. Diagnosing and troubleshooting common equipment issues
9. Preventative maintenance and required documentation
10. Health and safety considerations
11. Warranty information
12. Identified system deficiencies
13. Measurement and Verification (M&V) plan and KPIs which directly impact savings

4.5 FIM 5.00 High-Efficiency Transformers

4.5.1 Existing Conditions

Transformers operate continuously and consume energy through there inherent inefficiency. There are 16 transformers on the Tsaile campus that have been identified as good candidates for replacement due to their age and inefficiency. This will save energy and improve aging infrastructure.

Transformers step down higher voltages delivered via utility distribution to lower voltages required for most building applications, including HVAC, lighting, and plug loads. Regardless of connected demand, transformers operate 24 hours per day and 365 days per year and experience roughly constant losses. These losses originate from two major transformer components: the core (typically made of steel), and coil windings (made of aluminum or copper). Standards for minimum transformer energy efficiencies were adopted at the discretion of manufacturers until 2007, when minimum efficiency legislation was enacted. The table below includes appropriate candidates for replacement.

Table 47: FIM 5 HE Transformers – Existing Low Voltage Transformer Inventory

Tag	Facility	Location	KVA	Primary	Secondary
75397	Tsaile Student Success Center	Outside Mechanical Rm	75	480	208/120
75396	Tsaile Cafeteria	Outside West	500	480	208/120
75390	Tsaile Guy Gorman Classroom Building	Custodian / Mechanical	112.5	480	208/120
75391	Tsaile Guy Gorman Classroom Building	Custodial Near GCB 116	112.5	480	208/120
75392	Tsaile Gym	Gym West Wall	150	480	208/120
75393	Tsaile Gym	Electrical	45	480	208/120
75398	Tsaile Ned Hatathli Center	114 Elevator Equip (Out front)	45	480	208/120
75400	Tsaile Ned Hatathli Center	2nd-216D	225	480	208/120
75401	Tsaile Ned Hatathli Center	5th Fl Elec Rm. Inside Men’s Rm 504A	112.5	480	208/120
75402	Tsaile Ned Hatathli Center	605B Elec Rm in Men's Rm	45	480	208/120
75403	Tsaile Ned Hatathli Center	605B Elec Rm Inside Men's Rm	25	480	208/120
75388	Tsaile Network Operating Center	Loan 103	75	480	240/120

75389	Tsaile Network Operating Center	Computer Lab	45	480	208/120
75394	Tsaile Student Union Building	138	30	480	240/120
75395	Tsaile Student Union Building	Custodial By Sub-216	225	480	240/120
75404	Tsaile Student Family Housing	North Center Circle Outside	45	480	240/120

Low-Voltage Transformers

Several transformers like the one shown at right sandwiched between two electrical boxes at the cafeteria are present throughout the exteriors and electrical rooms of the facilities. Many of these units have been in place since the time of the building's original construction.



4.5.2 Proposed Modifications

Modifications will include replacement of the existing transformers, shown in Table 47, with new, high-efficiency Powersmiths model E-Saver-80R transformers. Energy savings are driven by modern, precision-crafted cores and coil windings. Refer to **Appendix H3** for specifications.

4.5.3 Savings Methodology

Transformer losses are comprised of two major energy losses:

14. Core loses, also known as no-load losses or energizing losses, are present continuously, regardless of load.
15. Coil losses, also known as load losses, vary with the square of the load placed upon them.

Total Transformer Losses are calculated as follows:

[Total Transformer Losses = No-load Losses (Core) + Load Losses (Coils)]

The below graph is the summary of a survey by the Northeast Energy Efficiency Partnership that indicates that typical transformer loading typically falls within the range of 7 – 24%.



(SOURCE DATA: INDUSTRIAL AND PUBLIC BUILDINGS, THE CADMUS GROUP INC. 12/7/99, PREPARED FOR NEFP)

Figure 140: Root Mean Square (RMS) Transformer Average Load Factor by Facility Type

The following graph shows the two loss components for a representative 75-kVA transformer. No-load losses represent 80-95% of the total losses, with only a small percentage (depicted in the blue-shaded triangular area between the red and orange lines) associated with load-dependent losses.

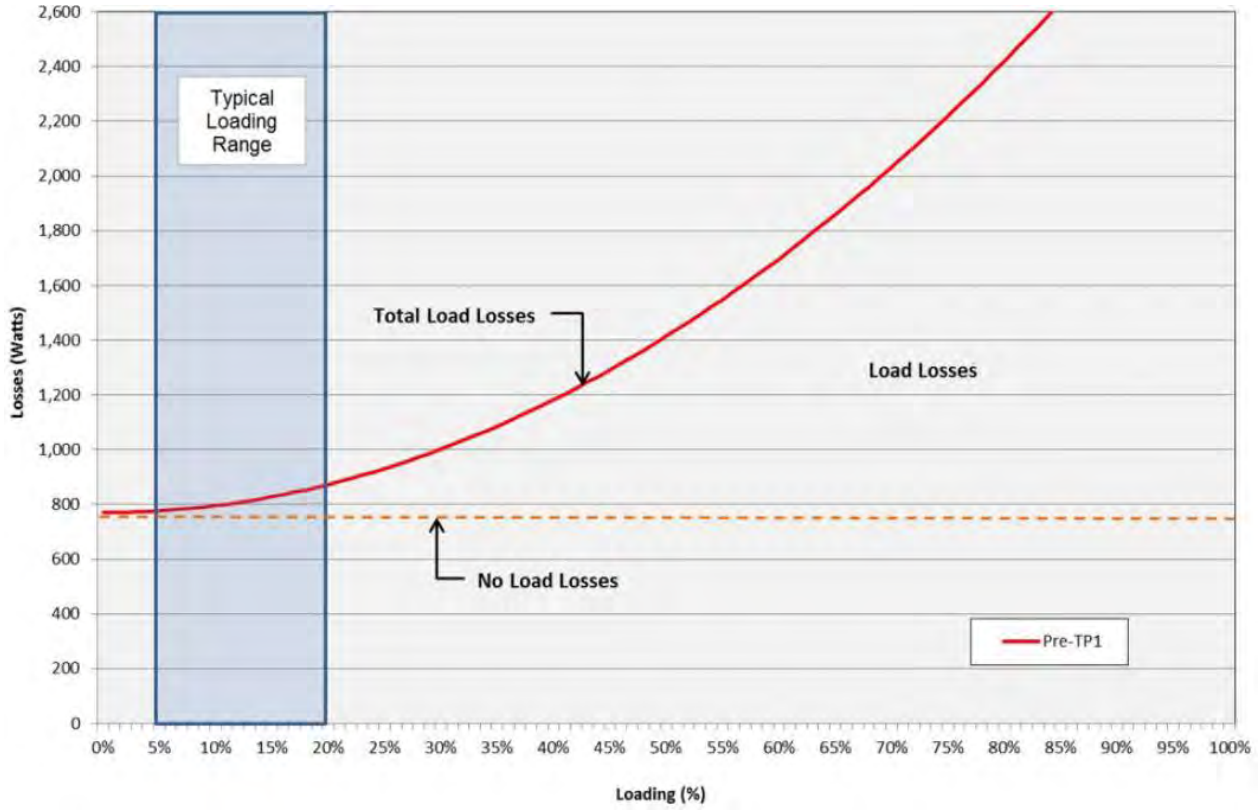


Figure 141: Typical 75 kVA NEMA TP-1 Low-Voltage Dry-Type Transformer Energy Loss Profile

Savings calculations are based on extensive field data collected by Powersmiths over the past decade across the country and Tsaile campus facility field measurements of the % loading and kW losses were performed on several existing transformers. Most transformers exhibit a very predictable duty-cycle using.

The following equation was used to calculate the on- and Off-Peak power savings:

$$[\ Lp = Ln + I^2 \times (Lf - Ln)\ ]$$

where:

Lp	Total transformer power losses (kW)
Ln	No-load losses (kW)
Lf	Full-load losses (kW)
I	Loading during operating hours (%)

The below table shows the load losses for the baseline and new proposed transformer.

Table 48: FIM 5 HE Transformers – Average Load Losses

Size kVA	Baseline Losses		Proposed Losses (E-Saver-80R)	
	No Load	Full Load	No Load	Full Load
	W	W	W	W
25	398	1369	57	674
30	468	1462	57	1332
45	658	2202	78	1,725
75	853	3347	111	2,537
112.5	1205	4271	164	3,313
150	1252	5544	203	3945
225	1824	8088	319	4317
500	3466	11796	558	8419

Energy losses were calculated as follows:

[Le = Lp x H]

Savings for power (kW) and energy (kWh) were calculated as follows:

[Savings = Baseline Transformer Losses – Proposed Transformer Losses]

Where:

Lp Total transformer power losses (kW)
Le Total transformer energy losses (kWh)
H Hours of operation (h/y)

See **Appendix H1** for savings calculation.

4.5.4 Guaranteed Year 1 Utility Savings

Table 49: FIM 5 HE Transformers – Year 1 Guaranteed Utility Savings

FIM No.	Facility	Electricity	
		kW	Total kWh
5.04	Tsaile Student Success Center	8	5,854
5.06	Tsaile Cafeteria	31	22,948
5.07	Tsaile Guy Gorman Classroom Building	22	16,404
5.08	Tsaile Gym	18	12,870
5.10	Tsaile Ned Hatathli Center	44	32,052
5.11	Tsaile Network Operating Center	14	10,419
5.15	Tsaile Student Union Building	21	15,222
5.16	Tsaile Student Family Housing	6	4,566
Total		165	120,334

4.5.5 O&M Savings

The O&M savings for this FIM are related to the cost of repair or replacement of older transformers. Not only will the college not have to worry about spending capital on materials but also is paid time of employees to repair or replace this equipment.

No data was available from the Diné College's maintenance department for a proper analysis of O&M cost and savings. Yearout Energy took 15% of the calculated utility savings for this FIM as a conservative estimate of O&M savings. The savings are then multiplied by the ration of the average service life for this FIM to the finance term for the project if the service life is less than the finance term.

See section 6.2 for more information.

