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Transportation Systems Assessment — Kittelson & Associates

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Technical Memorandum

March 17, 2023 Project# 27915.00

To: Thom Darrah
Director of Facilities Management Services and Capital Planning
Oregon Tech
3201 Campus Drive, Klamath Falls, OR 97601

From: Phill Worth, Miranda Barrus, PE

Project: OIT Master Plan Update

Subject: Site Visit and Current Conditions

INTRODUCTION

The Oregon Institute of Technology (Oregon Tech) is updating its Campus Master Plan. This technical memorandum presents the current transportation conditions on and surrounding campus in terms of available infrastructure and the ease with which students, faculty, staff, and visitors can move around Oregon Tech. This memorandum focuses on presence and quality of facilities such as widths, barriers, and connections of walkways, as opposed to physical conditions of pavement (this type of assessment is provided in other documentation provided by ZCS). Information contained in this memorandum was gathered and assembled from a site visit in November 2022, feedback offered by students and faculty, Geographic Information System (GIS) data and other information provided by Oregon Tech, and aerial imagery. The current conditions presented herein will help inform the near-, mid-, and long-term walking, biking, transit, and driving needs on and surrounding campus. Note that this memorandum does not address wheelchair/accessibility conditions or needs.

CURRENT CONDITIONS

This summary of current conditions is organized into two primary sections:

1. The current infrastructure on and surrounding campus and how it supports internal and external circulation for all modes.
2. The nighttime conditions on campus and areas of expressed personal safety concern.

The summary identifies gaps and barriers in the system and provides supporting aerial and photographic imagery. Many of these gaps and barriers were observed during the campus site visit in November 2022 at various times of day, while classes were in session, during peak times between class periods when students and faculty were traveling between buildings, and after dark when classes were generally out of session. Additional input provided by people on campus is incorporated into these findings, including specific feedback from students from the Civil Engineering Department, which is contained in Attachment A as markups to a campus map.

Infrastructure and Circulation

The transportation infrastructure within and surrounding campus supports both active transportation (walking, rolling, biking, transit) and motor vehicles, to varying degrees of completeness and comfort, as summarized in the following sections.

Active Transportation Facilities

Active transportation facilities generally include those that accommodate walking, rolling, biking, and riding transit. Figure 1 illustrates these active transportation facilities that are available both on and around campus. They are further summarized in the following sections, including their gaps and barriers.

Campus Walking and Rolling (Pedestrian) Infrastructure

As illustrated in Figure 1, the campus pedestrian system is well connected with wide pathways between transit services, buildings, and most parking lots. What is not shown in Figure 1 as constructed is the new Center for Excellence in Engineering and Technology (CEET) on the far west side of campus and its connecting pathways to adjacent parking lots and campus buildings or the new roundabout just south of campus at Campus Drive / Daggett Avenue. The following gaps and barriers in the internal pathway system were observed during the campus site visit:

- There are no defined walkways between the following locations that connect to the campus pedestrian system:
  - The Facilities Management Building and parking lots J, G, H, Q, and I; this area also lacks delineated crossings on Facilities Loop or for traveling through the side-by-side parking lots to access adjacent buildings.
  - Dobs Way (at Campus Drive) to the west down to parking lot E (near the Soccer Complex);
    - Parking lot X (southwest) can only be accessed by entering Purvine Hall or the CEET at the top level and exiting through the bottom level or using an external stairway on the south side of Purvine Hall; there is no external pathway to this parking lot between Purvine Hall and the CEET.
  - The south side of the Dowe Center and Campus Drive.
  - The Village and the College Union (between the dorms and the tennis courts).
- There are no walkways along Facilities Loop, Engineering Court, Danny Miles Way, Yates Drive or Dobbs Way, particularly around the stadium and baseball/softball field.
- Sidewalks in the following locations experience vehicle bumper overhang, diminishing the facility's effective width:
  - Along the south side of parking lot K near the Learning Resource Center (LRC).
  - The south side of the Residence Hall; this walkway is narrow and heavily trafficked by students (one of the few congested areas observed on campus).
- There is no clear delineation for pedestrians accessing or crossing parking lots on campus, except for parking lot F (can be a model design).

Many of these gaps and barriers are identified in Figure 1 and associated photos are included in Attachment B.

Oregon TECH

Figure 1 - Active Transportation Facilities

Surrounding Walking and Rolling (Pedestrian) Infrastructure

Regarding the external street system that surrounds the campus, no walking facilities are available except for a short section of sidewalk on the south side of Campus Drive (Campus Drive to parking lot B) and two marked crossings on both Campus Drive and Bryant Williams Drive. According to the Klamath Falls Urban Area Transportation System Plan (TSP), N University Drive, E University Drive, and Campus Drive are classified as Local Streets and Industrial Park Drive and Dan O'Brien Way are classified as Collectors. Based on the City's street standards, six-foot sidewalks with four-foot planter strips are required along Collectors (Minor) and five-foot sidewalks with four-foot planter strips are required along Local Streets.

Although no pedestrian facilities are provided at the intersections of the external street system, historical traffic counts show pedestrian activity at the following locations during weekday AM and PM peak hours:

- **Campus Drive / Dan O'Brien Way**
  - AM Peak: 3 people crossing the north leg, 3 people crossing the east leg, and 12 people crossing the west leg (18 total people)
  - PM Peak: 4 people crossing the north leg and 5 people crossing the west leg (9 total people)
- **Industrial Park Drive / Dan O'Brien Way**
  - AM Peak: 2 people crossing the north leg and 3 people crossing the south leg (5 total people)
  - PM Peak: 2 people crossing the south leg
- **Industrial Park Drive / Facilities Loop**
  - AM Peak: 4 people crossing the south leg and 2 people crossing the north leg (6 total people)
  - PM Peak: 2 people crossing the north leg, 1 person crossing the south leg, and 2 people crossing the east leg (5 total people)

Additional details on these historical traffic counts are included under the Motor Vehicle Facilities section.

Biking Facilities

Bicycling is allowed on campus but discouraged on sidewalks (maximum speed 1.5 miles per hour). Cyclists are encouraged to walk their bikes to bike racks provided at several locations on campus. Bike racks were observed at Semon Hall, Owens Hall, the Dowe Center, the Athletic Center, the College Union, and northwest of parking lot B. The locations of these bike racks are identified in Figure 1 and corresponding photos illustrating their type and quality are included in Attachment C. Bike racks were also identified at the LRC and Boivin Hall by students during the site visit, as well as inside of the Residence Hall quad and at each Village building according to Oregon Tech parking information on its website, but they were not photographed.

The bicycle facilities on the external street system surrounding campus are limited to paved shoulders on Dan O'Brien Way (Pilot driveway to Campus Drive). A bike lane is available on Dan O'Brien Way northwest of the Pilot service station driveway on the southwest side of the street. Based on the City's street standards, the external streets can function as shared roadways for bicyclists and motorists so long as Industrial Park Drive and Dan O'Brien Way, as Collectors, have two 14-foot travel lanes and parking on both sides of the street. Otherwise, these two streets require two six-foot bike lanes. Although aerial imagery of campus indicates that six-foot striped paved shoulders and 12-foot travel lanes are available along Dan O'Brien Way today, no bike lane pavement markings or signage are present. Industrial Park Drive has travel lanes wider than 14 feet and parking is allowed along its west side but prohibited along the east side.

The historical traffic counts referenced in the previous section showed the following bicycle activity at these locations during the AM and PM peak hours:

- **Campus Drive / Dan O'Brien Way**
  - AM Peak: 2 bicyclists making a northbound right turn
  - PM Peak: 1 bicyclist making a northbound right turn and 3 bicyclists making westbound left turns (4 total bicyclists)
- **Industrial Park Drive / Dan O'Brien Way**
  - AM Peak: no bicyclist activity observed
  - PM Peak: 1 bicyclist making a southbound left turn
- **Industrial Park Drive / Facilities Loop**
  - AM Peak: no bicyclist activity observed
  - PM Peak: no bicyclist activity observed

Transit Facilities

As shown in Figure 1, the campus is served by transit, which is operated by Basin Transit Service (BTS), and has a transit stop on the south side of campus between the Dowe Center and parking lot B. The stop includes a shelter and trash receptacle and is well connected to the campus pedestrian system. Two fixed routes operate at this stop on weekdays from 6:43 AM to 7:43 PM on one-hour headways but are staggered to provide 30-minute headways depending on the rider's origin/destination. On weekends, these routes operate from 10:43 AM to 4:43 PM with similar headways. These fixed routes connect to all areas of Klamath Falls in coordination with other fixed routes.

Student Input on Active Transportation Needs

Specific active transportation needs identified by students include:

- Walking paths along all external streets so people don't walk in the roads.
- A path from the College Union to the Arboretum.
- Limited visibility of pedestrians near parking lot P due to parked vehicles and dumpster (pedestrians not visible until they are in the roadway).
- A walkway/pathway along Yates Drive from the College Union, across N University Drive, up to the "O" trailhead.
- Marked crossings on Industrial Park Drive for students who use on-street parking.
- A walkway connection between parking lot Q and parking lot K (via Danny Miles Way).
- Improved signage/wayfinding for the path to the Native Plant Garden southwest of the Facilities Management Building.
- Icy campus pathways in winter conditions, especially from the Village to the Residence Hall.

Finally, Oregon Tech owns the property on the west side of Industrial Park, north of Dan O'Brien way, which has the potential to be identified for development through this master planning effort, highlighting the possible need for walking and biking connections across Industrial Park Drive.

Motor Vehicle Facilities

Motor vehicle facilities generally include internal and external roadways and parking lots. As shown in Figure 2, there is an external street system that surrounds the campus.

Figure 2 - Motor Vehicle Facilities

According to the City's street standards, these are the motor vehicle features required for the external street system:

- Industrial Park Drive and Dan O'Brien Way (Collectors):
  - Two 14-foot travel lanes if parking is on both sides of the street and bicyclists share the lane with motorists or two 12-foot travel lanes if no parking is present and bicycle lanes are provided.
  - One 12-foot median or turn lane if no parking is present and bicycle lanes are provided; otherwise, no median.
- Campus Drive, N University Drive, and E University Drive (Local Streets):
  - Two 14-foot travel lanes, shared between motorists and bicyclists.
  - 7-foot parking on one or both sides of the street depending on right-of-way; otherwise, no parking.

Dan O'Brien Way generally complies with its standard for motor vehicles, but as indicated above, no bike lane pavement markings or signage are present, and no sidewalks or planter strips are available. This is a similar condition for Industrial Park Drive, although, the street includes a median, which is not consistent with its standard if cyclists are required to share the travel lane with motorists. On-street parking is prohibited along Campus Drive, N University Drive, and E University Drive and the travel lane widths of these streets are narrower than 14 feet.

Campus Motor Vehicle Parking Utilization

The external street system provides access to 16 campus parking lots, either directly or by way of internal streets (Facilities Loop, Engineering Court, Danny Miles Way, and Yates Drive). A majority of the 16 parking lots are concentrated in the southeast quadrant of campus near the Village, Residence Hall, College Union, Snell Hall, and the Dowe Center, and on the west side of campus near the Soccer Complex, CEET, Cornett Hall, and the Facilities Management Building. These are the larger parking areas on campus. The smaller parking lots are tucked further into the central part of campus around the LRC, Athletic Center, College Union, and the information center/permit booth south of Campus Drive. On-street parking along Industrial Park Drive is controlled by the City, with parking on the east side being prohibited and parking on the west side being allowed without time limit or fee.

Parking on campus in the 16 parking lots is managed by Campus Safety. Students, Faculty, and Staff who park on campus are required to purchase virtual parking permits (associated with the registered license plate) annually or per term. Certain parking lots are designated for certain uses (e.g., "Faculty Only," "Student Residents Only," etc.) and are signed as such on campus and are also identified on a campus parking map that is available online and provided at the time of permit purchase. Visitor parking is free on a limited basis to individuals each term and issued at the permit booth in Parking Lot D.

A parking utilization assessment of current campus parking was conducted on the Monday and Wednesday of the second week of Winter Term in 2023 at 11:00 AM. The assessment is summarized in Table 1.

Table 1: Average Parking Utilization on Campus (Data from January 2023)

Parking Lot	Capacity[1]			Usage			Utilization		
	Standard	ADA[2]	Service	Standard	ADA[2]	Service	Standard	ADA[2]	Service
A	390	6	4	387	2	0	**99%**	**25%**	**0%**
B	136	14	2	123	2	1	**90%**	**14%**	**50%**
D	70	-	-	62	-	-	**84%**	-	-
E	220	7	-	79	0	-	**36%**	**0%**	-
F1/F2	195	8	-	164	2	-	**84%**	**25%**	-
G	94	2	-	53	0	-	**56%**	**0%**	-
H	88	-	-	61	-	-	**69%**	-	-
I	8	5	-	7	0	-	**88%**	**0%**	-
J	17	1	-	10	0	-	**59%**	**0%**	-
K	93	5	-	84	1	0	**90%**	**20%**	-
L	13	2	4	Not Photographed					
M	20	2	-	19	0	-	**93%**	**0%**	-
N	16	2	-	12	0	-	**75%**	**0%**	-
O	Not Allowed for Regular Use – Only Open for Special Events								
P	25	-	-	Not Photographed					
Q	137	-	-	33	-	-	**24%**	-	-
Dobs Way	Not Photographed								
Fuel Island	20	-	-	14	-	-	**70%**	-	-
Industrial Park Drive	Not Photographed								
TOTAL	**1,529**	**54**	**10**	**1,108**	**7**	**1**	**72%**	**13%**	**10%**

1 – Capacity was provided by OIT Facilities staff.

2 – ADA: Americans with Disabilities Act

As shown from Table 1:

- Parking Lots A, B, K, and M were 90% utilized, or higher.
  - **Lot A (general and student housing parking)** has the highest utilization of its standard parking at 99%, likely due to its proximity to student housing and the center of campus, as well as its visibility and accessibility to visitors. While 390 standard parking spaces (and 6 ADA parking spaces) are available in this lot, only 174 are reserved for on campus student housing (which is also shared with Integrated Student Health Center parking) and approximately 677 students live on campus today (out of 1,984 total students). Note that Parking Lot P, just east of the Village along E University Drive (Bryan Williams Drive), was not photographed, but was observed during the site visit to have a similar utilization. While this is general parking, it is assumed that student housing residents occupy this lot given its location.

- **Lot B (employee parking)** shows 90% of its standard parking is utilized. Faculty and staff park in this lot but also park in other lots around campus depending on where their offices and classrooms are located.
- **Lot K (general parking)** shows 90% of its standard parking is utilized, likely due to its proximity to the LRC (library) and the center of campus. A mixture of students (likely commuters), faculty, and staff use this lot.
- **Lot M (general parking)** shows 93% of its standards parking is utilized, likely due to its proximity to the Athletic Center, College Union, and possibly student housing. A mixture of students (likely residents) and staff (likely College Union employees) use this lot.

- Parking Lots D, F, and I were 84% utilized, or higher.
  - **Lot D (general parking)**, south of Campus Drive where the information/parking permit booth is located, shows 84% of its standard parking is utilized. However, 3 "empty" spaces were blocked by snow piles and unavailable for use, indicating higher utilization is possible. Further, 2 spaces are for electric vehicles (EVs) and 1 space is "reserved," but all 3 were unused at the time the drone shot was captured. A mixture of students (likely commuters), faculty, and staff use this lot.
  - **Lot F (general parking)** shows 84% of its standard parking is utilized. However, 4 "empty" spaces were blocked by snow piles and unavailable for use, indicating higher utilization is possible. Further, 5 spaces are for EVs and 11 spaces are "reserved" (likely for faculty), but 4 EV spaces and 4 "reserved" spaces were unused at the time the drone shot was captured. A mixture of students (likely commuters), faculty, and staff use this lot.
  - **Lot I (general parking)**, directly south of Lot H, has 8 standard parking spaces and shows 88% of them (7 spaces) are utilized. A mixture of students (likely commuters), faculty, and staff use this lot.

Other things to consider from the parking utilization assessment:

- A total of 2,368 people either attend or are employed as faculty and staff at Oregon Tech.
  - 1,984 are students; 677 live on campus.
  - 384 are faculty and staff; this does not include adjunct professors or temporary staff.
- No ADA spaces were more than 25% utilized at the time the drone shots were captured.
- A new snow event occurred before/while the Wednesday drone shots were captured and showed evidence of additional parked vehicles from earlier in the day than was captured in the photos.
- On-street parking is restricted along all the campus perimeter roadways, except for the west side of Industrial Park Drive. Industrial Park Drive was not photographed but was observed during the site visit to be approaching capacity, as has been the case in the past.
- Dobs Way was not photographed but appears in aerial imagery to have up to 8 ADA spaces and was observed during the site visit to be at least at half capacity. Additionally, Boivin Hall was under renovation during the site visit and some spaces were fenced off, limiting availability.
- The "Fuel Island" parking area on campus is near the Facilities Management Building, just south of Parking Lot J, and is likely used primarily by staff who work in Facilities.

Major Campus Intersections

The intersections on campus that support the external street system, shown in Figure 2, are either stop- or yield-controlled and include:

- Campus Drive / Dan O'Brien Way
- Campus Drive / Parking Lot B
- Campus Drive / Bryant Williams Drive
- N University Drive / Yates Drive
- N University Drive / Danny Miles Way
- N University Drive / Facilities Loop
- N University Drive / Industrial Park Drive
- Industrial Park Drive / Facilities Loop
- Industrial Park Drive / Dan O'Brien Way

Historical traffic counts were collected at Campus Drive / Dan O'Brien Way, Industrial Park Drive / Dan O'Brien Way, and Industrial Park Drive / Facilities Loop in April 2019 during the morning and evening peak hours of a typical mid-weekday. The counts showed that the AM peak hour for all intersections occurred from 8:00 to 9:00 AM and the PM peak hour varied slightly, but generally occurred in the 4:00 to 5:00 PM timeframe. Table 2 summarizes the directional vehicular volumes at each intersection. Attachment D includes the historical traffic count sheets.

Table 2: Directional Vehicular Peak Hour Volumes

Intersection	Location	Direction	AM Peak Hour		PM Peak Hour	
			Volume	Percentage	Volume	Percentage
Campus Dr / Dan O'Brien Way	South Leg	NB / SB	414 / 112	79% / 21%	99 / 327	23% / 77%
	East Leg	WB / EB	102 / 181	36% / 64%	230 / 69	77% / 23%
	West Leg	EB / WB	86 / 309	22% / 78%	134 / 67	67% / 33%
Industrial Park Dr / Dan O'Brien Way	North Leg	SB / NB	45 / 238	16% / 84%	137 / 26	84% / 16%
	East Leg	WB / EB	227 / 86	73% / 27%	62 / 137	31% / 69%
	West Leg	EB / WB	80 / 28	74% / 26%	21 / 57	27% / 73%
Industrial Park Dr / Facilities Loop	North Leg	SB / NB	21 / 48	30% / 70%	46 / 13	78% / 22%
	South Leg	NB / SB	220 / 36	86% / 14%	25 / 106	19% / 81%
	East Leg	WB / EB	14 / 171	8% / 92%	60 / 12	83% / 17%

From the detailed traffic counts:

- Approximately 76% of AM peak hour traffic on Campus Drive and Dan O'Brien Way enters campus (most coming from Campus Drive).
  - About 60% of traffic entering campus from Campus Drive and Dan O'Brien travel in the direction of Industrial Park Drive, supporting the observation that many commuters likely park in the lots on the west side of campus.
- Approximately 75% of PM peak hour traffic on Campus Drive and Dan O'Brien Way exits campus (most going to Campus Drive).
  - About 61% of traffic exiting campus from Campus Drive travel from the direction of Parking Lot A/B, likely reflecting staff and faculty ending their workdays.
- All the intersections have relatively low peak hour factors during the AM peak hour, and the 15-minute period where the most vehicles are traveling through the intersection ("peak 15 minutes") occurs from 8:45 to 9:00 AM, indicating that the intersection is its busiest in the 15-minute period before 9:00 AM classes begin. On the contrary, the peak hour factors for the PM peak hour are higher and the peak 15 minutes vary by intersection, indicating that the traffic is more spread out throughout the PM peak hour.

Lastly, the Campus Drive / Dan O'Brien Way intersection serves as the primary gateway to campus and its current traffic control, lane configurations, and overall geometry can be confusing, particularly for campus visitors who are not familiar with it. An improvement to this intersection is likely needed to better facilitate all intersection users, including people driving, walking, rolling, and biking, and to also create better place making as the campus gateway. A roundabout has been identified for the intersection and design drawings have been developed. The need for this improvement will be considered as part of this master planning process.

Student Input

Specific motor vehicle needs identified by students include:

- Increasing delineation on the corner of Facilities Loop near parking lot G for driving during winter conditions.
- Designating parking near the Softball Complex.
- Removing the "employee only" parking in lot B.
- Minimizing the confusion geometry between the Campus Drive / Dan O'Brien Way intersection, facilities road near Boivin Hall, and the upper entrance to parking lot E.
- Expanding parking lot P to the north and south.
- Making parking lot O official by paving it.
- Accommodating large vehicles in parking lots F1 and F2.
- Monitoring vehicle speeds along N University Drive and E University Drive.
- Increasing parking for students who live on campus.
- Delineating the travel lanes and median on Industrial Park Drive.

Personal Safety Concerns

During the site visit conducted in early November 2022, input was collected from people regarding their sense of personal safety while they move about campus, particularly during nighttime conditions. Nighttime conditions were also observed around campus, including the central areas, parking lots, and external streets. Regarding this observation, Figure 3 identifies both areas of concern in terms of lighting and locations where photographs were taken to demonstrate lighting conditions. Attachment E includes photos of nighttime conditions around campus.

The following needs were identified from input received and nighttime observations made:

- Better lighting along N University Drive and E University Drive, especially for parking lot P.
- Facilities on campus that alert police/campus safety of emergencies.
- Better lighting in the area around the fountain and directly south of the College Union.
- Wildlife sightings on campus, including cougars/mountain lions.
- Better lighting in the areas around parking lot K through M, the Softball Complex, Arboretum, tennis courts, Boivin Hall, between the College Union and parking lot B (in the grassy/tree area), and south of the Dowe Center.

Much of the lighting located in the internal areas of campus has been upgraded to (LED) poles that are tall and provide expansive light coverage. An example of this lighting is provided in Attachment E as a photograph. Facilities staff have plans to continue upgrading the remaining older lighting.

Figure 3 - Nighttime Conditions

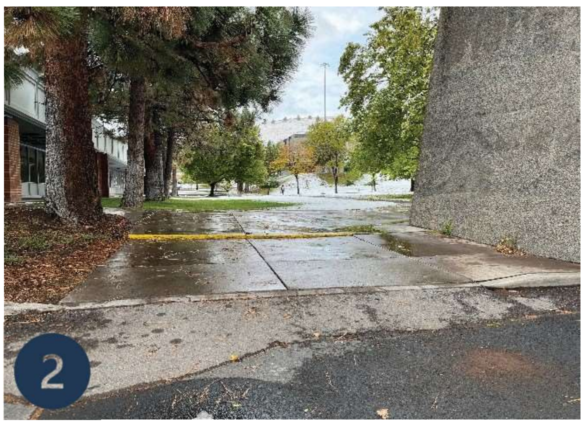
SUMMARY OF FINDINGS

- Gaps in campus pedestrian facilities present challenges to comfortable movement between all campus destinations and should be evaluated to determine solutions and timing of implementation.
- Locations where pedestrians and motor vehicles are potentially in conflicts, for example in parking lots and at internal campus intersections, should be considered for delineation as well as supportive lighting.
- Surrounding public streets lack complete pedestrian and bicycle facilities to optimize the effectiveness of these travel modes to and from the campus.
- With 72% of the general vehicle parking capacity being occupied during the typical weekday peak parking hour, there is more than sufficient parking to meet the needs of the current campus population.
- Key intersections in the campus vicinity appear to operate acceptably during typical weekday AM and PM peak hours.
- The Campus Drive / Dan O'Brien Way intersection presents challenges and opportunities that may benefit from consideration of a roundabout for traffic control, as well as placemaking.
- Campus lighting was raised as a concern in several areas on campus as well as the desire for emergency calling facilities to support the sense of personal safety on campus.

Attachment B Photos of Walking & Rolling Gaps & Barriers


1


Danny Miles Way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3


4


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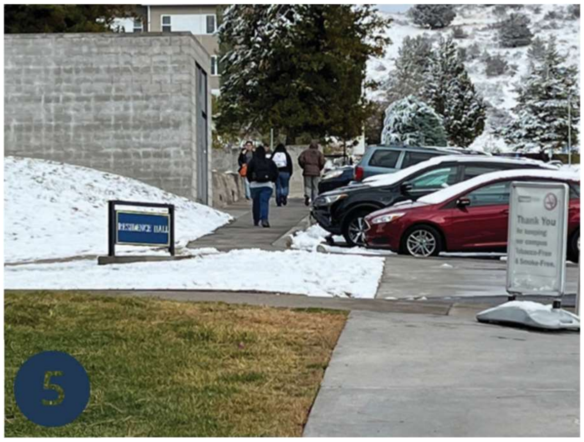
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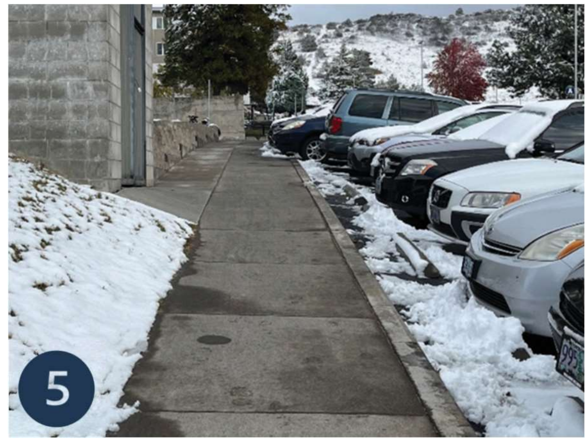

5

Attachment C Photos of Bike Racks


1

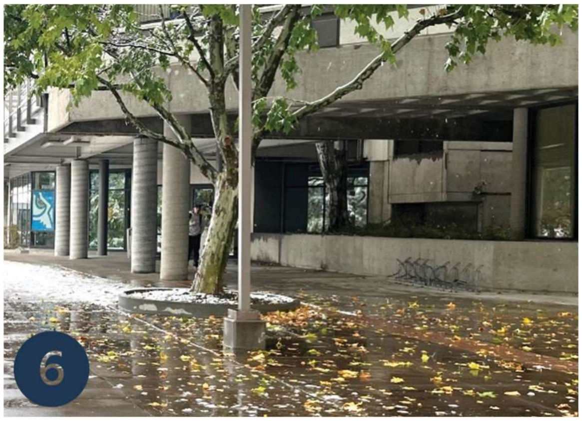

2


3


OWENS
HALL
4


5


5


6

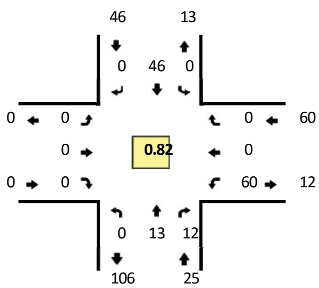

7

Attachment D Historical Traffic Counts

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

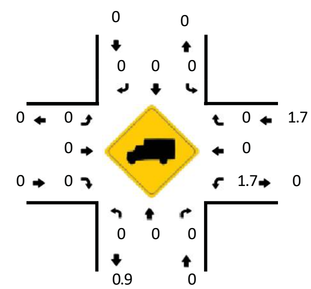
LOCATION: Industrial Park Dr -- Facilities Loop | **QC JOB #:** 14935608

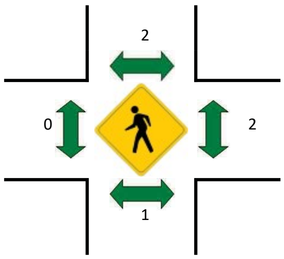
CITV/STATE: Klamath Falls, OR | **DATE:** Wed, Apr 3 2019

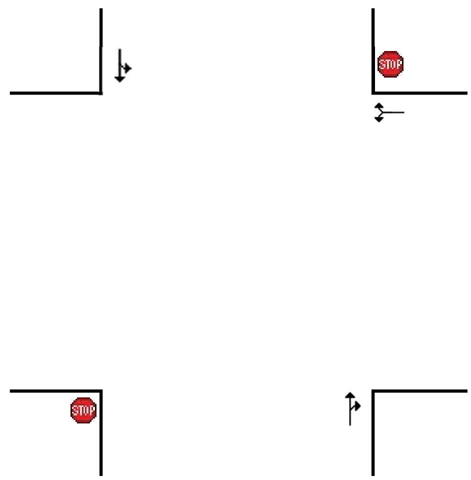


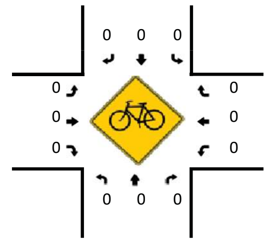
Peak-Hour: 4:05 PM -- 5:05 PM

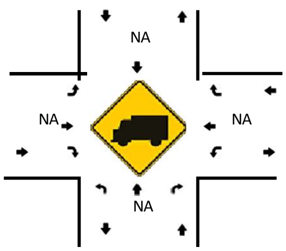
Peak 15-Min: 4:15 PM -- 4:30 PM

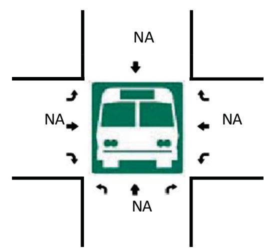












5-Min Count Period Beginning At	Industrial Park Dr (Northbound)				Industrial Park Dr (Southbound)				Facilities Loop (Eastbound)				Facilities Loop (Westbound)				Total	Hourly Totals
	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u		
4:00 PM	0	0	1	0	1	2	0	0	0	0	0	0	8	0	0	0	12	
4:05 PM	0	1	1	0	0	5	0	0	0	0	0	0	9	0	0	0	16	
4:10 PM	0	1	1	0	0	1	0	0	0	0	0	0	7	0	0	0	10	
4:15 PM	0	1	3	0	0	3	0	0	0	0	0	0	5	0	0	0	12	
4:20 PM	0	1	2	0	0	7	0	0	0	0	0	0	6	0	0	0	16	
4:25 PM	0	1	0	0	0	6	0	0	0	0	0	0	5	0	0	0	12	
4:30 PM	0	1	0	0	0	4	0	0	0	0	0	0	5	0	0	0	10	
4:35 PM	0	1	2	0	0	5	0	0	0	0	0	0	1	0	0	0	9	
4:40 PM	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	4	
4:45 PM	0	2	0	0	0	3	0	0	0	0	0	0	1	0	0	0	6	
4:50 PM	0	1	0	0	0	3	0	0	0	0	0	0	6	0	0	0	10	
4:55 PM	0	2	1	0	0	2	0	0	0	0	0	0	5	0	0	0	10	127
5:00 PM	0	0	1	0	0	6	0	0	0	0	0	0	9	0	0	0	16	131
5:05 PM	0	0	0	0	0	5	0	0	0	0	0	0	5	0	0	0	10	125
5:10 PM	0	3	1	0	0	5	0	0	0	0	0	0	6	0	0	0	15	130
5:15 PM	0	0	1	0	0	2	0	0	0	0	0	0	3	0	0	0	6	124
5:20 PM	0	1	2	0	0	3	0	0	0	0	0	0	1	0	0	0	7	115
5:25 PM	0	1	0	0	0	2	0	0	0	0	0	0	2	0	0	0	5	108
5:30 PM	0	5	1	0	0	3	0	0	0	0	0	0	1	0	0	0	10	108
5:35 PM	0	3	1	0	0	3	0	0	0	0	0	0	5	0	0	0	12	111
5:40 PM	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	4	111
5:45 PM	0	2	0	0	0	2	0	0	0	0	0	0	2	0	0	0	6	111
5:50 PM	0	2	0	0	0	2	0	0	0	0	0	0	4	0	0	0	8	109
5:55 PM	0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	14	113

Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	
All Vehicles	0	12	20	0	0	64	0	0	0	0	0	0	64	0	0	0	160
Hea@y Trucks	0	0	0		0	0	0		0	0	0		0	0	0		0
Pedestrians		0				8				0				8			16
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

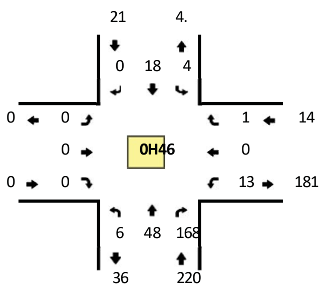
Comments:

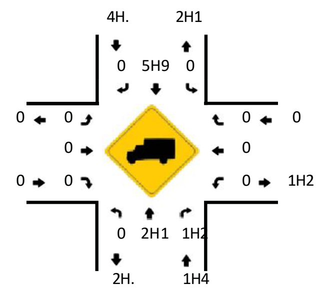
Report generated on 4/10/2019 8:08 PM | SOuRCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

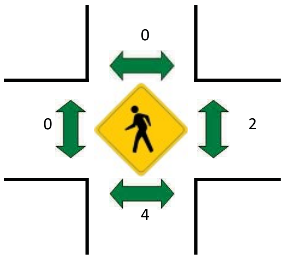
Type of peak hour being reported: Intersection Peak Method for determining peak hour: Total Entering Volume

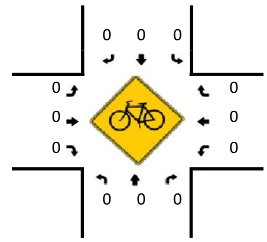
LOCATION: Industrial Park Dr -- Facilities Loop **QC JOB #:** 14935608
CITV/STATE: Klamath Falls, OR **DATE:** Wed, Apr 3 2019

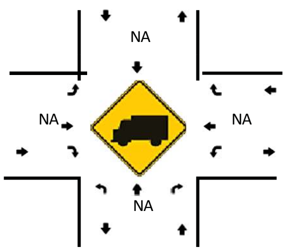
Peak-7 our: . :00 AM -- 9:00 AM
Peak 15-Min: . :45 AM -- 9:00 AM

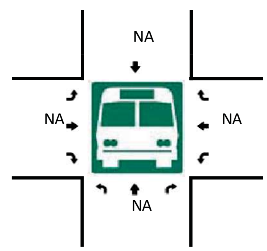












5-Min Count Period Beginning At	Industrial Park Dr (Northbound)				Industrial Park Dr (Southbound)				Facilities Loop (Eastbound)				Facilities Loop (Westbound)				Total	7ourly Totals
	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u		
8:00 AM	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
8:05 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8:10 AM	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
8:15 AM	0	3	5	0	0	1	0	0	0	0	0	0	0	0	0	0	9	
8:20 AM	0	2	2	0	0	1	0	0	0	0	0	0	1	0	0	0	6	
8:25 AM	0	1	4	0	0	1	0	0	0	0	0	0	0	0	0	0	6	
8:30 AM	0	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	9	
8:35 AM	0	5	11	0	0	2	0	0	0	0	0	0	0	0	0	0	1.	
8:40 AM	0	.	9	0	0	0	0	0	0	0	0	0	0	0	0	0	18	
8:45 AM	0	9	23	1	0	0	0	0	0	0	0	0	0	0	0	0	33	
8:50 AM	0	.	31	0	1	4	0	0	0	0	0	0	2	0	0	0	46	
8:55 AM	0	5	1.	1	0	2	0	0	0	0	0	0	1	0	1	0	2.	18.
. :00 AM	0	5	11	0	0	1	0	0	0	0	0	0	0	0	0	0	18	191
. :05 AM	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6	198
. :10 AM	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	4	199
. :15 AM	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6	196
. :20 AM	0	4	6	0	0	2	0	0	0	0	0	0	0	0	0	0	12	202
. :25 AM	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	.	204
. :30 AM	0	5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	12	208
. :35 AM	0	3	1.	0	0	2	0	0	0	0	0	0	0	0	0	0	23	212
. :40 AM	0	2	20	4	0	1	0	0	0	0	0	0	1	0	0	0	2.	223
. :45 AM	0	9	30	0	2	2	0	0	0	0	0	0	2	0	0	0	45	235
. :50 AM	0	2	38	2	0	6	0	0	0	0	0	0	4	0	0	0	51	240
. :55 AM	0	8	25	0	1	3	0	0	0	0	0	0	6	0	1	0	43	255

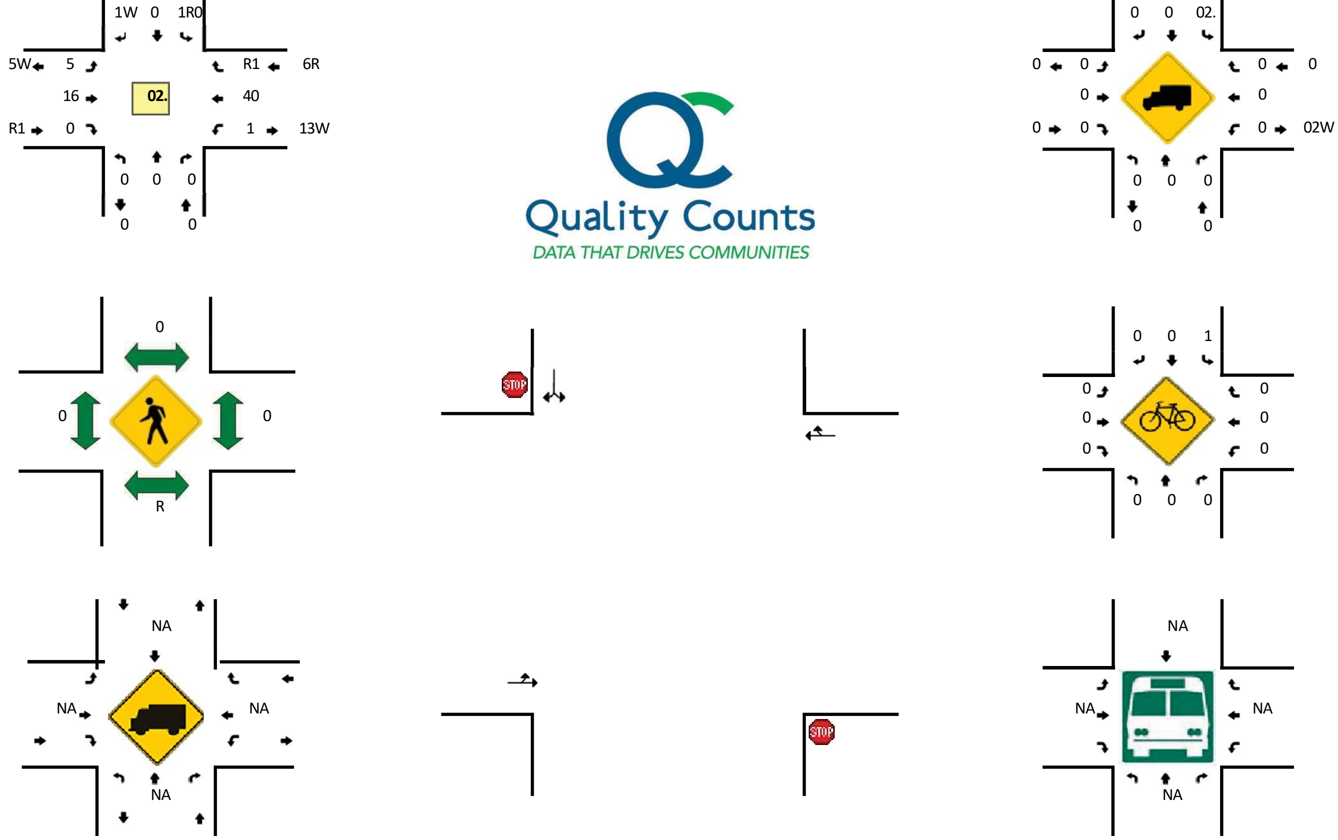
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	
All Vehicles	0	82	36.	.	12	44	0	0	0	0	0	0	4.	0	4	0	556
7eavy Trucks	0	0	0		0	4	0		0	0	0		0	0	0		4
Pedestrians		16				0				0				0			16
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
Railroad																	
Stopped Buses																	

Comments:

Report generated on 4/10/2019 . :0. PM SOuRCE: Quality Counts, LLC (http://wwwHqualitycountsHnet) 1-. 88-5. 0-2212

LOCATION: Industrial Park Dr -- Dan Obrien F ay | **QC JOB #:** 14935604
CIT8V/TATE: SlamathKO, | **DATE:** F edKApr 3 R019

Peak-Hour: 4:00 PM -- 5:00 PM
Peak 15-Min: 4:00 PM -- 4:15 PM



5-Min Count Period Beginning At	Industrial Park Dr 7Northbound(				Industrial Park Dr 7/outhbound(				Dan Obrien F ay 7Eastbound(				Dan Obrien F ay 7F estbound(				Total	Hourly Totals
	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)		
4:00 PM	0	0	0	0	16	0	3	0	0	3	0	0	0	R	1	0	R5	
4:05 PM	0	0	0	0	11	0	R	0	1	0	0	0	0	6	R	0	RR	
4:10 PM	0	0	0	0	15	0	R	0	1	0	0	0	0	R	R	0	RR	
4:15 PM	0	0	0	0	.	0	0	0	0	3	0	0	0	0	3	0	14	
4:R0 PM	0	0	0	0	14	0	1	0	0	1	0	0	0	3	R	0	R1	
4:R5 PM	0	0	0	0	13	0	3	0	0	R	0	0	0	R	1	0	R1	
4:30 PM	0	0	0	0	W	0	1	0	0	R	0	0	0	4	1	0	15	
4:35 PM	0	0	0	0	9	0	0	0	0	0	0	0	0	4	3	1	1W	
4:40 PM	0	0	0	0	4	0	1	0	1	R	0	0	0	5	R	0	15	
4:45 PM	0	0	0	0	4	0	1	0	1	3	0	0	0	1	1	0	11	
4:50 PM	0	0	0	0	13	0	3	0	1	0	0	0	0	5	0	0	RR	
4:55 PM	0	0	0	0	6	0	0	0	0	0	0	0	0	6	3	0	15	RR0
5:00 PM	0	0	0	0	15	0	R	0	0	1	0	0	0	1	1	0	R0	R15
5:05 PM	0	0	0	0	1R	0	1	0	0	1	0	0	0	4	0	0	1.	R11
5:10 PM	0	0	0	0	10	0	3	0	0	1	0	0	0	W	4	0	R5	R14
5:15 PM	0	0	0	0	R	0	R	0	0	1	0	0	0	1	1	0	W	R0W
5:R0 PM	0	0	0	0	4	0	1	0	0	1	0	0	0	R	R	1	11	19W
5:R5 PM	0	0	0	0	4	0	R	0	0	1	0	0	0	1	1	0	9	1. 5
5:30 PM	0	0	0	0	4	0	0	0	3	1	0	1	0	1	3	0	13	1. 3
5:35 PM	0	0	0	0	6	0	0	0	0	R	0	0	0	6	4	0	1.	1. 4
5:40 PM	0	0	0	0	6	0	0	0	0	1	0	0	0	5	R	0	14	1. 3
5:45 PM	0	0	0	0	3	0	0	0	1	R	0	0	0	1	3	0	10	1. R
5:50 PM	0	0	0	0	W	0	0	0	0	5	0	0	0	4	R	0	1.	1W.
5:55 PM	0	0	0	0	0	0	0	0	R	1	0	0	0	R	1	0	6	169

Peak 15-Min ulowrates	Northbound				/outhbound				Eastbound				F estbound				Total
	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)	
All Vehicles	0	0	0	0	16.	0	R.	0	.	1R	0	0	0	40	R0	0	RW6
Heavy Trucks	0	0	0		4	0	0		0	0	0		0	0	0		4
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		1	0	0		0	0	0		0	0	0		1
, ailroad																	
/topped Buses																	

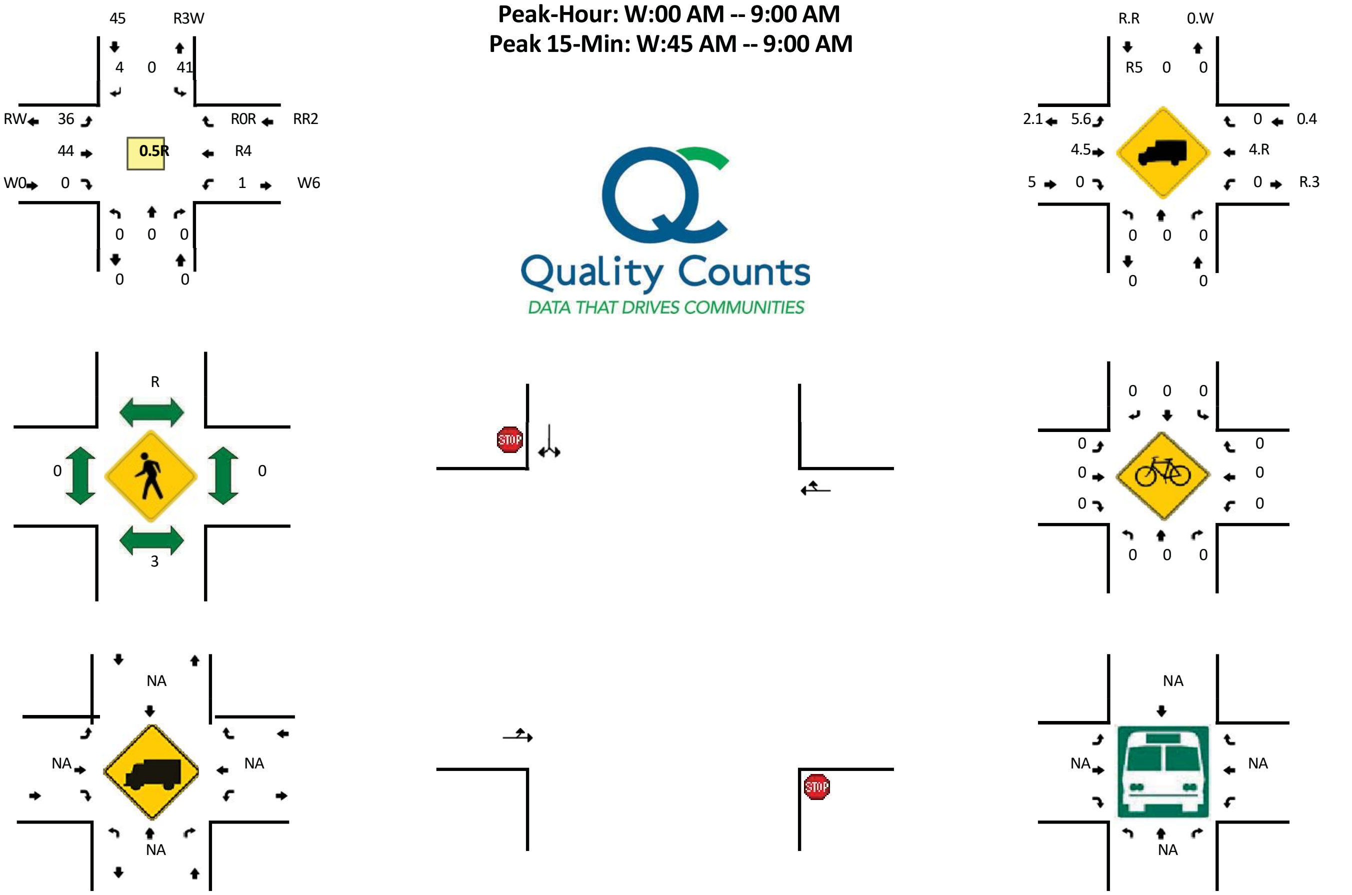
Comments:

, eport generated on 4V10VR019 . :0. PM

LOCATION: Industrial Park Dr -- Dan Obrien F ay — **QC JOB #:** 14935603

CIT8V/TATE: SlamathKO, — **DATE:** F edKApr 3 R019

Peak-Hour: W:00 AM -- 9:00 AM
Peak 15-Min: W:45 AM -- 9:00 AM



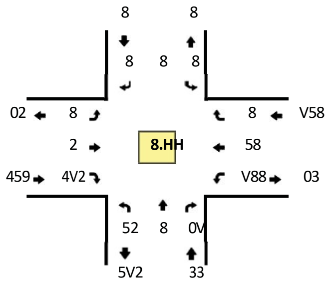
5-Min Count Period Beginning At	Industrial Park Dr 7Northbound(				Industrial Park Dr 7/outhbound(				Dan Obrien F ay 7Eastbound(				Dan Obrien F ay 7F estbound(				Total	Hourly Totals
	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)		
2:00 AM	0	0	0	0	1	0	0	0	R	4	0	0	0	1	R	0	10	
2:05 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	
2:10 AM	0	0	0	0	0	0	0	0	0	R	0	0	0	0	R	0	4	
2:15 AM	0	0	0	0	1	0	0	0	R	6	0	0	0	0	6	0	15	
2:R0 AM	0	0	0	0	0	0	R	0	3	5	0	0	0	0	R	0	1R	
2:R5 AM	0	0	0	0	1	0	0	0	1	6	0	0	0	0	6	0	14	
2:30 AM	0	0	0	0	0	0	0	0	R	R	0	0	0	0	9	0	13	
2:35 AM	0	0	0	0	0	0	0	0	4	6	0	0	0	0	12	0	R2	
2:40 AM	0	0	0	0	1	0	0	0	5	10	0	0	0	R	14	0	3R	
2:45 AM	0	0	0	0	0	0	0	0	1R	9	0	0	0	0	R3	0	44	
2:50 AM	0	0	0	0	3	0	R	0	1R	10	0	0	0	1	30	0	5W	
2:55 AM	0	0	0	0	3	0	0	0	9	6	0	0	0	1	R1	0	40	R20
W:00 AM	0	0	0	0	0	0	0	0	R	4	0	0	0	3	11	0	R0	RW0
W:05 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	5	0	6	RW5
W:10 AM	0	0	0	0	R	0	0	0	0	5	0	0	0	1	3	0	11	R9R
W:15 AM	0	0	0	0	9	0	0	0	0	R	0	0	0	0	5	0	16	R93
W:R0 AM	0	0	0	0	R	0	0	0	R	1	0	0	0	3	11	0	19	300
W:R5 AM	0	0	0	0	0	0	0	0	0	2	0	0	0	3	9	0	19	305
W:30 AM	0	0	0	0	0	0	0	0	1	5	0	0	0	1	1R	0	19	311
W:35 AM	0	0	0	0	R	0	0	0	1	6	0	0	0	R	R5	0	36	3R0
W:40 AM	0	0	0	0	4	0	0	0	6	3	0	0	0	R	RR	0	32	3R5
W:45 AM	0	0	0	0	R	0	0	0	W	R	0	0	0	3	36	0	51	33R
W:50 AM	0	0	0	0	6	0	1	0	1R	4	0	0	0	3	36	1	63	332
W:55 AM	0	0	0	0	14	0	3	0	4	4	0	0	0	3	R2	0	55	35R

Peak 15-Min ulowrates	Northbound				/outhbound				Eastbound				F estbound				Total
	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)	Left	Thru	, ight	)	
All Vehicles	0	0	0	0	WW	0	16	0	96	40	0	0	0	36	396	4	626
Heavy Trucks	0	0	0		0	0	4		0	4	0		0	0	0		W
Pedestrians		1R				W				0				0			R0
Bicycles	0	0	0		0	0	0		0	0	0		0	0	0		0
, ailroad /topped Buses																	

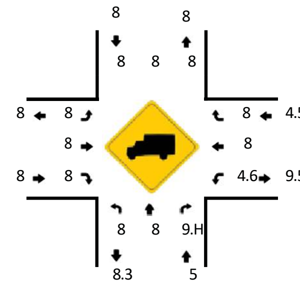
Comments:

, eport generated on 4V10VR019 W:0WPM — /O) , CE: Quality CountsKLLC 7http:VVwww.qualitycounts.net(1-W22-5W0-RR1R

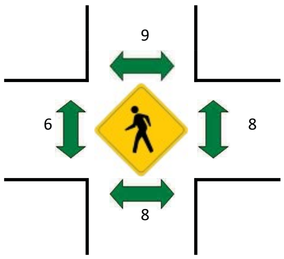
LOCATION: Campus Dri- e **F**Dan Obrien Q ay **J C BO# 1:** 4935608V
CIT/ SKTATE: , lamathROW **DATE:** Q edRApr 5 V843

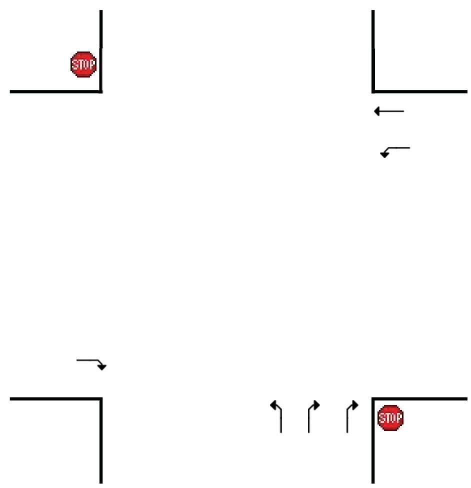


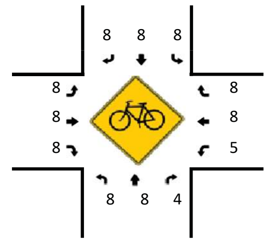
PeakF7 our: 9:46 PM F6:46 PM
Peak 46FMin: 6:88 PM F6:46 PM

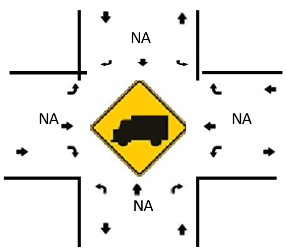


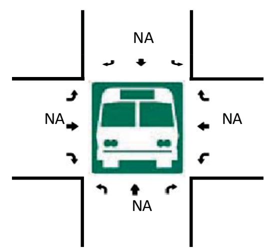
Quality Counts
DATA THAT DRIVES COMMUNITIES











6FMin Count Period #eginning At	Campus Dri- e (Northbound)				Campus Dri- e (Kouthbound)				Dan Obrien Q ay (Eastbound)				Dan Obrien Q ay (Q estbound)				Total	7ourly Totals
	Left	Thru	Wight	u	Left	Thru	Wight	u	Left	Thru	Wight	u	Left	Thru	Wight	u		
9:88 PM	4	8	5	8	8	8	8	8	8	5	42	8	43	V	8	8	96	
9:86 PM	5	8	V	8	8	8	8	8	8	4	45	8	40	2	8	8	9V	
9:48 PM	V	8	9	8	8	8	8	8	8	8	40	8	40	V	8	8	98	
9:46 PM	9	8	H	8	8	8	8	8	8	8	3	8	45	8	8	8	59	
9:V8 PM	V	8	5	8	8	8	8	8	8	8	40	8	4V	V	8	8	56	
9:V6 PM	V	8	9	8	8	8	8	8	8	8	42	8	45	4	8	8	52	
9:58 PM	9	8	0	8	8	8	8	8	8	V	2	8	42	4	8	8	52	
9:56 PM	6	8	9	8	8	8	8	8	8	4	H	8	VV	0	8	8	90	
9:98 PM	9	8	0	8	8	8	8	8	8	8	2	8	4H	5	8	8	5H	
9:96 PM	4	8	5	8	8	8	8	8	8	V	6	8	4H	4	8	8	58	
9:68 PM	9	8	9	8	8	8	8	8	8	4	45	8	49	4	8	8	52	
9:66 PM	0	8	48	8	8	8	8	8	8	8	0	8	4V	9	8	8	5H	963
6:88 PM	V	8	6	8	8	8	8	8	8	4	45	8	V8	4	8	8	9V	960
6:86 PM	8	8	5	8	8	8	8	8	8	8	49	8	4H	5	8	8	5H	96V
6:48 PM	5	8	0	8	8	8	8	8	8	8	4V	8	V5	2	8	8	64	905
6:46 PM	5	8	H	8	8	8	8	8	8	8	5	8	43	4	8	8	59	905
6:V8 PM	6	8	2	8	8	8	8	8	8	4	6	8	48	V	8	8	58	96H
6:V6 PM	4	8	48	8	8	8	8	8	8	8	6	8	H	4	8	8	V6	990
6:58 PM	9	8	H	8	8	8	8	8	8	8	9	8	49	4	8	8	54	998
6:56 PM	H	8	44	8	8	8	8	8	8	V	0	8	44	V	8	8	98	959
6:98 PM	3	8	4V	8	8	8	8	8	8	4	H	8	H	5	8	8	94	952
6:96 PM	0	8	3	8	8	8	8	8	8	8	5	8	48	8	8	8	VH	956
6:68 PM	2	8	H	8	8	8	8	8	8	6	3	8	2	5	8	8	53	952
6:66 PM	5	8	2	8	8	8	8	8	8	8	8	8	44	9	8	8	V6	9V9

Peak 46FMin wlov rates	Northbound				Kouthbound				Eastbound				Q estbound				Total
	Left	Thru	Wight	u	Left	Thru	Wight	u	Left	Thru	Wight	u	Left	Thru	Wight	u	
All Vehicles	V8	8	60	8	8	8	8	8	8	9	460	8	V99	99	8	8	6V9
7ea- y Trucks	8	8	9		8	8	8		8	8	8		9	8	8		H
Pedestrians		8				4V				9				8			40
#icycles	8	8	8		8	8	8		8	8	8		5	8	8		5
Wailroad																	
Ktopped #uses																	

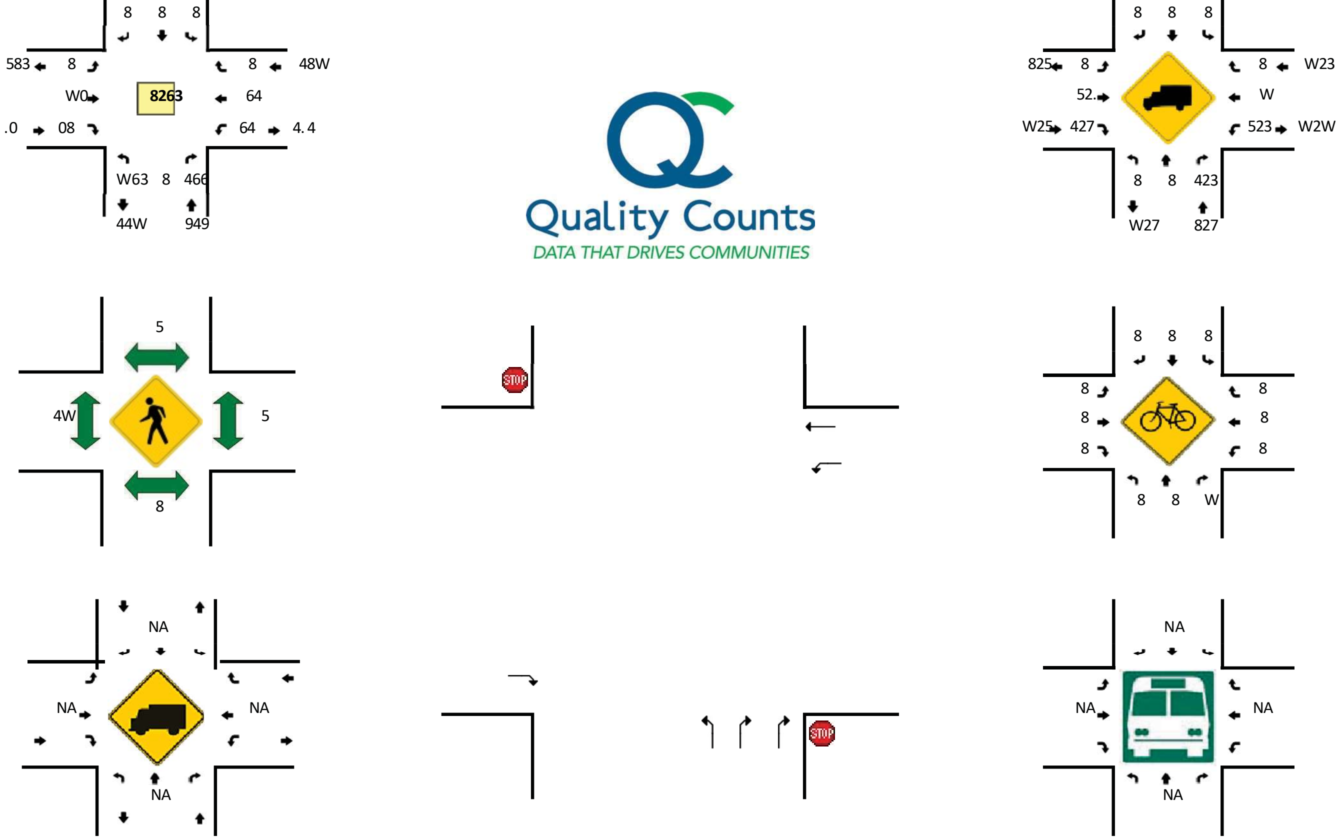
Comments: This intersection is a N#SE# stop.

Weport generated on 9S48SV843 H:8H PM KOuWCE: J uality CountsRLLC (http:SSv v v .qualitycounts.net) 4FH22F6H8FVV4V

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Campus Dri- e **F**Dan Obrien Q ay | **J C BO# 1:** 49356084
CITV/STATE: Klamath, OR | **DATE:** Q ed, Apr 5 W843

PeakFHour: . :88 AM F3:88 AM
Peak 46FMin: . :96 AM F3:88 AM



6FMin Count Period #eginning At	Campus Dri- e (Northbound)				Campus Dri- e (Southbound)				Dan Obrien Q ay (Eastbound)				Dan Obrien Q ay (Q estbound)				Total	Hourly Totals
	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u		
7:88 AM	W	8	3	8	8	8	8	8	8	8	6	8	W	8	8	8	4.	
7:86 AM	8	8	7	8	8	8	8	8	8	8	4	8	4	8	8	8	3	
7:48 AM	W	8	49	8	8	8	8	8	8	W	8	8	4	8	8	8	43	
7:46 AM	0	8	.	8	8	8	8	8	8	5	5	8	8	8	8	8	W8	
7:W8 AM	5	8	45	8	8	8	8	8	8	6	4	8	8	8	8	8	WW	
7:W6 AM	9	8	4.	8	8	8	8	8	8	W	9	8	W	4	8	8	54	
7:58 AM	48	8	W8	8	8	8	8	8	8	W	4	8	4	8	8	8	59	
7:56 AM	WW	8	W7	8	8	8	8	8	8	5	W	8	0	5	8	8	05	
7:98 AM	W4	8	96	8	8	8	8	8	8	0	6	8	6	4	8	8	. 5	
7:96 AM	W5	8	56	8	8	8	8	8	8	0	W	8	6	4	8	8	7W	
7:68 AM	5.	8	5.	8	8	8	8	8	8	3	6	8	4	4	8	8	3W	
7:66 AM	43	8	W.	8	8	8	8	8	8	W	5	8	9	6	8	8	04	6W9
. :88 AM	45	8	4.	8	8	8	8	8	8	5	W	8	6	6	8	8	90	66W
. :86 AM	5	8	44	8	8	8	8	8	8	4	8	8	4	W	8	8	4.	604
. :48 AM	9	8	45	8	8	8	8	8	8	5	W	8	6	8	8	8	W7	603
. :46 AM	3	8	4W	8	8	8	8	8	8	9	3	8	6	W	8	8	94	638
. :W8 AM	3	8	.	8	8	8	8	8	8	4	W	8	9	9	8	8	W.	630
. :W6 AM	44	8	45	8	8	8	8	8	8	W	9	8	W	W	8	8	59	633
. :58 AM	45	8	3	4	8	8	8	8	8	4	6	8	W	9	8	8	56	088
. :56 AM	W3	8	49	8	8	8	8	8	8	5	9	8	W	6	8	8	67	639
. :98 AM	W7	8	4W	8	8	8	8	8	8	9	9	8	9	48	8	8	04	67W
. :96 AM	65	8	45	8	8	8	8	8	8	4	5	8	W	6	8	8	77	677
. :68 AM	65	8	43	8	8	8	8	8	8	W	3	8	7	7	8	8	37	6. W
. :66 AM	59	8	45	8	8	8	8	8	8	4	40	8	4W	6	8	8	. 4	08W

Peak 46FMin wlov rates	Northbound				Southbound				Eastbound				Q estbound				Total
	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	Left	Thru	Right	u	
All Vehicles	608	8	4. 8	8	8	8	8	8	8	40	44W	8	. 9	0.	8	8	48W8
Hea- y Trucks	8	8	9		8	8	8		8	8	9		8	8	8		.
Pedestrians		8				8				40				8			40
#icycles	8	8	4		8	8	8		8	8	8		8	8	8		4
Railroad																	
Stopped #uses																	

Comments: This intersection is a N#/E# stop2

Report generated on 9/48/W843 . :8. PM

SOuRCE: J uality Counts, LLC (http://v v v 2qualitycounts2net) 4F. 77F6. 8FWW4W

Attachment E Nighttime Conditions Photos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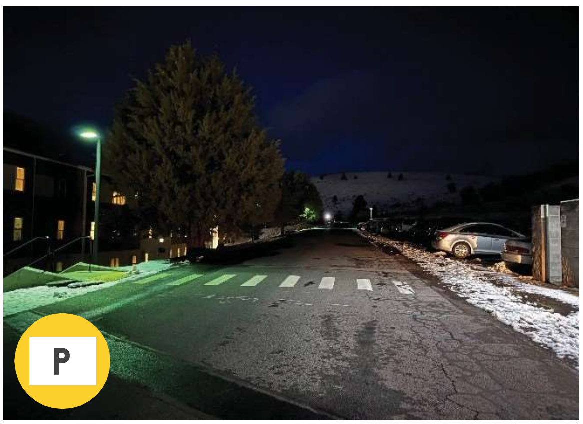
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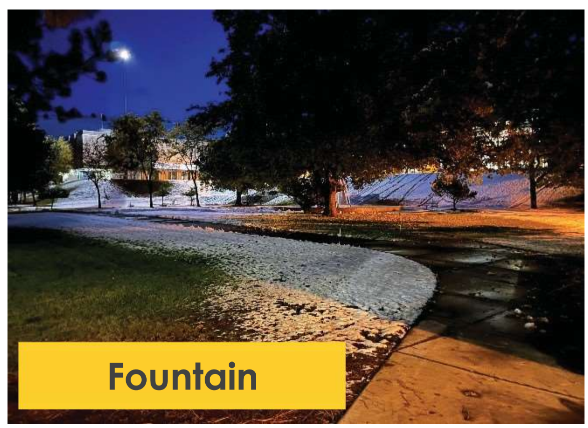
Q


New Lighting


Fountain

College Union	

11.2 Appendices

2022 Oregon Tech Geothermal Condition Assessment (Heating) — Fluent Engineering, Inc.

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2022 OREGON TECH GEOTHERMAL CONDITION ASSESSMENT

Submitted By:

Fluent Engineering, Inc.

June 28, 2022

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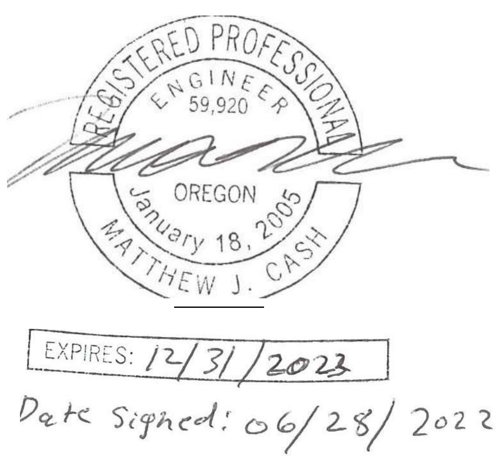
Engineering Stamps

Report Sections Applicable to Brian Brown, PE Stamp and Signature: Mechanical

Report Sections Applicable to Matthew J. Cash, PE Stamp and Signature: Electrical



Contents

Executive Summary

The geothermal heating system at the Klamath Falls Campus of Oregon Tech has been effective for over 60 years and is not only a unique renewable resource that benefits Oregon, but it is critical to the continued operation of Oregon Tech. Geothermal is the only heating source for almost all of the campus, and the majority of the system is beyond its service life. The consequences of not addressing the deficiencies of the system range from periodic with increasing frequency operational disruptions to a complete loss of assets at the entire Klamath Falls Campus. As evidenced approximately 3 weeks prior to the date of this report, a geothermal valve/pipe failed, resulting in a complete shutdown of the system. Fortunately, this occurred during non-freezing temperatures. The Geothermal system is critical to Oregon Tech's operations, and given that Klamath Falls is at or below freezing on average 7 months out of the year due to its higher elevation, loss of heat can result in complete loss of some/all buildings on campus. Comfort heating is required for at least 3 more months. It has snowed in July on several occasions in Klamath Falls.

The geothermal heating system is made up of wells, pumps, heat exchangers, heated air/water distribution systems, campus distribution piping, and injection wells that return the resource back to the ground. There are four crucial elements to the system which are described below. If any one of these crucial elements fails, the entire campus heating system at Oregon Tech- Klamath Falls will no longer function. The list and condition of these crucial elements are as follows:

Geothermal Wells

Description:

Wells in the ground produce the heated geothermal water that is distributed to the buildings and injection wells to return the geothermal water to the ground. Wells include casings, pumps, shafts, electrical, and piping.

Condition:

Most are in poor condition, do not meet current standards, and have exceeded expected service life. Cannot rely on redundant wells due to inability to increase flow without damage/debris.

Geothermal Mechanical Building Sediment Tank & Electrical

Description:

All the wells route the water to this building, where it is then distributed to the campus. The building also powers and monitors (controls) the wells and other parts of the geothermal system network.

Condition:

Tank- Unknown/Poor, undersized for the campus, and does not provide adequate protection from sediment esp. as existing wells fail. Tank is critical to system operation and therefore inspection windows are short/cannot risk a shutdown of the system for scheduled tank inspection. Tank is beyond expected service life.

Electrical- Fair Condition, but has no backup and does not meet current code. Additionally, is distributed such that multiple single failure points exist (should be consolidated with the ability to -bypass failure points).

Distribution Piping

Description:
Moves geothermal water across campus, to each building, snow melt, and back to Injection Wells. Includes Valves, supports, piping, etc.

Condition:
Mostly good to fair; however, this is due to correct material selection which is not present throughout the system, and there is no ability to isolate such that a small failure, and/or failure in one area results in a full campus shutdown for potentially extended periods of time. Areas with inferior materials will cause complete loss of the system that can result in loss of heat for extended periods (weeks to months).

Campus Main Electrical Gear & Distribution System

Description:
Provides power to all the buildings, and Geothermal controls, pumps, warm air distribution, etc. This is where the 12,470 Volt campus distribution system splits from the utility feed coming in, to each building, and consists of disconnects, breakers, transformers, and fuses.

Condition:
Main Electrical Equipment- Poor, life reduced due to previous damage, and Complex to replace. Has experienced flooding, and due to its location is subject to additional damage. Does not meet current code, or standards.

Campus distribution- Good. Due to recent investments, after the main electrical gear, the campus distribution system is poised to serve years into the future meeting modern standards.

In addition to the crucial elements above, the geothermal system also consists of the following important elements. Failure to the following systems, while serious, would be localized and not take down the entire campus heating system.

Building heat exchange

Description:
Transfers heat from the geothermal distribution system to the buildings for space heating and domestic hot water.

Condition:
Heat exchangers, pumps, and controls in older buildings are generally in poor condition or not optimized for efficient use of the geothermal resource

Snowmelt:

Description:
Transfers heat from the geothermal distribution system to exterior stairs and sidewalks for snow removal/deicing. The snowmelt serves the students, faculty, and staff by keeping sidewalks passable and de-iced which also provides removal of ADA barriers.

Condition:
Existing snowmelt equipment has been installed and is not connected to the Geothermal System. Some areas on campus do not have continuous paths between buildings, additional GEO snowmelt should be added to address the most commonly utilized pathways. Future snowmelt locations should also be identified as part of the overall system capacity and distribution upgrades. Older heat exchangers and pumps are no longer adequate and require replacement.

The geothermal system is an excellent renewable resource that has no harm to the natural biological environment and provides Oregon with protection from rising energy costs. According to a 2010 article on the uses of geothermal at Oregon Tech, former Oregon Tech Professor Dr. John Lund estimates that the return on investment is at least $1M/year in energy savings (Lund & Boyd, 2010).

If the deficiencies outlined in this report are corrected, the vulnerabilities in the systems listed above will be eliminated. In other words, the system would no longer be subject to these single points of failure and could continue to operate with electrical backup, and system isolation to fix issues that may arise. The estimated cost of the recommended actions in this report is $14,951,000. If these items are addressed, the Geothermal Heating system will continue to serve the campus for the next 60 years and beyond.

1. Introduction

1.1 Project Description and Scope

Fluent Engineering, Inc. was tasked with evaluating the hydrothermal (Geothermal) resources of the Oregon Tech – Klamath Falls Campus. The purpose of this task was to aid in the development of an emergency funding request to the Oregon Higher Education Coordinating Committee (HECC) to address immediate life safety and risk of failure concerns within the geothermal system of Oregon Tech.

The objectives of this project were as follows:

- Provide information used to develop an emergency funding request
- Provide Campus overview and history of the geothermal system
  - Describe the history of geothermal at Oregon Tech
  - How geothermal energy is integral, and critical to campus operation and ongoing development
- Provide a description of the existing geothermal system
  - Uses of geothermal energy at Oregon Tech
  - Determine System Capacity
- Describe environmental and financial benefits of geothermal
- Analyze concerns and consequences of system failure
  - Age and deterioration of critical components
    - Production wells and pumps
    - Pipelines
    - Injection wells
    - Heat exchangers in buildings
    - Isolation valves in distribution piping
  - Lack of resiliency to component failure (including geothermal distribution and supporting electrical power)
    - Loss of critical components can shut down the entire system and campus operations
    - No way to isolate a portion of the system while the rest continues to operate
    - Possible collateral damage to other systems or buildings
    - No other source of heat or hot water
  - Life safety risks
    - Risk of scalding with hot water in confined space utility tunnels
    - Equipment such as snowmelt systems in tunnels
    - No way to quickly respond to failure
    - Aging system in mechanical rooms
    - Failing/non-compliant wells
  - Environmental risks
  - Capacity
    - Ability to support planned campus growth
    - Ability to modulate system
- Provide recommended actions to address concerns

- Identify and repair or replace critical components
- Improve resiliency
- Improve or optimize system capacity
  - Establish a plan for support of future buildings
  - Optimize the use of resources to allow more buildings to be served
  - Operation plan for production wells to meet capacity peaks
- Improve Safety

This project served to complement a Facility Condition Assessment performed by Fluent Engineering in 2018 that examined elements of the campus geothermal system. That analysis addressed immediate and long-term concerns of the system. This analysis builds on that assessment to provide a comprehensive set of recommendations to address life safety concerns, improve system resiliency, support future campus growth, and address components that have either failed or reached the end of their expected life.