4.5.6 Financial Summary

Table 50: FIM 5 HE Transformers – Financial Summary

FIM No.	Facility	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs
5.04	Tsaile Student Success Center	$789	$118	$908	$9,405
5.06	Tsaile Cafeteria	$3,095	$464	$3,559	$29,297
5.07	Tsaile Guy Gorman Classroom Building	$2,212	$332	$2,544	$25,008
5.08	Tsaile Gym	$1,735	$260	$1,996	$22,117
5.10	Tsaile Ned Hatathli Center	$4,322	$648	$4,970	$58,134
5.11	Tsaile Network Operating Center	$1,405	$211	$1,616	$17,879
5.15	Tsaile Student Union Building	$2,053	$308	$2,361	$27,635
5.16	Tsaile Student Family Housing	$616	$92	$708	$8,725
Total		$16,227	$2,434	$18,661	$198,200

Scope of Work

The scope shall include the equipment as shown in the below table and work shall be performed as follows:

1. Verify all dimensions in the field.
2. Check for damage and loose connections.
3. Set the transformer plumb and level.
4. Mount transformer on vibration isolation pads suitable for isolating the transformer.

Table 51: FIM 5 HE Transformers – Proposed Scope of Work

Scope Item	Quantity
Demolish transformer	16
Install 25Kva high-efficiency transformer	1
Install 30Kva high-efficiency transformer	1
Install 45Kva high-efficiency transformer	5
Install 75Kva high-efficiency transformer	2
Install 112.5Kva high-efficiency transformer	3
Install 150Kva high-efficiency transformer	1
Install 225Kva high-efficiency transformer	2
Install 500Kva high-efficiency transformer	1

Please refer **Appendix H** for a detailed baseline and proposed transformers.

CLARIFICATIONS

1. Work will require system shutdowns. All work shall be coordinated with the Owner to minimize the effect on day-to-day operations. Work shall be conducted during normal work hours when utility interruptions are approved; otherwise, work will be conducted outside of normal work hours when utility interruptions are not approved. All preparation work shall be done prior to shut down to minimize the time the system is down.
2. Installation will be executed in accordance with industry-standard safety practices and with the care, skill, and diligence provided by a contractor skilled in building envelope services.
3. Installation of all materials will be executed per manufacturer's recommendations.
4. Any conditions not meeting current codes, and any system deficiencies will be brought to the attention of the Owner. Any work required to remedy these situations is excluded.

EXCLUSIONS

5. Removal of asbestos-containing materials, lead-containing materials or any other hazardous/suspect materials above the scope covered by allowance amount described in the

hazardous material and testing included in FIM 7. No work will be performed in areas containing hazardous materials.

6. New vibration isolation pads suitable for isolating
7. Repair or installation of any structural systems and/or installation of seismic restraints where required.
8. Repair or installation of brick, concrete or other masonry materials or systems.

4.5.7 Equipment Service Life

The estimated service life for this FIM is as follows:

Table 52: FIM 5 HE Transformers – Estimated Service Life

FIM Component	% Of FIM Total Cost	Median Service Life
HE Transformers	100%	32 Years
FIM Weighted Average Service Life		32 Years

4.5.8 Preliminary Commissioning Plan

The following preliminary commissioning plan is intended to serve as the outline from which the final commissioning plan will be developed during the pre-construction / design phase. The final commissioning plan will be primarily focused on validating the functionality of the proposed equipment/ strategies and are implemented in accordance with the savings methodology associated with each measure. All relevant Facility Improvement Measures will be included and tracked in one commissioning planned and one commissioning issues log.

1. Develop and issue construction phase commissioning plan
2. Review equipment submittals to validate the specified performance criteria is in alignment with the proposed savings methodology
3. Review manufacturer's startup documentation
4. Develop equipment Pre-Functional Checklists (PFCs)
5. Develop and conduct Functional Performance Testing (FPT) procedures on equipment and sequences of operation to ensure proper operation
6. Create and maintain a commissioning issues log

4.5.9 Preliminary Measurement & Verification Plan

M&V Option A – Retrofit Isolation
Guarantee Factor: 90%

Refer to SECTION 5 for a detailed preliminary M&V Plan.

4.5.10 Warranty

An industry standard 1-year materials and workmanship warranty is provided by Yearout Energy. Any material warranties that extend beyond this period will be transferred to the Owner upon project closeout. All available warranty information can be found in **Appendix H3**.

The warranty period information for the major pieces of equipment associated with this measure is summarized in the table below.

Table 53: FIM 5 HE Transformers – Warranty Information

Equipment Description	Warranty Period
Powersmiths Opal Transformers	32 years

4.5.11 Training

Yearout Energy will co-develop a training plan with the Owner that is tailored to the needs and skill level of the building operators. Training sessions will be conducted during the project implementation phase. These sessions will be recorded and provided in electronic format to the Owner for future reference. Topics commonly covered during these training sessions include:

1. Equipment start-up, proper operation, shutdown, power failure, etc.
2. Sequences of operation
3. Operations and maintenance (O&M) manuals
4. Diagnosing and troubleshooting common equipment issues
5. Preventative maintenance and required documentation
6. Health and safety considerations
7. Warranty information
8. Identified system deficiencies
9. Measurement and Verification (M&V) plan and KPIs which directly impact savings

4.6 FIM 6.00 Water Conservation

To develop this measure, Yearout Energy conducted a thorough on-site walkthrough audit of the facilities, including engineering evaluations of water and energy savings opportunities. These evaluations include an examination of a sample of water-use equipment, measurements of existing water consumption, and analysis of historical water use data and facility demographics.

4.6.1 Existing Conditions

A variety of plumbing fixture configurations and flow rates were identified during the audit of the Tsaile campus.

1. Domestic water fixtures throughout the buildings include mainly older standard fixtures with a spattering of high efficiency fixtures mixed in.
2. Most toilets are flushometer (flush valve) type. Toilet flush rates are typically 1.60 gallons per flush (gpf).
3. Approximately 80% of the sink faucets can be retrofit to low flow specifications.
4. Urinal fixture rates flows range from 0 gpf (waterless type) to 2 gpf, there are several that can be retrofit to low flow specifications.
5. During the site survey H2O recorded existing fixture counts, types, and manufacturer's rated flows. The subject buildings are typical of higher education institutions and include student housing, academic buildings, dining facilities, etc. H2O measured the building water pressure in various dorms and Ned Hatathli Center on the Tsaile Campus: values are low, ranging from 24-40 psi.
6. The Scotsman model C0630SA ice machine in the Tsaile Cafeteria has a rated capacity of 640 lbs. of ice per day. It is used year-round.

Flushometers

Flushometers like those shown at right are prone to leakage and in many cases have fallen into disrepair, resulting in a release of much more water than is necessary. This measure will replace most of this type of fixture with low flow toilet and sensor activated flush valve. This will conserve water and virus and bacterial transmission.



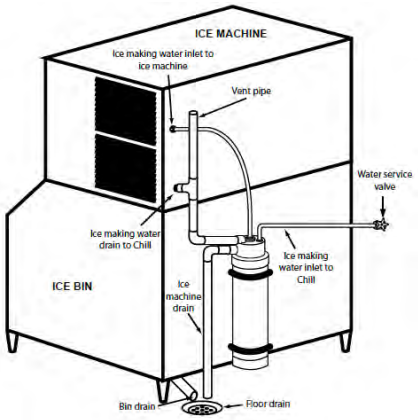
High Flow Sink Fixtures

Existing lavatory fixtures will be replaced with low flow fixtures with sensor activated faucets. This will not only conserve water but increase pandemic preparedness.



Ice Machine Economizer

With an ice machine economizer, the wastewater is piped to a shell and tube heat exchanger with the potable makeup water where it cools down the entering water before going to drain. The compressor must do less work and therefore consumes less energy to lower the temperature of the cooler makeup water to its freezing point.



4.6.2 Proposed Modifications

The proposed modifications include the following:

1. Replacement of existing flushometers toilets with 1.28 gpf china and sensor activated flush valves
2. Replacement of high flow tank toilets with 0.8 gpf tank fixtures
3. Low flow china with high flow valves will be retrofitted with low flow valves with sensors
4. Existing low flow flushometer toilets will be fitted with flush valve sensors where possible
5. Replacement of high flow urinals with 0.125 gpf china and sensor activated flush valves
6. Existing urinals in good condition will be retrofitted with 0.125 gpf sensor flush valves
7. Urinal upgrades with a new 0.5 gpf Sloan flush valve diaphragm kit
8. Lavatory sink replacement with 0.5 or 1.0 gpm sensor-activated faucets

9. Installation of new or replacement of existing vandal-resistant flow control devices (aerators) at all lavatory and general-use sinks.
10. Replace high flow showerheads with 1.5 gpm fixtures
11. Add ice economizer to Cafeteria ice machine

Please refer to **Appendix I** for detailed fixture audit and new equipment specifications.

4.6.3 Savings Methodology

Domestic plumbing fixture water usage is based primarily on facility occupancy. Detailed savings calculations can be found in **Appendix I1**. In general, domestic plumbing fixtures savings can be calculated as follows:

$$[\ Sw = d \times n \times F \times \Delta q\ ]$$

where:

Sw	Water savings (gal/y)
n	Number of occupants
F	Fixture usage per day (FUPD, flush/d/occupant)
Δq	Baseline flush rate – proposed flush rate (gal/flush)
D	Days in use per year (d/y)

Industry-standard assumptions[1] of use are utilized to determine fixture usage per day (FUPD) as follows:

1. Occupant and time-of-occupancy information is collected through IGA.
2. A split of 50% male and 50% female occupants is assumed.
3. Occupants will use restrooms once per two hours (0.5 uses per hour).
4. Males will use urinals 75% of the time.
5. New ADA handle

[1]References: Building Science Corporation, “Setting Up Performance and Prescriptive Criteria for Domestic Water Use and Construction Waste Generation”, 1996; U.S. Department of Defense, “Military Handbook: Water Conservation”, 1997; Pacific Institute, “Waste Not, Want Not: The Potential for Urban Water Conservation in California”, 2003; Report sponsored by FEMP and conducted by Urban Systems Engineering, “WATERGY: A Water and Energy Conservation Model for Federal Facilities”, 1996.

6. Non-residential lavatory usage is tied to the number of flushes and averages 6 seconds (0.1 minutes) per flush.
7. Residential lavatory usage averages 5 minutes per person per day.
8. Non-residential kitchenette, or general-purpose, faucets are used an average of 2 minutes per person per day.
9. Residential kitchen faucets are used an average of 3 minutes per person per day.
10. Non-residential shower use averages 8 minutes per shower; residential shower use averages 10 minutes per shower.
11. Usage factors are applied to each calculation to scale usage up or down depending on special conditions. Typically, these usage factors remain at 100% unless there is an indication of a modified usage pattern (e.g., it is known that a shower is used by only one person, once per week.)