The analysis looked at the following systems and components:

- Central Plant / Heat Exchange Building
  - Storage
  - Settling Tank
  - Pumps
  - Valves
  - Strainers
  - Electrical Feeders Serving Geothermal Systems
- Geothermal Supply Well #6
- Geothermal Injection Wells #1 and #2
- Distribution Supply and Return Piping
- Heat Transfer Within Building (Heat-Exchangers)
- Snow-Melt System
- Electrical Distribution System

1.2 Project Team

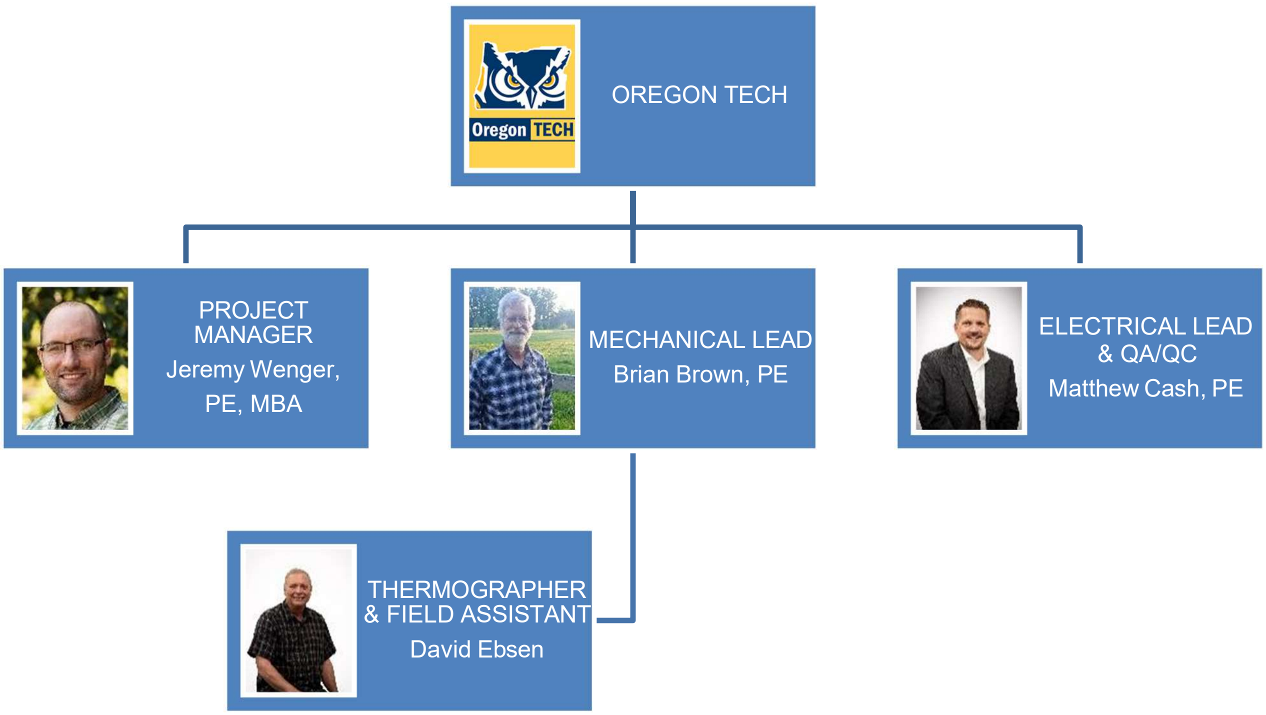
The Fluent Engineering project team consisted of the following individuals:

Jeremy Wenger, PE, MBA served as Fluent Engineering's Project Manager. Jeremy served as the Project Manager of a 2018 Facilities Condition Assessment of the Oregon Tech Campuses in Klamath Falls and Wilsonville.

Brian Brown, PE served as the lead engineer for the planning and evaluation of the geothermal system. Brian has over twenty-two years of experience working with the Oregon Tech geothermal systems and is an alumnus of Oregon Tech. Brian has provided engineering throughout the entire campus and has consistently assisted with the operation and provided engineering of the geothermal heating systems, geothermal power plants, fire water systems, domestic water system/irrigation, and central chilled water loop. Brian is currently Oregon Tech's on-call engineer for mechanical and plumbing systems.

Matthew Cash, PE served as the lead engineer for evaluating the electrical system associated with the geothermal system. Matt has extensive historical and current knowledge of the campus power distribution system as it relates to capacity, limitations, lifespans, and interconnections for the purposes of master planning.

Organizational Chart



1.3 Limitations of the Evaluation

The scope of this project was limited to components that were readily accessible such as exposed piping, valves, fittings, pumps, heat exchangers, tanks, and electrical gear. Direct buried pipes were not accessible and no destructive or invasive testing methods were employed.

Some piping in the tunnels was evaluated but due to the confined nature of the tunnels and accessibility, not all of it was able to be viewed. Assumptions about those elements that were non-accessible were based on the known age of the equipment and those elements that were able to be observed.

The large electrical power plant consisting of powerplants Alpha and Bravo along with small power plant Charlie, along with the associated production Well #7 were excluded from the scope of this project.

The cost estimate produced in this report is reported in 2022 dollars. Due to current high inflation levels, with prices in April 2022 being 8.3% higher than the previous year, we recommend that the funding request should include a factor for inflation based upon when the funds will be made available (U.S. Bureau of Labor Statistics, 2022).

2 Oregon Tech Geothermal System

2.1 Overview of Geothermal

At its most basic level, geothermal energy is simply heat that is from the earth. Early civilizations used geothermal energy in the form of hot springs and fumaroles (steam discharges) for cooking, heating, and bathing. In modern times, in addition to the more ancient uses, geothermal energy is used to provide building heat, generate electricity, and provide chilled water through absorption refrigeration. Geothermal energy has provided renewable, clean, affordable, and reliable heating for commercial and residential buildings in the United States since the 1890s and has continued to expand to include utility-scale power generators, distributed or district-wide heating, and supporting various industrial processes (Mink, 2017).

Geothermal heat radiates from the Earth's hot core outward to the surface. The temperature at the center of the Earth is nearly 10,800°F which is nearly the same temperature as the surface of the sun (U.S. Department of Energy, 2019). Geothermal heat flows upward to the surface but the temperature of the earth at various locations changes based on the geological conditions including soil and rock types, locations of fault lines, proximity to magma chambers, and changes based on depth from the surface. Resources are typically accessed through the use of well-drilling which can be on the order of magnitude of tens of feet to up to 4 miles with current drilling technology.

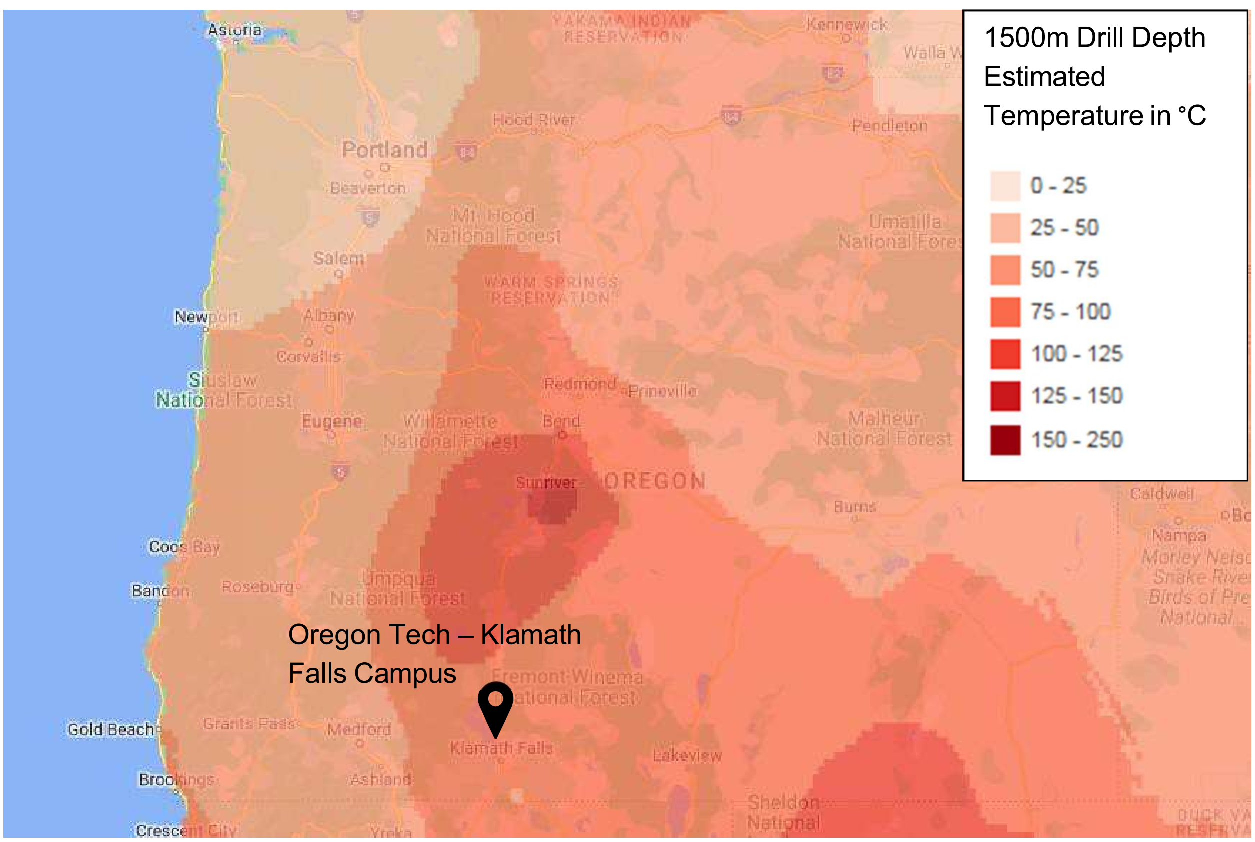


FIGURE 1: MAP OF ESTIMATED BELOW-GROUND TEMPERATURES IN OREGON AT 1500M DEPTH (SOURCE: NREL GEOTHERMAL PROSPECTOR TOOL)

It is important to distinguish different types of Geothermal energy and common terms in order to understand the unique renewable resource at Oregon Tech. Oregon Tech utilizes Geothermal water that the US Department of Energy also calls “Hydrothermal”.

Hydrothermal Renewable Resource(Commonly Referred to as “Geothermal” by Oregon Tech &What the Term “Geothermal” Used Throughout This Report Refers To):
Underground aquifers and groundwater [typically] deep below the Earth’s surface can have temperatures ranging from just a few degrees above ambient surface temperatures to temperatures exceeding 700°F. This is the type of geothermal resource used in most geothermal heating and power generation applications today. Higher temperatures provide greater opportunities for power generation and better efficiency. The tradeoff is that higher temperatures are found at deeper well depths and are more costly to access.

DOE defined Hydrothermal as the type of resource utilized by Oregon Tech. Other areas of the state generally refer to “Geothermal” as a Heat-Pump Resource. Per DOE Geothermal Heat-Pump Resources:

Shallow soil, rock, and aquifers provide valuable thermal storage properties. At depths of around 30 ft, the ground temperature is stable all year round and can be used with ground-source heat pump (GHP) mechanical equipment for both heating and cooling. Heat can be pumped to and from the ground to provide both heating and cooling to buildings and are generally more efficient than air-based heat exchangers.

Ground Source Heat Pumps aka Heat-Pump geothermal can generally be implemented throughout Oregon with enough ground/depth surface area, where the Geothermal renewable resource at Oregon Tech is localized with nearer surface hot water.

2.2 History of Geothermal at Oregon Tech

The use of geothermal energy at Oregon Tech has been at the core of the university since the 1960s. The campus was relocated from a World War II military facility to its current location to take advantage of the geothermal hot water available at the campus’ current location (Lund & Boyd, 2010). Below is a summarized timeline of the major milestones in the history of the campus geothermal system.

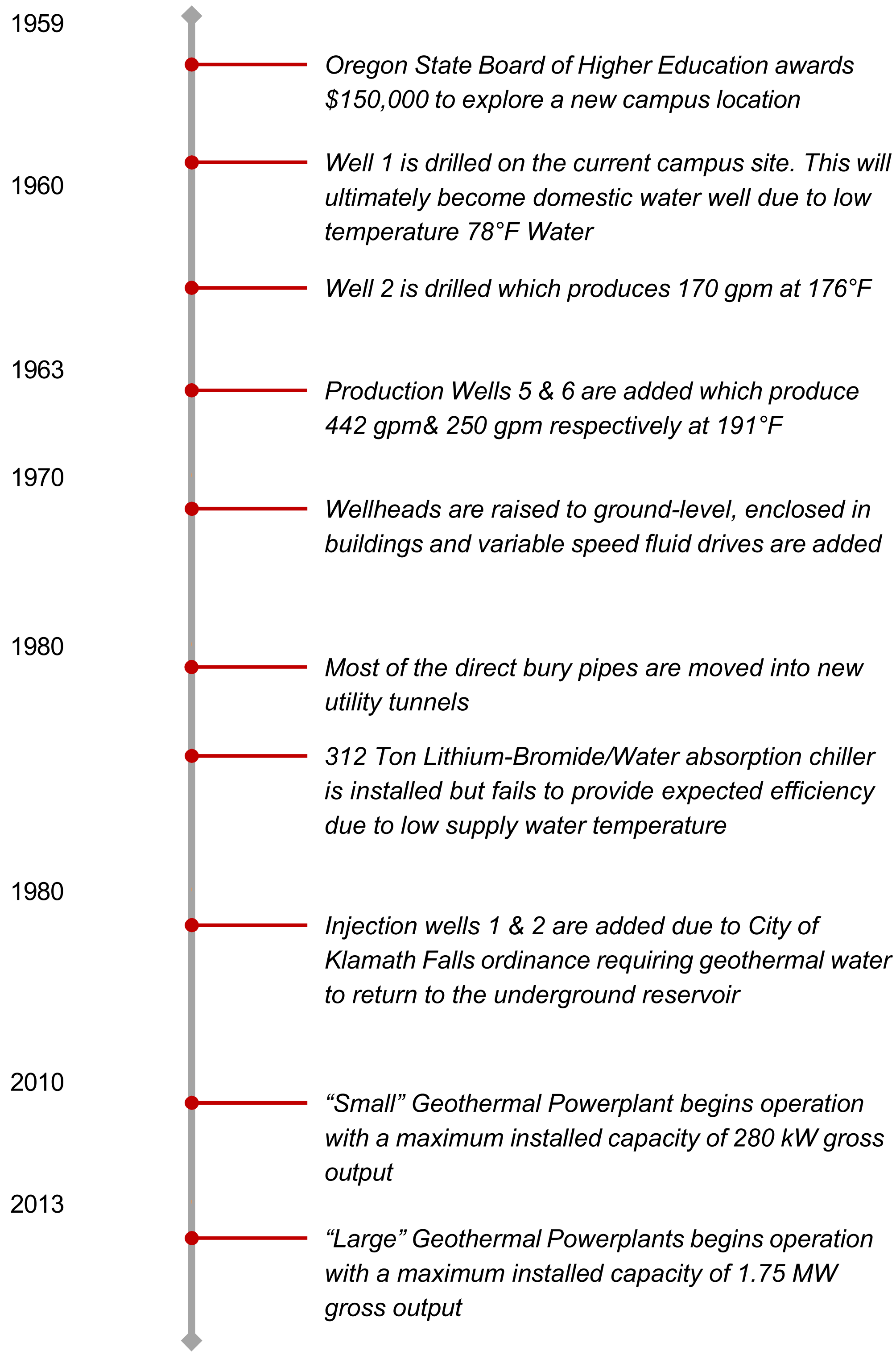


FIGURE 2: MAJOR MILESTONES IN THE HISTORY OF THE GEOTHERMAL SYSTEM AT OREGONTECH

A more thorough description of the history of the Oregon Tech Geothermal System can be found in former Oregon Tech Professor John W Lund’s report “Geothermal Uses and Projects on the Oregon

Institute of Technology Campus". This report was published in the May 2010 edition of the Geo-Heat Center Bulletin which can be found in the link below which is also listed in the References section of this report:

https://oregontechsfcdn.azureedge.net/oregontech/docs/default-source/geoheat-center-documents/quarterly-bulletin/vol-29/art3c37aee4362a663989f6fff0000ea57bb.pdf?sfvrsn=5edc8d60_4

2.3 Description and Condition of Existing System at Oregon Tech

2.3.1 Overview

The Oregon Tech campus utilizes a near-surface hot (~194°F) geothermal resource as the exclusive heat source for heating major campus buildings, major domestic hot water needs, and snowmelt/deicing of outside stairs and sidewalks. Additionally, the 194°F geothermal water is used to generate electricity that helps offset power demand by the well pumps and campus. The geothermal water is pumped from wells into a holding tank and flows from there by gravity. Supply piping conveys the geothermal water to heat exchangers where the heat is transferred to meet building, hot water, and snowmelt heat loads. The cooled geothermal water is collected by return/collection pipes and injected back into the ground into a similar aquifer.

2.3.2 Production Wells

The source of the geothermal energy used at the Oregon Tech campus is residual volcanic heat, transferred to the water that flows up from several thousand feet deep through a fault that crosses campus. Prior studies indicate that the source water temperature is in excess of 300°F. The source hot water mixes with cooler groundwater to provide water temperature for campus heat of about 192°-196°F. The main production wells for the campus heating system are wells #5 and #6, which have a nominal pumping capacity of 500 GPM and 350 GPM respectively. These geothermal wells were drilled in 1962 and 1963 to supply heat to the then-new Oregon Tech campus buildings.

Production Well #	ODWR Well #	Depth	Static Water Level	Casing Depth	Pump Flow Data
Well 5	KLAM 11830	1716 ft	358 ft below surface	12.75" from +1' to 529'3" 10.75" from +1' to 813'6" 8.625" from 790'6" to 1109' 6.625" from 1068' to 1716'	500 GPM @ 425' TDH 100 HP
Well #6	KLAM 11829	1805 ft	359 ft below surface	12.75" from +1' to 416'4" 10.75" from +1' to 867' 6" 8.625" from ~850' to ~1145' 6.625" from ~1127' to 1805'	325 GPM @ 630' TDH 100 HP

Table 1: Production Well Data

Condition of Wells:

Production Well #5

Well #5 exhibited considerable corrosion of the original 12" casing and 10" casing liner, resulting in cold groundwater intrusion into the well and sediment and scale interfering with pump operation. A contract to repair the well was issued in 2019. Repair and upgrades included:

- New casing with grouting per Oregon Department of Water Resources (ODWR) requirements
- Cleaning of the well to the original depth
- New deep well turbine pump
- Reconditioning of the pump motor
- New well house

PRODUCTION WELL #6

Well#6 is nearly the same age as Well #5 and is expected to have similar age-related problems. Verification of well condition will require removal of the pump and camera inspection of the well. The pump has likely lost efficiency as indicated by the power required to supply the maximum available flow. Existing pump efficiency is estimated to be 52%, compared to better than 75% for a new pump.

Recommendations:

PRODUCTION WELL #5

- No modifications needed

PRODUCTION WELL #6

- Remove pump for well inspection
- Replace casing as indicated per inspection. New work will be required to meet to current OWDR well standards
- Install new pump
- Install new or reconditioned pump motor
- Install new well house

Each well listed above is connected to the geothermal mechanical building's power distribution system. Refer to section 2.3.4 Geothermal Mechanical Building section below for further discussion.

2.3.3 Injection Wells

Originally, the geothermal water was used directly in the building heating equipment, with wastewater discharged to the storm sewer through building roof drains. In 1985 the City of Klamath Falls instituted an ordinance requiring that geothermal waters be reinjected into the same or similar aquifer to better conserve the resource. Oregon Water Resources regulations require the same for all new water rights issued for thermal energy extraction from groundwater. In response to the ordinance, Oregon Tech installed geothermal collection piping and injection wells #1 (1989) and #2 (1992) at the southwest corner of campus.

Condition of Wells:

INJECTION WELL #1:

The ODWR well log shows a 14" outer casing to 73', and a 10" inner casing to 1685', with perforations between 1450' and 1644' Inspection in 2018 showed that the well has significant deterioration of the near-surface outer casing and inner casing. Additionally, the well is significantly obstructed with scale.

Injection Well #2:

The ODWR well log shows a 16" outer casing to 72', and a 10" inner casing to 950', with an open borehole to 992'. Inspection in 2018 showed that the well casing appears to be in good condition. There is some minor scale accumulation inside the casing.

Recommendations:

Injection Well #1

- Clean accumulated scale from inside of the well casing
- Camera inspection of cleaned casing and perforations
- Replace a portion of the inner and outer casing as indicated by the inspection
- Clean perforations as indicated by inspection

Injection Well #2

- Clean accumulated scale from inside of the well casing
- Camera inspection of cleaned casing
- Additional work as indicated by inspection

2.3.4 Geothermal Mechanical Building

The geothermal mechanical building (AKA Heat Exchanger Building) is located at the southwest corner of campus, near the production wells.

The building houses:

- 4000 gal receiving/storage/settling tank receiving flow from the well pumps
- Circulation pump to supply GEO to Crystal Terrace (GEO heat sales customer)
- 280 kW UTC geothermal power generator
- Electrical power supply for well pumps, with variable frequency drives to control pump speed and flow
- Controls to operate wells, pumps, and GEO power generation

The storage tank is a vented tank that receives all the flow from the production wells. A tank level controller attached is used to control pump speed and flow to maintain a tank level setpoint. GEO supply to all uses on campus flows from the tank by gravity, with the total flow determined by the sum of flow demand at each individual heat load.

The geothermal power generator is an Organic Rankine Cycle power plant manufactured by United Technologies Corp. (UTC) that uses geothermal heat to generate electrical power. The power plant generates enough power to operate the production pumps which heat the campus and supply additional power to the campus electrical grid. The heat input for power generation is derived by cooling the geothermal water from about 194°F input to about 165° delivered to campus for heating.

The electrical system for the geothermal mechanical building supports the production well pumps. Should any portion of the geothermal mechanical building's power distribution system fail, heat throughout the campus will be unavailable for the duration of the failure or normal power outage. The

Geothermal Mechanical Building's power distribution system consists of a building service feeder, building transformer, building feeder, building main distribution board, fuses, and manual switches.

Condition of the Geothermal Mechanical Building:

- GEO storage tank:
  - Tank is steel, is open to oxygen from the air through the tank vent, and likely has significant corrosion. There is evidence of leaking from the tank under the insulation.
  - Tank provides only about 5 minutes of storage at the design campus GEO flow
  - Small tank size results in instability in the tank level and production pump control loop
  - Tank elevation is inadequate to supply the new student housing (Center for Sustainable Living) at design heating flow. That resulted in the need for a booster pump station.
  - Tank size does not allow for effective settling and separation of fine sand in the geothermal water, resulting in sediment accumulation in downstream heat exchange equipment.
- Crystal Terrace pump: The pump is in serviceable condition, however, the configuration of the piping leads to inadequate flow to the pump under some conditions.
- UTC power plant: The power plant was installed in 2009 and is still operable. However, there is little technical or maintenance support available as the equipment is no longer manufactured. Evaluation of power production is outside the scope of this study, but the design of improvements to the GEO supply system needs to accommodate power production in some form.
- Electrical System: Generally in good condition; however, does not meet current code, or industry protection standards. Additionally, there are unnecessary fuses, breakers, and a power train that has additional but not redundant equipment. There are multiple points of failure in the system. Some variable frequency drives (VFD) are nearing the end of service life, and/or are no longer manufactured.

Recommendations:

- Replace the GEO tank with a larger approximately 45,000 gallon, in-ground insulated concrete tank located further up the hill. Features/Benefits:
  - More pressure head to supply uses at higher elevations on campus. Eliminates the need for booster pump serving Villages and accommodates the proposed new residence hall
  - More storage volume, ~45 minutes of available heating water
  - More stable level and pump control
  - Corrosion-resistant
  - Better sand separation
- Replace piping and valves
- Replace older pump VFDs
- Consolidate electrical equipment to reduce failure points. Include backup power generation, bypass, and servings switches as part of the consolidation.

2.3.5 Distribution System

The geothermal distribution system is the piping that conveys the hot geothermal fluid from the production wells to point of beneficial heat use and thence to the injection wells for disposal of the cooled fluid. Specific components of the distribution system include:

- Piping from the production wells to a storage and settling tank in the geothermal building
- Gravity flow supply piping from the tank to heat transfer equipment in the buildings
- Gravity flow return/collection piping from the buildings to an injection collection tank
- Pumped or gravity flow from the collection tank to the injection wells

Supply Piping

The original design in the 1960s used direct-buried steel piping, insulated with rigid "foamglass" insulation to distribute the geothermal fluid to the buildings. The experience over the first 17 years of operation was that thermal expansion of the piping created cracks in insulation, introducing groundwater and surface runoff with deicing salts to the exterior of the steel pipe, causing extensive corrosion. The resolution was to replace the steel pipe with fiberglass pipe (FRP) and to route the piping through utility tunnels within the campus (Boyd, March 1999). Currently, the piping from the wells to the heat exchanger building still uses the original steel pipe. There is also some direct-buried steel piping between the heat exchanger building and the campus tunnel system, and some steel pipe within the tunnel. The balance of the GEO supply piping is FRP.

The GEO supply piping includes valves at building connections and strategic locations in the tunnels or outside vaults to isolate sections of the distribution system.

Condition of Supply Piping:

- Wells to Geothermal Mechanical Building: Buried original steel pipe; condition unknown. No leaks have been observed. Well #6 piping is now inaccessible under a new parking lot.
- Geothermal Mechanical Building to campus: Buried, believed to be fiberglass with some sections of steel. Condition unknown, no leaks have been observed
- Supply valve vault in the lawn between Snell and Residence Hall: Fiberglass pipe, butterfly valve is in poor condition, inadequate temporary thrust restraint
- Isolation valves: Generally in poor condition or non-functional. The lack of isolation valves requires that the entire system be shut down and drained to work on the system
- FRP pipe in tunnels: Generally in good condition. Minor leaks at some joints

Recommendations:

- Replace steel piping between wells and Geothermal Mechanical Building
- Repair/ replace piping and valve in supply vault
- Remove GEO valves and connections located above electric panels in the chiller building; replace with continuous pipe section and relocate valve.
- Replace building and in-line isolation valves in tunnels. Consider motorized valves that can be operated without entering tunnels
- Consider a new main 8" supply feed from the Heat Exchanger building, past the site of the proposed new residence hall, to tie into the existing tunnel piping between LRC and Cornett. Add isolation valves so any building can be isolated and adjacent buildings can be fed in

either direction through the supply piping loop. This new supply would add resiliency so a single point of failure is less likely to cause a complete system failure.

Return Piping and Collection System

In the original 1960s design, the geothermal fluid was discharged directly to the building roof drain/ storm sewer system after extracting heat for space heating. A waste geothermal collection system was installed in the late 1980s to collect the water and route it to a 5000-gallon collection tank west of Purvine Hall. The collection system piping is mostly FRP and is mostly installed in the tunnels. There is a short section of 6" steel pipe in the tunnel near the Residence Hall and College Union buildings.

A GEO injection pump station near the collection tank provides additional pressure as needed to discharge the waste GEO into the injection wells. The pumps were replaced in 2018, and the controls were upgraded to variable speed pump control to better match the required flow and pressure boost. If the injection system fails, the collection tank overflows into the storm sewer.

Condition of Return Piping and Collection System:

- Leaking and corrosion in the steel pipe, on the return from the Residence Hall
- FRP pipe in tunnels: Generally in good condition. No leaks were noted.
- Isolation valves at buildings are not operable
- Injection pumps are new and in good shape

Recommendations:

- Replace approximately 30 feet of 6" steel piping in the tunnels
- Replace isolation valves, consider motorized valves to allow isolation of a leak without entering the tunnels

2.3.6 Building Heat Exchange System

The GEO is used for heating the buildings and domestic hot water. Originally, building heat was provided by using the geothermal water directly in the coils of heating equipment. That led to coil failure due to the corrosive nature of the geothermal water. The design was modified to isolate the GEO from a closed-loop building heating water system with a heat exchanger.

A typical building heating system consists of:

- A heat exchanger to transfer heat from the GEO to the building heating water
- Circulation pumps to circulate the building heating water
- A water-to-air heat transfer coil to deliver heat to the building air. A control valve limits the heating water flow based on air temperature
- A fan to circulate the heated air to the rooms
- Electrical power at each building to operate the heating water circulation pumps, fans, and controls

All stages of the building heating process provide opportunities for optimizing the use of renewable geothermal energy to protect buildings and maintain occupant comfort. The building heating systems were generally designed to use 190°F supply water temperature and reduce the water temperature by about 40°F to heat air to maintain a building air temperature of about 72°F. The objective of maintaining 72°F can be accomplished at a lower water temperature by improving the effectiveness of the heat transfer.

At Oregon Tech, most of the buildings were designed to operate on 192°F water from the well. However, they have operated successfully on 165°F supply water leaving the power plant. Newer buildings on the lower (west) end of campus, including Dow, Purvine, and CEET were designed to operate on reduced-temperature return water from the building higher on campus. The heating system at Purvine was designed to operate using 130°F geothermal water.

Planning for future buildings at the Oregon Tech campus needs to consider both available flow and temperature. Improvements to delivery piping and production and injection wells can increase the available flow to campus. Optimizing flow to existing buildings can make existing flow capacity available for new loads. Designing for GEO with lower supply and discharge temperature will make more heat available without increasing flow demand.

Building heat is required for:

- Heating to replace heat loss through the building envelope to the cold outside. Heat demand is proportional to the temperature difference divided by the envelope insulation value.
- Heating of ventilation air
- Heating for morning warm-up after a setback in space temperature when the building is unoccupied.

The campus heating system was designed in the 1960s to support 1960s buildings with relatively minimal insulation and ventilation control. As buildings are upgraded with improved insulation the heat requirement for the building envelope is reduced. Building ventilation improvements such as demand-controlled ventilation and ventilation heat recovery reduce the heat requirement for ventilation. More efficient buildings free up GEO capacity to serve additional buildings.

One significant component of the existing building load is morning warm-up from a night setback. Currently, the maximum GEO system demand occurs during the morning warm-up. Night setback reduces energy use because the temperature difference between the inside of the building and the ambient air is reduced during the setback period. In a conventional heating system, with natural gas or oil as the heat source, then the energy savings directly results in energy cost savings. In the geothermal heating system, the energy itself does not cost anything. What costs money is the power needed to run the pumps and fans to deliver the energy.

In a closed-loop heating water or heating air delivery system, with variable speed pumps and fans, the power to operate the pumps and fans is proportional to the cube of the speed. At 25% speed, the power is 0.25 x 0.25 x 0.25 = 0.0156; or less than 2% of the power at full speed. Operating the system overnight at minimum speed will require less power than operating at full speed for one to two hours for morning warm-up.

Eliminating the night setback and morning warm-up will reduce cooling and heating stress on the buildings and will reduce the maximum heating demand on the GEO heating system. It will also likely reduce the cost of heating.

Details of the condition of specific geothermal building systems are in Table 2 below.

Building	Geothermal Equipment		Heating water		Air Handling	Domestic Hot Water	
	HX	*Piping*	*Pumps[1]*	*Pump Type*	*Fan Type*	*HX*	*Storage Tanks*
Villages	GOOD	GOOD	1 EACH BLDG	CV	CV	GOOD	GOOD
Residence Hall	POOR	GOOD	1	CV	CV	GOOD	GOOD
College Union	GOOD	GOOD	2	CV	VV	GOOD	GOOD
PE	GOOD	GOOD	1	CV	CV	GOOD	GOOD
LRC	POOR	POOR	2	CV	CV	NA/Electric	
Cornett	GOOD	GOOD	2	VV	CV	NA/Electric	
Facilities	POOR	POOR	1	CV	CV	NA/Electric	
Snell	FAIR	FAIR	1	CV	CV	NA/Electric	
Owens	POOR	POOR	1	CV	VV	POOR	POOR
Dow	GOOD	POOR	2	VV	VV	GOOD	GOOD
Semon	GOOD	GOOD	1	CV	CV	GOOD	GOOD
Boivin[2]	GOOD	GOOD	2	VV	VV	GOOD	GOOD
Purvine	GOOD	GOOD	1	CV	VV	NA/Electric	
CEET	GOOD	GOOD	2	VV	VV	GOOD	GOOD

TABLE 2: BUILDING HEATING SYSTEM CONDITION OVERVIEW

[1]Heating Water Pumps: 2 parallel pumps with VFD, with lead/lag control is recommended
[2]Boivin condition reflects upgrades currently under construction

<u>Pump and Fan Type Legend:</u>

CV: Constant volume. Consider upgrading to a variable volume system

VV: Variable volume; preferred for optimum geothermal efficiency

<u>Rating Descriptions:</u>

GOOD: Likely service life > 10 years

FAIR: Nearing the end of service life, consider replacing

POOR: Active corrosion or leaking, beyond service life, replace now

For the Geothermal System to distribute heat throughout each building, electrical power is required. Each building is fed from the 12,470 Volt campus power distribution system. There is only one piece of equipment that controls the entire campus distribution from the incoming utility feeder line. Should this one unit fail, get damaged, and/or otherwise become inoperable, there will be a loss of campus power. This single unit is currently located in the chiller building that houses various piping systems including large, main geothermal lines. In the past, those lines/chillers have leaked and started to flood the electrical equipment. Due to the slight elevation of the equipment (approx. 4 inches above the floor), quick notice and reaction of Oregon Tech facilities staff, and ability at the time to shut down the water flow, the equipment “survived” past flood events. The electrical equipment still experienced water intrusion/damage/dampness, and additionally is beyond its service life, and does not meet current industry standards and codes. Relocation of the chillers, geothermal, cooling towers, and the like is more expensive than relocation and replacement of the electrical equipment, especially since the electrical equipment requires replacement already.

Condition of Building Heating System:

- Heat exchangers at some buildings are currently leaking and need to be replaced; others are new and in good condition.
- Piping and valves associated with heat exchangers are leaking or corroded in some buildings
- Most buildings have a single constant speed, constant flow heating water pump
- Building air handling systems are a mix of constant airflow for older systems and variable airflow for newer systems
- Electrical equipment in the chiller building is beyond its service life and does not meet current code and standards

Recommendations:

- Replace leaking heat exchangers. Size new replacements to accommodate lower GEO supply water temperature.
- Replace leaking or corroded piping and valves associated with heat exchangers.
- Upgrade heating water pumping system to variable-flow with VFD-controlled circulation pumps, lead/lag pumps, and 2-way valves at air handlers
- Upgrade air handling systems to variable air-flow
- Modify controls to minimize morning warm-up heat demand by minimizing night setbacks
- Upgrade air handler ventilation control to provide demand-controlled ventilation
- Replace & relocate electrical equipment currently in the chiller building as noted above.

2.3.7 Snowmelt System

Oregon Tech experiences several snowfall events each winter, and about seven months per year when conditions could be conducive to snow or ice accumulation on outdoor sidewalks and steps. Geothermally-heated thermal snowmelt/de-icing systems are installed in many of the sidewalks and steps which provide these benefits:

- Reduced risk of slip and fall due to icy walking surfaces
- Reduced concrete deterioration from freeze-thaw cycles
- Reduced concrete deterioration and environmental risk from de-icing salt

A thermal snowmelt system works by maintaining a concrete surface temperature of about 38°F; warm enough to melt fresh snow and prevent ice accumulation. The heat load to maintain a clear sidewalk depends on snowfall rate, wind speed, and temperature. The existing snowmelt systems at Oregon Tech and in Klamath Falls are designed for a heat output of about 80 Btu per square ft (Btu/ft^2). That heat output is not adequate to keep up with heavy snowfall but will catch up in a reasonable time. It does prevent ice from sticking to the concrete, making manual removal much easier if needed. 80 Btu/ft^2 is also not able to keep the concrete surface above 32°F in extremely cold weather with high wind. However, snowfall in Klamath Falls does not usually occur in those conditions so the sidewalk would likely be dry.

Snowmelt is a lower priority than building heat, so in cold weather, it may be necessary to curtail snowmelt operation to adequately supply building heat. A standby mode snowmelt operation can maintain some heat in the concrete at a lower heat output than would be required for active melting.

The snowmelt mechanical system consists of a heat exchanger, circulation pump, supply and return mains, distribution headers, and PEX tubing embedded in the sidewalk concrete. The mechanical equipment for the newer, larger, existing snowmelt systems is located in building mechanical rooms. These larger snowmelt systems total about 60,000 ft^2 and include:

- Dow Hall
- Cornett Hall
- CEET
- Center for Sustainable Living

Several smaller, generally older, snowmelt systems are supplied by mechanical equipment located in the utility tunnels. These systems total about 5,000 ft^2 and include:

- Snell steps
- College union and residence hall steps
- Owens steps
- Bovin Ramp

About 40,000 ft^2 of snowmelt tubing has been installed in sidewalks but is not connected to pumps or heat exchange equipment. Most of the supply mains are stubbed into the tunnels, with the original intent of installing equipment in the tunnel to supply the heat.

The total installed snowmelt system area is about 105,000 ft^2. As additional sidewalks are replaced over time, the intent is to include snowmelt in most of the sidewalks. It is likely that an additional 100,000 ft^2 of existing sidewalks could be added, bringing the total to about 200,000 ft^2, not including a new residence hall or other new buildings. At 80 Btu/ft^2, the potential snowmelt heat load would be 16,000,000 Btu/hr.

As buildings become more efficient and as snowmelt area is increased, it is likely that snowmelt will be the largest heat load on the system. Location of the snowmelt systems centralized in building mechanical rooms provides more ability to control snowmelt operation or shed snowmelt load as needed to meet the higher priority building heating load. Also, the removal of snowmelt mechanical equipment from the tunnels will reduce the safety concern of a hot water leak in the tunnel's confined space. Snowmelt supply and return mains can be routed through the tunnels to the service snowmelt connections.

Recommendations:

- Supply snowmelt connections from building mechanical rooms, eliminating pumps and heat exchangers in tunnels
- Connect new and existing tunnel-fed snowmelt systems to new snowmelt supply and return mains routed through the tunnels

- Expand the snowmelt system from the main SW parking lot to the Physical Education building to improve accessibility for athletic events
- Generally supply snowmelt systems from GEO return piping, reducing the impact on required system GEO flow
- Provide controls with the ability to shed snowmelt heating load when required to meet building heating requirements

2.3.8 Domestic Hot Water Systems

GEO heat is used to heat potable water for domestic hot water demands. The major hot water demands are in the residence halls, PE building, and College Union food services. Those heat exchangers and storage tanks are relatively new or have been upgraded recently.

Recommendations:

- The hot water tank and heat exchanger in Owens Hall is in poor condition and should be replaced.

2.4 Critical Nature of Geothermal System to Campus Operations

Virtually all elements of the geothermal system are critical to campus operations. The geothermal system serves as the ONLY source of heating for all significant buildings on campus. Below is a graph of the yearly average temperatures in Klamath Falls:

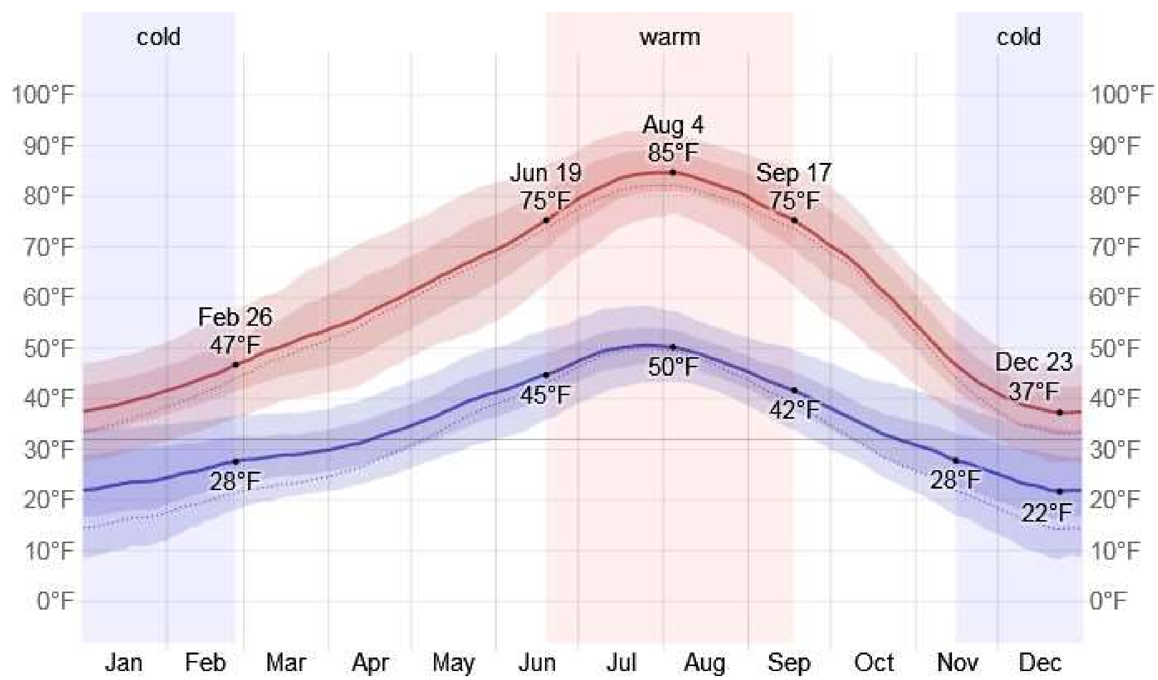


FIGURE 3: AVERAGE YEARLY TEMPERATURES IN KLAMATH FALLS, OR. (SOURCE: WEATHERSPARK.COM)

As can be seen in the above graph, average low temperatures are below freezing for nearly 7 months out of the year. Any downtime or loss of the geothermal heating system during the cold months would have catastrophic consequences not only on the educational function and operation of the campus but would likely result in severe damage to building components and systems resulting in potentially millions of dollars worth of damage.

Below is a list of the major elements of the geothermal system and the resulting consequence if a failure occurs in any one of these elements:

Geothermal Wells

- The loss of both of the production wells would result in no heating water to the campus.
- A loss of just one of the wells would substantially reduce the system capacity and could result in freezing conditions in one or more buildings
- A loss of electrical power at the wells would disable the pumping system resulting in the inability to distribute heat to the buildings.

Geothermal Mechanical Building (AKA Heat Exchanger Building)

- Loss of the GEO storage tank and piping system can lead to the inability to heat campus buildings. There is no backup or standby heating system.

Geothermal Distribution Piping

- Loss of the supply piping system can lead to the inability to heat campus buildings. There is no backup or standby heating system.
- Loss of a section of the piping or a fitting leak can result in loss of the entire system due to a lack of isolation capacity and alternate flow routing.

An example of this occurred on June 14th, 2022. A break from a corroded section of pipe ruptured leaving the campus without water for building heating or domestic hot water.

Figure 4: Ruptured Pipe in Tunnel

- Leaks in the tunnels can lead to personnel life safety risks due to the high temperature and confined space
- Large leaks in the tunnels can lead to building or electrical service flooding

Building Heat Exchange System

- Loss of building heat exchange system can lead to the inability to heat the specific campus building. There is no backup or standby heating system.

3 Sustainability & Financial Benefits of Geothermal

The hot geothermal water source provides a unique benefit to the Oregon Tech and helps reduce educational costs by maintaining a system to fully heat Oregon Tech's entire campus for a nearly insignificant electrical cost to various pumps and wells. The energy source is renewable because the amount of water removed equals the amount of water placed back in.

Provided the system utilizes appropriate materials and is maintained and operated effectively there is no reason to believe the system would not last for another 60 years between major overhauls. The geothermal resource provides a nearly perfect balance for energy because a) what is removed is re-injected, b) there are no emissions, and c) there are no known resource impacts on any biological/ecological systems.

Maintaining the system and addressing the deficiencies is substantially cheaper than replacing the system.

For additional geothermal sustainability, and renewable benefits, see the DOE's GeoVision Report.

4 Summarized Recommendations with Estimated Costs

Note: A more detailed list of the recommended actions and costs can be found in Appendix C.

Production & Injection Wells

Recommended actions include:

- Rebuilding production well #6
- Cleaning and repairing injection well #1
- Cleaning and inspecting injection well #2

The estimated cost for these projects, including construction costs, soft costs, contingency, and other costs is estimated to be $2,553,000

Geothermal Mechanical Building and Main Geothermal Storage and Pumping System

Recommended actions for the production include:

- Replacement of the geothermal water storage tank
- Replacement of piping and valves inside the Geothermal Mechanical Building
- Replacing end-of-life pump speed controllers
- Adding a backup generator to supply power to the geothermal pumping system and controls to maintain heat during power outages

The estimated cost for these projects, including construction costs, soft costs, contingency, and other costs is estimated to be $2,235,000

Geothermal Distribution System

Recommended actions for the production include:

- Replacing the piping between production wells 5 & 6 and the geothermal mechanical building
- Repairing the supply piping and valves near Snell Hall
- Replacing and supplementing the distribution supply and return isolation valves to be able to isolate sections of the system in case of leaks
- Adding a new supply main and return line to the north side of campus to add system redundancy

The estimated cost for these projects, including construction costs, soft costs, contingency, and other costs is estimated to be $5,382,000

Building Heat Exchange System

Recommended actions for the production include:

- Repairing and replacing leaking heat exchangers in the Residence Hall, Learning Resource Center, Facilities, Snell Hall, and Owens Hall
- Upgrading building heating water equipment to provide variable flow circulation with added system monitoring and controls
- Replace the domestic hot water heat exchanger and storage tank in Snell Hall

The estimated cost for these projects, including construction costs, soft costs, contingency, and other costs is estimated to be $1,152,000

Campus Snowmelt System

Recommended actions for the production include:

- Move snowmelt pumps and heat exchangers out of the tunnels into the Purvine mechanical room for most of the system with other building mechanical rooms used as needed.
- Connect snowmelt systems that were installed but never connected, and provide for future snowmelt as sidewalks and stairs are replaced.
- Expand the snowmelt system to improve access between the main SW parking lot and the Physical Education building

The estimated cost for these projects, including construction costs, soft costs, contingency, and other costs is estimated to be $1,697,000

Campus Main Electrical Equipment

Recommended actions for the production include:

- Relocate, and replace the main campus power distribution system switchgear that is located in the same room as a geothermal and chilled water piping system

The estimated cost for these projects, including construction costs, soft costs, contingency, and other costs is estimated to be $1,932,000

The total estimated cost of all recommendations is $14,951,000 including construction costs, soft costs, contingency, and other costs.

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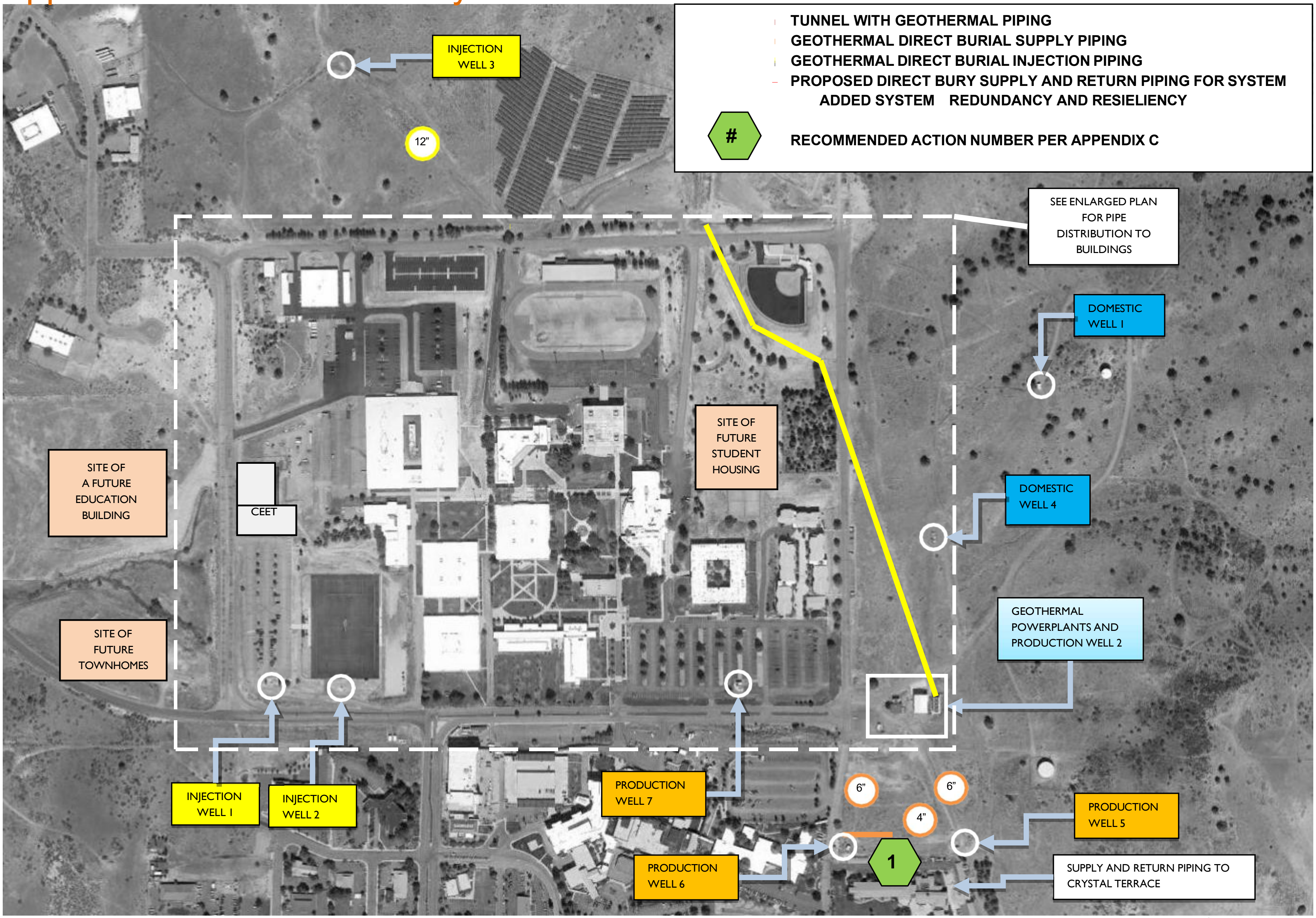
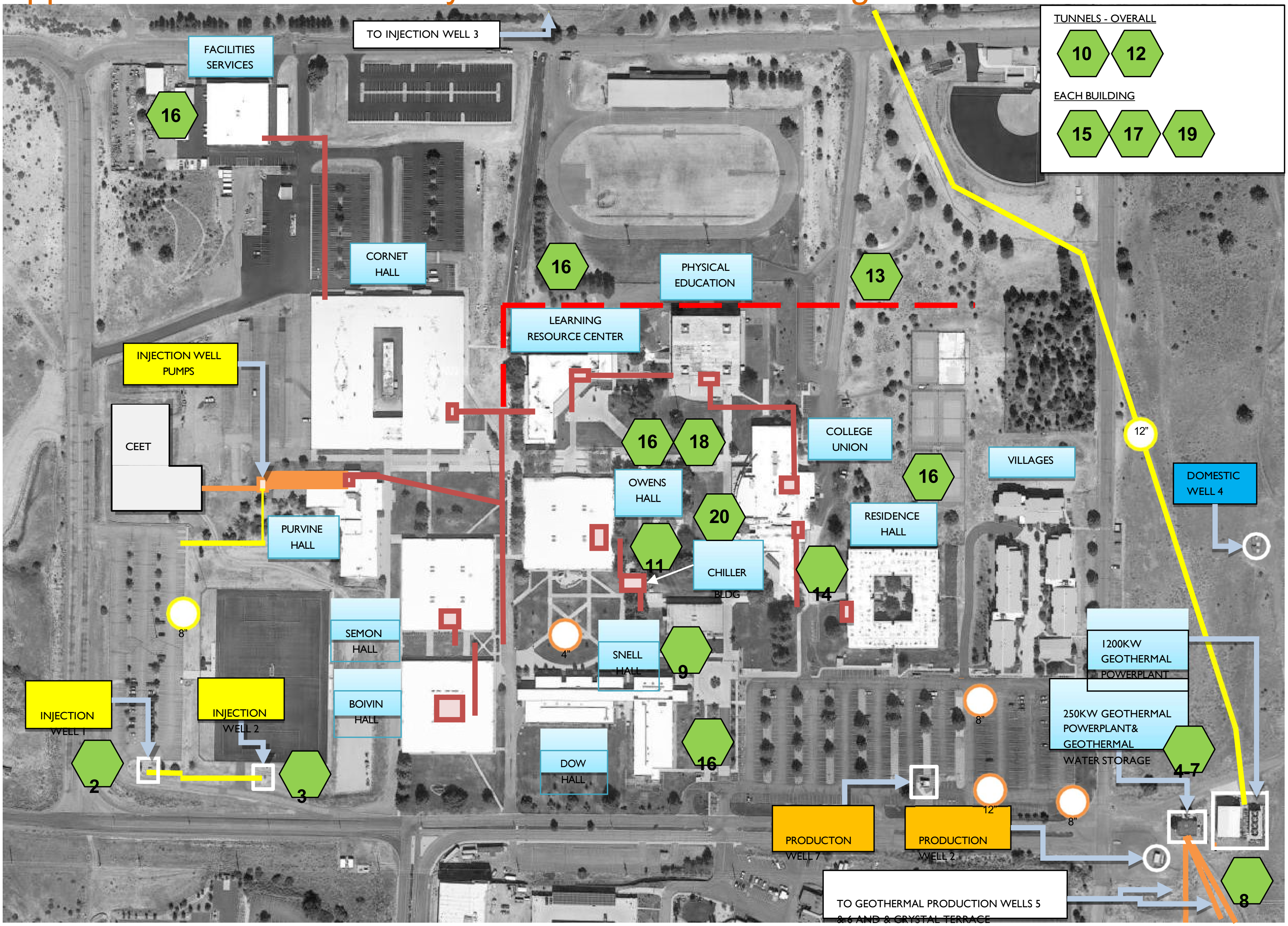
Appendix A: Acronyms

BLM	Bureau of Land Management (U.S. Department of the interior)
Btu	british thermal units
CAPEX	capital expenditure
CEET	Oregon Tech Center for Excellence in Engineering and Technology
CO_2	carbon dioxide
COP	coefficient of performance
DOE	U.S. Department of Energy
EER	energy efficiency ratio
EPA	Environmental Protection Agency
FRP	fiberglass reinforced plastic
FORGE	Frontier Observatory for Research in Geothermal Energy
GEO	geothermal or referring to the geothermal system
GHG	greenhouse gas(es)
GHP	geothermal heat pump
GHX	ground heat exchanger
HVAC	heating, ventilation, and air conditioning
HX	heat exchanger
kW	kilowatt(s)
NO_x	nitrogen oxides
ODWR	Oregon Department of Water Resources
PEX	cross-linked polyethylene
ROI	Return on investment
SO_2	sulfur dioxide
TDH	total dynamic head
TES	thermal energy storage
USGS	U.S. Geological Survey
VAV	variable-air volume
VFD	variable frequency drive

Appendix B1: Geothermal System Distribution – Overall Site



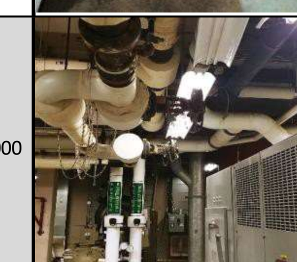
Appendix B2: Geothermal System Distribution – Enlarged

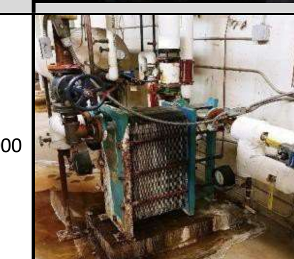
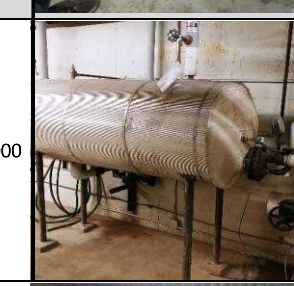


Appendix C: Detailed Evaluation Cost Estimates

Oregon Tech - Geothermal System Evaluation and Estimates

		Observed Issues and Recommended Remedy	Rationale for Recommendation	Benefits of Recommended Action				Cost to Implement (in 2022 Dollars) Total rounded to nearest $5,000 increment					Supporting Photos
Item #	Location/System Element	Description of Recommended Action	Why is this recommended	Improved Safety	Improves System Resiliency & Redundancy	Increases System Capacity	Reduces System Maintenance Costs	Construction Estimate	Design/Soft Costs	Contingency	Other Costs	TOTAL COSTS	Photos
1	Production and injection wells	Rebuild Well #6: new casing as required, new pump, new or reconditioned pump motor, new wellhouse.	Deterioration of well presents reliabilty problems, End of life	-	YES	POTENTIALLY	YES	$ 1,000,000	$ 200,000	$ 120,000	$ 60,000	$ 1,380,000	
2	Wells	Clean/ repair Inj Well #1. Access for repair will probably require replacement of the well vault.	Well is unuseable die to plugging and casing corrosion.	YES	YES	YES	YES	$ 750,000	$ 150,000	$ 90,000	$ 45,000	$ 1,035,000	 
3	Wells	Clean Inj Well #2	Remove scale accumulation in well	-	YES	-	-	$ 100,000	$ 20,000	$ 12,000	$ 6,000	$ 138,000	
4	Geothermal Mechanical Building	New concrete GEO storage/settling tank, to be located in-ground at about 20' higher elevation.	Existing tank is corroded and at risk of failure. New tank will provide more capacity, more head to better serve campus, better sand removal	YES	YES	YES	YES	$ 850,000	$ 170,000	$ 102,000	$ 51,000	$ 1,173,000	
5	Geothermal Mechanical Building	Replace piping and valves inside geothermal building. Accommodate power generation, heat sales to Crystal Terrace, second supply main to campus	Existing piping has been in service for 60 years. Removal of tank will allow reconfiguration of piping	YES	YES	YES	YES	$ 180,000	$ 36,000	$ 21,600	$ 10,800	$ 248,000	
6	Geothermal Mechanical Building	Replace older well pump speed controllers (variable frequency drives) as needed	End of life and reliability	-	YES	YES	YES	$ 40,000	$ 8,000	$ 4,800	$ 2,400	$ 55,000	

		Observed Issues and Recommended Remedy	Rationale for Recommendation	Benefits of Recommended Action				Cost to Implement (in 2022 Dollars) Total rounded to nearest $5,000 increment					Supporting Photos
Item #	Location/System Element	Description of Recommended Action	Why is this recommended	Improved Safety	Improves System Resiliency & Redundancy	Increases System Capacity	Reduces System Maintenance Costs	Construction Estimate	Design/Soft Costs	Contingency	Other Costs	TOTAL COSTS	Photos
7	Geothermal Mechanical Building Electrical	Provide ~500kW backup electrical generator at building supplying the Geothermal Heating Wells. Generator will also connect to head-end Geothermal controls. Replace electrical panels.	No campus heating will be available if a single building loses power, and/or has electrical equipment failure. Power at heat-exchange building is critical to entire system operation.	YES	YES	YES	YES	$ 550,000	$ 110,000	$ 66,000	$ 33,000	$ 759,000	
8	GEO Supply Piping	Replace steel piping between wells #5, #6 and Geothermal Mechanical Building. Re-route Well #6 piping around parking lot. Include power and communications conduits.	Piping is about 60 years old, and may be significantly corroded.	YES	YES	YES	YES	$ 400,000	$ 80,000	$ 48,000	$ 24,000	$ 552,000	
9	GEO Supply Piping	Repair GEO supply piping and valve in the 8" GEO supply pipe vault near Snell Hall	Valve is inoperable, pipe connections are questionable	YES	YES	-	-	$ 450,000	$ 90,000	$ 54,000	$ 27,000	$ 621,000	
10	GEO Supply Piping	Replace GEO isolation valves in tunnels. Use power operated valves to allow isolation of a leak without entering the tunnel.	Allows work on a segment of the supply system without shutting off entire system.	YES	YES	-	YES	$ 235,000	$ 47,000	$ 28,200	$ 14,100	$ 324,000	
11	GEO Supply Piping	Remove three (3) 6" valves in geothermal piping located above the electrical switchgear in chiller building. Replace with continuous pipe.	Improved safety by ruducing chance of a leak above the main electrical switchgear. See also Item #20.	YES	-	-	YES	$ 45,000	$ 9,000	$ 5,400	$ 2,700	$ 62,000	
12	GEO Supply Piping	Repair leaks in fiberglass piping joints in tunnels, ~20 places	Improved safety, reduce moisture in tunnels	YES	-	-	YES	$ 15,000	$ 3,000	$ 1,800	$ 900	$ 21,000	

		Observed Issues and Recommended Remedy	Rationale for Recommendation	Benefits of Recommended Action				Cost to Implement (in 2022 Dollars) Total rounded to nearest $5,000 increment					Supporting Photos
Item #	Location/System Element	Description of Recommended Action	Why is this recommended	Improved Safety	Improves System Resiliency & Redundancy	Increases System Capacity	Reduces System Maintenance Costs	Construction Estimate	Design/Soft Costs	Contingency	Other Costs	TOTAL COSTS	Photos
13	GEO Supply and Return Piping	Add new 8" supply main from Geothermal Mechanical Building to the North side of campus. Connect into existing piping in tunnel between LRC and Cornett. Add valves to allow building to feed either direction through a loop. Include 6" return pipe starting at Villages connection.	Provides increased capacity, improved resiliance. Could facilitate supplying hotter geothermal water to select buildings for adsorption cooling. Will supply capacity for planned residence hall and other potential future buildings.	YES	YES	YES	YES	$ 2,700,000	$ 540,000	$ 324,000	$ 162,000	$ 3,726,000	
14	GEO Return Piping	Replace about 30' of 6" steel return pipe with FRP pipe and fittings in tunnel where return from residence hall joins return from College Union.	This is the only steel pipe in the tunnel; the rest is FRP. Pipe is corroded, and will continute to be subject to corrosion. Changing to FRP pipe will orevent corrosion and have a longer lifespan.	YES	-	-	-	$ 30,000	$ 6,000	$ 3,600	$ 1,800	$ 41,000	
15	GEO Return Piping	Replace building isolation valves	Valves are non-functional. Required to allow working on building piping without shutting off entire system.	YES	-	-	YES	$ 25,000	$ 5,000	$ 3,000	$ 1,500	$ 35,000	
16	Building Heating	Repair or replace leaking heat exchangers in Residence Hall, Learning Resource Center, Facilities, Snell Hall, and Owens Hall buildings. Replace associated GEO piping and valves	Leaking is a safety hazard, introduces moisture in buildings. Leaking heat exchangers prevent operation of power generation because the leakage is worse at lower water temperature.	YES	YES	YES	YES	$ 350,000	$ 70,000	$ 42,000	$ 21,000	$ 483,000	
17	Building Heating	Upgrade building heating water equipment and controls to provide variable-flow heating water circulation; with 2-way valves at heating coils, lead-lag variable-speed heating water pumps	Improved reliability and better utilization of available GEO resource, reduced pumping power	YES	YES	YES	YES	$ 440,000	$ 88,000	$ 52,800	$ 26,400	$ 607,000	
18	Owens Building Domestic Hot Water	Replace domestic hot water heat exchanger and storage tank at Owens	Tank is likely to fail due to corrosion	YES	YES	YES	YES	$ 45,000	$ 9,000	$ 5,400	$ 2,700	$ 62,000	

		Observed Issues and Recommended Remedy	Rationale for Recommendation	Benefits of Recommended Action				Cost to Implement (in 2022 Dollars) Total rounded to nearest $5,000 increment					Supporting Photos
Item #	Location/System Element	Description of Recommended Action	Why is this recommended	Improved Safety	Improves System Resiliency & Redundancy	Increases System Capacity	Reduces System Maintenance Costs	Construction Estimate	Design/Soft Costs	Contingency	Other Costs	TOTAL COSTS	Photos
19	Snowmelt	Move snowmelt pumps and heat exchangers out of the tunnels into building mechanical rooms, connect snowmelt systems that were installed and never connected, expand the snowmelt system from the main SE parking lot to the Physical Education building. Includes 35,000 SF of additional snowmelt.	Improved safety by moving equipment out of the confined-space tunnels, Improved control, increased capacity by allowing use of return water	YES	YES	YES	YES	$ 1,230,000	$ 246,000	$ 147,600	$ 73,800	$ 1,697,000	
20	Campus Main Electrical Gear in Chiller Building	Relocate, and Replace the Main Campus Power Distribution System Switchgear that is located in the same room as a geothermal and chilled water piping system. Some Geothermal piping is routed over the switchgear which is not permitted by current code. Addtionally, electrical equipment is at end of expected service life. This equipment is for the 12,470 Volt Power Distibution System.	The campus main electrical equipment has begun to flood in the past; and is subject to complete failure bringing down the majority of the campus. End of Life electrical gear does not meet current code, industry standards, and subjects all connected facilities to extended power loss, and heat distribution failure.	YES	YES	-	-	$ 1,400,000	$ 280,000	$ 168,000	$ 84,000	$ 1,932,000	 
							TOTALS	$ 10,835,000	$ 2,167,000	$ 1,300,200	$ 650,100	$ 14,951,000	

11.3 Appendices

Technical Examination of Geothermal Electrical Power Generation Plant — EDT Forensic Engineering and Consulting

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EDT
Forensic Engineering & Consulting

SEATTLE-TACOMA DISTRICT OFFICE
2006 48th Ave. Ct. E
Fife, Washington 98424
(253) 345-5187

June 16, 2023

REPORT TO: Mr. Michael Shea
Soderstrom Architects
1331 NW Lovejoy Street, #775
Portland, Oregon 97209

FROM: David S. Williams, P.E.

REFERENCE: Cause of issues with geothermal power plant
Location of Matter: Klamath Falls, Oregon
EDT File Number: STA0809-75995

REGISTERED PROFESSIONAL ENGINEER
91206PE
OREGON
MAY 10, 2016
DAVID S. WILLIAMS
RENEws: 51301 w2rw1

The following is a report concerning a technical examination of a geothermal electrical power generation plant at a university in Klamath Falls, Oregon. The geothermal electrical power generation plant is not functional. The purpose of this examination has been to review the status of the geothermal electrical power generation plant, determine the cause of issues encountered while operating, and assess the ability to achieve operational status.

The conclusions and opinions stated herein are based on information available to the investigation as of this writing. It is conceivable that additional information may be forthcoming which bears on these conclusions and opinions. Therefore, the right is reserved to review and modify all conclusions and opinions at any future point in time should, in fact, additional information become available.

For convenience in presentation, the report is divided into sections as follows:

A. Background Information

B. Work of Investigation

C. Observations

D. Discussion

E. Conclusions

F. Recommendations

Figures

Appendices:

I. Relevant Contract Details

II. Results of Laboratory Analysis

III. Mathematical Models of the ORPP

IV. Water analysis for well 4

A. BACKGROUND INFORMATION

Oregon Institute of Technology (OIT) has an Organic Rankine Cycle geothermal electrical power generation plant (ORPP) at its campus in Klamath Falls, Oregon. On March 30, 2023, Engineering Design & Testing Corp. (EDT) was contacted to determine the cause of issues OIT has been experiencing with the ORPP.

OIT opened in 1947 and currently has 4,910 enrolled students with a student-to-faculty ratio of 16:1. OIT is a polytechnic university specializing in engineering, technology, healthcare, business, communication, and applied sciences. OIT's location over some of the most accessible geothermal hot water sources in North America has enabled it to become one of the leading sources of geothermal research. OIT currently uses geothermal wells for campus heating, hot water generation, and power generation.

Organic Rankine Cycle (ORC) power generation was invented in the late 1950's as a means of generating electrical power using water that is not hot enough to flash to steam. A fluid that has a lower flash point temperature, but high molecular mass (working fluid) is used. The working fluid used in the ORPP is pentafluoropropane (R245fa). The high molecular mass allows the working fluid to retain a greater amount of heat. Instead of flashing water to steam and sending the steam to a turbine, ORC plants transfer the heat from the geothermal water to the working fluid and then it travels to a turbine as vapor. After leaving the turbine, the working fluid is condensed to liquid using water from a cooling tower. Water evaporates away in the cooling tower and is replenished with water from a make-up water well. A pump is used to raise the pressure of the working fluid and the high-pressure liquid working fluid is then sent to a heat exchanger (evaporator/boiler) where the geothermal water gives up its heat, flashing the working fluid to vapor. Although this is a simplistic description of an ORC, it describes the basics of the process.

Geothermal wells used for ORC have at least two wells. That is, there is a production well where the hot water is extracted from the ground, and at least one injection well where the lower-temperature water is reinjected into the ground. The injection wells are located in an area where the water table temperature is lower than at the production well site but picks-up heat as it moves through the ground flowing back toward the production well. OIT's power generation well (well 7) has a depth of 5,402 feet and produces 2,000 gallons per minute (gpm) of water at 195 °F. The make-up water well (well 4) has a depth of 1,224 feet and produces 400 gpm of water at 92 °F.

In September of 2011, OIT entered into contract with Johnson Controls, Inc. (JCI) of Milwaukie, Oregon, to design and build the ORPP. A summary of relevant details in the contract are contained in Appendix I. Substantial completion of the ORPP was scheduled to be on March 3, 2013. JCI provided a document with the following sequence of events:

- Well issues lasting from 2012 until December 2014
- Leaks found and corrected through February 2015
- Working fluid pump issues through February 2016
- Blockages in evaporator prevent testing through mid-April 2016
- Working fluid feed pump issues and working fluid leaks through January 2017
- Bad bearings in generator and turbine through October 2017
- Additional bad bearing through July 2018
- Gasket issues through mid-April 2019
- Various electrical issues throughout the above timeline

Work stopped in mid-April 2019. It is understood that JCI proposed a treatment plant for the make-up water from well 4 indicating that the source of blockages in the system are due to hard water.

B. WORK OF INVESTIGATION

On April 19, 2023, EDT examined the ORPP and another ORC electrical power generation plant on the OIT campus. As part of this examination, photographs were taken, Messrs. James Lake and Thom Darrah, employees of OIT, provided background information. The contract between OIT and JCI was reviewed (Appendix I). Samples of blockage material were analyzed, and the results are included in Appendix II. Mathematical Models of the ORPP and cooling tower were generated and are included in Appendix III. Literature on Pulse Wave Technology was reviewed. Water analysis data for well 4 was obtained and is included in Appendix IV.

C. OBSERVATIONS

1. At the time of the examination, the ORPP was partly disassembled and not being used. The ORPP contains two power generation portions (plant A and plant B). Plant A is shown to be capable of generating 1,000 kilowatts (kW) of electrical power and plant B is shown to be capable of generating 750 kW of electrical power. Plants A and B are fitted with Clearwater Systems Corp. Dolphin Series 3000 pulsed wave water treatment devices. The anticipated actual power output of plants A and B was between 1,441 kW and 1,232 kW with parasitic loads of 504 kW. The driving factor responsible for the variation in power output is outside temperature. In months when the high outside temperature is not above 65 °F, the power output is maximum. In July, when the high temperature is 86 °F, the output is reduced by almost 15% (Figures 1 - 6).

2. Much of the electrical wiring was not routed through conduit and was strewn about in a haphazard manner. There had been several electrical issues and covers for electrical wire trays were removed. Several wires were not connected (Figures 7 – 11).

3. Water from well 7 was being used in another ORC plant (plant C). Plant C is shown to be capable of generating 225 kW of electrical power. Plant C is fitted with an Evapco Pulse-Pure pulse wave water treatment device (Figures 12 – 14).

4. The working fluid leaks were documented inside a control cabinet. The leaks in plant A were extensive and related to piping and equipment connections (Figure 15).

5. The design flow rates, temperatures, and pressures of all fluids were used in generating baseline mathematical models of plants A and B modelled as a single unit for simplicity (Figures 16 – 18).

6. Samples of material removed from blocked heat exchangers were sent to Triclinic Labs of Lafayette, Indiana. The SEM and EDX-STD tests showed the material that had deposited as scale was consistent with calcium carbonate (limestone). The silicon content of the first material was 0.2% by weight. The second sample that had been a loose accumulation similar to a rock was consistent with calcium carbonate and oxidized iron. The silicon concentration of the second sample was 1% by weight Appendix II.

7. Plant C uses make-up water from well 4.

8. When the ORPP was operating, the power output was verified to match the advertised quantities and the make-up water demand was 80,000 gallons per day.

9. The mathematical models of the ORPP show that the performance of the system as predicted by JCI is consistent with calculated values (Appendix III).

10. The pulse wave water treatment device technology was invented by Clearwater Systems Corp. which no longer exists as it was purchased by Evapco and the technology was incorporated into their Pulse-Pure device, used in plant C.

11. Plant C operates without major issues and its heat exchangers require cleaning twice a year due to fouling. The fouling is due to limestone from the make-up water building-up as scale.

12. It is understood that while the ORPP was being run, the Dolphin 3000 water treatment devices had not been energized.

13. Plant C does not incorporate the preheat recuperating stages that the ORPP does. The working fluid of the ORPP travels from the pump through a recuperator then through a preheater, then through the boiler, then through the turbine, then through a condenser. The preheater, recuperator, and condenser are all heat exchangers (Figure 20).

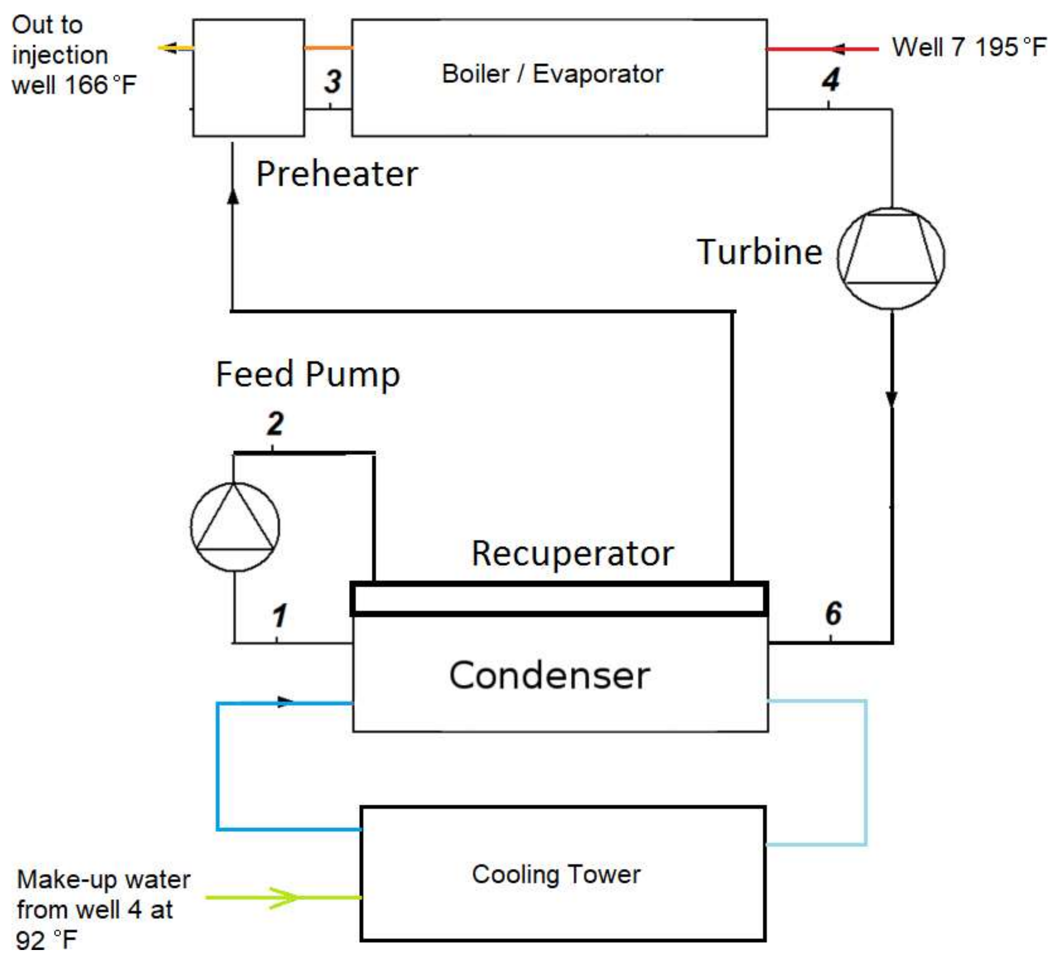
14. The water quality testing of well 4 showed elevated limestone and a relatively small amount of iron (Appendix IV).

15. The working fluid feed pumps (feed pumps) had issues with cavitation on startup. JCI was working to switch the pump types and change the orientation of the pumps to eliminate the cavitation. It was found that there was a minimum working fluid level required in the boiler in order to prevent cavitation. It is noted that the phase change temperature for plant B is lower than for plant A which means that the positive pressure at plant B feed pumps will be less than in plant A.

16. At some point, chemical treatment of the make-up water from well 4 was attempted. Chemical treatment was not successful.

D. DISCUSSION

The following is a simplified diagram of the ORPP.



When construction of the ORPP was completed, well 7 was experiencing malfunctions with its well pumps. After two attempts at using well pumps from Hydro Resources of Winnemucca, Nevada, the decision was made to purchase a pump from another company which worked as advertised and has not experienced malfunctions. The well 7 issues resulted in an almost 2-year delay. During that time, the ORPP system could not be operated. It is reasonable to expect that during such a delay, JCI project team cohesiveness would deteriorate. When the

ORPP was brought online, several leaks were found, many of which were there the entire time but due to the loss of team cohesiveness, JCI's response was not ideal. However, there is no evidence that the leaks cannot be corrected and maintained with regular maintenance.

The feed pump issues have to do with cavitation. Pump cavitation has to do with pump design, placement, suction head, and controls. For the ORPP, the design of the feed pumps was defective and had to be changed. JCI was correcting the feed pump issues but they did not reinstall them. If the ORPP is to be made operational, JCI will need to ensure the feed pumps operate as specified.

Recall that plant C uses the same production well and the same make-up water well as the ORPP. Plant C operates without major issues and requires its heat exchangers to be cleaned twice a year. Plant C uses pulse wave technology which according to literature from the manufacturer, prevents the majority of scale build-up. The technology is relatively new but is being used in many systems with success. When the ORPP was being operated, the pulse wave water treatment devices were not energized. Despite the addition of heat exchangers on the ORPP, the single significant difference is the lack of operation of the pulse wave water treatment devices when the ORPP was operating. Therefore, it is reasonable to conclude that with respect to fouling, the ORPP should expect to have similar maintenance requirements as plant C.