Thermal energy and cost savings are calculated as follows:

$$[\ Se = Sw \times \rho \times Cp \times \Delta T\ ]$$

$$[\ Sc = Se / \varepsilon * f\ ]$$

where:

Sw	Water savings (gal/y)
Se	Thermal energy savings (BTU/y)
Sc	Thermal energy cost savings ($/y)
ρ	Water density = 8.34 lb./gal
Cp	Specific heat of water = 0.999 BTU/lb.-°F
ΔT	Hot water design temperature – mean inlet water temperature (°F)
f	Fuel unit cost ($/BTU)
ε	Efficiency (dimensionless)

The calculations for the ice machine economizers savings work as follows:

[Energy savings(kWh)= Ice Machine Nominal Capacity x .75 x (5.63kWh/100 lbs. ice)]

The assumptions being make are:

1. Daily ice production is 75% of the ice machine nominal capacity.
2. Based on typical operations of an average, reasonably efficient, ice machine, compressor energy consumption is estimated at 5.63 kwh/100 pounds of ice.

See Appendix I3 for more information.

4.6.4 Guaranteed Year 1 Utility Savings

Table 54: FIM 6 Water Conservation – Year 1 Guaranteed Utility Savings

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	kgal
6.02	Tsaile Maintenance	0	0	39	17
6.03	Tsaile Silversmith	0	0	0	2
6.04	Tsaile Student Success Center	0	0	20	7
6.05	Tsaile Archival Center	0	0	20	8
6.06	Tsaile Cafeteria	0	1,609	49	17
6.07	Tsaile Guy Gorman Classroom Building	0	0	68	31
6.08	Tsaile Gym	0	0	49	22
6.09	Tsaile Library	0	0	59	27
6.10	Tsaile Ned Hatathli Center	0	0	176	77
6.11	Tsaile Network Operating Center	0	0	20	7
6.14	Tsaile Dorms	0	0	978	360
6.15	Tsaile Student Union	0	0	78	32
6.16	Tsaile Student Family Housing	0	0	382	144
6.17	Tsaile Faculty Office Building 1	0	0	0	1
6.18	Tsaile Faculty Office Building 2	0	0	0	1
6.19	Tsaile Faculty Office Building 3	0	0	10	5

FIM No.	Facility	Electricity		Propane	Water
		kW	kWh	gal	kgal
6.20	Tsaile Land Grant Modular Building	0	0	10	2
Total		0	1,609	1,957	760

4.6.5 O&M Savings

Savings for this FIM are related to the deferred cost of repairs and replacing equipment such as china, fixtures, valves, diaphragms, and aerators. Again, this estimate includes the cost of material and labor associated with repair and replacement.

No data was available from the Diné College's maintenance department for a proper analysis of O&M cost and savings. Yearout Energy took 15% of the calculated utility savings for this FIM as a conservative estimate of O&M savings. The savings are then multiplied by the ration of the average service life for this FIM to the finance term for the project if the service life is less than the finance term.

See section 6.2 for more information.

4.6.6 Financial Summary

Table 55: FIM 6 Water Conservation – Financial Summary

FIM No.	Facility	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs
6.02	Tsaile Maintenance	$218	$33	$250	$6,848
6.03	Tsaile Silversmith	$19	$3	$22	$1,391
6.04	Tsaile Student Success Center	$95	$14	$109	$8,768
6.05	Tsaile Archival Center	$104	$16	$120	$6,344
6.06	Tsaile Cafeteria	$435	$65	$500	$16,726
6.07	Tsaile Guy Gorman Classroom Building	$388	$58	$446	$16,708
6.08	Tsaile Gym	$275	$41	$316	$9,304

FIM No.	Facility	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs
6.09	Tsaile Library	$341	$51	$392	$630
6.10	Tsaile Ned Hatathli Center	$985	$148	$1,132	$22,537
6.11	Tsaile Network Operating Center	$95	$14	$109	$6,548
6.14	Tsaile Dorms	$4,736	$710	$5,447	$157,559
6.15	Tsaile Student Union	$417	$63	$479	$40,627
6.16	Tsaile Student Family Housing	$1,885	$283	$2,168	$50,334
6.17	Tsaile Faculty Office Building 1	$9	$2	$11	$1,391
6.18	Tsaile Faculty Office Building 2	$9	$2	$11	$1,391
6.19	Tsaile Faculty Office Building 3	$57	$8	$65	$5,666
6.20	Tsaile Land Grant Modular Building	$28	$5	$33	$1,409
Total		$10,096	$1,514	$11,610	$354,182

4.6.7 Scope of Work

Please refer **Appendix I** for a detailed baseline and proposed room-by-room water fixture inventory.

Table 56: FIM 6 Water Conservation – Proposed Scope of Work

Facility	Flushometer Fixtures				Tank Toilets	Sinks		Shower
	Replace Fixture/ Sensor Upgrade	Flush Sensor Upgrade	Replace Valve/Flush Sensor Upgrade	Valve/Diaphragm Upgrade	Replace Fixture	Replace Faucet/ Sensor Upgrade	Replace Aerator	Replace Fixture
Tsaile Maintenance	3	0	0	0	0	4	1	0

Facility	Flushometer Fixtures				Tank Toilets	Sinks		Shower
	Replace Fixture/ Sensor Upgrade	Flush Sensor Upgrade	Replace Valve/Flush Sensor Upgrade	Valve/Diaphragm Upgrade	Replace Fixture	Replace Faucet/ Sensor Upgrade	Replace Aerator	Replace Fixture
Tsaile Silversmith	0	0	0	0	1	1	0	0
Tsaile Student Success Center	6	0	0	0	0	4	1	0
Tsaile Archival Center	5	1	0	0	0	2	1	0
Tsaile Cafeteria	4	3	0	0	0	11	0	0
Tsaile Guy Gorman Classroom Building	10	2	0	0	0	8	1	0
Tsaile Gym	6	0	0	0	0	4	0	8
Tsaile Library	0	0	0	4	0	0	2	0
Tsaile Ned Hatathli Center	0	13	9	0	0	20	2	0
Tsaile Network Operating Center	3	3	0	0	0	4	1	0
Tsaile Dorms	0	0	0	0	80	139	0	78
Tsaile Student Union	23	0	4	0	0	19	0	0
Tsaile Student Family Housing	0	0	0	0	36	36	32	40
Tsaile Faculty Office Building 1	0	0	0	0	4	4	1	0
Tsaile Faculty Office Building 2	0	0	0	0	1	1	0	3
Tsaile Faculty Office Building 3	0	0	0	0	1	1	0	0
Tsaile Land Grant Modular Building	0	0	0	0	1	1	1	0
Total	60	22	13	4	124	259	43	129

Clarifications

1. Above quantities and sizing are preliminary and will be finalized once final equipment selections are made.
2. All piping modifications will be made with material that complies with standard trade practice and like existing materials.
3. Prior to construction, Owner will identify isolation valves. Isolation valves are required to be in working order for the above scope of work to be performed. Failed isolation valves are the Owner's responsibility to repair or replace.
4. Permit fees are not expected for this scope of work since it is a retrofit scope of work and no major modifications to infrastructure are being made. Yearout Energy has excluded permits from project cost at this time and would pass them through at cost (without markup) should they be required.
5. It is the Owner's responsibility to continue to provide domestic water at 25-85 psi and suitable flowrates to all fixtures. Deviations from this pressure range will require additional retrofits external to this project scope.

Exclusions

1. Removal of asbestos-containing materials, lead-containing materials or any other hazardous/suspect materials above the scope covered by allowance amount described in the hazardous material and testing included in FIM 7. No work will be performed in areas containing hazardous materials.
2. Control stops and shutoff valves.
3. Special-use sinks, volume-based sinks, and irregular sinks that are incompatible with retrofit scope of work.
4. Sink faucets and peripherals.
5. Shower peripherals.
6. Broken toilet flanges. Flange repairs and/or replacements will incur an additional charge external to this project scope.
7. Broken carriers (for wall-mount toilets and urinals).
8. Painting, extensive tile work, and wall repair outside of footprint-related patching.
9. Pre-existing damage to walls and/or flooring will be brought to the attention of the Owner and the best course of action will be determined. Yearout Energy will repair any damage caused by its installations. Yearout Energy will attempt to match existing conditions, but where unique finishes are present it may require the Owner to supply material.

4.6.8 Equipment Service Life

The estimated service life for this FIM is as follows:

Table 57: FIM 6 Water Conservation – Estimated Service Life

FIM Component	% Of FIM Total Cost	Median Service Life
All Domestic Water Fixtures	100%	20 Years
FIM Weighted Average Service Life		20 Years

4.6.9 Preliminary Commissioning Plan

The following preliminary commissioning plan is intended to serve as the outline from which the final commissioning plan will be developed during the pre-construction / design phase. The final commissioning plan will be primarily focused on validating the functionality of the proposed equipment/ strategies and are implemented in accordance with the savings methodology associated with each measure. All relevant Facility Improvement Measures will be included and tracked in one commissioning planned and one commissioning issues log.

1. Develop and issue construction phase commissioning plan
2. Review equipment submittals to validate the specified performance criteria is in alignment with the proposed savings methodology
3. Perform a random inspection to validate the implemented water fixture improvements align with the proposed scope of work.
4. Create and maintain a commissioning issues log

4.6.10 Preliminary Measurement & Verification Plan

M&V Option A – Retrofit Isolation
Guarantee Factor: 90%

Refer to SECTION 5 for a detailed preliminary M&V Plan.

4.6.11 Warranty

An industry standard 1-year materials and workmanship warranty is provided by Yearout Energy. Any material warranties that extend beyond this period will be transferred to the Owner upon project closeout. All available warranty information can be found in **Appendix F2**.

The warranty period information for the major pieces of equipment associated with this measure is summarized in the table below.