There are disconnected wires, and the routing of wiring is untidy. There had been electrical issues and it is not surprising given the haphazard manner in which many wires were routed. However, correcting electrical issues is feasible and protection of wiring that is not routed in conduit is possible using specific training techniques. Therefore, issues with electrical wiring can be corrected.

Both generators and one turbine experienced bearing issues. Recall that the system spent long periods of time non-operational. It is reasonable to expect bearings to experience issues when they sit idle for extended periods. It is not expected that there would be increased bearing issues on the generators and turbines if the ORPP was operational.

The analysis of the second sample of material taken from the heat exchangers of the ORPP showed that, there was iron oxide. While the water analysis of well 4 showed some iron, it was not a large amount. When well 4 is not used for extended periods, the pipes do not remain full and the unwetted surfaces oxidize. The relatively small amount of iron in the well's fast flowing areas is rapidly depleted as the well is used. When the well is stagnant, iron from areas where flow is normally low, oxidizes and precipitates out in larger amounts. When the well is used following extended down-time, much of the iron oxide in the well and oxidized layer on the piping will come out and will tend to be deposited in the heat exchangers. It is important to note that the material containing iron oxide was not deposited as scale but rather lumped together. The pulse wave technology prevents scale build-up from limestone constituents and not iron oxide or silicon. However, the lumped-together portions do not result in the same amount of fouling as scale from limestone and the silicon concentration is very low. If after long periods of unuse, the initial discharge of water from well 4 is to waste, the excess levels of iron oxide would not be deposited in the heat exchangers. Therefore, if the ORPP was kept operational, iron oxide deposits are not expected to be a source of significant fouling.

The mathematical models show that the cooling tower is capable of condensing the working fluid on even the hottest of days, albeit at a reduced capacity. However, it is possible that the pulse wave technology will not affect what happens in the cooling tower. Therefore, deposits from limestone are expected to be high in the cooling tower. Despite this, during times when half of the cooling tower can be shut down due to low demand, rigorous cleaning can be completed one-half at a time. Therefore, it is reasonable to expect that a rigorous maintenance routine on the cooling tower can allow for continuous operation of the ORPP.

The ORPP is capable of generating power levels as described by JCI. JCI needs to provide a plan for reassembly, leak checks, functional testing of the generators and turbines, and establishment of operational parameters that yield the most robust operating envelope. This robust operating envelope may be outside the most efficient at which the ORPP is capable, which may mean a net output loss. Additional maintenance and operational changes may be acceptable if they resulted in a net decrease of less than 10%. An example of operational changes is related to the feed pumps. The lower pressure of plant B results in an increased risk of cavitation in the feed pumps. Success in plant A feed pumps should not be used to justify expectations for plant B. If the risk of cavitation of the feed pumps for plant B cannot be eliminated, it is possible for JCI to adjust the operating pressure of plant B to reduce the chance of cavitation. Making changes to the pressure in plant B would affect temperatures and pressures in many other areas as well, which could lead to a loss of power generation capability. However, robustness is itself a cost avoidance, and such changes must be considered.

One of the things attempted in the ORPP was to use chemicals to reduce fouling in the heat exchangers. Chemical treatment of the make-up water was not successful. Since plant C does not use any form of chemical treatment of the make-up water from well 4, the ORPP should not need to use chemicals for anything except during periodic cleaning of the heat exchangers.

If the ORPP is to be made operational, priority should be placed on the items that would take the longest to correct. For example, issues with the generator and turbine bearings need to be identified first. During reassembly, all gaskets should be replaced to eliminate as many leaks as possible but scheduled so that completion of that work coincides closely with startup. All electrical wiring should be checked for continuity, tightness at terminal blocks, and correct shield grounding. Electrical wiring checks should begin as soon as possible. If JCI has verified the feed pump issues have been corrected, then they should be installed when it fits the schedule of piping reassembly.

Plant C cleans the heat exchangers twice each year. For the ORPP, the initial cleaning should be scheduled twice as often and then adjusted over time to yield similar results as plant C.

In summary, the ORPP does have the capability of power generation as quoted by JCI albeit at a slightly reduced amount should some unknowns regarding the feed pumps require it. The physical limitations of the ORPP such as leaks and wiring issues can be corrected with typical methods. The make-up water from well 4 can be used, provided the pulse wave devices are properly energized.

E. CONCLUSIONS

1. There is no evidence that the leaks cannot be corrected and maintained with regular maintenance.

2. JCI will need to ensure the feed pumps operate as specified.

3. With respect to fouling, the ORPP should expect to have similar maintenance requirements as plant C.

4. Issues with electrical wiring can be corrected.

5. It is not expected that there would be increased bearing issues on the generators and turbines if the ORPP was operational.

6. If the ORPP was kept operational, iron oxide deposits are not expected to be a source of significant fouling.

7. A rigorous maintenance routine on the cooling tower can allow for continuous operation of the ORPP.

8. Minor changes to the operation of the ORPP resulting in reduced output should be considered in order to make a more robust system.

9. The ORPP should not need to use chemicals for anything except during periodic cleaning of the heat exchangers.

F. RECOMMENDATIONS

If the ORPP is to be made operational, priority should be placed on the items that would take the longest to correct. For example, issues with the generator and turbine bearings need to be identified first. During reassembly, all gaskets should be replaced to eliminate as many leaks as possible but scheduled so that completion of that work coincides closely with startup. All electrical wiring should be checked for continuity, tightness at terminal blocks, and correct shield grounding. Electrical wiring checks should begin as soon as possible. If JCI has verified the feed pump issues have been corrected, then they should be installed when it fits the schedule of piping reassembly.

Plant C cleans the heat exchangers twice each year. For the ORPP, the initial cleaning should be scheduled twice as often and then adjusted over time to yield similar results as plant C.

In summary, the ORPP does have the capability of power generation as quoted by JCI albeit at a slightly reduced amount should some unknowns regarding the feed pumps require it. The physical limitations of the ORPP such as leaks and wiring issues can be corrected with typical methods. The make-up water from well 4 can be used, provided the pulse wave devices are properly energized.

FIGURES

Figure 1	Inside the ORPP building showing partly disassembled system Arrow 1: Plant A Arrow 2: Plant B

Figure 2	The opposite end as shown in Figure 1 showing partly disassembled system

Figure 3	Feed pumps not installed

Figure 4	View outside the ORPP building showing covers and piping removed from system

Figure 5	View inside ORPP building Arrow 1: Piping disconnected Arrows 2: Dolphin 3000 pulse wave devices

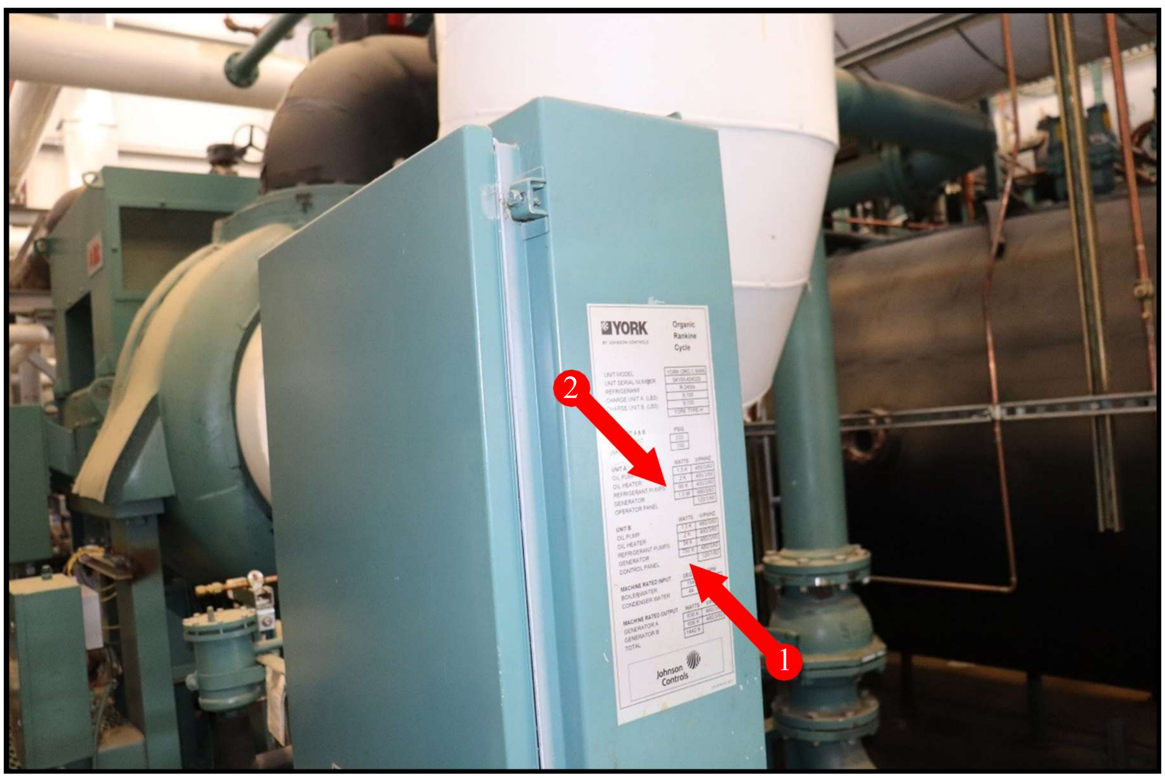


Figure 6	Nameplate for ORPP Arrow 1: Plant B 750 kW Arrow 2: Plant A 1,000 kW

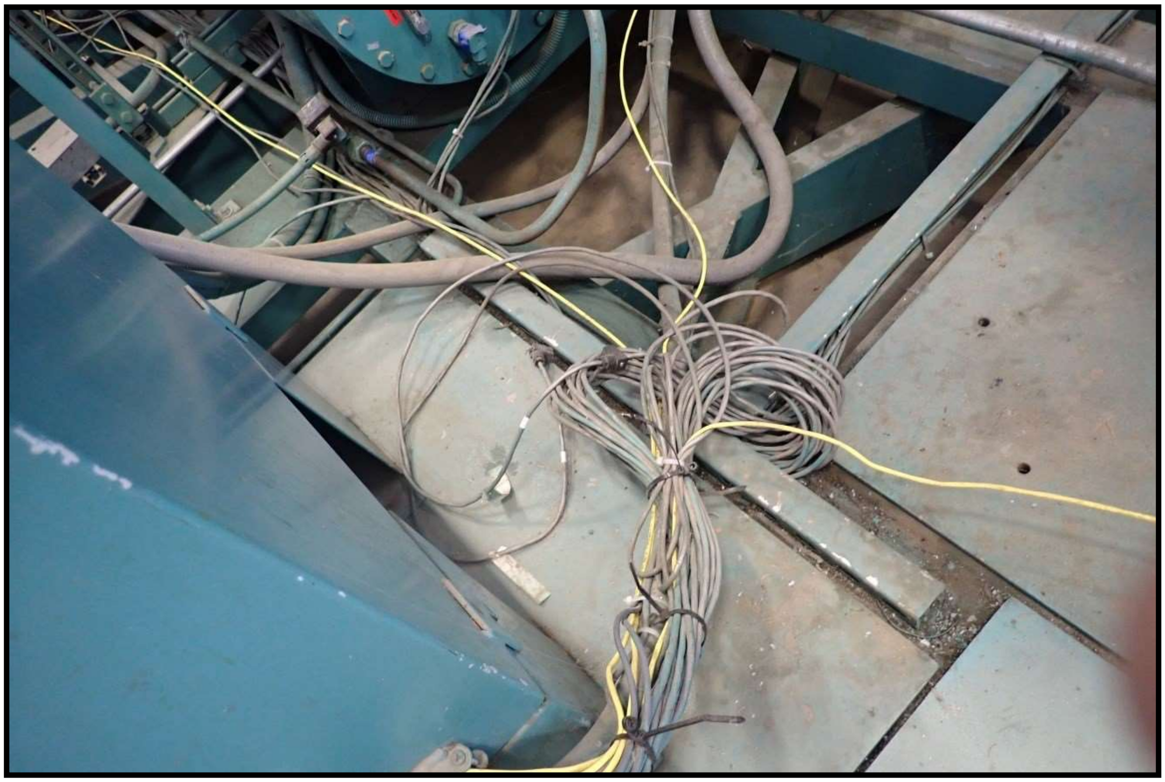


Figure 7	View of ORPP behind a control cabinet showing wires not in conduit and strewn about haphazardly

Figure 8	Alternate view of ORPP showing wires not in conduit and strewn about haphazardly

Figure 9	Control box with cover removed

Figure 10	Another control box with door open, arrow points to wireway with cover removed and wires pulled out

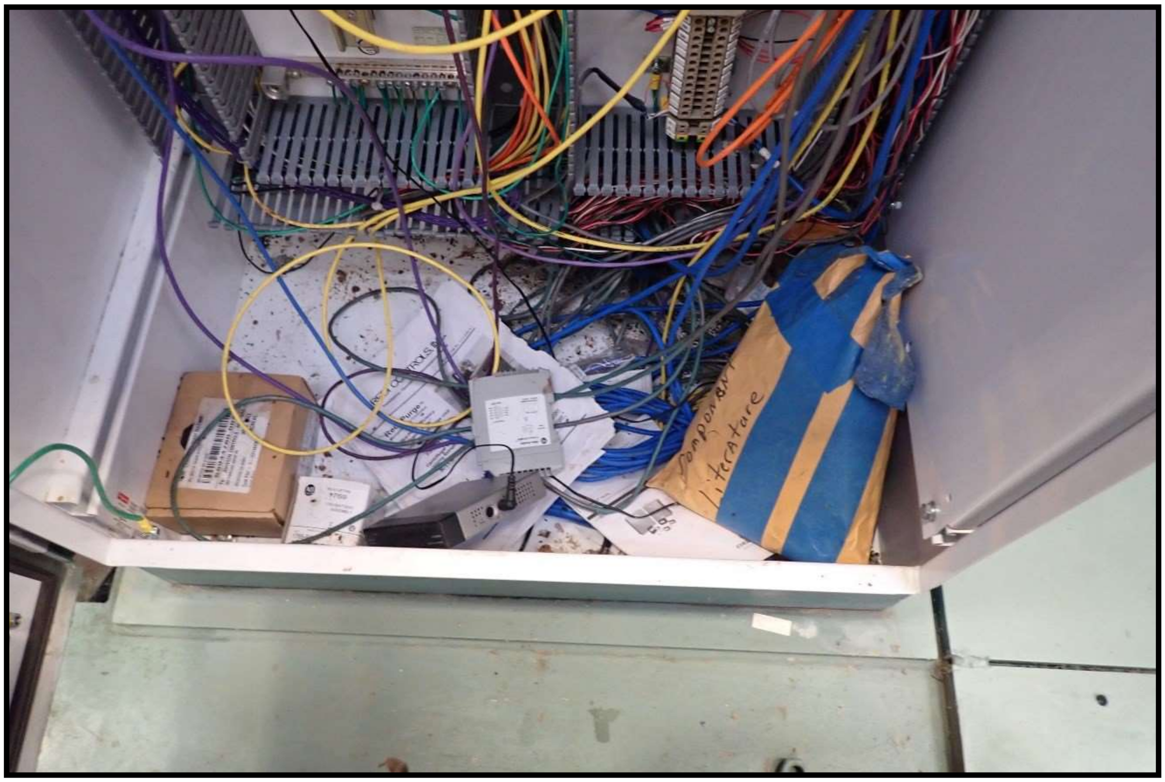


Figure 11	Wires inside a control cabinet not restrained in wireways, wires and debris in bottom

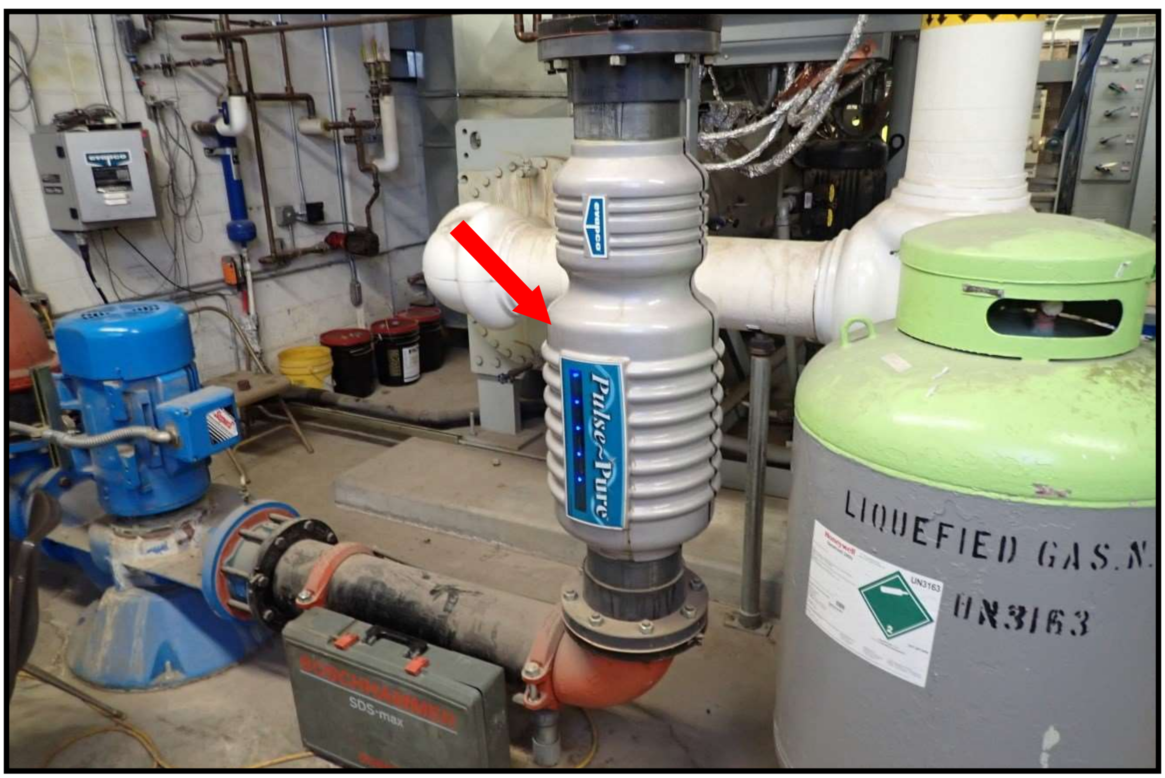


Figure 12	View inside plant C building, arrow points to the pulse wave water treatment device from Evapco

Figure 13 Alternate view of plant C

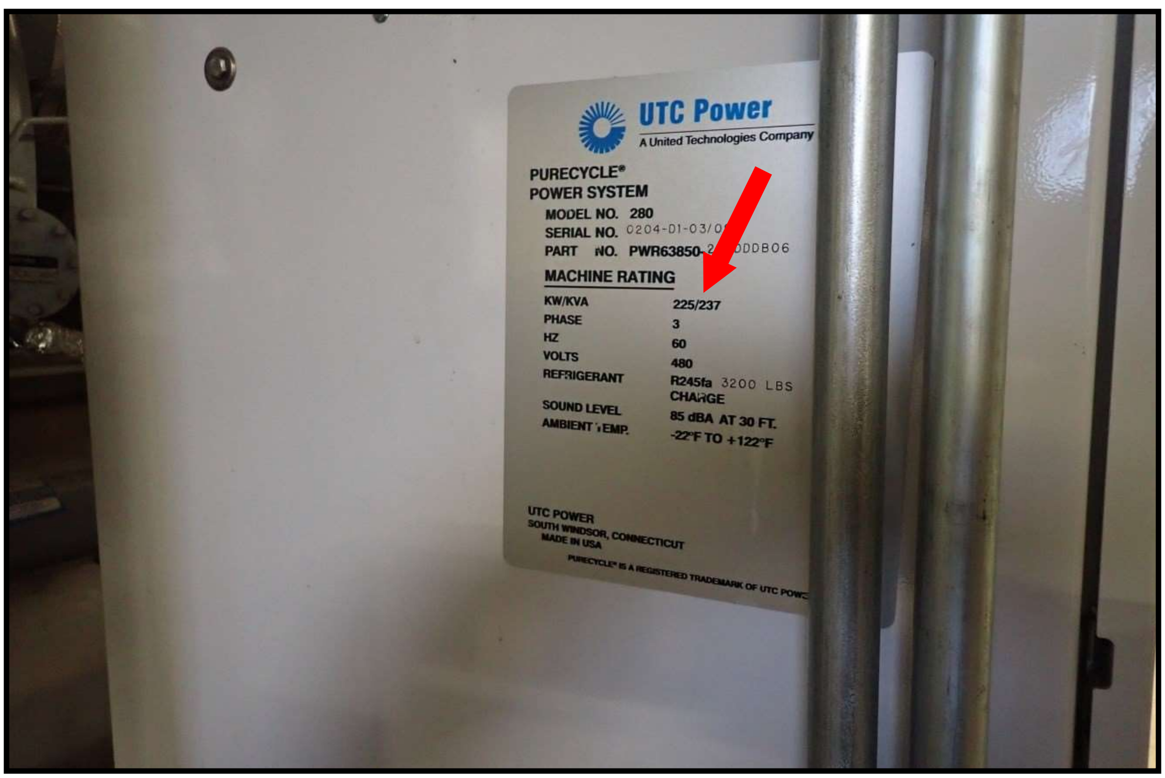


Figure 14 Plant C label plate, arrow points to rating of 225 kW

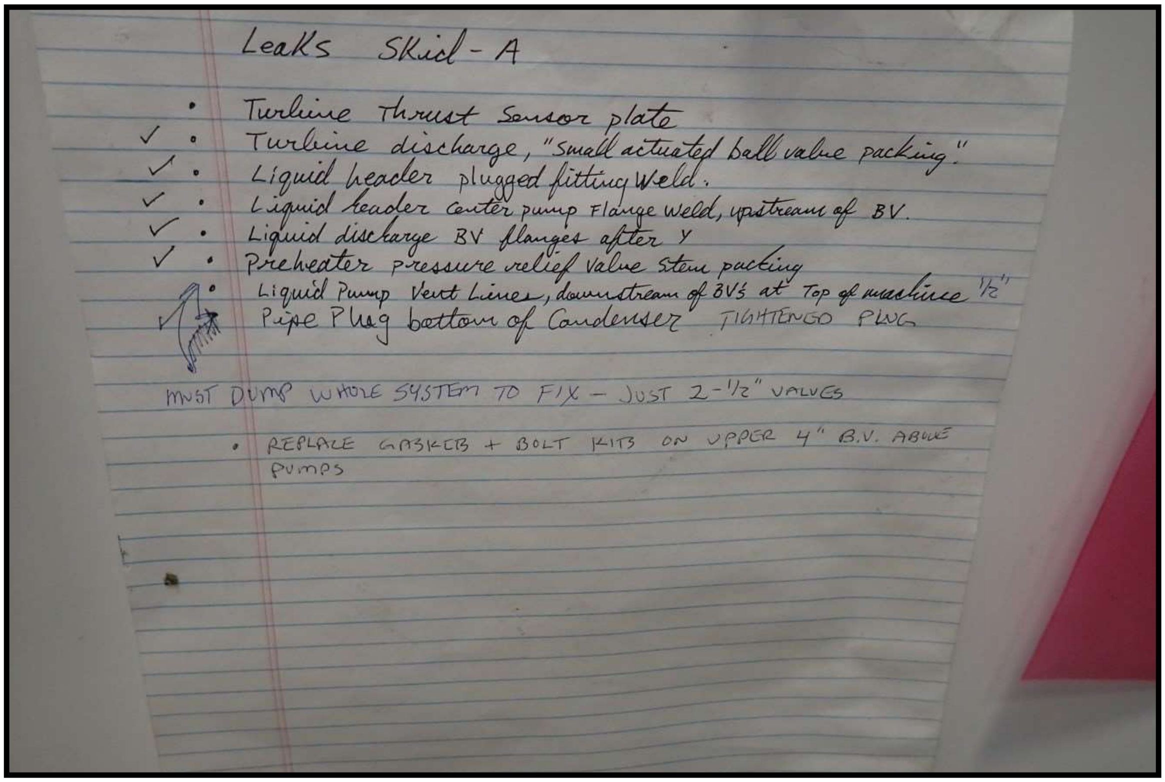


Figure 15 Documentation of leaks inside door of control cabinet

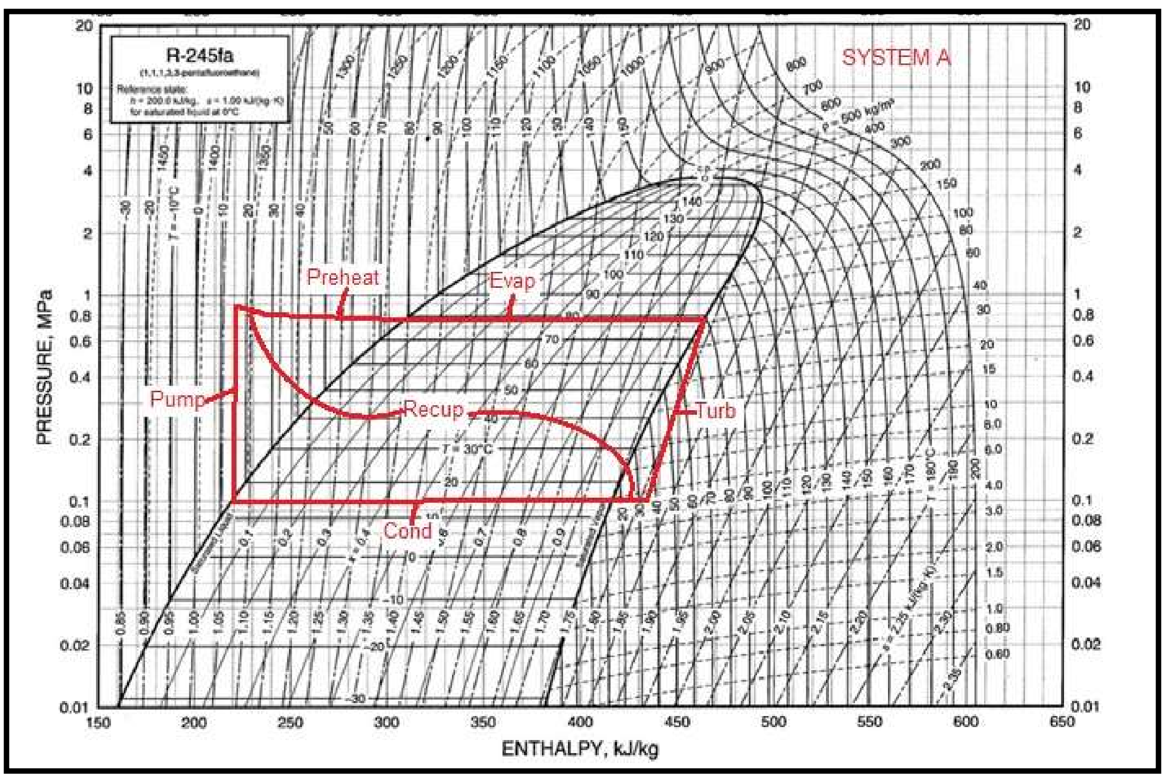


Figure 16 Pressure enthalpy diagram of plant A

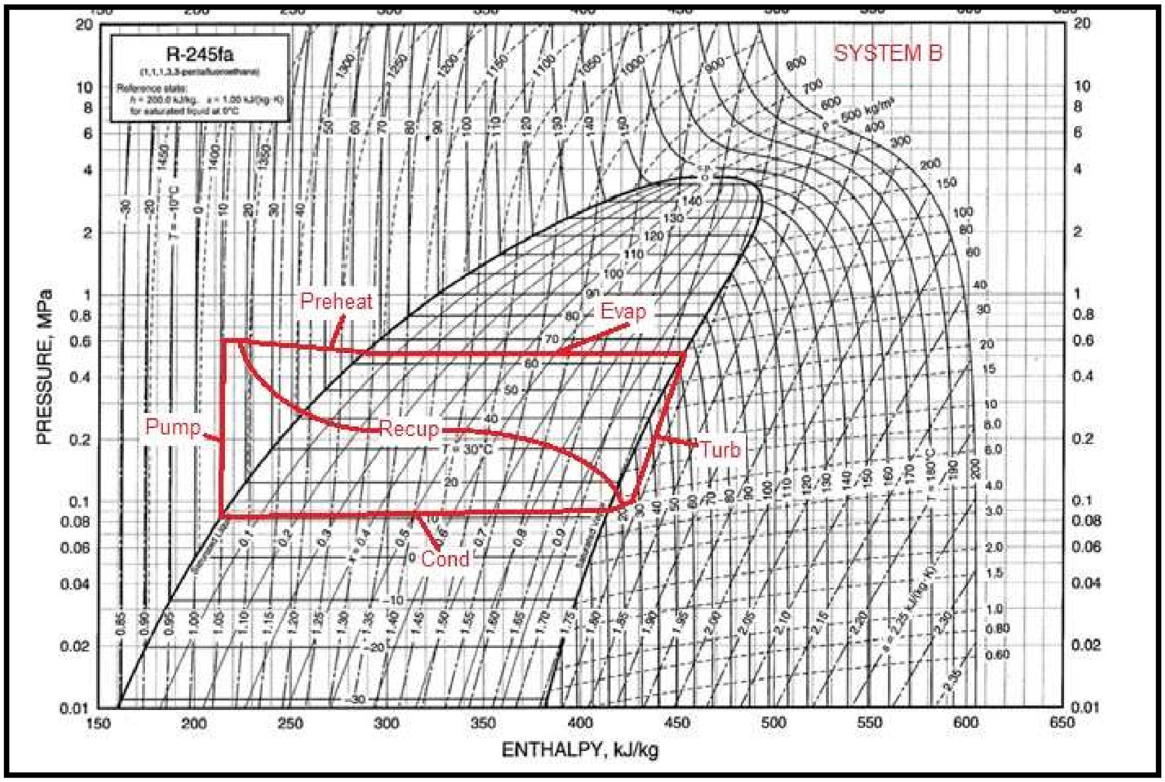


Figure 17 Pressure enthalpy diagram of plant B (note “Cond” line is lower pressure than in plant A shown in Figure 16

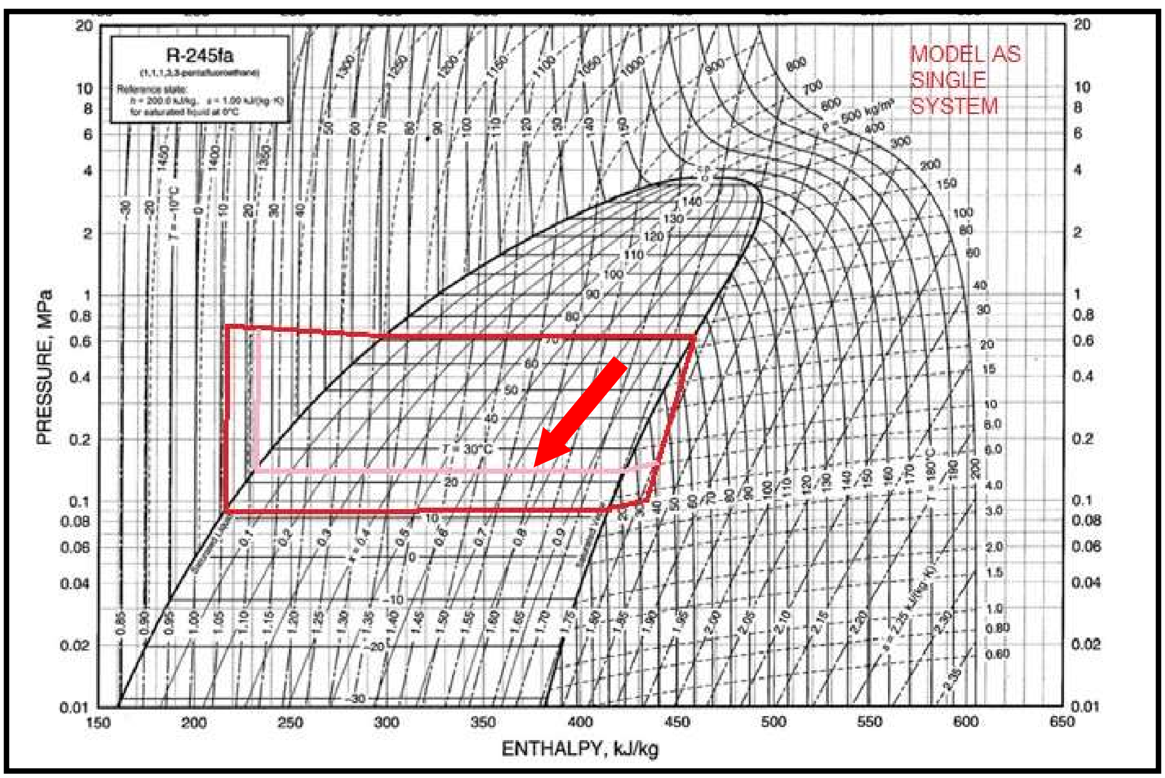


Figure 18 Light colored line represents operating points when the outside temperature is at its highest (arrow)

APPENDICES

APPENDIX II

Results of Laboratory Analysis

Triclinic Labs

Scientific Report

Elemental Analysis of Foreign Materials

Engineering Design & Testing Corp.

Prepared for David Williams

May 15, 2023

Project Number 2023256

Report Number R2023263.01

Author: Mendy M. Gould 05.15.2023

Mendy M. Gould, Scientific Investigator Date

Reviewer: David E. Bugay 05.15.2023

David E. Bugay, Ph.D., Chief Scientific Officer Date

This is a non-cGMP report.

Introduction

Engineering Design & Testing Corp. submitted two samples of a foreign material to Triclinic Labs (TCL) for elemental analysis via scanning electron microscopy (SEM) coupled with energy dispersive X-ray (EDX) analysis. Figures 1 through 4 present the elemental analysis results.

Table 1. Sample Information

Sample Name	Triclinic Labs Identifier	EDX Filename
Foreign material 1	TCL19914	EDX1-124
Foreign material 2	TCL19915	EDX1-125

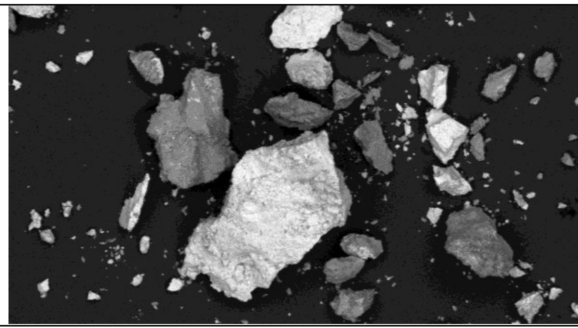
Experimental

EDX

EDX analysis was conducted using a Phenom XL Benchtop SEM equipped with a thermoelectrically cooled silicon drift detector (SDD) for EDX analysis. An ultra-thin silicon nitride (Si_3N_4) X-ray window allowed detection of elements with atomic numbers ranging from 4 to 95. Solids were mounted to an aluminum SEM stub with double-sided carbon tape. The instrument was configured in backscatter electron detection (BSD) mode with approximately 11 mm working distance. The beam voltage was adjusted to optimize the signal intensity while avoiding charging at the sample surface. Phenom User Interface version 1.4 was used to acquire and save images and spectral data. EDX spectra show both the atomic percent and the weight percent of the detected elements.

Figures

Figure 1. SEM image and EDX elemental color maps of Foreign material 1.



SEM Image (EDX1-124)

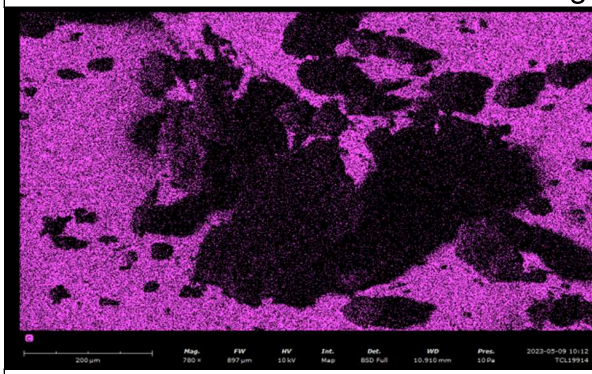
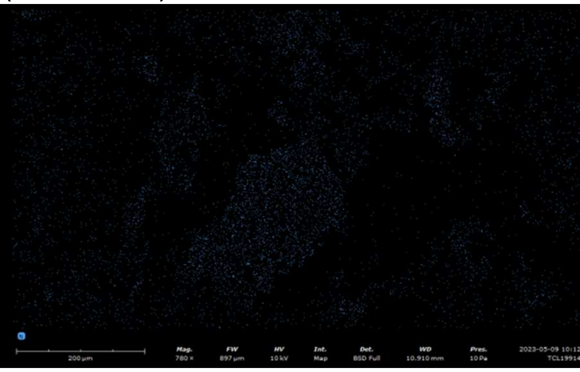
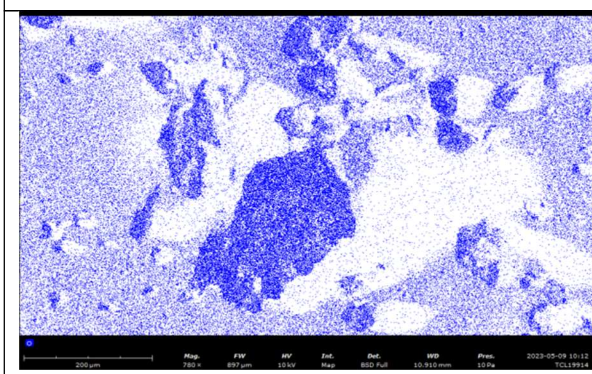
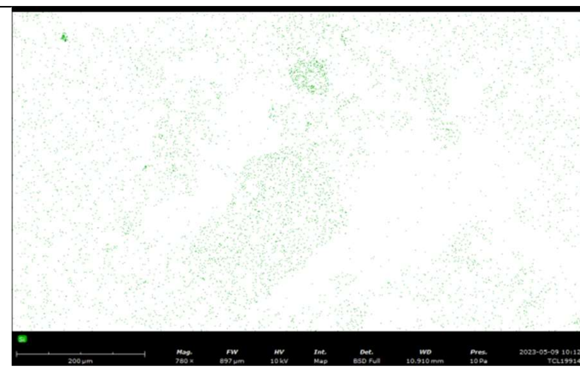
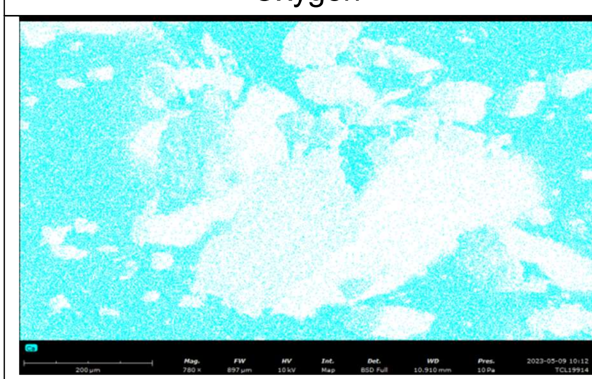
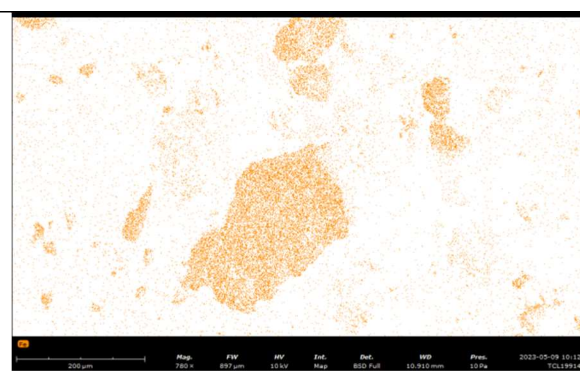
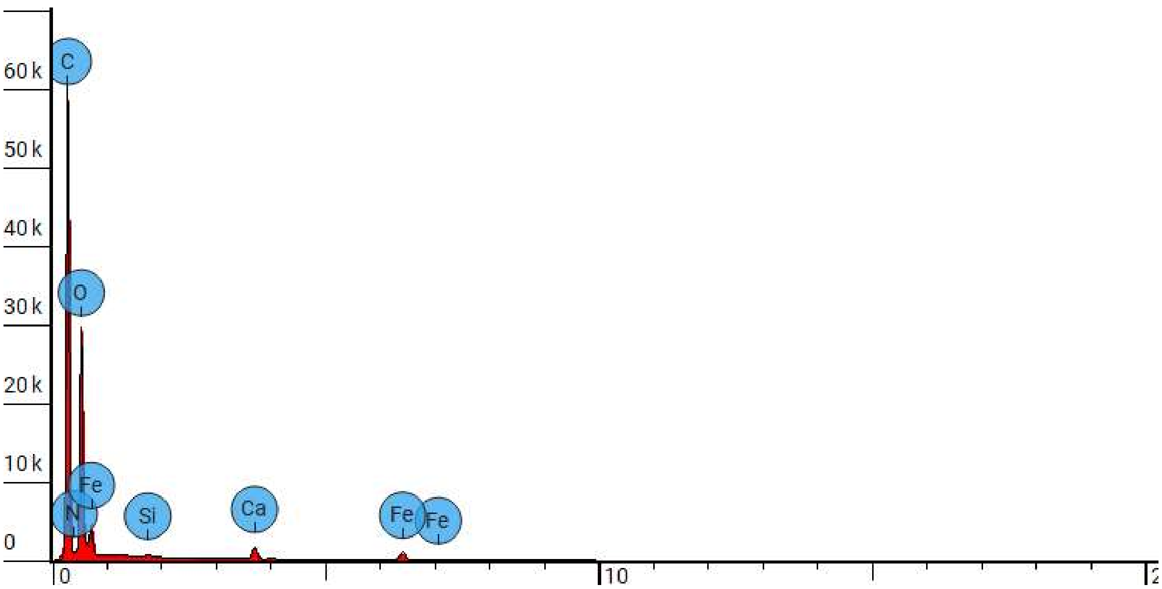
	
Carbon	Nitrogen
	
Oxygen	Silicon
	
Calcium	Iron

Figure 2. Composite EDX spectrum and elemental composition for Foreign material 1.

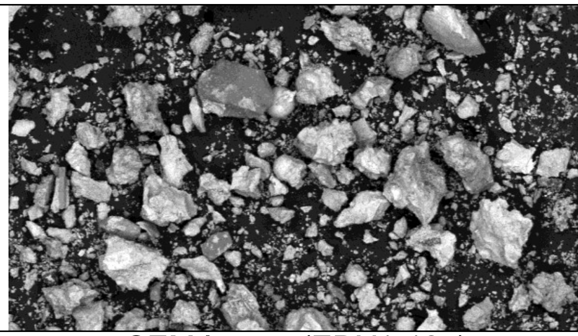
	Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
	6	C	Carbon	59.603	43.100
	7	N	Nitrogen	3.794	3.200
	8	O	Oxygen	28.131	27.100
	14	Si	Silicon	0.118	0.200
	20	Ca	Calcium	1.782	4.300
	26	Fe	Iron	6.572	22.100



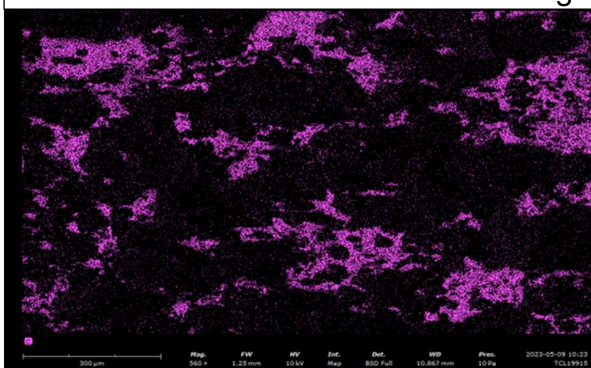
879 253 counts in 0:03:04 (4 773 c/s)

FW: 897 µm, Mode: 10 kV - Map, Detector: BSD Full, Time: 5/9/23 10:12 AM

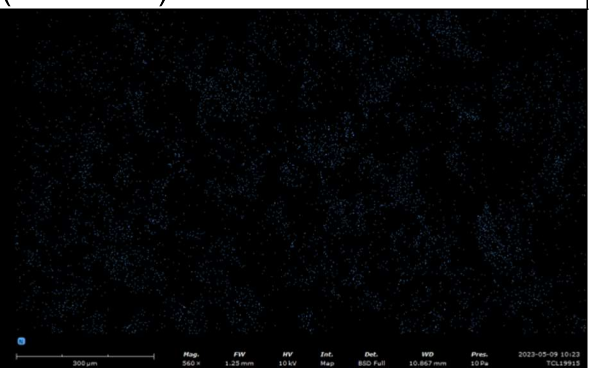
Figure 3. SEM image and EDX elemental color maps of Foreign material 2.



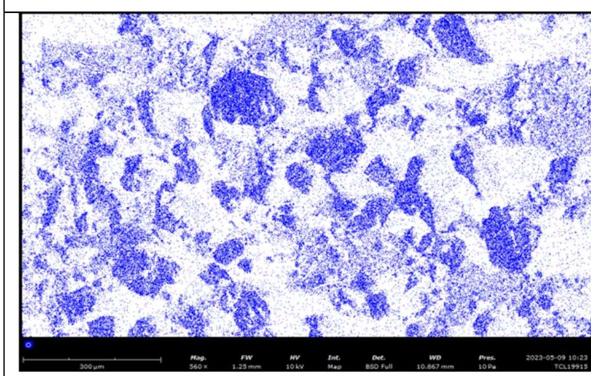
SEM Image (EDX1-125)



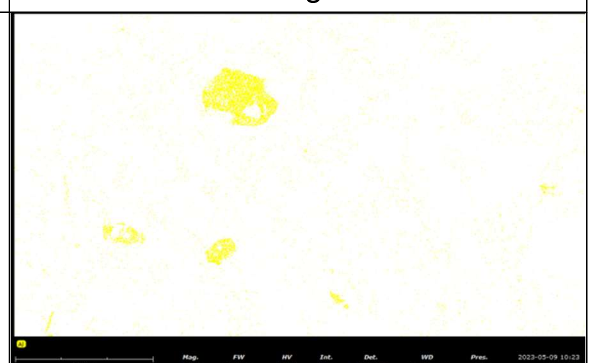
Carbon



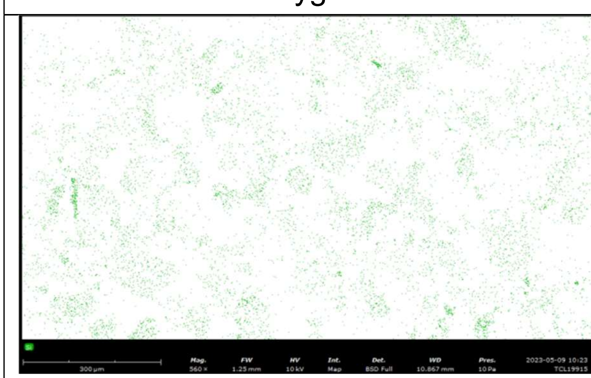
Nitrogen



Oxygen

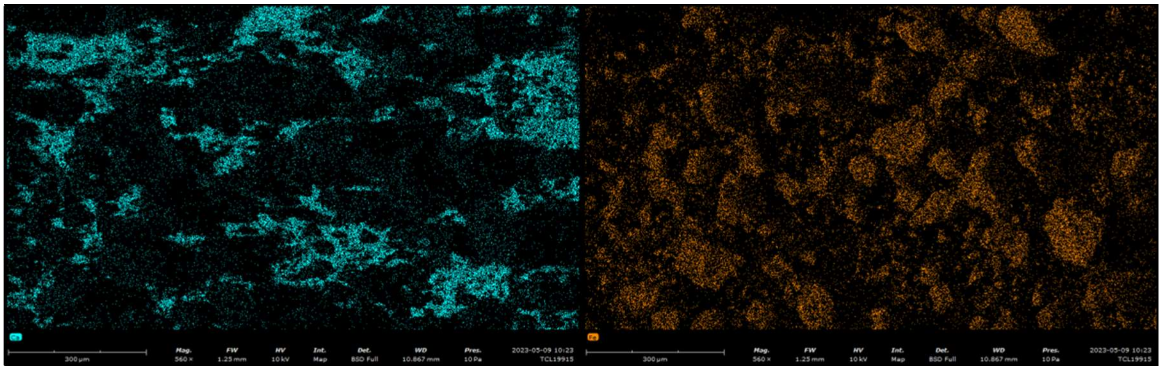


Aluminum



Silicon

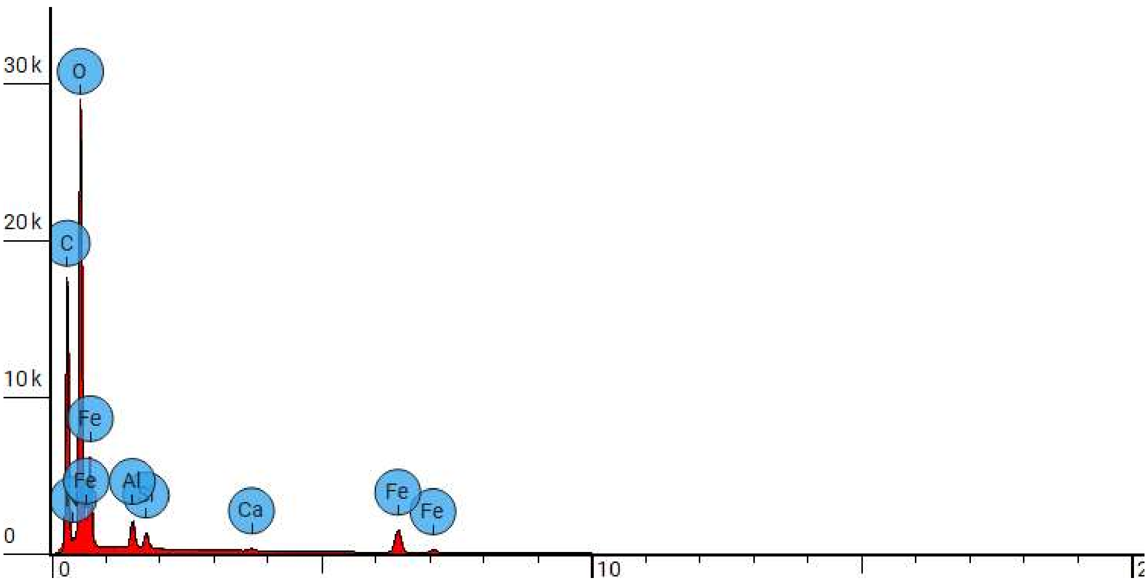
Figure 3 cont. SEM image and EDX elemental color maps of Foreign material 2.



Calcium	Iron

Figure 4. Composite EDX spectrum and elemental composition for Foreign material 2.

	Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
	6	C	Carbon	42.455	24.675
	7	N	Nitrogen	3.684	2.498
	8	O	Oxygen	35.868	27.772
	13	Al	Aluminum	1.684	2.198
	14	Si	Silicon	0.735	0.999
	20	Ca	Calcium	0.309	0.599
	26	Fe	Iron	15.265	41.259



593 250 counts in 0:02:24 (4 101 c/s)

FW: 1 mm, Mode: 10 kV - Map, Detector: BSD Full, Time: 5/9/23 10:23 AM

APPENDIX III

Mathematical Models of the ORPP

Baseline of evaporator

Variables Sheet

Input	Name	Output	Unit	Comment
				Cooling tower fluid
7	MinFld#			Minimum Fluid number(See Fluid Table)
	MinFld	'Saturated_water		Minimum Fluid name
44	Ti		F	Inlet temperature
	To	55.155779	F	Outlet temperature
	Tmina	49.577890	F	Average temperature (Guess)
	cpmin	1.002068	Btu/lbm.F	Specific heat
	mdotmin	1101.556836	lbm/s	Mass flow rate
				(Condensing fluid)
9	MaxFld#			Maximum Fluid number(See Fluid Table)
	MaxFld	'R245fa		Maximum Fluid name
60	Tmax		F	Phase change temperature
	hfg	84.236154	Btu/lb	Latent heat of vaporization
	mdotmax	146.189400	lbm/s	Mass flow rate
				Tube parameters:
500	nt			Number of tubes
2	np			Number of passes
20	L		ft	Length
	A	3272.492347	ft^2	Area for which U is defined
.625	D		in	Diameter
1450	U		B/f^2.h.F	Overall heat transfer coefficient
				Capacity rates and analysis parameters:
	Cmin	3971264.799706	Btu/h.R	Minimum fluid (Cc or Ch)
	NTU	1.194802		Number of transfer units
	effect	0.697236		Heat exchanger effectiveness
				Heat transfer rates:
	qmax	6.354E7	Btu/hr	Maximum possible
	q	4.430E7	Btu/hr	Actual
7920	Qmin		gal/min	Flow rate of water to/from cooling tower
	rhomin	62.425889	lbm/ft^3	Density of water

Input	Name	Output	Unit	Comment
29.007574	Pmin		psi	Pressure of water
	rhomax	85.155003	lbm/ft^3	Density of refrigerant liquid
.19	Pmax		MPa	Pressure of refrigerant

Rules Sheet

Rules

$$Tmina = \frac{Ti + To}{2}$$

if given('MinFld#) then call getprop(MinFld# , Tmina ; MinFld , cpmin)

if given('MaxFld#) then call gethfg(MaxFld# , Tmax ; MaxFld , hfg)

$$A = nt \cdot \pi \cdot D \cdot L \cdot np$$

$$Cmin = mdotmin \cdot cpmin$$

$$NTU = \frac{U \cdot A}{Cmin}$$

$$qmax = Cmin \cdot | Tmax - Ti |$$

$$q = effect \cdot qmax$$

call relation(NTU ; effect)

$$q = mdotmax \cdot hfg$$

$$To = \frac{q}{Cmin} + Ti$$

$$Qmin = \frac{mdotmin}{rhomin}$$

rhomin = $DENSITY(1 , 'water , 'T , Ti , 'P , Pmin)

rhomax = $DENSITY(1 , 'R245fa , 'T , Tmax , 'P , Pmax)

Functions Sheet

Name	Type	Arguments	Comment
getprop	Rule	fluid#,Tf;fluid,cp	Get constants from fluid property table
gethfg	Rule	fluid#,Tf;fluid,hfg	Get constants from fluid property table
relation	Rule	NTU;ee	All exchangers, Cr=0
waterrhof	List	watertl;waterrhol	List functions of properties:
watercpf	List	watertl;watercpl	
watermuf	List	watertl;watermul	
waterkf	List	watertl;waterkl	
hfgf	List	Tl;hfgl	heat of vaporization vs T, H2O
hfgr245	List	r245t;hfgr245	heat of vaporization for R-245fa

Rule Function: getprop

Comment	Get constants from fluid property table
Parameter Variables	
Argument Variables	fluid#,Tf
Result Variables	fluid,cp

Rule

if or(fluid# < 1 , fluid# > length('fluid)) then call errmsg('Error__ , 'No , 'material , 'has , 'given , 'material , 'number)

$fluid = given['fluid , fluid , 'fluid\_des_{fluid\#}]$

$fl = 'fluid_{fluid\#}$

if check(fl) = 0 then call errmsg('ERROR_ , '' , fluid , '' , 'Table , 'Not , 'Found__ , 'Check , '' , fl , '' , al , '' , 'on , 'List , 'Sheet)

$m1 = min[fl_5]$

$m2 = max[fl_5]$

if or(Tf < m1 , Tf > m2) then call errmsg('Error__ , 'Tf , 'Out , 'of , 'Table , 'Range)

$cp = apply[fl_2 , Tf]$

Rule Function: gethfg

Comment	Get constants from fluid property table
Parameter Variables	
Argument Variables	fluid#,Tf
Result Variables	fluid,hfg

Rule

if or(fluid# < 1 , fluid# > length('fluid)) then call errmsg('Error__ , 'No , 'material , 'has , 'given , 'material , 'number)

$fluid = given['fluid , fluid , 'fluid\_des_{fluid\#}]$

$fl = 'fluid_{fluid\#}$

if check(fl) = 0 then call errmsg('ERROR_ , '' , fluid , '' , 'Table , 'Not , 'Found__ , 'Check , '' , fl , '' , al , '' , 'on , 'List , 'Sheet)

$m1 = min[fl_1]$

$m2 = max[fl_1]$

if or(Tf < m1 , Tf > m2) then call errmsg('Error__ , 'Tf , 'Out , 'of , 'Table , 'Range)

hfg = hfgr245(Tf)

Rule Function: relation

Comment	All exchangers, Cr=0
Parameter Variables	
Argument Variables	NTU
Result Variables	ee

Rule

$$ee = 1 - e^{(-NTU)}$$

Worst-case-evaporator

Variables Sheet

Input	Name	Output	Unit	Comment
				Cooling tower fluid
7	MinFld#			Minimum Fluid number(See Fluid Table)
	MinFld	'Saturated_water		Minimum Fluid name
90	Ti		F	Inlet temperature
	To	101.253975	F	Outlet temperature
	Tmina	95.626988	F	Average temperature (Guess)
	cpmin	.998542	Btu/lbm.F	Specific heat
	mdotmin	1096.086274	lbm/s	Mass flow rate
				(Condensing fluid)
9	MaxFld#			Maximum Fluid number(See Fluid Table)
	MaxFld	'R245fa		Maximum Fluid name
73.93	Tmax		F	Phase change temperature
	hfg	82.309088	Btu/lb	Latent heat of vaporization
	mdotmax	149.651043	lbm/s	Mass flow rate
				Tube parameters:
500	nt			Number of tubes
2	np			Number of passes
20	L		ft	Length
	A	3272.492347	ft^2	Area for which U is defined
.625	D		in	Diameter
1450	U		B/f^2.h.F	Overall heat transfer coefficient
				Capacity rates and analysis parameters:
	Cmin	3937639.248034	Btu/h.R	Minimum fluid (Cc or Ch)
	NTU	1.205005		Number of transfer units
	effect	0.700310		Heat exchanger effectiveness
				Heat transfer rates:
	qmax	6.328E7	Btu/hr	Maximum possible
	q	44315900.170871	Btu/hr	Actual
7920	Qmin		gal/min	Flow rate of water to/from cooling tower
	rhomin	62.115869	lbm/ft^3	Density of water

Input	Name	Output	Unit	Comment
29.007574	Pmin		psi	Pressure of water
	rhomax	83.860733	lbm/ft^3	Density of refrigerant liquid
.19	Pmax		MPa	Pressure of refrigerant

Cooling-tower-wc

Variables Sheet

Input	Name	Output	Unit	Comment
				Humidity, Up to Three States
				See COMMENT: PSYCHRO for instructions.
	omega1	0.005971	lbv/lba	Humidity ratio, state 1
0.2	phi1			Relative humidity, state 1
	va1	13.984	ft^3/lbm	Specific volume of air, state 1
	vg1	468.38	ft^3/lbm	Specific vol, saturated vapor at T1
90	T1		F	Temperature, state 1
	pa1	14.56	psi	Partial pressure of air, state 1
	pv1	0.13981	psi	Partial press, water vapor, state 1
14.7	pm1		psi	Mixture pressure, state 1
	pg1	0.69905	psi	Saturation press, water vapor, at T1
	dp1	43.5	F	Dew point, state 1
	hm1	28.175	B/lbm	Enthalpy of mixture, state 1
	ha1	21.605	B/lbm	Enthalpy of air, state 1
	hv1	1100.3	B/lbm	Enthalpy of water vapor, state 1
	Tas1	62.575	F	Adiabatic saturation temperature, st 1
	omegaas1	0.012262	lbv/lba	Humidity ratio at Tas1
	hgas1	1088.4	B/lbm	hg at Tas1
	hfas1	30.622	B/lbm	hf at Tas1
	pgas1	0.28081	psi	Saturation press, water, at Tas1
	vgas1	1094.1	ft^3/lbm	Specific vol, water vapor, at Tas1
	omega2	277.89	grainv/lba	Humidity ratio, state 2
0.9	phi2			Relative humidity, state 2
	va2	15.031	ft^3/lbm	Specific volume of air, state 2
	vg2	340.75	ft^3/lbm	Saturated vapor specific volume, st 2
101	T2		F	Temperature, state 2
	pa2	95.271	kPa	Partial pressure of air, state 2
	pv2	6.0818	kPa	Partial press, water vapor, state 2
14.7	pm2		psi	Mixture pressure, state 2
	pg2	0.9801	psi	Saturation press, water vapor, at T2
	dp2	97.5	F	Dew point, state 2
	hm2	68.116	B/lbm	Enthalpy of mixture, state 2
	ha2	24.245	B/lbm	Enthalpy of air, state 2
	hv2	1105.1	B/lbm	Enthalpy of water vapor, state 2
	Tas2	97.851	F	Adiabatic saturation temperature, st 2
	omegaas2	0.040479	lbv/lba	Humidity ratio at Tas2

Input	Name	Output	Unit	Comment
	hgas2	1103.7	B/lbm	hg at Tas2
	hfas2	65.862	B/lbm	hf at Tas2
	pgas2	0.8911	psi	Saturation press, water, at Tas2
	vgas2	369.47	ft^3/lbm	Specific vol, water vapor, at Tas2
	omega3		lbv/lba	Humidity ratio, state 3
	phi3			Relative humidity, state 3
	va3		ft^3/lbm	Specific volume of air, state 3
	vg3		ft^3/lbm	Saturated vapor specific volume, st 3
	T3		F	Temperature, state 3
	pa3		psi	Partial pressure of air, state 3
	pg3		psi	Partial press, water vapor, state 3
	pm3		psi	Mixture pressure, state 3
	pv3		psi	Saturation press, water vapor, at T3
	dp3		F	Dew point, state 3
	hm3		B/lbm	Enthalpy of mixture, state 3
	ha3		B/lbm	Enthalpy of air, state 3
	hv3		B/lbm	Enthalpy of water vapor, state 3
	Tas3		F	Adiabatic saturation temperature, st 3
	omegaas3		lbv/lba	Humidity ratio at Tas3
	hgas3		B/lbm	hg at Tas3
	hfas3		B/lbm	hf at Tas3
	pgas3		psi	Saturation press, water, at Tas3
	vgas3		ft^3/lbm	Specific vol, water vapor, at Tas3
	Ra	0.287	kJ/(kg*K)	Gas constant for air
	Rv	0.4615	kJ/(kg*K)	Gas constant for water vapor
	h0	0	kJ/kg	Reference enthalpy
	cp	1.005	kJ/(kg*K)	Specific heat of air
	T0	255.37	K	Reference temperature
101	twin		F	Water temperature in
90	twout		F	Water temperature out
1100	mwin		lbm/s	Mass flow rate water in
	mwout	0.30258	lbm/s	Mass flow rate water out
	mwe	1.073E1	lbm/s	Make up water
	hwin	69.031	B/lbm	Enthalypy water in
	hwout	58.05	B/lbm	Enthalpy water out
	ma	3.18E2	lbm/s	Mass flow rate dry air
	Qdot	12729	B/s	Heat transfer rate
	mwev	77.318	gpm	Flow rate of makeup water
62.4	rhomw		lbm/ft^3	Density of makeup water
	q	7928.9	gpm	Flow rate of water from cooling tower
	eff	0.95098		Effectiveness of heat transfer
72.5	uf			Typical cooling tower efficiency %

Input	Name	Output	Unit	Comment
	Twb	85.828	F	Outside temperature (avg hot day)

Rules Sheet

Rules

call PS1(pm1 , T1 , 'phi, phi1, 'Tas; Tas1)

call PS1(pm1 , T1, 'w, omega1 , Tas; Tas1)

call PS1(pm1 , T1, 'w, omega1 , 'phi; phi1)

call PS1(pm1 , T1 , 'dp, dp1, 'phi; phi1)

call PS1(pm2, T2, 'phi, phi2, 'Tas; Tas2)

call PS1(pm2, T2, 'w, omega2, Tas; Tas2)

call PS1(pm2, T2, 'w, omega2, 'phi; phi2)

call PS1(pm2, T2, 'dp, dp2, 'phi; phi2)

call PS1(pm3, T3, 'phi, phi3, 'Tas; Tas3)

call PS1(pm3, T3, 'w, omega3, Tas; Tas3)

call PS1(pm3, T3, 'w, omega3, 'phi; phi3)

call PS1(pm3, T3, 'dp, dp3, 'phi; phi3)

; Humidity or Psychrometrics, Three States **PSYCHRO.TKW**

call psat(T1 ; pg1)

call psat(T2 ; pg2)

$$omega1 = \frac{phi1 \cdot va1}{vg_1}$$

$$va1 = \frac{Ra \cdot T1}{pa1}$$; Ideal gas equation of state for air

$$vg1 = \frac{Rv \cdot T1}{pg1}$$; Ideal gas equation of state for water vapor

pm1 = pa1 + pv1

$$phi1 = \frac{pv1}{pg1}$$; Definition of relative humidity, phi

$$omega2 = \frac{phi2 \cdot va2}{vg_2}$$

$$va2 = \frac{Ra \cdot T2}{pa2}$$; Ideal gas equation of state for air

$$vg2 = \frac{Rv \cdot T2}{pg2}$$; Ideal gas equation of state for water vapor

pm2 = pa2 + pv2

$$phi2 = \frac{pv2}{pg2}$$; Definition of relative humidity, phi

call Tsat(pv1 ; dp1) ; Relates dew point to vapor pressure

Input	Name	Output	Unit	Comment

call Tsat(pv2 ; dp2); Relates dew point to vapor pressure

hm1 = ha1 + omega1 · hv1

$ha1 = h0 + cp \cdot (T1 - T0)$

$hv1 = hg(T1)$

$$omega1 = \frac{cp \cdot (Tas1 - T1) + omegaas1 \cdot (hgas1 - hfas1)}{hv1 - hfas1}$$

$$omegaas1 = \frac{Ra \cdot Tas1}{(pm1 - pgas1) \cdot vgas1}$$

$hfas1 = hf(Tas1)$

$vgas1 = vg(Tas1)$

$pgas1 = psat(Tas1)$

$hgas1 = hg(Tas1)$

$$omega2 = \frac{cp \cdot (Tas2 - T2) + omegaas2 \cdot (hgas2 - hfas2)}{hv2 - hfas2}$$

$$omegaas2 = \frac{Ra \cdot Tas2}{(pm2 - pgas2) \cdot vgas2}$$

$hfas2 = hf(Tas2)$

$vgas2 = vg(Tas2)$

$pgas2 = psat(Tas2)$

$hgas2 = hg(Tas2)$

$hm2 = ha2 + omega2 \cdot hv2$

$ha2 = h0 + cp \cdot (T2 - T0)$

$hv2 = hg(T2)$

call psat(T3 ; pg3)

$$omega3 = \frac{phi3 \cdot va3}{vg3}$$

$va3 = \frac{Ra \cdot T3}{pa3}$; Ideal gas equation of state for air

$vg3 = \frac{Rv \cdot T3}{pg3}$; Ideal gas equation of state for water vapor

$pm3 = pa3 + pv3$

$phi3 = \frac{pv3}{pg3}$; Definition of relative humidity, phi

call Tsat(pv3 ; dp3) ; Relates dew point to vapor pressure

$hm3 = ha3 + omega3 \cdot hv3$

$ha3 = h0 + cp \cdot (T3 - T0)$

$hv3 = hg(T3)$

$$omega3 = \frac{cp \cdot (Tas3 - T3) + omegaas3 \cdot (hgas3 - hfas3)}{hv3 - hfas3}$$

$$omegaas3 = \frac{Ra \cdot Tas3}{(pm3 - pgas3) \cdot vgas3}$$

$hfas3 = hf(Tas3)$

Rules

$vgas3 = vg(Tas3)$

$pgas3 = psat(Tas3)$

$hgas3 = hg(Tas3)$

Ra = 287 ;Units are in J/(kg*K) since they must be in the calculation units for the model.

Rv = 461.5 ;Units are in J/(kg*K) since they must be in the calculation units for the model.

cp = 1005 ;Units are in J/(kg*K) since they must be in the calculation units for the model.

T0 = 255.37 ;Units are in K since they must be in the calculation units for the model.

$h0 = 0$

$Qdot = ma \cdot (hm2 - hm1)$

$Qdot = mwin \cdot hwin - mwout \cdot hwout$

$mwe = mwin - mwout$

$mwe = ma \cdot (omega2 - omega1)$

hwin = $ENTHALPY(1 , 'WATER , 'x , 0 , 'T , twin)

hwout = $ENTHALPY(1 , 'WATER , 'x , 0 , 'T , twout)

$$mwev = \frac{mwe}{rhomw}$$

$$q = \frac{mwin}{rhomw}$$

$$mwin = \frac{Qdot}{hwin - hwout} \cdot eff$$

$$uf = \frac{(T2 - T1) \cdot 100}{T2 - Twb}$$

Functions Sheet

Name	Type	Arguments	Comment
psat	Rule	T;pg	psat as a function of T
Tsat	Procedure	p;T	Tsat as a function of p
hg	Rule	T;hv	hg as a function of T
hf	Rule	T;hfas	hf as a function of T
vg	Rule	Tas;vgas	vg as a function of T
PS1	Procedure	pm,T,xi,x,yi;y	Psychrometric chart function with procedural backsolving
psatp	Procedure	T;p	psat as a function of T
Tsatold	Rule	p;y	Tsat as a function of p

Rule Function: psat

Comment	psat as a function of T
Parameter Variables	
Argument Variables	T
Result Variables	pg

Rule

Rules

TC = T - 273.15

Rules

b1 = -.4844517101508523

b2 = .07169359159718827

b3 = -.0002610577465536052

b4 = .0000005409672516889577

$$\ln\left[\frac{pg}{1000}\right] = b1 + b2 \cdot TC + b3 \cdot TC^{2} + b4 \cdot TC^{3}$$

Procedure Function: Tsat

Comment	Tsat as a function of p
Parameter Variables	
Input Variables	p
Output Variables	T

Statement

b1 = -.4844517101508523

b2 = .07169359159718827

b3 = -.0002610577465536052

b4 = .0000005409672516889577

x = 10

Loop :

$$y = e^{\left[b1 + b2 \cdot x + b3 \cdot x^{2} + b4 \cdot x^{3}\right]} \cdot 1000 - p$$

T = x + 273.15

if| y |< 1e-6 return

xx = x · (1.0001)

$$yy = b1 + b2 \cdot xx + b3 \cdot xx^{2} + b4 \cdot xx^{3} - T$$

$$yy = e^{\left[b1 + b2 \cdot xx + b3 \cdot xx^{2} + b4 \cdot xx^{3}\right]} \cdot 1000 - p$$

$$x := x - \frac{y}{\frac{yy - y}{x \cdot 0.0001}}$$

goto Loop

Rule Function: hg

Comment	hg as a function of T
Parameter Variables	
Argument Variables	T
Result Variables	hv

Rule

a1 = 2139.249698443622

a2 = .2333088806088613

a3 = .006060231619479418

a4 = -.000007592650007183477

$$hv = \left[a1 + a2 \cdot T + a3 \cdot T^{2} + a4 \cdot T^{3}\right] \cdot 1000$$

Rule Function: hf

Comment	hf as a function of T
Parameter Variables	
Argument Variables	T
Result Variables	hfas

Rule

s1 = -1244.695259976376

s2 = 5.170318750622429

s3 = -.003170151834960868

s4 = .0000033854597583993382

$$hfas = \left[s1 + s2 \cdot T + s3 \cdot T^{2} + s4 \cdot T^{3}\right] \cdot 1000$$

Rule Function: vg

Comment	vg as a function of T
Parameter Variables	
Argument Variables	Tas
Result Variables	vgas

Rule

Rule Function: psat

o1 = 163.5252112872776

o2 = -1.649646425967393

o3 = .00664340481453769

o4 = -.00001237268479804369

o5 = 8.787396941471892E-9

$$vgas = e^{\left[o1 + o2 \cdot Tas + o3 \cdot Tas^{2} + o4 \cdot Tas^{3} + o5 \cdot Tas^{4}\right]}$$

Procedure Function: PS1

Comment	Psychrometric chart function with procedural backsolving
Parameter Variables	
Input Variables	pm,T,xi,x,yi
Output Variables	y

Statement

Ra= 287 ;Units are in J/(kg*K)

Rv = 461.5 ;Units are in J/(kg*K)

cp = 1005 ;Units are in J/(kg*K)

TO= 273.15 ;Units are in K

hO = 0

call psat(T; pg)

$$vg=\frac{Rv\cdot T}{pg}$$

hv= hg(T)

ha= hO + cp · (T - TO)

eps=1e-12

ifxi ='Tas then goto Twetsolve

ifxi ='phi then goto phisolve

ifxi ='dp then goto dpsolve

ifxi ='w then goto wsolve

ifxi ='hm then goto hmsolve

ifxi ='va then goto vsolve

Twetsolve:

Tas = T

hfas = hf;Tas)

vgas = vg(Tas)

pgas = psat(Tas)

hgas = hg(Tas)

$$was=\frac{Ra\cdot Tas}{(pm - pgas)\cdot vgas}$$

$$w=\frac{cp\cdot(Tas - T) + was\cdot(hgas - hfas)}{hv - hfas}$$

hm =ha+ w · hv

phi= 0.3

LTwet:

pv= phi· pg

call Tsat(pv; dp)

pa= pm -pv

Procedure Function: PS1

$va = \frac{Ra \cdot T}{pa}$

$vg = \frac{Rv \cdot T}{pg}$

$w1 = \frac{phi \cdot va}{vg}$

$hm = ha + w1 \cdot hv$

$z1 = w1 - w$

if $|z1| < eps$ then goto results

$phi2 = phi \cdot (1 + .0001)$

$pv = phi2 \cdot pg$

call Tsat(pv ; dp)

$pa = pm - pv$

$va = \frac{Ra \cdot T}{pa}$

$vg = \frac{Rv \cdot T}{pg}$

$w2 = \frac{phi2 \cdot va}{vg}$

$z2 = w2 - w$

$phi = phi - \frac{z1}{\frac{z2 - z1}{phi \cdot .0001}}$

goto LTwet

phisolve :

$phi = x$

$pv = phi \cdot pg$

call Tsat(pv ; dp)

$pa = pm - pv$

$va = \frac{Ra \cdot T}{pa}$

$vg = \frac{Rv \cdot T}{pg}$

$w = \frac{phi \cdot va}{vg}$

$hm = ha + w \cdot hv$

$Tas = T - 10$

Lphi :

$hfas = hf(Tas)$

Procedure Function: PS1

$vgas = vg(Tas)$

$pgas = psat(Tas)$

$hgas = hg(Tas)$

$$was = \frac{Ra \cdot Tas}{(pm - pgas) \cdot vgas}$$

$$w1 = \frac{cp \cdot (Tas - T) + was \cdot (hgas - hfas)}{hv - hfas}$$

$z1 = w1 - w$

if $|z1| < eps$ then goto results

$Tas2 = Tas \cdot (1 + .0001)$

$hfas = hf(Tas2)$

$vgas = vg(Tas2)$

$pgas = psat(Tas2)$

$hgas = hg(Tas2)$

$$was = \frac{Ra \cdot Tas2}{(pm - pgas) \cdot vgas}$$

$$w2 = \frac{cp \cdot (Tas2 - T) + was \cdot (hgas - hfas)}{hv - hfas}$$

$z2 = w2 - w$

$$Tas = Tas - \frac{z1}{\frac{z2 - z1}{Tas \cdot .0001}}$$

goto Lphi

dpsolve :

$dp = x$

call psat(dp ; pv)

$$phi = \frac{pv}{pg}$$

$pa = pm - pv$

$$va = \frac{Ra \cdot T}{pa}$$

$$vg = \frac{Rv \cdot T}{pg}$$

$$w = \frac{phi \cdot va}{vg}$$

$hm = ha + w \cdot hv$

$Tas = T - 10$

Ldp :