Table 58: FIM 6 Water Conservation – Warranty Information

Equipment Description	OEM Warranty Period	Water Conservation Partner Warranty
Flushometer valve components	3 years	3 years
Diaphragm	3 years	10 years
Hands-free handle mounts	3 years	3 years
Supply lines	N/A	3 years
Aerators	1 year	3 years
Screen washers	5 years	10 years
Urinals	3 years	3 years

4.6.12 Training

Yearout Energy will co-develop a training plan with the Owner that is tailored to the needs and skill level of the building operators. Training sessions will be conducted during the project implementation phase. These sessions will be recorded and provided in electronic format to the Owner for future reference. Topics commonly covered during these training sessions include:

5. Equipment start-up, proper operation, shutdown, power failure, etc.
6. Sequences of operation
7. Operations and maintenance (O&M) manuals
8. Diagnosing and troubleshooting common equipment issues
9. Preventative maintenance and required documentation
10. Health and safety considerations
11. Warranty information
12. Identified system deficiencies
13. Measurement and Verification (M&V) plan and KPIs which directly impact savings

4.7 FIM 7.00 Hazardous Materials Testing and Abatement Allowance

4.7.1 Existing Conditions

Buildings built before 1980 are likely to contain asbestos in the ceiling, walls, flooring, insulation, paint, adhesives, or several other construction items. A list of the buildings included in this FIM can be found below:

Table 59: FIM 7 Hazardous Material – Tsaile Campus Facilities Built Before 1980

FIM No.	Facility	Year Built
7.02	Tsaile Maintenance	1971
7.03	Tsaile Silversmith	1972
7.06	Tsaile Cafeteria	1971
7.08	Tsaile Gym	1971
7.09	Tsaile Library	1972
7.10	Tsaile Ned Hatathli Center	1974
7.12	Tsaile Head Start	1980
7.14	Tsaile Dorms	1971
7.15	Tsaile Student Union	1973

4.7.2 Proposed Modifications

As the implementation of several of our proposed FIMs may lead to the exposure of the workers and other building occupants, this measure will test and abatement hazardous materials at select facilities impacted by the overall project scope prior to any demolition or construction.

4.7.3 Savings Methodology

There are no savings directly associated with this FIM.

4.7.4 Guaranteed Year 1 Utility Savings

There are no savings directly associated with this FIM.

4.7.5 Financial Summary

The following table outlines the allowance carried for the hazardous materials testing and abatement at select facilities on the Tsaile Campus.

Table 60: FIM 7 Hazardous Materials – Financial Summary

FIM No.	Facility	Testing Cost	Abatement Allowance
7.02	Tsaile Maintenance	$5,940	$52,698
7.03	Tsaile Silversmith	$2,376	$21,156
7.06	Tsaile Cafeteria	$5,940	$52,698
7.08	Tsaile Gym	$4,860	$43,090
7.09	Tsaile Library	$5,940	$52,698
7.10	Tsaile Ned Hatathli Center	$27,000	$159,225
7.12	Tsaile Head Start	$2,700	$23,971
7.14	Tsaile Dorms	$43,200	$382,372
7.15	Tsaile Student Union	$9,720	$86,180
Total		$107,675	$874,088

4.7.6 Scope of Work

A full scope of work will be developed after testing has occurred.

4.7.7 Equipment Service Life

No new equipment proposed for this measure.

4.7.8 Preliminary Commissioning Plan

There are no components requiring commissioning for this FIM.

4.7.9 Warranty

No new equipment proposed for this measure.

4.7.10 Training

No training required for this measure.

4.8 Shiprock North and South Campus Potential FIMs

4.8.1 LED Lights

There is the opportunity to upgrade the lighting at all the buildings on both the North and South campuses. Around 90% of these campuses are currently non-LED. Considering the quick payback and other benefits associated with this measure, Yearout Energy highly recommends pursuing these upgrades.

4.8.2 HVAC Systems Upgrades

There are a few upgrades that Yearout Energy recommend making at the Shiprock South campus. First, an open protocol building automation platform that integrates with all other campuses . Second, investigate economizer cooling and outside air supply for the Student Success Center. These wouldn't be overly expensive upgrades but will make a big difference in energy efficiency and pandemic preparedness.

At Shiprock North, much of the HVAC equipment is aged and in need of replacement. It will take a large capital investment to upgrade these buildings. With the use of the building decreasing and it's future unsure, Yearout Energy recommends Diné College define the buildings prospects before pursuing any major upgrades.

4.8.3 Renewable Energy

Currently there is a solar installation on the Shiprock South Classroom building. There is the ability to add more PV solar to this campus, especially with the addition of the Science Building currently under construction. Yearout Energy would work with NTUA and Diné College to figure out the proper solution to provide additional renewable energy to this campus.

Until the future of the Shiprock North campus is determined it does not make sense to add PV solar.

4.8.4 Building Envelope

This FIM has the possibility to be a great opportunity at both campuses since it is inexpensive and can save a significant amount of energy. With the North campus being as old as it is this FIM could make a considerable difference in the energy consumption and therefore energy spend. Yearout Energy recommends pursuing this building improvement measure at both the North and South campuses.

4.8.5 HE LV Transformers

Both campuses were surveyed during the IGA phase, and there were not any transformers on the South campus that could benefit from this measure. At the North campus there are seven transformers that make a good candidate for this upgrade. Yearout Energy recommends pursuing this measure at the North campus.

4.8.6 Water Conservation

There is the opportunity to upgrade the water fixtures at the North and South campuses for both water savings and pandemic preparedness. From our assessment of these campuses about 40% of the fixtures are a good candidate for upgrades. Yearout Energy would recommend similar upgrades that were proposed for the Tsaile campus.

4.9 Measures Evaluated but Not Recommended

4.9.1 UV Air Sterilization

Yearout Energy evaluated opportunities for UV air sterilization at all campuses but was dropped at the request of the Diné College due to cost and uncertainty around the overall benefit of the technology.

4.9.2 Voltage Optimization

This measure was considered at the Tsaile campus. However, it was found that the electrical system layout of campus was not conducive to this technology.

4.9.3 Utility Management

Sub-metering of on the Tsaile campus was evaluated to measure and track the energy performance of each building more accurately. This measure was dropped due to the substantial up-front and ongoing costs required to implement and maintain.

4.10 General Clarifications and Exclusions

4.10.1 General Clarifications

1. Yearout Energy shall provide the necessary scheduling and coordination of its own forces and of subcontractors sufficient to operate the orderly and efficient completion of Yearout Energy's work without delay, interference, or interruption. Yearout Energy will make all efforts to meet schedules agreed to in advance. Yearout Energy's work shall be performed during five-day, forty-hour work weeks. If extended hours are required due to circumstances beyond the control of Yearout Energy, Yearout Energy shall be compensated for additional overhead, premium time costs, and lost productivity. Yearout Energy will substantiate circumstances beyond control in writing to Diné College prior to incurring any additional costs for overhead, premium time, and lost productivity.

2. The project will be invoiced monthly, projecting the work through the end of the month. Invoices will include pay requests and schedule of values. Our proposal may involve a significant amount of off-site prefabrication. Yearout Energy anticipates invoicing for materials stored and work performed off-site at our fabrication facility.

3. Payment and performance bond are included.

4. Assumes reasonable access to the work areas.

5. Upgrades and modifications are to match existing material types in like-kind unless specifically noted otherwise in the scope of work.

6. Diné College should anticipate limited planned outages and service interruptions as necessary to complete the scope of work. Yearout Energy will work diligently with Diné College to determine the best plan for work.

7. Assumes that existing building electrical service and infrastructure is adequate to power new equipment.

8. We anticipate temporary power for tools and welding equipment will be available within 75' of work areas.

9. Our proposal anticipates operating under the guidelines of Yearout Energy's Safety Program. We reserve the right to review requirements of any other safety program that will be in force on the project to determine if additional costs will apply.

10. We anticipate parking for craft and supervisory personnel will be on the job site. Any necessary permits will be issued by Diné College for craft personnel. Transportation of our employees from an off-site location is not included.

11. Assumes adequate lay-down areas and storage facilities will be available to facilitate the execution of our work.

12. Yearout Energy has included separate trash dumpster for disposal of construction waste.

13. Permits and inspections by the AHJ are included.

4.10.2 General Exclusions

1. Removal of any hazardous materials. Should any hazardous materials be encountered, we will immediately notify Diné College to determine a mutually agreeable course of action. We reserve the right to be compensated for cost related to the discovery of any hazardous material above the allowance amount included in the asbestos removal included in FIM 7. No work will be performed in areas containing hazardous materials.
2. Provisions for seismic calculations
3. The requirement to provide additional insured status on the employer's worker's compensation insurance.
4. Repair or correction of pre-existing code violations.
5. Temporary heating and cooling.
6. Existing ductwork cleaning or sealing.

5.0 MEASUREMENT AND VERIFICATION (M&V)

M&V is the process of planning, measuring, collecting, and analyzing data for the purpose of verifying and reporting energy savings resulting from the implementation of conservation measures. The primary objectives for M&V include:

- Identify and allocate risks between project stakeholders
- Accurately assess savings and persistence of savings for a project
- Reduce uncertainties to reasonable levels
- Aid in monitoring equipment performance
- Identify additional savings opportunities
- Improve operations and maintenance (O&M)

An accurate and thoughtfully planned Measurement and Verification(M&V) approach is essential to a successful project outcome. Yearout Energy's dedicated M&V team follow DOE FEMP M&V Guidelines and the International Performance and Measurement Verification Protocol (IPMVP) which establishes the framework for evaluating energy efficiency and savings-based projects. The IPMVP is published and maintained by the Efficiency Valuation Organization (EVO), which is the only non-profit organization in the world solely dedicated to creating M&V tools.

M&V Methodologies have been carefully chosen to ensure project risks and responsibilities are properly allocated between Yearout Energy and the Owner. The preliminary M&V plan has been developed in accordance with the following six principles of M&V:

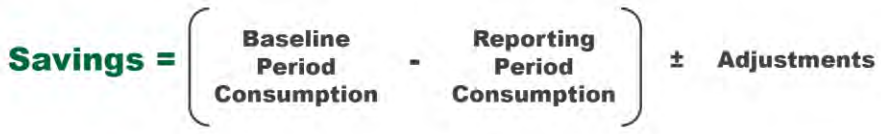
- Accurate: M&V reports should be as accurate as the M&V budget will allow.
- Complete: Reporting of savings should consider all effects of a project. M&V activities should use measurements to quantify the significant effects, while estimating all others.
- Conservative: Where judgements are made about uncertain quantities, M&V procedures should be designed to under-estimate savings.
- Consistent: The reporting of a project's energy effectiveness should be consistent.
- Relevant: The determination of savings should measure the performance parameters of concern, or least well known, while other less critical or predictable parameters may be estimated.
- Transparent: All M&V activities should be clearly and fully disclosed.

IPMVP outlines four options for selection of M&V approach. The most appropriate option is selected based on the measure type, complexity, interaction with other measures, and magnitude of savings.

- Option A: Retrofit Isolation – Key Parameter Measurement
- Option B: Retrofit Isolation – All Parameter Measurement
- Option C: Whole Facility – Measurement
- Option D: Whole Facility – Calibrated Simulation

Actual savings cannot be directly measured since they represent the absence of consumption. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions.