$hfas = hf(Tas)$

Procedure Function: PS1

vgas = vg(Tas)

pgas = psat(Tas)

hgas = hg(Tas)

$$was = \frac{Ra \cdot Tas}{(pm - pgas) \cdot vgas}$$

$$w1 = \frac{cp \cdot (Tas - T) + was \cdot (hgas - hfas)}{hv - hfas}$$

z1 = w1 - w

if|z1|< eps then goto results

Tas2 = Tas · (1 + .0001)

hfas = hf(Tas2)

vgas = vg(Tas2)

pgas = psat(Tas2)

hgas = hg(Tas2)

$$was = \frac{Ra \cdot Tas2}{(pm - pgas) \cdot vgas}$$

$$w2 = \frac{cp \cdot (Tas2 - T) + was \cdot (hgas - hfas)}{hv - hfas}$$

z2 = w2 - w1

$$Tas = Tas - \frac{z1}{\frac{z2 - z1}{Tas \cdot .0001}}$$

goto Ldp

wsolve :

w = x

hm = ha + w · hv

if yi < > 'Tas then goto NT

Tas = T - 10

LL1 :

hfas = hf(Tas)

vgas = vg(Tas)

pgas = psat(Tas)

hgas = hg(Tas)

$$was = \frac{w \cdot (hv - hfas) - cp \cdot (Tas - T)}{hgas - hfas}$$

$$was1 = \frac{Ra \cdot Tas}{(pm - pgas) \cdot vgas}$$

z1 = was1 - was

if|z1|< eps then goto results

Procedure Function: PS1

$Tas2 = Tas \cdot (1 + .0001)$

$hfas = hf(Tas2)$

$vgas = vg(Tas2)$

$pgas = psat(Tas2)$

$hgas = hg(Tas2)$

$$was = \frac{w \cdot (hv - hfas) - cp \cdot (Tas2 - T)}{hgas - hfas}$$

$$was1 = \frac{Ra \cdot Tas2}{(pm - pgas) \cdot vgas}$$

$z2 = was1 - was$

$$Tas = Tas - \frac{z1}{\frac{z2 - z1}{Tas \cdot .0001}}$$

Goto LL1

NT :

$phi = .5$

BB :

$pv = phi \cdot pg$

call Tsat(pv ; dp)

$pa = pm - pv$

$$va = \frac{Ra \cdot T}{pa}$$

$$vg = \frac{Rv \cdot T}{pg}$$

$$w1 = \frac{phi \cdot va}{vg}$$

$hm = ha + w1 \cdot hv$

$z1 = w1 - w$

if $|z1| < eps$ then goto results

$phi2 = phi \cdot (1 + .0001)$

$pv = phi2 \cdot pg$

call Tsat(pv ; dp)

$pa = pm - pv$

$$va = \frac{Ra \cdot T}{pa}$$

$$vg = \frac{Rv \cdot T}{pg}$$

$$w2 = \frac{phi2 \cdot va}{vg}$$

Procedure Function: PS1

z2=w2-w

z1

$$phi = phi - \frac{z2}{\frac{z2 - z1}{phi \cdot .0001}}$$

goto BB

hmsol :

hm = x

$$w = \frac{hm - ha}{hv}$$

ifyi < > 'Tas then goto NT

Tas=T-10

Goto LL1

vsolve:

va = x

$$pa = \frac{Ra \cdot T}{va}$$

pv= pm -pa

phi = J:':...
pg

call Tsat(pv; dp)

$$w = \frac{phi \cdot va}{vg}$$

hm =ha+ w · hv

Tas=T-10

ifyi = 'Tas then goto LL1

results :

y = value(yi)

Procedure Function: psatp

Comment	psat as a function of T
Parameter Variables	
Input Variables	T
Output Variables	p

Statement

b1 = 185.4706986495066

b2 = 17.42726820259139

b3 = -1.198970752324629

b4 = .09547905866509425

x := ln(1000)

Loop:

Procedure Function: PS1

Procedure Function: psatp

$y = b1 + b2 \cdot x + b3 \cdot x^2 + b4 \cdot x^3 - T$

$p = e^{(x)}$

if $| y | < 1e\text{-}6$ return

$xx = x \cdot (1.0001)$

$yy = b1 + b2 \cdot xx + b3 \cdot xx^2 + b4 \cdot xx^3 - T$

$$x := x - \frac{y}{\frac{yy - y}{x \cdot 0.0001}}$$

goto Loop

APPENDIX IV

Water analysis for well 4

EDGE ANALYTICAL

Reference Number: **19-47560**
Report Date: 12/30/19

Data Report

7440-50-8	**COPPER**	0.0048	0.002	2.76E-05	mgll	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7439-92-1	**LEAD**	0.0042	0.0005	6.66E-06	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7439-98-7	**MOLYBDENUM**	0.0102	0.001		mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-02-0	**NICKEL**	ND	0.0005	1.62E-05	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7782-49-2	**SELENIUM**	0.0003 J	0.001	2.66E-05	mgfl	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-22-4	**SILVER**	0.00073 J	0.0002	1.17E-05	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-28-0	**THALLIUM**	ND	0.0001	7.06E-06	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-62-2	**VANADIUM**	0.0077	0.001	7.76E-06	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-66-6	**ZINC**	0.608	0.0025	0.00055	mg/L	1.0	200.8/3010A	a	12118119	BJ	200.8_191218A2	

Sample Description: **-Well4** Sample Date: 12/12/19 10:45 am

Lab Number: 92279 Sample Comment: Collected By: AM

CASIO#	Parameter	**Result**	POL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment
7439-97-6	**MERCURY**	ND	0.0002	5.30E-05	mgll	1.0	245.1	a	12/18/19	AJW	245.1_191218	
16887-00-6	**CHLORIDE**	33.3	0.1	0.0944	mg/L	1.0	300.0	a	12/18119	AJW	IC02_191217A	
14808-79-8	**SULFATE**	240.4	0.2	0.0431	mg/L	1.0	300.0	a	12/18/19	AJW	IC02_191217A	
E-14506	**ALKALINITY**	59.0	2.0		mg CaC03/L	2.0	SM2320 B	a	12/21/19	SRS	ALK_191221	
E-10184	**ELECTRICAL CONDUCTIVITY**	515.0	10	10	uS/cm	1.0	SM2510 B	c	12/19/19	SVL	cec_191219	
E-10139	**HYDROGEN ION (pH)**	7.50 H3			pH Units	1.0	SM4500-H+ B	e	12/13/19	KRH	EpH_191213	Temp (CJ: 15.0
14797-55-8	**NITRATE-N**	0.36 H1	0.005	0.0009	mg/L	1.0	SM4500-NO3 F	c	12117/19	JAL	cno3_191217	
14797-65-0	**NITRITE-N**	0.01 H1	0.005	0.0011	mg/L	1.0	SM4500-NO3 F	c	12117119	JAL	cno3_191217	
14265-44-2	**ORTHO-PHOSPHATE**	0.02 H1	0.01		mg/L	1.0	SM4500-P F	c	12/19/19	JAL	cpo4_191219	
7429-90-5	**ALUMINUM**	ND	0.010	0.004	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
7440-42-8	**BORON**	0.03 J	0.05	0.007	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
E-11778	**HARDNESS as Calcium Carbonate**	172.0	3.30	0.01	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
7439-89-6	**IRON**	0.03 J	0.050	0.0012	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
7439-96-5	**MANGANESE**	0.011	0.001	0.0002	mg/L	1.0	200.7/3010A	a	12118119	BJ	200.7_191218A	
7440-09-7	**POTASSIUM**	0.8 J	1.0	0.1	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
	Silicate	29.5	0.1		mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	As Si02
7440-23-5	**SODIUM**	37.8	0.5	0.05	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
7440-32-6	**TITANIUM**	ND	0.010	0.001	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	200.7_191218A	
7440-62-2	**VANADIUM**	0.028	0.01	0.0015	mg/L	1.0	200.7/3010A	a	12/18/19	BJ	2D0.7_191218A	
7440-36-0	**ANTIMONY**	0.00008 J	0.001	6.91E-06	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-38-2	**ARSENIC**	0.0176	0.0005	2.18E-05	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-39-3	**BARIUM**	0.0019	0.001	1.49E-05	mgfl	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-41-7	**BERYLLIUM**	ND	0.0003	6.76E-06	mg/L	1.0	200.8/3010A	a	12118119	BJ	200.8_191218A2	
7440-43-9	**CADMIUM**	ND	0.0002t	1.13E-05	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-47-3	**CHROMIUM**	ND	0.001	2.03E-05	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7440-48-4	**COBALT**	0.00008 J	0.001	4.05E-06	mg/L	1.0	200.8/3010A	a	12118/19	BJ	200.8_191218A2	
7440-50-8	**COPPER**	0.0068	0.002	2.76E-05	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	
7439-92-1	**LEAD**	0.0012	0.0005	6.66E-06	mg/L	1.0	200.8/301DA	a	12/18/19	BJ	200.8_191218A2	
7439-98-7	**MOLYBDENUM**	0.0047	0.001		mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200.8_191218A2	

Notes:

ND= Not detected above the listed practical quantitation limit (PQL) or not above the Method Detection Limit (MDL), if requested.

PQL= Practical Quantitation Limit is the lowest level that can be achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

D.F. - Dilution Factor

ANALYTICAL

Reference Number: **19-47560**
Report Date: **12/30/19**

Data Report

7440-02-0	**NICKEL**	ND	0.0005	1.62E-05	mgfl	1.0	200.8/301QA	a	12118/19	BJ	200,8_191218A2
7782-49-2	**SELENIUM**	0.0005 J	0.001	2.66E-05	mg/L	1.0	200.8/301QA	a	12/18/19	BJ	200.8_191218A2
7440-22-4	**SILVER**	0.0006 J	0.0002	1.17E-05	mg/L	1.0	200.8/3010A	a	12118/19	BJ	200.8_191218A2
7440-28-0	**THALLIUM**	ND	0.0001	7.06E-06	mg/L	1.0	200.8/301QA	a	12/18/19	BJ	200.8_191218A2
7440-66-6	**ZINC**	0.0216	0.0025	0.00055	mg/L	1.0	200.8/3010A	a	12/18/19	BJ	200,8_191218A2

Notes:

ND= Not detected above the listed practical quanlitation limit (POL) or not above the Method Detection Limit (MDL), if requested.
POL= Practical Quantitation Limit is the lowest level that can be achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
D.F. - Dilution Factor

11.4 Appendices

Facility Assessments and Condition Indices

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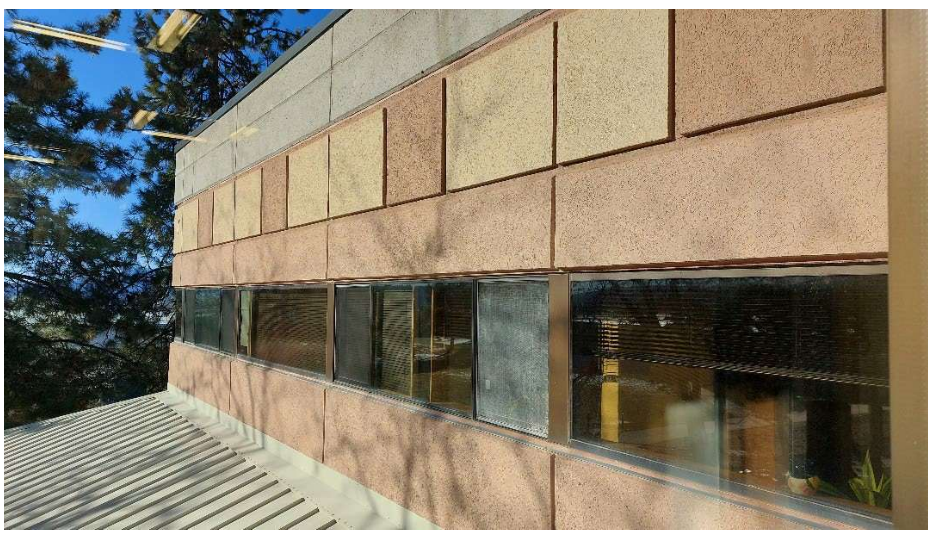
Learning Resource Center (LRC)

02 Architectural - General

The LRC was designed in 1980 and has undergone a number of remodels over the years. The exposed structure is concrete and exterior walls were originally designed as a combination of concrete and brick. In 1993, a strong earthquake damaged most of the brick and it was replaced with an exterior insulation and synthetic stucco finish (EIFS) applied on gypsum board sheathing. At some point also, the windows and skylights were replaced with new storefront window framing and double glazing.



Most of the roof is a 60 mil TPO roof installed in 2014. However, there are a number of lower shed roofs clad in standing seam metal. The lower roof over the main entry is original to the building but lower roofs at the other sides of the building were added over the top of the existing skylights and planters which were built into the structure.

The interiors also feature exposed brick walls. The condition is generally good, but the lighting is poorly designed, being far too bright in the central reading room, too dark elsewhere, and the carpet is worn.

02.02 Superstructures

02.02.10 Structural Framing Event

Description Concrete structural elements seem to be in good condition with the exception of the ground floor southwest corner of the building. Here the floor slab has subsided in the restrooms and the subsidence is visible at the exterior. While fallen brick cladding was replaced after the 1993 earthquake, no other structural upgrades were completed at that time. Without this the building does not meet current seismic safety codes and poses a risk to occupants in the next large earthquake.

Condition Assessment Poor.

Element State: Poor.

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace floor	2025	$200,000	High
Seismic upgrade	2025	$1,000,000	High

Event Justification & Strategy: A major renovation is planned for this building and the slab and footing should be repaired as part of the anticipated renovation. Deferral could lead to structural collapse and injuries. The plumbing under this slab and the finishes atop the slab will also need to be replaced.

A major seismic upgrade should be undertaken, bringing the building up to current safety standards.

02.03 Exterior Enclosure

02.03.10 Exterior Walls

Description The Exterior Insulation and Finish System is generally in good condition except that a number of the reveals in the system have accumulated lichens on the north and east sides of the building. Also, sealant between the EIFS panels is separating from the EIFS. This will lead to leaks if it hasn't already.

Condition Assessment Fair. All joints in the EIFS panels should be resealed. The surfaces of the reveals should be cleaned to remove lichens, with a solution recommended by EIFS manufacturers.

Element State: Fair.

Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2025	$45,000	High

02.03.40 Windows

Description Anodized aluminum double glazed windows and skylights were installed at some point, replacing the original windows.

Condition Assessment Fair. Several locations of intermittent leaks were observed.

Element State: Fair.

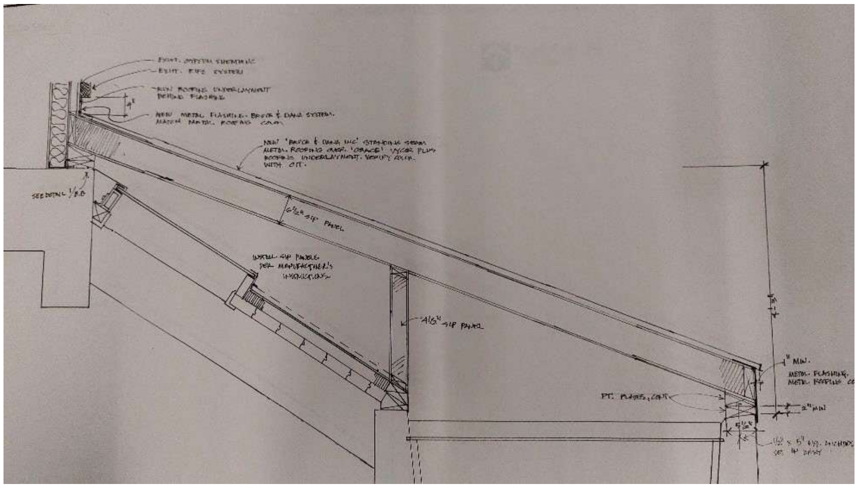
Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2025	$50,000	High

Event Justification & Strategy: Windows need to be water tested to identify leaking locations, and repairs need to be made at those locations. In some places, repairs are also needed to finishes which have already been water damaged.

02.04 ***Roofing***

Description A single ply .60 mil TPO roof was installed over the majority of the roof in 2014. This should not need replacement until 2037. The lower standing seam metal roofs, however, are in need of replacement. The roof finish is wearing away, indicating that it was probably a less expensive silicon polyester finish rather than a PVDF finish. Snow and leaves accumulate at the eave, contributing to standing water or moisture for long periods.

This roofing was installed at some point on wood framing to cover up the skylights, existing metal roofing and built in concrete planters as shown in the drawings below.



Its not clear why this was done. The structural insulated panels (SIP on the drawing) add insulation, and perhaps the skylights were leaking. This alteration significantly changed the appearance of the building from the original design.

Condition Assessment Poor. The metal roofing is rusting and will leak. Rather than replace the roofing, as part of the planned renovation, the altered areas should be restored to their original condition. The skylights should be tested for watertightness and repaired if needed. The built in planters should have the interior resloped to drains with lightweight concrete and coated with waterproofing and with some form of vegetation restored. The techniques of green or vegetated roofing have advanced since the original design of the building and have also advanced since these alterations were made.

As an alternate, the planters could be sloped to drain with tapered insulation and could be lined with single ply roofing.

Element State: Poor.

Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2025	$150,000	High

Event Justification & Strategy: The roofing needs replacement to prevent leaks. The building should be restored to its original or near original condition.

1. Mechanical Executive Summary

The Learning Resource Center mechanical systems consists of four indoor central station air handling units located in the basement. The building also has four rooftop air handling units to serve various spaces. Heating hot water is provided through a plate and frame heat exchanger connected to the campus geo-thermal system.

It was reported that all of the equipment except the newer packaged rooftop units were vintage to the building and most appeared to be properly maintained. The geo-thermal system components exhibited a large amount of corrosion buildup that had not yet been addressed.

User feedback from the building is that it has problems with comfort conditions. The original design of large opens spaces was subdivided into office and other suites with minimal attention to the HVAC distribution. In addition, many users report that the supply air systems deposit dust and dirt on nearby desk and other horizontal surfaces.

04 Mechanical
04.01 HVAC Full Replacement Option

Description: One option is to completely replace all of the HVAC equipment. A request has been submitted to the state legislature for a complete renovation of the building. All new energy efficient systems meeting contemporary comfort standards, and designed for the current building use should be a major part of this upgrade.

Condition Assessment Existing HVAC is vintage to the building, worn out, inefficient and not matched to the current uses of the building.

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Replace	2025	$3,000,000	High

04.01 HVAC Patch and Refurbish Option
Description: Another option is to make do and replace components piecemeal. In this option the following components would be addressed:

04.01.040 (HW/S) Heat Exchangers

Description Heat Exchanger connected to campus geothermal system provides heating hot water for the building.

Condition Assessment Heat exchanger appears to have been replaced at some point in time, however when this event occurred was not known. Heat exchanger appeared to be in good condition.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Replace	2033	$25,000	Medium

04.01.110 Computer Cooling AHU
Description A portion of the building is served by a dedicated computer room type unit to meet the specific heating/cooling and humidification needs of IT equipment in the space.

Condition Assessment: The air handling unit itself was in good condition, however the humidifier of the unit had a large amount of scale buildup. The humidifier needs to be serviced more regularly or replaced. However, the IT group is scheduled to move out of the building and this unit should become unnecessary.

Element State: Good

04.01.120 Rooftop AHU – Heating and Cooling
Description The building has a total of four rooftop units. Two PACE air handling units and two packaged DX units. The PACE units are vintage to the building, and one was reported to have a freezing coil issue. The two packaged DX units were installed in the last 10-15 years and still appeared to be in good condition and functioning properly.

Condition Assessment: PACE Air Handling Units: Equipment is in fair condition.

Element State: Fair

04.01.120 Rooftop AHU – Heating and Cooling – PACE Units

Event Type	***Event Year***	***Event Cost***	***Priority***
Refurbish	2025	$70,000	High

Event Justification & Strategy
Both of the air handling units are vintage to the building and past their maximum life of 12 years. Units are in fair condition from having proper maintenance done and components replaced when needed. A total refurbishment of all internal components would fix the freezing coil issues and renew these units to a full life expectancy.

Condition Assessment: Packaged DX Rooftop Units: Equipment is in good condition.

Element State: Good

04.01.120 Rooftop AHU – Heating and Cooling – Packaged DX Units

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2033	$12,000	Low

Event Justification & Strategy
Packaged DX Rooftop units are about halfway through their useful life. The units appeared to be in good condition with no reported issues. Units should be replaced when they reach the end of their useful life.

04.01.160 Central Station AHU
Description Four central station air handling units located in the basement also serve the building. These are all PACE units that were reported to be vintage to the building and internal components are all original.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Refurbish	2025	$80,000	High

Event Justification & Strategy
The units are past their useful life, but due to being installed indoors and having proper maintenance done and components replaced when needed are in fair condition. A total refurbishment of all internal components would renew these units to a full life expectancy again.

04.01.180 HVAC Pumps
Description Central pumps circulate heating hot water from the geo-thermal heat exchanger throughout the building to provide the necessary heating.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$12,000	High

Event Justification & Strategy
Units are in fair condition but exhibit corrosion on pump body and motor. Regular maintenance and replacement of parts have allowed these pumps to continue to operate.

04.01.240 Ventilation Fans
Description A number of rooftop exhaust fans serve this building. All fans are vintage to the building.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$20,000	Medium

Event Justification & Strategy
Units are in fair condition but are original to building. Units should be replaced with newer energy efficient energy recovery ventilators (ERVs).

2. Plumbing Executive Summary

The Learning Resource Center was built in the 1970's and appears to be comprised of original plumbing fixtures, the majority of the piping for water waste and vent appears to be original. The water source to the building is non-potable with point-of-use filters where potable water is required.

05 Plumbing
04.03 Plumbing Systems

Water, Sanitary, and Storm Piping

Description:
Water Piping: the building water supply is served by wat appears to be a 2-1/2" copper line. Water piping appears to be primarily fiberglass-wrapped copper piping with newer alterations being PEX.

Sanitary Piping: only a small portion of the sanitary waste and vent piping was able to be directly observed the piping appears to be cast iron.

Storm Piping: Only a small portion of the storm piping was able to be directly observed and it appears to be cast iron, with only a primary roof drain and no observable secondary drainage. There is also a storm drain sump pump in the basement.

Condition Assessment: Portions of copper piping that were able to be observed appear to be in decent condition. Copper pipe, depending on water quality typically lasts between 70 and 80 years. Portions of the sanitary waste piping that were able to be observed appear to be in decent condition with no major signs of leaks or failures. Cast Iron pipe can last between 50 and 75 years depending on water quality and climate. However it was noted that a portion of the building foundation has shifted causing the floor drains in one of the restroom groups to push up through the floor. This shifting in the foundation is likely putting strain on the waste piping below grade. Portions of the cast iron storm piping that were able to be observed looked to be in fair condition.

Element State: Good*

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$200,000*	High*

Event Justification & Strategy

Except as noted below the plumbing system appears to be in good condition. However, as water, sanitary, and storm piping begins to corrode it will begin to leak. Leaks can be costly to fix especially when having to contend with asbestos and can cause additional damage to the structure.

*Building foundation shifting should be addressed as a high priority and affected portions of the waste system should be corrected as soon as possible to limit further damage. Costs are included structural section of this assessment.

Recommendations and Additional Observations

It is recommended that water, sanitary, and storm lines be scoped to assess the internal condition of the pipe to get a better idea of life expectancy.
It was noticed that there were several inches of standing water on the roof because many of the primary roof drains had been obstructed by debris.

Water Heaters

Description: There is no central hot water heater system. Smaller electric hot water heaters are located throughout the facility to serve individual or small groups of fixtures.

Condition Assessment Equipment based on equipment serial numbers it looks like the electric water heaters are around 10 years old. If this is correct they are nearing the end of their lifespan.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$5,000	Medium

Water Filtration

Description site domestic water is not suitable for consumption, where potable water is required fixtures have been provided with point-of-use cartridge style water filters.

Condition Assessment Equipment appears to be being serviced regularly and all filters have dates when the last filter was installed.

Element State: Good

Plumbing Fixtures

Description Plumbing fixtures appear to be original fixtures with water closets and urinals having their manual flush valves. Original fixtures do not meet water conservation requirements of the plumbing code.

Condition Assessment Some of the stops/ shutoff valves at some of the fixtures are showing signs of corrosion the fixtures themselves appear to be in serviceable condition.

Element State: Fair

05. Electrical Executive Summary

The Learning Resource electrical systems consists of 480/277V and 208/120V electrical distribution equipment to serve building loads. All of the electrical distribution equipment is original to the building, which was constructed in 1980. Some lighting updates have been made to interior and exterior lighting, however, most of the lighting is original fluorescent fixtures. Overall, the building electrical systems are in fair condition, however, nearing the end of their expected life span.

05 Electrical
05.02 Secondary Electrical
05.02.10 Secondary Switchgear

Description: The Learning Resource Center is served via a 1200A, 480/277V, electrical service to a main switchboard in the basement level main electrical room. The main switchboard serves 480V loads including mechanical equipment, elevator, lighting, and step-down transformers to multiple 208/120V panelboards. All electrical distribution equipment is of original vintage to the building, which was construction in 1980.

Condition Assessment The electrical distribution equipment, including the main switchboard and panelboards, are installed indoors. No ongoing electrical maintenance program or testing of equipment and terminations was reported. An arc flash study was performed in 2019 and corresponding shock hazard labels applied to all distribution equipment.

All switchboards and panelboards are original to the building, which was constructed in 1980 and are in fair condition. Due to the age of the building, the electrical distribution equipment has reached its expected life span.

Other Observations The main switchboard in the Learning Resource Center was observed to also serve the elevator in the Athletics Building. This presents a code issue and severe safety concern, should power need to be shut off to the Athletics building, and the elevator remains energized as it is served from a separate building. Clear labeling indicating the elevator source power location from a separate building and requirements to de-energize either building was not observed at the LRC or Athletics building.

Element State: Fair

05.02.10 Secondary Switchgear – Event #1

Event Type	***Event Year***	***Event Cost***	***Priority***
Testing	2025	$5,000	High

Event Justification & Strategy

There is not currently an ongoing maintenance program or routine testing of electrical systems to ensure safe and properly functioning equipment. As equipment ages and reaches the end of its expected useful life, ongoing inspection and maintenance is vital in maintaining safe and proper functioning equipment. Testing of all equipment is recommended to include visual and infrared inspections, tightening of terminations as required, lubrication, cleaning of electrical equipment.

Implication of Event Deferral

Failure to maintain and inspect equipment can result in preventable equipment failure, power outages, and potential safety and/or fire hazards.

05.02.10 Secondary Switchgear – Event #2

Event Type	***Event Year***	***Event Cost***	***Priority***
Study	All	$5,000	High

Event Justification & Strategy

For any modifications made to the building electrical distribution, perform an updated system coordination study and arc flash analysis, and revised labeling provided on all equipment as required. Modifications to the electrical distribution system can impact the available fault currents and thus arc fault current at each piece of equipment.

Implication of Even Deferral

This is a code compliance safety issue.

05.02.10 Secondary Switchgear – Event #3

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$100,000	Moderate

Event Justification & Strategy

The electrical distribution equipment in the building was installed in 1980 and has reached its expected useful life and should be replaced in the near future. When replaced, the Athletics Building elevator should be disconnected from the LRC and connected to switchgear in the Athletics Building.

Implication of Event Deferral

A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.20 Secondary Transformers

Description Step down 480V:208/120V, 3-phase transformers are provided to serve receptacle and equipment loads throughout the building.

Condition Assessment –The transformers in the building are of original vintage and are in fair condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$25,000	Moderate

05.02.40 Inverters

Description An emergency lighting inverter was installed in 2019 and is located in the basement main electrical room.

Condition Assessment The inverter is newly installed and in good condition. It was noted that the inverter is very underutilized (approximately 10% loaded), as the circuitry of the existing building lighting currently prohibits further utilization. This is due to the current design that utilizes emergency battery packs at individual fixtures, and there not being separate circuits for emergency lights. Based on this existing circuiting, the emergency lighting cannot easily be reconnected to the emergency lighting inverter, without connecting entire lighting circuits (which inverter sizing typically cannot accommodate) or without rewiring the existing lighting to separate the emergency lighting. Future light fixture replacement/retrofit to LED may allow for some opportunities to move circuits onto the inverter in lieu of utilizing integral battery backs, due to the decreased load impact of LED fixtures.

Element State: The inverter is in good condition.

05.02.60 Cabling, Raceway & Bus Ducts

Description EMT, rigid, flexible metal, and gutter raceway were observed in the main electrical room. It was reported that copper conductors are used throughout the building/campus.

Condition Assessment Equipment conduits observed in the electrical room appear to be in fair condition and are original to the building. Feeders/conductors were not readily visibly observable. The 480V conductors serving the building from the campus medium voltage distribution were reported to have been updated in the past 1-2 years and in good condition.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Test/Replace	2025	$80,000	Moderate

Event Justification & Strategy

At the time of future equipment replacements, any existing feeders/conductors proposed to be reused shall be megger tested to confirm there has not been any degradation or damage to the conductor insulation.

Implication of Event Deferral

Conductors with worn, frayed or damaged insulation present safety and fire hazards.

05.03 Lighting Fixtures
05.03.10 Interior Lighting

Description Interior lighting includes fluorescent lighting throughout the building that is original to the building, including some fixtures that have been retrofitted with LED tubes. New LED light fixtures have been installed in the lobby area that replaced the original fluorescent fixtures.

Condition Assessment The interior fluorescent lighting is original to the building and in fair condition but at end of expected life. Many of the new LED fixtures that were installed in the lobby have been problematic with failed drivers and are no longer functional. Existing lighting controls includes manual switching throughout the building. Qualitatively, the lighting in the high ceiling spaces is excessively bright and has a very uncomfortable feel.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Test/Replace	2025	$800,000	High

Event Justification & Strategy

Existing fluorescent lighting is less efficient than LED lighting and has reached the end of its life span. More recently installed LED lighting is largely no longer operational. Replace all existing interior lighting with new LED light fixtures. At time of lighting replacement, upgrade the lighting controls in respective areas to provide occupancy sensors and daylight sensors as required by code, for additional energy savings.

Because the circuiting is not configured for separate circuits for emergency egress lighting, there are 2 options for this. One is to completely recircuit the building's lighting and use the existing fairly new inverter for egress lighting emergency power. The other is to remove the inverter, keep the circuiting the same and replace emergency egress fixtures with new LED fixtures that have onboard battery backup. If a wholesale renovation of the building is done, recircuiting is probably a better option. If only the light fixtures are replaced then this is not.

05.03.20 Exterior Lighting
Description Exterior lighting consist of LED fixtures located at building exits and pedestrian pathways.

Condition Assessment Exterior lighting was recently replaced with the new LED fixtures approximately two years ago and is in good condition.

Element State: Good

05.03.40 Emergency Lighting
Description Emergency lighting is provided throughout the building via emergency lighting inverter and battery ballast integral to light fixtures. Refer to previous Interior and Exterior lighting sections and 05.02.40 Inverters for additional information.

15 Year Expected Building Repair Replacement Costs

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
02.02.010	Concrete Structure	Replace SW ground floor slab	$200,000			$200,000		
		Seismic Upgrade	$1,000,000			$1,000,000		
02.03.010	Exterior walls	Reseal EIFS panel joints	$45,000			$45,000		
02.03.40	Exterior windows	Water test each window and seal leaks	$50,000			$50,000		
02.04	Roofing	Replace metal roofing	$150,000			$150,000		
04.01	Full HVAC Replacement	Replace entire system	$3,000,000			$3,000,000		
04.01.040	Heat Exchangers	Replace		$25,000		$25,000		
04.01.120	Rooftop AHU	Refurbish		$70,000		$70,000		
04.01.120	Packaged DX Units	Replace		$12,000		$12,000		
04.01.160	Central Station AHU	Refurbish		$80,000		$80,000		
04.01.180	HVAC pumps	Replace		$12,000		$12,000		
04.01.240	Exhaust fans	Replace with ERVs		$20,000		$20,000		
04.03	Plumbing - Water Heater	Replace		$5,000		$5,000		
04.03	Plumbing - Fixtures	Replace	$200,000			$200,000		
05.02.10	Secondary Switchgear	Event #1 - Testing	$5,000			$5,000		
		Event #2 - Arc Flash & Coordination	$5,000			$5,000		
		Event #3 - Replace	$100,000			$100,000		
05.02.20	Transformers	Replace	$25,000			$25,000		
05.02.60	Cable, Raceway a& Bus Ducts	Test/Replace	$80,000			$80,000		
05.03.10	Interior Lighting	Replace	$800,000			$800,000		
							52,640 SF	
							$600/SF	
Totals			$5,660,000	$224,000	$0	$5,884,000	$31,584,000	0.186

Purvine Hall

Purvine Hall is the home for electrical engineering and computer systems engineering technology (CSET). It has a mix of general use classroom, labs and offices. The building was designed in 1986 and appears to have had few modifications since then. Besides faculty offices, labs and classrooms, the design took advantage of the outdoor grade change to provide 2 tiered classrooms.

01 Property

01.01 Site

01.01.14 Site Related Stairs, Plazas and Decks

Description South stairs and west paving are concrete with additional paving of brick mortared in place.

Condition Assessment: south stairs are cracked and spalling. Concrete slabs have heaved probably due to freezing and thawing of expansive soils. Brick paving has heaved in some places and disintegrated at others.

South Stairs

Frost heaves at slabs

Broken brick paving

Element State: Poor.

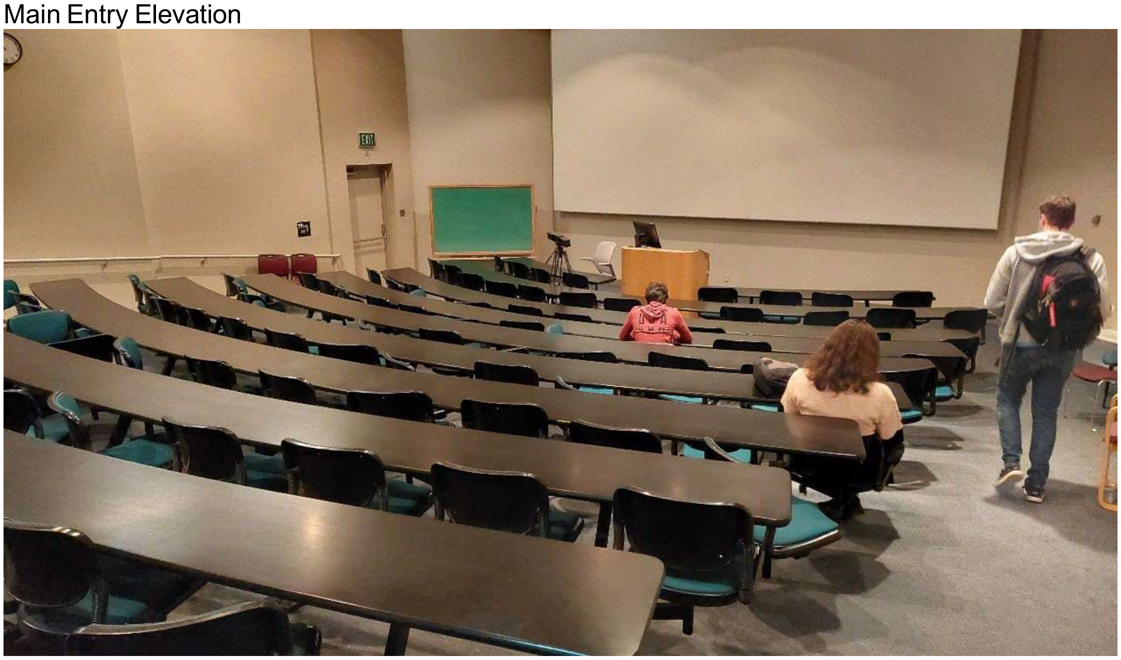
Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2033	$15,000	Medium

Event Justification & Strategy: The stairs are not in a high use area and repair might be deferable although they will become a hazard. The concrete slabs and broken brick paving will also become a hazard as time goes on.

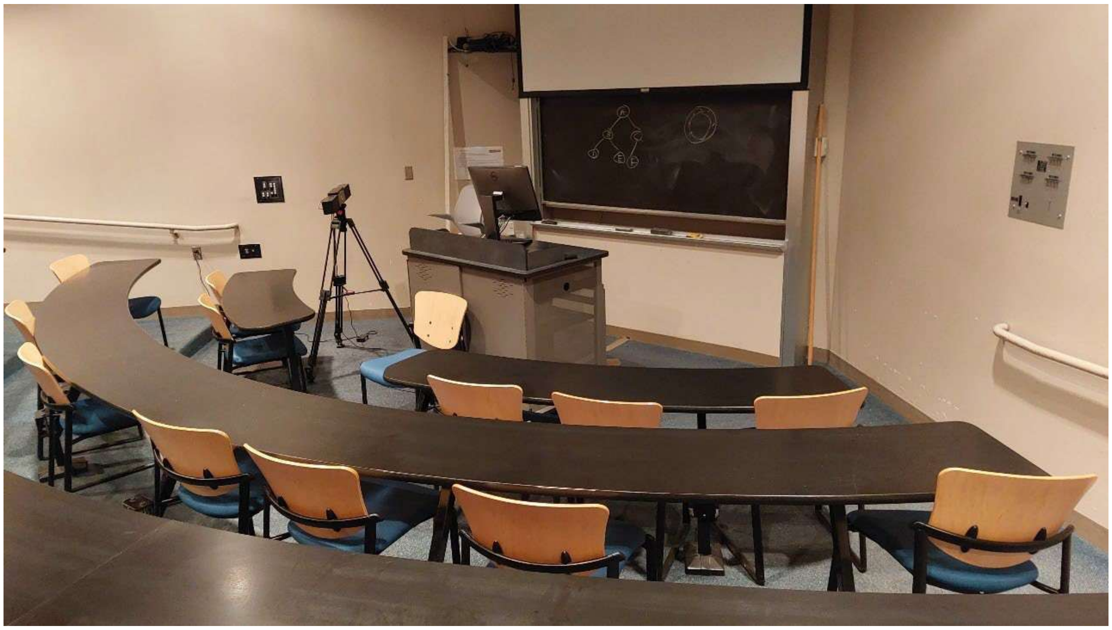
02 Architectural - General

Purvine is a steel framed building with brick and metal panel exterior cladding. The metal panels are a mix of surface fastened painted ribbed metal and smooth finished aluminum composite material.