The general M&V equation is as follows:



Adjustments to the baseline or estimated savings may be necessary when significant changes to governing factors occurs. Baseline adjustments come in two forms:

- Routine Adjustments (Governing factors that are expected to change routinely during the reporting period)
  - Weather
- Non-Routine Adjustments (Governing factors that are not usually expected to change during the reporting period)
  - Change in Facility Size
  - Change is Facility Type
  - Change in Design or Operation of Equipment
  - Change in Number of Occupants

Following the installation and commissioning of the project scope, Yearout Energy shall execute the post-construction Measurement and Verification plan to confirm the expected guaranteed savings are achievable based on as-built conditions. As with all construction projects, unforeseen conditions may lead to a change in the scope of work. Yearout Energy will address these conditions as they arise and will ensure that the final scope of work will meet or exceed the guaranteed savings proposed. Yearout Energy shall author, distributes and reviews the findings of this report with the Owner for complete transparency.

The project is then transitioned into the performance assurance phase, where Yearout Energy shall perform the co-developed annual M&V plan outlined herein for ongoing validation of guaranteed savings.

5.1 M&V Reporting

Yearout Energy will prepare an annual M&V Report which will detail the following items for the reporting period:

- Date and time of site visits
- Areas assessed with a summary of findings
- Evaluation of system and overall performance
- Changes to facility operation along with identified impacts to the guarantee
- Verified utility consumption and cost savings
- Comparison of verified versus guaranteed savings
- Description of any required adjustments to the baseline or guaranteed savings
- Description of any shortfalls in guaranteed savings and plan for reimbursement

Yearout Energy will require ongoing access to all utility information throughout the duration of the performance period. This information will be tracked monthly and summarized in the annual M&V Report.

5.2 M&V Option per FIM

The proposed M&V option per FIM is depicted in the following table.

Table 61: M&V Option per FIM

FIM No.	FIM Name	M&V Option
1	LED Lighting	Option A – Retrofit Isolation
2	Renewable Energy	Option B – Multiple Parameter Measurement
3	HVAC System Upgrades	Option A – Retrofit Isolation
4	Building Envelope	Option A – Retrofit Isolation
5	HE LV Transformers	Option A – Retrofit Isolation
6	Water Conservation	Option A – Retrofit Isolation
7	Hazardous Material Testing and Abatement Allowance	Non-Measured

5.3 Annual M&V Fee

The Year-1 M&V Fee is $41,281 The M&V Fee will escalate at a rate of 3.000% annually for the duration of the project as depicted in the table below. Diné College is responsible for payment of the annual M&V Fee, as these ongoing costs are considered annual fees, and cannot be financed up front.

Table 62: Annual M&V Fee

Year	M&V Fee	Year	M&V Fee
1	$41,281	11	$55,478
2	$42,519	12	$57,143
3	$43,795	13	$58,857
4	$45,109	14	$60,623
5	$46,462	15	$62,441
6	$47,856	16	$64,314
7	$49,292		
8	$50,770		
9	$52,294		
10	$53,862		

5.4 Preliminary M&V Plan

Table 63: Preliminary M&V Plan

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
1.00 LED Lighting	Tsaile Day Care Tsaile Maintenance Tsaile Silversmith Tsaile Student Success Center Tsaile Archival Center Tsaile Cafeteria Tsaile Guy Gorman Classroom Building Tsaile Gym Tsaile Library Tsaile Ned Hatathli Center Tsaile Network Operating Center Tsaile Head Start Tsaile Post Office Tsaile Dorms Tsaile Student Union Tsaile Student Family Housing Tsaile Central Hogan Tsaile Faculty Office Building 1 Tsaile Faculty Office Building 2 Tsaile Faculty Office Building 3 Tsaile Land Grant Modular Building	A	90%	1	Fixture Input Power	Refer to Appendix TBD (Room-by-Room)	Refer to Appendix TBD (Room-by-Room)	1. Detailed lighting survey 2. Reviewed as built and Mfr documentation 3. Pre-retrofit testing on a sample of fixtures.	1. Review and update as-built documentation based on final commissioned and verified equipment installed 2. Revise calculations based on as-built conditions. 3. Post-retrofit testing on a sample of fixtures.	1. Perform visual inspection of approximately 10% of the installed lighting equipment to validate proper operation	1. Maintain equipment per Mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to equipment or operation 3. Replacement equipment shall meet or exceed proposed equipment performance	1. Input power per Mfr data and original construction drawings and specifications.
				2	Fixture Quantities	Refer to Appendix TBD (Room-by-Room)	Refer to Appendix TBD (Room-by-Room)	1. Detailed lighting survey	1. Review as-built documentation based on final commissioned and verified equipment installed 2. Revise calculations based on as-built conditions	None	1. Immediately notify Yearout Energy of any changes to fixture quantities	None
				3	Burn Hours	Refer to Appendix TBD (Room-by-Room)	Refer to Appendix TBD (Room-by-Room)	1. Detailed lighting survey 2. Owner interviews 3. Applied industry standards / best practices 4. Occupancy/lighting logging	None	None	1. Immediately notify Yearout Energy of any changes to facility operation	1. Baseline and Proposed Burn Hours

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
2.00 Renewable Energy	Tsaile Campus	B	90%	1	Production	Refer to FIM Savings Methodology in IGA Report	Refer to FIM Savings Methodology in IGA Report	1. Review baseline utility information and electric rate structure 2. Site survey to confirm array orientation, available space and means of interconnection	1. Review as-built documentation to validate installed equipment meets minimum performance criteria.	1. Continuously review system production via remote monitoring to ensure proper operation.	1. Refrain from introducing any obstructions that would shade the PV system and negatively impact system performance 2. Maintain equipment free of debris 3. Maintain equipment per manufacturer's and Yearout Energy's recommendations 4. Immediately notify Yearout Energy of any changes made to equipment operation 5. Any replacement equipment shall meet or exceed the proposed performance criteria. 6. Provide Yearout Energy remote access for monitoring PV system operation	1. Weather / Solar Insolation 2. Solar Access / Shading 3. Proposed equipment efficiencies per Mfr's data. 4. Utility Net Metering Program 5. Utility Avoided Cost Rates
3.00 HVAC Equipment and Controls	Tsaile Cafeteria Tsaile Gym Tsaile Library Tsaile Ned Hatathli Center Tsaile Dorms Tsaile Student Union	A	90%	1	Schedules	Constant Air Volume	Refer to FIM Savings Methodology in IGA Report	1. Site survey 2. Owner Interviews 3. Data Logging / Trending	1. Review controls programming to validate schedules are properly established.	1. Trend a sample of spaces for a period of 2 weeks to verify proper operation.	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Replacement equipment shall meet or exceed proposed	1. Weather 2. Internal & External Loads 3. Operating Schedules 4. Set Points 5. Population

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
											equipment performance. 4. Provide Yearout Energy remote access for monitoring equipment operation.	
				2	Zone Temperature Set Points	Refer to FIM Savings Methodology in IGA Report	Refer to FIM Savings Methodology in IGA Report	1. Site survey 2. Owner Interviews 3. Data Logging / Trending	1. Review controls programming to validate set points are properly established.	None	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Replacement equipment shall meet or exceed proposed equipment performance. 4. Provide Yearout Energy remote access for monitoring equipment operation.	1. Weather 2. Internal & External Loads 3. Operating Schedules 4. Set Points 5. Population

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
				3	Heating Efficiency	EXISTING EQUIPMENT AND EFFICIENCY	NEW EQUIPMENT AND EFFICIENCY	1. Site survey 2. Review As-Built Drawings 3. Review equipment nameplate information	1. Review as-built documentation to validate installed equipment meets minimum performance criteria.	1. Visually inspect equipment condition.	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Replacement equipment shall meet or exceed proposed equipment performance. 4. Provide Yearout Energy remote access for monitoring equipment operation.	1. Weather 2. Internal & External Loads 3. Operating Schedules 4. Set Points 5. Population 6. Baseline Equipment Heating Efficiencies
				4	Cooling Efficiency	EXISTING EQUIPMENT AND EFFICIENCY	NEW EQUIPMENT AND EFFICIENCY	1. Site survey 2. Review As-Built Drawings 3. Review equipment nameplate information	1. Review as-built documentation to validate installed equipment meets minimum performance criteria	1. Visually inspect equipment condition	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Replacement equipment shall meet or exceed proposed equipment performance. 4. Provide Yearout Energy remote access for monitoring equipment operation.	1. Weather 2. Internal & External Loads 3. Operating Schedules 4. Set Points 5. Population 6. Baseline Equipment Heating Efficiencies

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
				5	Supply Air Fan Operation	Constant Air Volume	3-Stage Variable Air Volume	1. Site survey 2. Review As-Built Drawings 3. Review equipment nameplate information	1. Review controls programming to validate proper operation in AUTO setting.	1. Trend fan speed for a sample of units for a period of 2 weeks to verify proper operation.	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Replacement equipment shall meet or exceed proposed equipment performance. 4. Provide Yearout Energy remote access for monitoring equipment operation.	1. Weather 2. Internal & External Loads 3. Operating Schedules 4. Set Points 5. Population 6. Baseline Cooling Equipment Efficiencies
				6	Minimum Outside Air	BASED ON EXISTING EQUIPMENT AND CONTROLS PROGRAMMING	BASED ON NEW EQUIPMENT AND PROGRAMMING	1. Site survey 2. Review As-Built Drawings 3. Review equipment nameplate information 4. Review Controls Program	1. Verify Outside Air with Controls Program 2. If No Controls, Field Verification with Data-Logging	1. Verify Outside Air with Controls Program 2. If No Controls, Field Verification with Data-Logging	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Replacement equipment shall meet or exceed proposed equipment performance. 4. Provide Yearout Energy remote access for monitoring equipment operation.	1. Weather 2. Internal & External Loads 3. Operating Schedules 4. Set Points 5. Population

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
4.00 Building Envelope	Tsaile Day Care Tsaile Maintenance Tsaile Silversmith Tsaile Student Success Center Tsaile Archival Center Tsaile Cafeteria Tsaile Guy Gorman Classroom Building Tsaile Gym Tsaile Library Tsaile Ned Hatathli Center Tsaile Network Operating Center Tsaile Head Start Tsaile Post Office Tsaile Dorms Tsaile Student Union Tsaile Student Family Housing Tsaile Central Hogan Tsaile Faculty Office Building 1 Tsaile Faculty Office Building 2 Tsaile Faculty Office Building 3 Tsaile Land Grant Modular Building	A	90%	1	Leakage Area	Refer to FIM Savings Methodology in IGA Report	Refer to FIM Savings Methodology in IGA Report	1. Detailed site survey to identify existing leakage area	1. Review as-built documentation to validate materials installed and leakage area addressed meet minimum performance criteria. 2. Visually inspect a sample of areas in post implementation to validate materials installed are performing as intended.	1. Visually inspect a sample of areas in post implementation and in Year 2 to validate materials installed are performing as intended.	1. Maintain materials per mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to materials. 3. Any replacement materials shall meet or exceed the proposed performance criteria.	1. Weather 2. Heating and Cooling Equipment Efficiencies 3. Operating Schedules
5.00 High Efficiency Transformers	Tsaile Student Success Center Tsaile Cafeteria Tsaile Guy Gorman Classroom Building Tsaile Gym Tsaile Ned Hatathli Center Tsaile Network Operating Center Tsaile Student Union Tsaile Student Family	A	90%	1	Transformer Losses	Refer to FIM Savings Methodology in IGA Report	Refer to FIM Savings Methodology in IGA Report	1. Site survey of existing equipment 2. Applied industry standards / best practices"	1. ISO 17025 Certified Test Lab measurements of replacement transformers to validate performance.	None	1. Maintain equipment per Mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to equipment or operation 3. Replacement equipment shall meet or	1. Equipment Operating Hours 2. Equipment Percent Loads 3. Heating and Cooling System Efficiencies

FIM	Facility	IPMVP Option	Guarantee Factor	KPI No.	Key Performance Indicator	Baseline Value	Proposed Value	Baseline Audit Task	Post-Retrofit M&V Task	Annual M&V Task	Ongoing Owner Responsibilities	Stipulated Factors
	Housing										exceed proposed equipment performance criteria. 4. Provide Yearout Energy remote access for monitoring equipment operation.	
6.00 Water Conservation	Tsaile Day Care Tsaile Maintenance Tsaile Silversmith Tsaile Student Success Center Tsaile Archival Center Tsaile Cafeteria Tsaile Guy Gorman Classroom Building Tsaile Gym Tsaile Library Tsaile Ned Hatathli Center Tsaile Network Operating Center Tsaile Head Start Tsaile Post Office Tsaile Dorms Tsaile Student Union Tsaile Student Family Housing Tsaile Central Hogan Tsaile Faculty Office Building 1 Tsaile Faculty Office Building 2 Tsaile Faculty Office Building 3 Tsaile Land Grant Modular Building	A	90%	1	Fixture Utilization	Refer to FIM Savings Methodology in IGA Report	Refer to FIM Savings Methodology in IGA Report	1. Occupancy information provided by owner 2. Site survey of fixture types and quantities	None	None	1. Immediately notify Yearout Energy of any major changes to buildings' occupancy or operation.	1. Occupancy / Enrollment 2. Building Operation Schedule
				2	Volume Flow Rate / Flush Volume	Refer to FIM Savings Methodology in IGA Report	Refer to FIM Savings Methodology in IGA Report	1. Pre-retrofit testing on a sample of fixtures with a calibrated water measuring device to validate proper operation	1. Post-retrofit testing on a sample of fixtures with a calibrated water measuring device to validate proper operation 2. Revise calculations based on as-built conditions	1. Visually inspect a sample of fixtures in Year 1 only to validate proper operation	1. Maintain equipment per Mfr's and Yearout Energy's recommendations 2. Immediately notify Yearout Energy of any changes made to equipment or operation 3. Replacement equipment shall meet or exceed proposed equipment performance	1. DHW Temperature 2. Percent hot water 3. Water Pressure

6.0 ECONOMIC ANALYSIS

6.1 Guaranteed Annual Utility Savings

The following table depicts the Year 1 guaranteed utility consumption savings per FIM. The savings presented in this report are guaranteed each year for the duration of the project term.

Table 64: Year 1 Guaranteed Utility Consumption Savings per FIM

FIM No.	FIM Name	Electricity		Propane	Water
		kW	kWh	gal	kgal
1.00	LED Lighting	1,455	351,133	(750)	0
2.00	Renewable Energy	0	1,552,510	0	0
3.00	HVAC System Upgrades	(3,083)	(341,083)	30,943	0
4.00	Building Envelope	0	33,072	18,354	0
5.00	HE LV Transformers	165	120,334	0	0
6.00	Water Conservation	0	1,609	1,957	760
7.00	Hazardous Material Testing and Abatement Allowance	0	0	0	0
Total		(1,463)	1,717,576	50,503	760

A FIM specific guarantee factor (GF) is applied to the estimated savings to determine the guaranteed savings for each FIM. The guarantee factors can be found in Sections 4 and 5 herein. The applied guarantee factor is dependent on the FIM type, a methodology for calculating savings, understanding of the facility, experience implementing similar measures, and the level of risk acceptable to meet Diné College's financial objectives for the project.

Where the estimated savings are positive, the guarantee factor is applied as follows:

*[Guaranteed Savings = Estimated Savings * Guarantee Factor]*

Where the Estimated Savings are a negative value, the Guarantee Factor is applied as follows:

*[Guaranteed Savings = Estimated Savings * (1 + (1 – Guarantee Factor))]*

The following table depicts the Year 1 utility cost savings per FIM.

Table 65: Year 1 Utility Cost Savings per FIM

FIM No.	FIM Name	Electricity	Propane	Water	All Utilities
		$	$	$	$
1.00	LED Lighting	$51,480	($705)	$0	$52,762
2.00	Renewable Energy	$200,337	$0	$0	$200,337
3.00	HVAC System Upgrades	($57,086)	$30,366	$0	($26,720)
4.00	Building Envelope	$4,268	$18,012	$0	$22,501
5.00	HE LV Transformers	$16,227	$0	$0	$16,227
6.00	Water Conservation	$208	$1,920	$7,968	$10,096
7.00	Hazardous Material Testing and Abatement Allowance	$0	$0	$0	$0
Total		$215,433	$50,503	$7,968	$272,995

6.2 Operations & Maintenance (O&M) Savings

Historic operations and maintenance (O&M) costs were not available for evaluation during the IGA. Therefore, Yearout Energy has applied a conservative O&M savings estimate for applicable measures which equate to roughly 5% of total annual savings. To determine the average annual O&M savings, the identified reduction to baseline O&M expenditures was multiplied by the ratio of the service life of each specific FIM over the finance term. If the service life exceeds the finance term, the ratio is fixed at 1.

*[Average Annual O&M Savings = Est. Annual O&M Savings * (FIM Service Life / Finance Term)]*

Based on this analysis, the Year 1 O&M saving established for this project is depicted in the table below.

Table 66: Year 1 Operations & Maintenance (O&M) Savings

FIM No.	FIM Name	Avg Service Life	Annual Utility Savings	Average Annual O&M Savings	% Of Annual Utility Savings
1.00	LED Lighting	15.0 Years	$50,775	$7,140	14.06%
2.00	Renewable Energy	30.0 Years	$200,337	$0	0.00%
3.00	HVAC System Upgrades	20.0 Years	($26,720)	$0	0.00%
4.00	Building Envelope	20.0 Years	$22,280	$3,342	15.00%
5.00	HE LV Transformers	32.0 Years	$16,227	$2,434	15.00%
6.00	Water Conservation	20.0 Years	$10,096	$1,514	15.00%
7.00	Hazardous Material Testing and Abatement Allowance	N/A	$0	$0	0.00%
Total	----------	20.3 Years	$272,995	$14,431	5.36%

6.3 Capital Contribution by Dine College

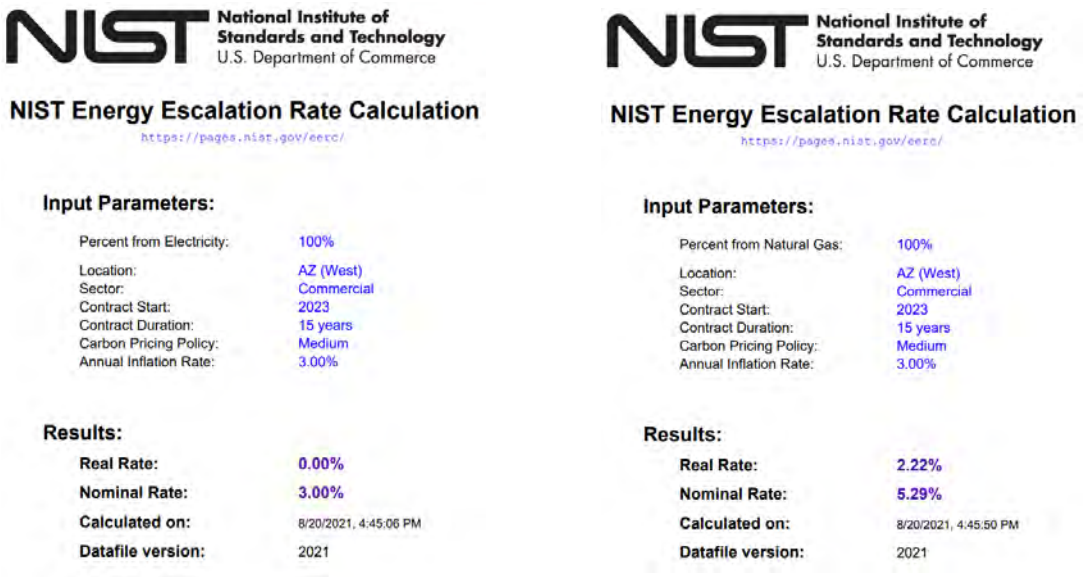
Diné College is drawing from multiple available funding sources to apply an upfront capital contribution of $16,000,000 towards this project. This contribution is a mix of internal funding and grants from the federal, state, and Navajo Nation.

6.4 Estimated Incentives | Rebates

There are no anticipated rebates from the utility providers for this project. Yearout Energy will continue to explore the opportunity for utility rebates during the project implementation phase.

6.5 Escalation Rates

The proposed utility escalation rates were determined using the Energy Escalation Rate Calculator (EERC), a tool developed by the National Institute for Standards and Technology (NIST), which computes an average rate of escalation for a specified period, which can be used as an escalation rate for contract payments in Guaranteed Energy Savings Performance Contracts (EPC). The calculator prompts the user for information on project location, fuel usage, industry sector, and the beginning and end dates of the performance period. A description of these inputs is provided below.



NIST National Institute of Standards and Technology U.S. Department of Commerce

NIST Energy Escalation Rate Calculation

https://pages.nist.gov/eerc/

Input Parameters:

Percent from Electricity:	100%
Location:	AZ (West)
Sector:	Commercial
Contract Start:	2023
Contract Duration:	15 years
Carbon Pricing Policy:	Medium
Annual Inflation Rate:	3.00%

Results:

Real Rate:	**0.00%**
Nominal Rate:	**3.00%**
Calculated on:	8/20/2021, 4:45:06 PM
Datafile version:	2021

NIST National Institute of Standards and Technology U.S. Department of Commerce

NIST Energy Escalation Rate Calculation

https://pages.nist.gov/eerc/

Input Parameters:

Percent from Natural Gas:	100%
Location:	AZ (West)
Sector:	Commercial
Contract Start:	2023
Contract Duration:	15 years
Carbon Pricing Policy:	Medium
Annual Inflation Rate:	3.00%

Results:

Real Rate:	**2.22%**
Nominal Rate:	**5.29%**
Calculated on:	8/20/2021, 4:45:50 PM
Datafile version:	2021

Figure 142: Energy Escalation Rate Calculators

The results of this EERC analysis generated a nominal annual escalation rate of 3.00% for electricity and 5.29% for natural gas/propane. The annual escalation rates applied to this project are 3.00% for electricity and 5.00% for propane as depicted in the preliminary project financial analysis herein.

Percent of Energy Cost Savings: Percentage of energy cost savings in dollars that is attributable to one or more of the fuel types used in the project. This input is used to weight the escalation rate.

Location: Selection of the state in which the project is located allows the program to select the energy price escalation rates for the corresponding Census Region.

Sector: Selection of commercial or industrial sector determines the type of utility rate schedule applied to the energy cost calculation.

Performance Period Start Date: Date when energy savings start to accrue, which is usually after project acceptance at the beginning of the performance period.

Performance Period Duration: Number of years of the performance period for which the average escalation rate will be calculated.

Carbon Pricing Policy: Medium Carbon Price. Assumes the most recent climate change bill (American Clean Energy and Security Act of 2009: H.R. 2454) is enacted as is with no restrictions on offsets or generating capacity installation. Assumes that all states decrease electricity emissions at the national average rate for this policy option

Inflation Rate: The sustained increase in the general price level of goods and services in an economy over a period.

Real and Nominal Escalation Rates: The output of the program is the calculated average escalation rate, stated both in real terms (excluding the rate of inflation) and in nominal terms (including the rate of inflation).

The following annual escalation rates have been factored into the project's economic analysis.

Table 67: Annual Escalation Rates

Category	Escalation Rate
Electricity	3.000% / Year
Propane	5.000% / Year
Water & Sewer	3.000% / Year
Operations & Maintenance	3.000% / Year

6.6 EPC Project Budget Summary

The table below depicts the proposed EPC Project open-book budget summary.

Table 68: EPC Project Budget Summary

Investment Grade Audit (IGA)	Area	$/SF	$
Investment Grade Audit (IGA) Cost	606,500 SF	$0.100/SF	$60,650
		IGA Subtotal	$60,650
Implementation Cost			$
Pre-Construction Costs			
Design and Other Engineering			$929,916
Pre-Construction Services			$446,027
Other Pre-Construction Costs			$292,010
		Pre-Construction Subtotal	$1,667,953.00
Construction Costs			
Subcontracted Labor, Equipment & Materials			$11,511,508
Construction Management			$963,450
Project Engineering			$313,368
General Conditions			$321,111
Construction Completion			$820,458
Other Construction Costs			$797,870
		Construction Subtotal	$14,727,765
		Implementation Subtotal	$16,395,719
Profit | Contingency			$
Profit			$1,645,637
Contingency			$658,255
		Profit | Contingency Subtotal	$2,303,892
Total Funded Amount (Before Taxes and Review Fees)			$18,760,261
Other Project Cost			$
3rd Party Reviewer Fee			$12,950
Navajo Nation Sales Tax		6.00%	$1,126,393
		Other Project Cost Subtotal	$1,139,343
Total Funded Amount			$19,899,603

The following table provides a description of each cost category from the Budget Summary above:

Table 69: Description of Project Cost Categories

Investment Grade Audit	Description
Investment Grade Audit Fee	The IGA fee is based on the number of facilities and gross square footage included in the project.
Pre-Construction Costs	**Description**
Design and Other Engineering	All professional architectural and engineering costs required to design and specify the project scope of work, including engineering design, architectural design, additional energy engineering not included in IGA, engineering oversight and direction, code review.
Pre-Construction Services	Activities required prior to commencing construction, including safety planning, additional bid solicitation, design review, submittal review, construction management planning, constructability reviews, coordination of utility incentives, scheduling, procurement planning and other direct costs associated with presenting the best information to the Owner.
Other Pre-Construction Costs	Site visits and Owner meetings are necessary before construction to ensure designs and equipment meet customer needs and align with project objectives. Other Pre-construction Costs may include but are not limited to administrative support, legal review, accounting services, printing, copying, binding, office supplies, business travel, business meals and supervision of project development staff.
Construction Fees	**Description**
Subcontracted Labor, Equipment & Materials	All subcontracted labor, equipment, and materials necessary to complete the project scope of work.
Construction Management	Oversight and coordination of all work (direct and subcontractors) including construction management, site supervision, safety, quality control, scheduling, budget management, contract administration, submittals, and other construction-related items).
Project Engineering	Engineering & design support during the project implementation phase. Periodic inspections of work and supporting the construction manager with an engineering analysis of required field modifications.

General Conditions	Miscellaneous project implementation costs, including job trailer, trailer office equipment, temporary utilities, permanent utility connection fees, barriers/security fencing, scaffolding, equipment rental, site guards, cleaning and trash and recycling dumpsters, lifts, and other direct project costs.

Construction Completion	Description
Commissioning	At the completion of the construction, Yearout Energy shall perform pre-functional and post-functional tests of all installed measures to ensure proper operation. This intensive quality assurance process ensures all systems and components installed as part of the EPC project are operating as intended to achieve the desired performance and guaranteed savings.
Construction Measurement & Verification (M&V)	At the completion of construction, Yearout Energy shall perform the measurement and verification (M&V) of installed equipment to verify post-retrofit energy efficiency and operation. These activities include; establishing trends and deploying long-term data loggers, reviewing as-built documentation, and updating savings calculations, accordingly, performing post-installation M&V activities defined in performance assurance plan, generating and delivering the post-installation M&V report, and other M&V activities. This effort is necessary to ensure systems will meet the guaranteed energy savings and commence the performance assurance phase.
O&M Manuals	At the completion of construction, Yearout Energy shall provide complete Operation and Maintenance (O&M) Manuals to the Owner for reference.
Training	The process of ensuring that facility staff have been properly trained to operate and maintain the new systems and components installed as part of the EPC project.

Other Construction Costs	Description
Permits	Construction is performed in various jurisdictions requiring compliance with jurisdictional codes. Yearout Energy must pay each jurisdiction to review design drawings and render decisions on designs meeting code. In addition, Yearout Energy must apply for and receive any necessary construction permits based on designs and/or code review. This line item includes all costs associated with paying code reviewers, application fees and inspections fees for such permits.
Insurance	Yearout Energy is required to possess various levels of Builder's Risk Insurance, Automobile Liability Insurance, Professional Liability Insurance, and other General Liability Umbrella policies. This line item shall include an average amount of insurance that would be attributed to the project scope of work.
Performance & Payment Bonds	A surety bond issued to guarantee satisfactory completion of the project delivered by Yearout Energy to the Owner. The P&P Bond cost ranges from 0.8% to 1.2% based on the total project amount and construction period duration. A premium is often applied if the construction period extends beyond 24 months.
Warranty Labor	The costs associated with supporting and coordinating equipment warranties during the first year following substantial completion.

Profit | Contingency	Description
Profit	The compensation to Yearout Energy for the assumption of the risk and delivery of the EPC Project.
Contingency	A special monetary provision used to cover uncertainties or unforeseeable elements of cost during project implementation. Any unused contingency will be applied towards additional scope as approved by the Owner.

Annual Costs	Description
Measurement & Verification (M&V)	The process for quantifying the savings delivered by the various measures included in the EPC project following IPMVP guidelines. Actual costs for this item are highly dependent upon the final measures installed and M&V options selected.
Maintenance	This is an optional item that is at the Owner's discretion to include. The inclusion of this item is encouraged for Owners that do not have the in-house capabilities to maintain the equipment after installation.

6.7 FIM Summary

The determination of appropriate FIM's for implementation is the result of an iterative process with input from Diné College, engineering best practices, and an economic analysis. Infrastructure capital improvement measures are not driven simply by utility savings or return on investment, but rather by the necessity to keep the facility operational and occupants comfortable. This project includes both capital improvement and energy conservation type measures which are blended into a bundled solution that achieves Diné College's operational and financial objectives.

Table 70: Recommended FIMs Summary

FIM No.	FIM Name	Year 1 Annual Utility Savings	Year 1 Annual O&M Savings	Year 1 Total Annual Savings	Labor, Equip & Material Costs	Net Cost
1.00	LED Lighting	$50,775	$7,140	$57,915	$698,458	**$698,458**
2.00	Renewable Energy	$200,337	$0	$200,337	$2,378,419	**$2,378,419**
3.00	HVAC System Upgrades	($26,720)	$0	($26,720)	$6,749,342	**$6,749,342**
4.00	Building Envelope	$22,280	$3,342	$25,622	$151,144	**$151,144**
5.00	HE LV Transformers	$16,227	$2,434	$18,661	$198,200	**$198,200**
6.00	Water Conservation	$10,096	$1,514	$11,610	$354,182	**$354,182**
7.00	Hazardous Material Testing and Abatement Allowance	$0	$0	$0	$981,763	**$981,763**
Total		$272,995	$14,431	$287,425	$11,511,508	$11,511,508
Investment Grade Audit						$60,650
Pre-Construction Cost						$1,667,954
Construction Cost (Includes FIM Labor, Equipment and Materials Cost)						$14,727,765
Profit						$1,645,637
Contingency						$658,255
Total Funded Amount (Before Taxes and Review Fees)						$18,760,261
3rd Party Reviewer Fee						$12,950
Navajo Nation Sales Tax						$1,126,393
Total Funded Amount						$19,899,603

6.8 Preliminary Project Financial Analysis

General Inputs	
Length of Analysis	20 Years
Turn-Key Project Cost	$19,899,603
Up-Front Capital Contribution | Grants	$16,000,000
Other Incentives	$0
Utility Rebate	$0
Capitalized Interest	$155,984
Cost of Issuance	$81,112
Net Financed Amount	$4,136,699
Type of Amortization	Savings
Finance Term	16 Years
Annual Interest Rate	3.000%
Measurement & Verification	
Year 1 M&V Fee	$41,281
M&V Duration	3 Years
Annual Maintenance	
Year 1 Maintenance Fee	$12,000
On-Going Maintenance Duration	20 Years

	Annual Savings			Annual Costs				Amortization Schedule				
Annual Escalation ->	Electricity	Natural Gas	Water & Sewer	O&M	M&V	Solar O&M	Total Annual Savings Less Costs	Interest	Principal	Total Payment	Ending Balance	Annual Cash Flow
	3.000%	5.000%	3.000%	3.000%	3.000%	3.000%						
Year 1	$215,433	$49,593	$7,968	$14,431	($41,281)	($12,000)	$234,144	($124,101)	($110,043)	($234,143)	$4,026,656	$1
Year 2	$221,896	$52,073	$8,207	$14,864	($42,520)	($12,360)	$242,160	($120,800)	($121,361)	($242,159)	$3,905,295	$1
Year 3	$228,553	$54,676	$8,453	$15,309	($43,795)	($12,731)	$250,467	($117,159)	($133,308)	($250,466)	$3,771,988	$1
Year 4	$235,410	$57,410	$8,707	$15,769	$0	($13,113)	$304,183	($113,160)	($191,024)	($304,182)	$3,580,964	$1
Year 5	$242,472	$60,281	$8,968	$16,242	$0	($13,506)	$314,457	($107,429)	($207,028)	($314,456)	$3,373,936	$1
Year 6	$249,746	$63,295	$9,237	$16,729	$0	($13,911)	$325,096	($101,218)	($223,878)	($325,095)	$3,150,058	$1
Year 7	$257,239	$66,459	$9,514	$17,231	$0	($14,329)	$336,115	($94,502)	($241,613)	($336,114)	$2,908,445	$1
Year 8	$264,956	$69,782	$9,800	$17,748	$0	($14,758)	$347,528	($87,253)	($260,274)	($347,527)	$2,648,171	$1
Year 9	$272,905	$73,272	$10,094	$18,280	$0	($15,201)	$359,349	($79,445)	($279,904)	($359,348)	$2,368,267	$1
Year 10	$281,092	$76,935	$10,397	$18,829	$0	($15,657)	$371,595	($71,048)	($300,547)	($371,594)	$2,067,720	$1
Year 11	$289,525	$80,782	$10,709	$19,394	$0	($16,127)	$384,282	($62,032)	($322,250)	($384,281)	$1,745,470	$1
Year 12	$298,210	$84,821	$11,030	$19,975	$0	($16,611)	$397,426	($52,364)	($345,062)	($397,425)	$1,400,408	$1
Year 13	$307,157	$89,062	$11,361	$20,575	$0	($17,109)	$411,045	($42,012)	($369,033)	($411,044)	$1,031,376	$1
Year 14	$316,371	$93,515	$11,702	$21,192	$0	($17,622)	$425,157	($30,941)	($394,216)	($425,156)	$637,159	$1
Year 15	$325,862	$98,191	$12,053	$21,828	$0	($18,151)	$439,782	($19,115)	($420,668)	($439,781)	$216,492	$1
Year 16	$335,638	$103,100	$12,414	$22,482	$0	($18,696)	$454,940	($6,495)	($216,492)	($222,986)	$0	$231,954
Year 17	$345,707	$108,255	$12,787	$23,157	$0	($19,256)	$470,650	$0	$0	$0	$0	$470,650
Year 18	$356,079	$113,668	$13,170	$23,852	$0	($19,834)	$486,935	$0	$0	$0	$0	$486,935
Year 19	$366,761	$119,352	$13,565	$24,567	$0	($20,429)	$503,816	$0	$0	$0	$0	$503,816
Year 20	$377,764	$125,319	$13,972	$25,304	$0	($21,042)	$521,317	$0	$0	$0	$0	$521,317
Total	$5,788,777	$1,639,842	$214,109	$387,756	($127,596)	($322,444)	$7,580,443	($1,229,073)	($4,136,699)	($5,365,756)	---------	$2,214,687

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7.0 ENVIRONMENTAL IMPACT

As a result of implementing the recommended scope and conservation measures detailed in this report, Diné College will significantly reduce its direct energy and water consumption at the impacted project sites. Table 71 demonstrates the annual reduction in GHG emissions directly linked to these savings.

Table 71: GHG emissions reduction and equivalents

Utility Type	Annual Savings	lbs. CO_2	Metric Tonnes CO_2
Electricity	1,717,576 kWh	1,511,247	685.49
Propane	50,503 Gallon	631,286	286.35
Water	760 kgal	9,404	4.27
Total	----------	2,142,533	972

To better understand the annual reduction in emissions, Table 72 depicts a variety of equivalencies.

Table 72: Emissions Reduction and Equivalencies, Annual

187	Number of Vehicles Removed from Roads (Avg Size); or
1,264,094	Number of Miles Not Driven (Avg Size); or
26,782	Number of 75-Watt Light bulbs Not Energized; or
94	Number of Avg Sized Houses Removed from Power Grid; or
266	Acres of Trees Planted; or
1,001,184	Pounds of Coal Not Burned

8.0 OWNER AWARENESS

It is essential that the Diné College is fully informed and engaged in the EPC process to ensure a successful project outcome. The table below outlines the key elements from experience and the proposed project scope that the Diné College should carefully review and understand.

Table 73: Owner Awareness

The IGA Report should be distributed to all staff and other project stakeholders that may be responsible for implementing and/or maintaining key elements of the scope of work and associated utility and operational savings.
Owner has reviewed the proposed utility baselines detailed herein.
Owner has reviewed the proposed annual escalation rates detailed herein.
Owner has reviewed the existing operating hours, set points, sequences of operation, and other inputs outlined throughout this report used to establish the baseline operation of each facility are accurate.
Owner understands how the proposed scope of work may impact building occupants.
Owner acknowledges responsibility to properly maintain the equipment installed per the manufacturer's and Yearout Energy's recommendations.
Owner acknowledges responsibility for ongoing maintenance and commissioning of systems to ensure savings are sustained throughout the performance period.
Owner acknowledges that a full-building interruption to electrical service may be required at select facilities undergoing electrical service upgrades and/or solar interconnection.

Owner agrees to provide Yearout Energy with network connections were required to implement the proposed scope of work including at solar PV sites.

Owner has carefully reviewed the preliminary M&V Plan and understand the approach for how guaranteed savings will be evaluated.

Owner acknowledges that utility rebates are estimated, and the final awarded incentive amount is not guaranteed by Yearout Energy, as these programs are at the discretion of the utility company. All incentives will be paid directly to the Owner from the utility provider.

Owner acknowledges that the electric utility provider, NTUA, must review and approve all solar PV interconnection applications prior to Yearout Energy executing the proposed scope of work. The duration and result of this approval process from the utility provider may have an impact on the project schedule, scope, cost, and savings. Yearout Energy will coordinate any required changes with Diné College to amend the project scope and contract if necessary, following this pre-construction phase activity.

Owner acknowledges that additional tribal, state, and/or federal approvals may be required prior to the installation The duration and result of this approval process from the current landowners may have an impact on the project schedule, scope, cost, and savings. Yearout Energy will coordinate any required changed with Diné College to amend the project scope and contract where necessary following this pre-construction phase activity.

Owner acknowledges that pricing provided is based on conditions at time of document release and does not account for any additional tariffs or increases in material costs which may occur prior to implementation.

Owner agrees to provide Yearout Energy with the following items for the entire duration of the performance period:

- Grant remote access to all HVAC Controls and Building Automation Systems (BAS)
- Grant access to utility information directly from providers
- Grant access to utility provider web portals where available
- Copies of monthly utility bills (Provided to Yearout Energy electronically)
- Completed Maintenance Checklists (Provided to Yearout Energy electronically)

Owner agrees to immediately notify Yearout Energy of any of the following:

- Changes to the facility or individual space operating hours,
- Additions / Remodels to the facility,
- Changes to how individual spaces are utilized,
- Changes to facility equipment,
- Changes to set points, schedules, and sequence of operation,
- Issues with facility equipment; and
- All other items that may affect the energy performance of the facility.

Owner acknowledges responsibility for addressing any existing code violations discovered during the project implementation phase that are not specified within the project scope.

Owner acknowledges that an allowance for hazardous material testing and abatement has been established within the project scope as detailed in Section 4 – FIM 7 herein. Owner accepts responsibility for identifying and removing any hazardous material above the allotted allowance for this project within the affected areas prior to the installation of the project scope.

APPENDICES

A Facility Worksheet

B Utility Baseline

B1 Baseline Utility Analysis

- Detailed summary of consumption and cost data that establishes the baseline for each facility

B2 Utility Rate Analysis

B3 Tariffs

B4 Propane Data and Calculations

C Existing Equipment and Plug Loads

C1 HVAC and DHW Inventory

C2 Plug Load Inventory

D FIM 1:00 Lighting System

D1 Baseline and Proposed Room-by-room Lighting Inventory

Provides a detailed room-by-room description of pre-retrofit and post-retrofit lighting information, including location, fixture type, fixture quantity, burn hours, and electric demand and energy

D2 Preliminary Lighting Product Data

D3 Lighting Interaction with HVAC System Calculation

D4 ASHRAE Lighting and HVAC Interaction

D5 Standard Burn Hours

D6 Diversity Factors and Foot-candle Levels

E FIM 2.00 Renewable Energy

E1 Solar PVWatts Model Summary

E2 Array Rendering

E3 Solar PV Equipment Cut-sheets

F FIM 3.00 HVAC System Upgrades

F1 Cafeteria HVAC Savings Calculations

F2 Dorms HVAC Savings Calculations

F3 Gym HVAC Savings Calculations

F4 Library HVAC Savings Calculations

F5 SUB HVAC Savings Calculations

F6 HVAC Equipment Cut-sheets Basis for Design

G FIM 4.00 Building Envelope

G1 Building Envelope Assessment

H FIM 5.00 High Efficiency Transformers

H1 Transformer Information and Energy Savings Calculation

H2 Proposed Transformer Product Data

I FIM 6.00 Water Conservation

I1 Water Savings Calculations

I2 Water Fixture Cut-sheets

I3 Ice Machine Calculations

J 3rd Party Review Comments

J1 3rd-party Reviewer Comments

J2 Comments Tracking Log

- Summary of all comments received and tracking log of comment closure

K Bi-weekly Progress Reports, Presentations, and Meeting Minutes

K1 Bi-weekly IGA Progress Reports/ Meetings

- Bi-weekly reports submitted to Diné College documenting recent progress, updates, two-week lookaheads, and help needed over the course of IGA development

K2 Other Meetings

K3 25% IGA Presentation

K4 50% IGA Presentation

K5 90% IGA Presentation