Main Entry Elevation



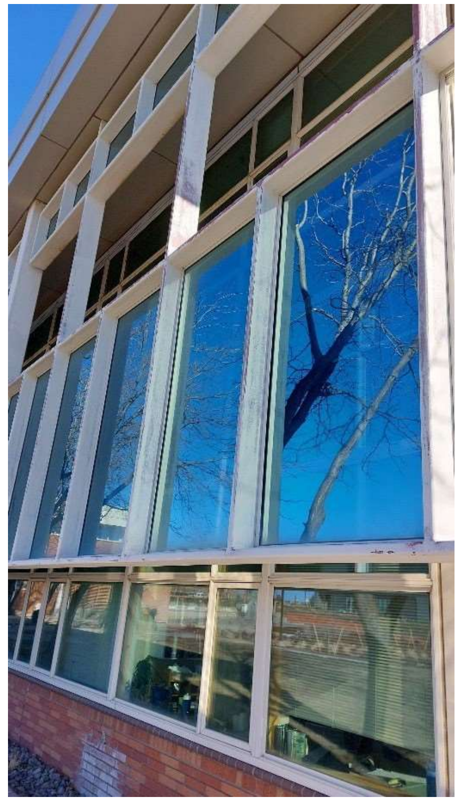
Large Tiered Classroom



Small Tiered Classroom

Purvine also has a 2 story atrium space with a view of Klamath Lake and art integrated into a large skylight. It also has a coffee/snack service at the atrium. The interiors are in generally good condition.

The office wing has west facing windows with some protection from the sun by means of a secondary wall of tinted glass in a painted hollow metal frame.



02.02 ***Superstructures***

02.02.10 Structural Framing

Description Steel columns are exposed to the outdoors at the west side of the building.
These are painted but paint has worn thin.

Condition Assessment Fair. Columns are rusted at the base, probably due to worn paint, moisture accumulating during snowfall and salt being used to melt the snow. The photo below shows visible salt.

Element State: Fair.

Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2025	$15,000	High

Event Justification & Strategy: These columns are critical structural components and should be maintained. Extensive rust would weaken the column to the point where safety would require its replacement. A small amount of maintenance cost can prevent an expensive replacement. The adjacent paving should be removed to get access to all areas of rust, so they can be ground off the column. A waterproof paint should be applied from below grade to 18” above grade, with no finish paint applied over the subgrade portion. Then the paving can be replaced and a finish paint applied over the above grade portion.

02.03 Exterior Enclosure

02.03.10 Exterior Walls

Description Brick cladding is generally in good condition except for one location at the east wall, where there is damage due to either a high velocity impact or possibly a seismic event. There is no apparent water penetration and no urgent need to repair the damage.

Condition Assessment Good.

Element State: Good.

Event Type	Event Year	Event Cost	Priority
Repair	2038	$15,000	Very Low

***02.04* Roofing**

Description A single ply .60 mil TPO roof was installed in 2017. This should not need replacement until 2040.

04 Mechanical

Mechanical Executive Summary
Purvine Hall mechanical systems consists of five indoor central station air handling units. Two of these units are in the first-floor mechanical room and the other three are in the rooftop penthouse. Heating hot water is provided through a plate and frame heat exchanger connected to the campus geo-thermal system.

The building has its own water-cooled chiller and associated cooling tower to provide the necessary cold water for cooling. VAV terminal units with hot water reheat serve the individual spaces throughout the building.

The building also houses the geo-thermal campus reinjection equipment. This consists of a large storage tank to collect the incoming return water and return pumps to evacuate the water out of the storage tank to the geo-thermal well.

It was reported that all equipment is vintage to the building.

04.01 HVAC

04.01.040 (HW/S) Heat Exchangers

Description Heat Exchanger connected to campus geothermal system provides heating hot water for the building.

Condition Assessment Heat exchanger is in fair condition

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$15,000	High

04.01.070 (CWC) Chillers
Description Water cooled chiller

Condition Assessment: The chiller is vintage to the building, with one of its compressor units replaced in 2018 and the other appeared to still be original to the equipment. Equipment is beyond its useful life expectancy and is in fair condition.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$700,000	High

04.01.080 (CWC) Cooling Towers
Description Cooling Tower

Condition Assessment: The cooling tower is vintage to the building. Equipment is beyond its useful life expectancy, and it is in fair condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$300,000	High

04.01.160 Central Station AHU

Description A total of five central station air handling units serve the building. These units were reported to be vintage to the building and internal components are all original.

Condition Assessment Equipment is all installed indoors and regular maintenance and replacement of parts has been done throughout the equipment's life. Equipment is in good condition.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Refurbish	2025	$1,000,000	High

Event Justification & Strategy
The units are past their useful life, but due to being installed indoors and having proper maintenance done and components replaced when needed are still in fair condition. A total refurbishment of all internal components would renew these units to a full life expectancy again.

04.01.180 HVAC Pumps

Description Central pumps circulate heating hot water from the geo-thermal heat exchanger throughout the building to provide the necessary heating. Chilled water and condenser water pumps are part of the building's chilled water system. The building also houses the main campus geo-thermal system reinjection pumps.

Condition Assessment Heating Water Pump: The heating water pump was replaced in 2018 and is at the beginning of its useful life.

Element State: New

Condition Assessment Chilled Water Pump: The chilled water pump was rebuilt in 2019 and is at the beginning of its useful life.

Element State: New

Condition Assessment Condenser Water Pump: The condenser water pump appeared to be newly replaced within the last few years and is at the beginning of its useful life.

Element State: New

Condition Assessment Geo-Thermal Water Pumps: The geo-thermal water pumps appeared to be newly replaced or rebuilt within the last 3-4 years and are at the beginning of their useful life.

Element State: New

04.01.190 Terminal Units

Description 54 Variable air volume terminal units serve the varies spaces throughout the building.

Condition Assessment Equipment is in good condition.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Replace	2033	$150,000	Low

Event Justification & Strategy
Terminal units were installed in 1999 and are still in good condition due to regular

maintenance. Units are at the end of their useful life expectancy; replacement will be needed in the next 10-15 years.

04.01.240 Ventilation Fans

Description 6 exhaust fans serve this building. All fans are vintage to the building.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$30,000	Medium

Event Justification & Strategy: Replace fans with Energy Recovery Ventilators. In this climate they will save a large amount of energy.

04.03 Plumbing Systems

Water, Sanitary, and Storm Piping

Description:
Water Piping: the building water supply is served by what appears to be a 3” copper line. Water piping appears to be primarily fiberglass-wrapped copper piping.

Sanitary Piping: sanitary waste and vent piping was not able to be directly observed, it is assumed to be cast iron. There is a sanitary sump pump that pumps out to the site level gravity waste.

Storm Piping: Storm piping was not able to be directly observed, it is assumed to be cast iron.

Condition Assessment: Portions of copper piping that were able to be observed appear to be in decent condition. Copper pipe, depending on water quality typically lasts between 70 and 80 years. Portions of the sanitary waste piping that were able to be observed appear to be in decent condition with some signs of past leaks. Cast Iron pipe can last between 50 and 75 years depending on water quality and climate. A large portion of the plumbing was replaced around 2018 and looks to be in good condition. The remainder of the facility looks to be original.

Element State: Good

Recommendations and Additional Observations

It is recommended that water, sanitary, and storm lines be scoped to assess the internal condition of the pipe to get a better idea of life expectancy.

Water Heaters

Description: There is no central hot water heater in the building, but incoming water to the water heaters is pre heated by small heat exchangers that are connected to the site geo-source heating water.

Condition Assessment Exact equipment age is not known but it appears to be original to the building and is likely close to or past is service life.

Element State: fair to poor.

Event Type	Event Year	Event Cost	Priority
Replace	2025	$50,000	Medium

Event Justification & Strategy: Equipment is past its typical useful life and should be replaced before unexpected failure and loss of hot water to the building.

Water Filtration
Description site domestic water is not suitable for consumption, however, it appears the building has a building level water filtration system.

Condition Assessment Equipment appears to be in good working condition.

Element State: Good

Plumbing Fixtures
Description The majority of the plumbing fixtures appear to be original with water closets and urinals having their manual flush valves.

Condition Assessment Some of the stops/ shutoff valves at some of the fixtures are showing signs of corrosion the fixtures themselves appear to be in serviceable condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$50,000	Medium

Event Justification & Strategy: Original fixtures are past their typical useful life and should be replaced. Unexpected failure is unlikely but new fixtures will reduce water consumption by about 35% according to the EPA.

Electrical Executive Summary

Purvine Hall electrical systems consists of 480/277V and 208/120V electrical distribution equipment to serve building loads. All of the electrical distribution equipment and lighting systems are original to the building, which was constructed in 1987. Normal and emergency power systems serve the building, with a standby diesel generator providing emergency power to egress lighting and a sewer pump.

05 Electrical
05.02 Secondary Electrical
05.02.10 Secondary Switchgear

Description: Purvine Hall is served via a 1600A, 480/277V, electrical service to a main switchboard in the basement level main electrical room. The main switchboard serves 480V loads including mechanical equipment, motor control centers, and the elevator. Loads in each lab space are fed from a dedicated panelboard fed via an isolation transformer for each respective space. All electrical distribution equipment is of original vintage to the building.

Condition Assessment The electrical distribution equipment, including the main switchboard and panelboards are installed indoors. No ongoing electrical maintenance program or testing of equipment and terminations was reported. An arc flash study was performed in 2019 and corresponding shock hazard labels applied to all distribution equipment.

All switchboards and panelboards are original to the building, which was constructed in 1987, and are in good condition considering they are nearing the end of their expected useful life.

Element State: Good

05.02.10 Secondary Switchgear – Event #1

Event Type	***Event Year***	***Event Cost***	***Priority***
Testing	2025	$5,000	High

Event Justification & Strategy

There is not currently an ongoing maintenance program or routine testing of electrical systems to ensure safe and properly functioning equipment. As equipment ages and reaches the end of its expected useful life, ongoing inspection and maintenance is vital in maintaining safe and proper functioning equipment. Testing of all equipment is recommended to include visual and infrared inspections, tightening of terminations as required, lubrication, cleaning of electrical equipment.

Implication of Even Deferral
Failure to maintain and inspect equipment can result in preventable equipment failure, power outages, and potential safety and/or fire hazards.

05.02.10 Secondary Switchgear – Event #2

Event Type	***Event Year***	***Event Cost***	***Priority***
Study	All	$5,000	High

Event Justification & Strategy

For any modifications made to the building electrical distribution, perform an updated system coordination study and arc flash analysis, and revised labeling provided on all equipment as required. Modifications to the electrical distribution system can impact the available fault currents and thus arc fault current at each piece of equipment.

Implication of Even Deferral
This is a code compliance safety issue.

05.02.10 Secondary Switchgear – Event #3

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2033	$120,000	Moderate

Event Justification & Strategy

The electrical distribution equipment in the building was installed in 1987 will have exceeded its expected useful life and should be replaced.

Implication of Event Deferral
A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.20 Secondary Transformers

Description Step down 480V:208/120V, 3-phase transformers are provided to serve receptacle, lighting and equipment loads. Each lab is also served via a dedicated isolated ground transformer.

Condition Assessment –The transformers in the building are of original vintage and are in fair condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2033	$150,000	Moderate

Event Justification & Strategy
The transformers will be nearing the end of their useful life and should be replaced.

Implication of Event Deferral
Failure of transformer would result in loss of power to downstream loads.

05.02.60 Cabling, Raceway & Bus Ducts

Description EMT, rigid, flexible metal, and gutter raceway were observed in the main electrical room. It was reported that copper conductors are used throughout the building/campus.

Condition Assessment Equipment conduits observed in the electrical room appear to be in good condition and are original to the building. Feeders/conductors were not readily visibly observable. The 480V conductors serving the building from the campus medium voltage distribution were reported to have been updated in the past 2-3 years and in good condition.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Test/Replace	2033	$40,000	High

Event Justification & Strategy
At the time of future equipment replacements, any existing feeders/conductors proposed to be reused shall be megger tested to confirm there has not been any degradation or damage to the conductor insulation.

Implication of Event Deferral
Conductors with worn, frayed or damaged insulation present safety and fire hazards.

05.03 Lighting Fixtures
05.03.10 Interior Lighting

Description Interior lighting includes fluorescent lighting throughout the building.

Condition Assessment The interior fluorescent lighting is original to the building and in fair condition but at end of expected life.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$875,520	Low

Event Justification & Strategy
Existing fluorescent lighting is less efficient than LED lighting and has reached the end of its life span. Replace existing fluorescent lighting with new LED light fixtures. At time of lighting replacement, upgrade the lighting controls in respective areas to provide occupancy sensors for additional energy savings and code compliance as appropriate for use, functionality, and safety.

05.03.20 Exterior Lighting

Description Exterior lighting consist of fixtures located at canopies at building exits. LED pole mounted area lights are installed in surrounding parking lots and pathways.

Condition Assessment Exterior building mounted lighting is in fair condition but utilizes inefficient outdated lighting technologies. The building mounted lighting is original vintage and is nearing the end of its life span. Surrounding pedestrian and parking lot lighting appears to have been recently installed and is in good condition. Exterior lighting is controlled via timeclocks with contactors, which have exceeded their expected life span.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$20,000	Low

Event Justification & Strategy
Provide new LED exterior building mounted lights. At time of lighting replacement, lighting controls should be upgraded to new relay based astronomical timeclock controls. Upgrade of existing lighting and controls will provide energy savings, reliable controls, and reduced maintenance for exterior lighting.

05.03.40 Emergency Lighting

Description Emergency lighting is provided throughout the building via generator backup of interior and exterior light fixtures. Refer to previous Interior and Exterior lighting sections and 05.05.30 Emergency Power Systems for additional information.

Condition Assessment Emergency lighting is in fair condition.

Element State: Fair

05.05 Electrical Systems

05.05.30 Emergency Power Systems

Description: A 20kW diesel generator supplies emergency power for egress lighting and a sewer pump, via an automatic transfer switch located in the main electrical room. The generator was installed in 1987 and is original to the building.

Condition Assessment The generator is installed at the exterior equipment yard located on the west side of the building. The generator is regularly tested as required for life safety requirements. It was reported that the generator has been problematic and has had ongoing charging issues. To address the issues, a battery was set outside the enclosure and wired into the genset for engine starting. Additionally, the enclosure appeared to be in poor condition. Overall, the generator appeared to be in poor condition and to have exceeded its life span.

Element State: Poor

05.05.30 Emergency Power Systems

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$50,000-80,000	High

Event Justification & Strategy
The generator is in poor condition, with ongoing issues, and is at the end of its useful life and should be replaced to maintain reliable backup power source to meet life safety

requirements.

Alternatively, a central emergency lighting inverter may be implemented to address egress lighting requirements. However, a separate generator or battery would still be needed for backup power requirements of the sewer pump, depending on the amount of time anticipated to be needed for the sewer pump to run on backup power.

Implication of Event Deferral

Potential failure of generator which is a life safety issue.

Purvine Hall

15 Year Expected Building Repair Replacement Costs

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
Purvine Hall			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
01.01.14	Site related stairs, plazas, decks	Repair concrete and brick paving		$15,000				
02.02.010	Exterior steel columns	Paint	$15,000					
02.03.010	Exterior walls	Repair damaged brick			$15,000			
04.01.040	Heat Exchangers	Replace	$15,000					
04.01.070	Chillers	Replace	$700,000					
04.01.080	Cooling Tower	Replace	$300,000					
04.01.160	Central Station AHU	Refurbish	$1,000,000					
04.01.190	Terminal Units	Replace		$150,000				
04.01.240	Exhaust fans	Replace with ERVs	$30,000					
04.03	Plumbing - Water Heater	Replace	$50,000					
04.03	Plumbing - Fixtures	Replace	$50,000					
05.02.10	Secondary Switchgear	Event #1 - Testing	$5,000					
		Event #2 - Arc Flash & Coordination	$5,000					
		Event #3 - Replace	$120,000					
05.02.20	Transformers	Replace		$150,000				
05.02.60	Cable, Raceway a& Bus Ducts	Test/Replace		$40,000				
05.03.10	Interior Lighting	Replace	$875,520					
05.03.20	Exterior Lighting	Replace	$20,000					
05.05.30	Emergency Power Systems	Replace	$80,000					
							46,470 SF	
							$600/SF	
Totals			$3,265,520	$355,000	$15,000	$3,635,520	$27,882,000	0.130

Semon Hall

02 Architectural - General

Semon Hall was one of the original buildings on campus in 1964. It has had no major renovations since the dental program was located there in 1969. The original design was identical to Boivin and Owens Halls but they have since been renovated. The structure is steel framed at the interior with concrete covered steel columns at the exterior porticos. The exterior walls consist of single pane windows in a wood framing system, with asbestos cement panels at opaque areas. A canopy covers all four sides of the building and the soffit has a coffered configuration.

The building was reroofed in 2009 with a 60 mil TPO roof and the roof is in good condition.

<u>02.03 Exterior Enclosure</u>

02.03.010 Exterior Walls

Description The walls are reputed to be clad in asbestos cement panels although they were not tested for this assessment. Previous renovation of Owens Hall is the source of that information and Semon is identical in design to Owens.

Condition Assessment: Good, but asbestos panels are a long term health risk.

Element State: Good.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$400,000	High

Event Justification & Strategy: Wall panels should be replaced with another material, perhaps that used on the recent renovation of Boivin, an almost identical building. The justification is simply the health of students and staff. Typically the asbestos is encapsulated in the panels but these panels are over 60 years old and any deterioration due to age will release asbestos fibers into the ambient air.

02.03.040 Exterior Windows

Description The windows are wood framed and site built with single pane glass. They don't appear to have ever been repainted. Deterioration of the 60 year old painted wood is evident in a number of places.

Condition Assessment Fair, poor at select locations.

Element State: Fair to poor.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$460,000	High

Event Justification & Strategy: Windows should be replaced with thermal break double glazed aluminum or fiberglass storefront. This will reduce energy use and the maintenance costs of repairing rotten wood sections and painting.
or near original condition.

02.05 Interior Construction

02.05.012 Ceiling Structures

Description The ceilings are suspended acoustic tile ceilings. They seem old but do not appear to be original to the building.

Condition Assessment Fair, poor at select locations. Location below is an example. This is at the dental clinic area. Because of the age it is unlikely that they meet current seismic codes.

Element State: Fair to poor.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$300,000	High

Event Justification & Strategy:
Ceilings in all locations should be refreshed with new seismically braced grid and tile. Justification is that the condition does not present Tech well to dental clientele from the community, as well as being less safe in an earthquake than code compliant buildings.

02. Structural Executive Summary

The Semon Hall building is a steel structure consisting of open web steel roof joists and steel decking supported by steel girder trusses and exterior concrete columns. The first floor is constructed with a concrete slab-on-grade.

The building design is identical to Boivin Hall and Owens Hall with structural design completed prior to 1964, when knowledge of west coast seismic risks and design solutions was lacking. Recent renovations of Boivin and Owens showed that this design, which was replicated 3 times, does not meet current safety standards for seismic resistance.

02 Structural
02.01 Foundations
02.01.10 Footings & Foundations
Description Visual observation and as-built drawings of the foundation was not available.

Condition Assessment Based on a visual observation of the superstructure, no obvious footings or foundation deficiencies are evident.

Element State: Good but lacking in seismic resistance. A seismic upgrade should be completed and this may require work to grade beams or other portions of the foundation. Cost is high because it requires removal and replacement of finishes.

Event Type	Event Year	Event Cost	Priority
Repair	2025	$200,000	High

Event Justification & Strategy: The building structure should be upgraded to comply with current seismic codes for the safety of students, staff and faculty, as well as clients of the dental clinic. The approach used should be the one used in the Boivin renovation, rather than the one used in Owens. The Boivin renovation has respected the original mid century modern design of the building while the Owens ignored it and introduced new materials and forms not seen on any other campus buildings.

02.02 Superstructure
02.02.10 Structural Framing
Description Steel structure supported by concrete columns.

Condition Assessment Good but lacking in seismic resistance. Significant upward deflection of the exterior eave beams was observed. There are no compelling theories as to why this has happened and that is a cause for concern.

Element State: Fair, with deflection created by unknown forces and seismic deficiencies identified by work in identically designed buildings.

Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2025	$450,000	High

Event Justification & Strategy: The building structure should be upgraded to comply with current seismic codes for the safety of students, staff and faculty, as well as clients of the dental clinic. The approach used should be the one used in the Boivin renovation, rather than the one used in Owens. The Boivin renovation has respected the original mid century modern design of the building while the Owens ignored it and introduced new materials and forms not seen on any other campus buildings.

Figure 1: Upward Deflection at Eave

04. Mechanical Executive Summary

Semon Hall mechanical systems consist of two indoor central station air handing units. Heating hot water is provided through a plate and frame heat exchanger connected to the campus geo-thermal system. It was reported that all equipment is vintage to the building.

04 Mechanical
04.01 HVAC

04.01.040 (HW/S) Heat Exchangers

Description A heat exchanger connected to campus geothermal system provides heating hot water for the building.

Condition Assessment Heat exchanger was replaced in 2021 and at the beginning of its useful life.

Element State: New

04.01.160 Central Station AHU

Description There are two central station air handling units serving the building. These units were reported to be vintage to the building and internal components are all original.

Condition Assessment Equipment is all installed indoors, and regular maintenance and replacement of parts has all be done throughout the equipment's life. Equipment is in fair condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Refurbish	2025	$50,000	High

Event Justification & Strategy
The units are past their useful life, but due to being installed indoors and having proper maintenance done and components replaced when needed are in fair condition. A total refurbishment of all internal components would renew these units to a full life expectancy again.

04.01.180 HVAC Pumps
Description Central pumps circulate heating hot water from the geo-thermal heat exchanger throughout the building to provide the necessary heating.

Condition Assessment Heating Water Pump: The heating water pump was reported vintage to the building and had significant scale/corrosion buildup on it causing expedited aging.

Elemnt State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$5,000	High

04. Plumbing Executive Summary
Semon Hall appears to have original plumbing fixtures. The water source to the building is non-potable with point-of-use filters where potable water is required. Central hot water is provided for most of the building using a storage tank and circulation pumps connected to plate and frame heat exchangers connected to the campus geo-thermal system.

05 Plumbing
04.03 Plumbing Systems

Water, Sanitary, and Storm Piping

Description:
Water Piping: the building water supply is served by a 2-1/2” copper line. Water piping appears to be primarily asbestos-wrapped copper piping.

Sanitary Piping: only a small portion of the sanitary waste and vent piping was able to be directly observed, piping appears to be cast iron.

Storm Piping: Only a small portion of the storm piping was able to be directly observed and it appears to be cast iron.

Condition Assessment: Portions of the asbestos-wrapped copper piping that were able to be observed appear to be in decent condition however state and federal laws must be followed when modifying portions of the system with the asbestos pipe. Copper pipe, depending on water quality typically lasts between 70 and 80 years. Portions of the sanitary waste piping that were able to be observed appear to be in decent condition with some signs of past leaks. Cast Iron pipe can last between 50 and 75 years depending on water quality and climate.

Element State: Good*

Recommendations and Additional Observations
- It is recommended that asbestos abatement specialists be consulted as required for any system modifications and requirements.
- It is recommended that water, sanitary, and storm lines be scoped to assess the internal condition of the pipe to get a better idea of life expectancy.

Water Heaters

Description: Central hot water is provided for most of the building using a storage tank and circulation pumps connected to plate and frame heat exchangers connected to the campus geo-thermal system.

Condition Assessment Equipment appears to be from 2013 and is in good working order.

Element State: Fair

Water Filtration

Description site domestic water is not suitable for consumption, it appears the building water supply has been reconfigured in 2008 so there is a building level water filtration system.

Condition Assessment Equipment appears to be in good working condition.

Element State: Good

Plumbing Fixtures

Description Plumbing fixtures appear to be original with water closets and urinals having their manual flush valves. The original fixtures no longer meet code requirements for water conservation

Condition Assessment Some of the stops/ shutoff valves of the fixtures are showing signs of corrosion the fixtures themselves appear to be in serviceable condition.

Element State: Fair

05. Electrical Executive Summary

Semon Hall electrical systems consists of 480/277V and 208/120V electrical distribution equipment of varying vintage to serve building loads. Normal and emergency power systems serve the building, with a standby diesel generator providing emergency power to egress lighting and fire alarm.

05 Electrical
05.02 Secondary Electrical
05.02.10 Secondary Switchgear

Description: Semon Hall is served via a 600A, 480/277V, electrical service to a main switchboard in the main electrical room. The main switchboard is original to the building and includes fused switches to serve loads throughout the building. Multiple step-down transformers and 208/120V panelboards located in the electrical room serve lighting, receptacle, and equipment loads throughout the building. The branch circuit panelboards in the main electrical room and select disconnect switches were replaced in 2008. Other disconnect switches appear to be of original vintage from building construction in 1964.

Condition Assessment Electrical distribution equipment included the main switchboard and panelboards are installed indoors. No ongoing electrical maintenance program or testing of equipment and terminations was reported. An arc flash study was performed in 2013 and corresponding shock hazard labels applied to all distribution equipment.

The main switchboard and disconnect switches are of original vintage and in fair condition, however, have exceeded their expected useful life. The panelboards and disconnect switches replaced during the 2008 renovation are in good condition.

Element State: Fair

05.02.10 Secondary Switchgear – Event #1

Event Type	***Event Year***	***Event Cost***	***Priority***
Testing	2025	$5,000	High

Event Justification & Strategy

There is not currently an ongoing maintenance program or routine testing of electrical systems to ensure safe and properly functioning equipment. As equipment ages and reaches the end of its expected useful life, ongoing inspection and maintenance is vital in maintaining safe and proper functioning equipment. Testing of all equipment is recommended to include visual and infrared inspections, tightening of terminations as required, lubrication, cleaning of electrical equipment.

Implication of Even Deferral
Failure to maintain and inspect equipment can result in preventable equipment failure, power outages, and potential safety and/or fire hazards.

05.02.10 Secondary Switchgear – Event #2

Event Type	***Event Year***	***Event Cost***	***Priority***
Study	All	$5,000	High

Event Justification & Strategy

For any modifications made to the building electrical distribution, perform an updated system coordination study and arc flash analysis, and revised labeling provided on all equipment as required. Modifications to the electrical distribution system can impact the available fault currents and thus arc fault current at each piece of equipment.

Implication of Even Deferral
This is a code compliance safety issue.

05.02.10 Secondary Switchgear – Event #3

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$100,000	High

Event Justification & Strategy

Replace electrical distribution equipment that is of original to the building (installed prior to the 2008 renovation), including the main switchboard, panelboards, disconnect switches, circuit breakers, and other components. This equipment has reached the end of its expected life span and should be replacement.

Implication of Event Deferral
A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.20 Secondary Transformers

Description Step down 480V:208/120V, 3-phase transformers are provided to serve receptacle, lighting and equipment loads. There are multiple transformers located in the main electrical room, all except one appear to be of original vintage.

Condition Assessment –The transformers in the building are of varying vintage and range from fair to good condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2033	$25,000	High

Event Justification & Strategy
The transformers original to the building have exceeded the expected useful life and should be replaced.

Implication of Event Deferral
Failure of transformer would result in loss of power to downstream loads.

05.02.60 Cabling, Raceway & Bus Ducts

Description EMT and flexible metal conduit was observed in the main electrical room. It was reported that copper conductors are used throughout the building/campus.

Condition Assessment Equipment conduits observed in the electrical room appear to be in fair condition and of varying vintages based on age of equipment and associated feeder. Feeders/conductors were not readily visibly observable. The 480V conductors serving the building from the campus medium voltage distribution were reported to have been updated in the past 2-3 years and in good condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Test/Replace	2025	$50,000	High

Event Justification & Strategy
At the time of equipment replacements, any feeders/conductors found to be original to the building shall be replaced with new. Existing conductors installed during the 2008 renovation proposed to be reused shall be megger tested to confirm there has not been any degradation or damage to the conductor insulation.

Implication of Event Deferral
Conductors with worn, frayed or damaged insulation present safety and fire hazards.

05.03 Lighting Fixtures
05.03.10 Interior Lighting

Description Interior lighting includes primarily fluorescent lighting throughout the building. LED light fixtures were installed in a portion of the building during a renovation 6-7 years ago. Lighting controls consist of occupancy sensors and light switches.

Condition Assessment The interior fluorescent lighting is in fair condition but at end of expected life. The lighting in the most recently renovated area that has been upgraded to LED is in good condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$40,000	Low

Event Justification & Strategy
Existing fluorescent lighting is less efficient than LED lighting and has reached the end of its life span. Replace existing fluorescent lighting with new LED light fixtures. At time of lighting replacement, upgrade the lighting controls in respective areas to provide occupancy sensors for additional energy savings, as appropriate for use, functionality, and safety.
05.03.20 Exterior Lighting

Description Exterior lighting consist of canopy fixtures located under building overhang along perimeter of the building and building mounted metal halide flood lights.

Condition Assessment Exterior lighting is in fair condition but utilizes inefficient outdated lighting technologies. Exterior lighting is nearing the end of its life span. Exterior lighting is controlled via timeclocks with contactors, which have exceeded their expected life span. The existing timeclocks must be manually adjusted two times a year during daylight savings time changes, and it was reported that at that time the timeclocks have often falling well out of tolerance.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$15,000	Low

Event Justification & Strategy
Provide new LED exterior canopy and flood lights. At time of lighting replacement, lighting controls should be upgraded to new relay based astronomical timeclock controls. Upgrade of existing lighting and controls will provide energy savings, reliable controls, and reduced maintenance for exterior lighting.

05.03.40 Emergency Lighting

Description Emergency lighting is provided throughout the building via generator backup of interior and exterior light fixtures. Refer to previous Interior and Exterior lighting sections and 05.05.30 Emergency Power Systems for additional information.

Condition Assessment Emergency lighting is in fair condition.

Element State: Fair

05.05 Electrical Systems
05.05.30 Emergency Power Systems

Description: A 15kW natural gas generator supplies emergency power to Semon Hall to primarily serve emergency lighting and fire alarm loads. The generator was manufactured in 1975 and serves emergency loads via an automatic transfer switch located in the main electrical room.

Condition Assessment The open genset is installed in the main electrical room. The generator is regularly tested as required for life safety requirements. Equipment appears to be in fair condition however has exceeded its expected useful life.

Element State: Fair

05.05.30 Emergency Power Systems – Event #1

Event Type	Event Year	Event Cost	Priority
Replace	2025	$30,000-50,000	High

Event Justification & Strategy
The generator is at the end of its useful life and should be replaced to maintain reliable backup power to meet life safety requirements. In lieu of installing a new generator, a similarly sized central lighting inverter would meet life safety requirements. This would limit required generator testing or other maintenance services associated with the generator.

Implication of Event Deferral
Potential failure of generator which is a life safety and code compliance issue.

Semon Hall

15 Year Expected Building Repair Replacement Costs

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
02.01.10	Footings	Seismic upgrade	$200,000					
02.01.11	Steel framing	Seismic upgrade	$450,000					
02.03.010	Exterior walls	Replace asbestos panels	$400,000					
02.03.040	Exterior windows	Replace windows	$460,000					
02.05.012	Ceiling Structures	Replace ceilings	$300,000					
04.01.160	Central Station AHU	Refurbish AHU	$50,000					
04.01.180	HVAC pumps	Replace	$5,000					
05.02.10	Secondary Switchgear	Event #1 - Testing	$5,000					
		Event #2 - Arc Flash & Coordination	$5,000					
		Event #3 - Replace distribution panels	$100,000					
05.02.20	Transformers	Replace transformers		$25,000				
05.02.60	Cable, Raceway a& Bus Ducts	Test/Replace	$50,000					
05.03.10	Interior Lighting	Replace	$712,320					
05.03.20	Exterior Lighting	Replace	$15,000					
05.05.30	Emegency Power Systems	Replace	$50,000					
							44520 SF	
							$600/SF	
Totals			$2,802,320	$25,000	$0	$2,827,320	$26,712,000	0.106

College Union

02 Architectural - General

The College Union was originally designed in 1964 and has undergone a number of major remodels in 1970, 1978 and 2003. The exposed structure is concrete and exterior walls were originally designed as a combination of concrete and glass, with some wood tongue & groove siding. In one of the renovations, added space was enclosed in metal panels.

The building contains the main campus food service operation, with kitchen, servery and dining space. It also includes a large auditorium with tiered seating and a stage, and six large meeting rooms separated by movable walls. Student gathering areas, the bookstore, print shop, and office suites complete the uses of the building. Office areas include:

1. Office of the Dean of Students
2. Diversity & Belonging & Treehouse
3. Outdoor Program
4. Veterans resource center
5. Student Belonging & Involvement
6. Admissions
7. Financial Aid
8. KTEC radio station

Most of the roof is a 60 mil TPO roof installed in 2014. The interiors also feature exposed concrete walls. The condition is generally good, but the finishes and furniture are outdated and worn.

02.03 Exterior Closures

02.03.10 Exterior Walls – East Entry Ramp

Description Accessibility ramp to east entry has exposed rebar and spalled concrete.

Condition Assessment Exposed rebar and corroded structural steel.

Element State: Poor.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2035	$10,000	Medium

Event Justification & Strategy
The ramp will continue to deteriorate, probably from salt application in winter until the concrete starts spalling away. This is the only handicap access on the east side of the building. Condition is unsightly but not dangerous.

02.03.11 Exterior Walls – Entry Retaining Wall

Description Retaining wall at NE corner of building is made of pressure treated wood. Gradual subsidence of wall has been postponed with wood braces against CU foundation wall, putting force on the wall that it may not have been designed for.

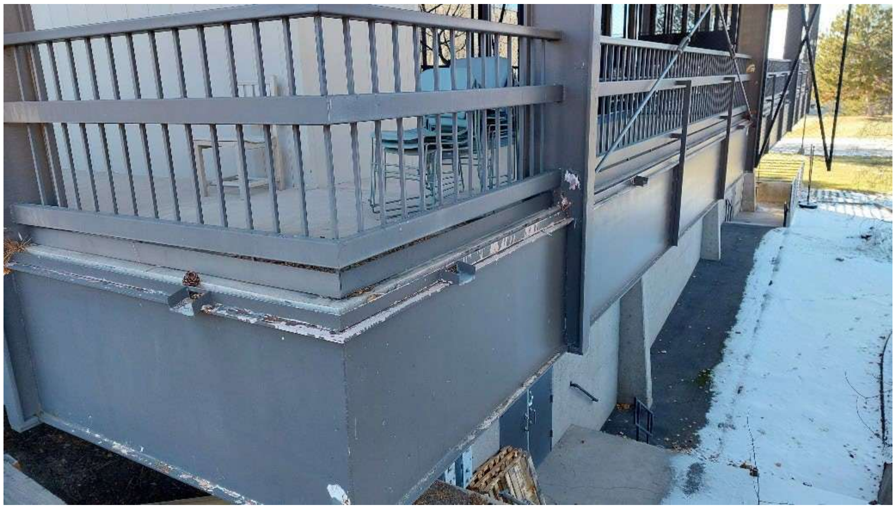
Condition Assessment Slowly failing wall.

Element State: Poor.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2033	$25,000	Medium

Event Justification & Strategy
The wall should be replaced with a freestanding concrete retaining wall, designed for trucks on adjacent road and independent of building structure.

2.03.012 Exterior Walls – Paint on Exposed Structural Steel



Description Paint on exposed structural steel has worn away to expose bare steel.

Condition Assessment Needs repainting.

Element State: Fair.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2033	$25,000	Medium

Event Justification & Strategy
The paint should be reapplied to protect the steel.

1. Architectural & Structural Executive Summary

The College Union Building is primarily a steel and concrete structure. The roof framing consists of a combination of a concrete waffle slab system, as well as steel wide flange (WF) beams supporting a metal deck. The floor framing consists of a concrete waffle slab system in addition to steel WF beams supporting a slab on metal deck. Both steel and concrete bearing elements are used to support the roof and floor framing systems.

No structural items of note were observed.

02 Architectural & Structural

02.01 Foundations

02.01.10 Footings & Foundations

Description As-built drawings of the 2002 addition were available and illustrate conventional reinforced shallow foundations. No other as-built drawings providing information on the foundation systems are available. Existing foundations are not accessible for visual observations.

Condition Assessment Foundation appears to be in good condition based on our visual observation of the superstructure.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

Event Justification & Strategy N/A

02.02 Superstructure

02.02.10 Structural Framing

Description Steel and concrete structure

Condition Assessment Good based on visual observations. However, seismic resistance does not meet current code requirements and will need to be upgraded in the event that the building is renovated.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Seismic upgrade	2030	$1,000,000	High

***Event Justification & Strategy*:** seismic resistance should be upgraded to current code for occupant safety in conjunction with any other major building renovation.

1. Mechanical Executive Summary

The College Union building mechanical systems consist of two indoor central station air handling units and three rooftop units with zoned terminal units to serve the individual zones and spaces. Heating hot water is provided through a plate and frame heat exchanger connected to the campus geo-thermal system.

The building also houses a commercial kitchen. This space contains two Type-2 grease exhaust hoods, a Type-1 vapor hood and an exhaust system for the dishwasher.

It was reported that all equipment was vintage to the building and most appeared to be properly maintained. The geo-thermal system components exhibited a large amount of corrosion/scale buildup that had not yet been addressed.

04 Mechanical
04.01 HVAC

04.01.040 (HW/S) Heat Exchangers

Description Heat Exchanger connected to campus geothermal system provides heating hot water for the building.

Condition Assessment Equipment and its associated control valves are nearing their end of useful life and were covered in large amounts of scale from the geo-thermal water. Unit was in fair condition due to expedited aging.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2033	$25,000	Medium

Event Justification & Strategy
The unit and the ability to control it, is the only source of heating for the building. Loss of the heat exchanger may make the building unable to be occupied during the colder months since proper indoor temperatures will not be able to be maintained without its operation.

04.01.120 Rooftop AHU – Heating and Cooling
Description Three rooftop air handling units serve the stage areas and other various portions of the building. ASU-2, ASU 3, SF-3 and SF-4 are vintage to the building and SF-5 was added in 1999.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Justification & Strategy
Both of the air handling units are vintage to the building and past their maximum life of 12 years. Units are scheduled for upgrades and repair in the summer of 2023.

04.01.120 Rooftop AHU – Heating and Cooling – Event #1: SF-5

Event Type	*Event Year*	*Event Cost*	*Priority*
Refurbish	2033	$15,000	Medium

Event Justification & Strategy
All air handling units are past their maximum life of 12 years. Units are in fair condition from having proper maintenance done and components replaced when needed. A total refurbishment of all internal components would renew these units to a full life expectancy. The college plans to refurbish ASU-2, ASU-3, SF-3 and SF-4 in the summer of 2023.

04.01.160 Central Station AHU
Description Two central station air handling units, one located in a first-floor north mechanical room and the second located in the first-floor south mechanical room.

Condition Assessment Equipment is in fair condition.

Element State: Fair

04.01.160 Central Station AHU – Event #1: ASU-1

Event Type	*Event Year*	*Event Cost*	*Priority*
Refurbish	2025	$35,000	Low

Event Justification & Strategy
The unit is past its useful life, due to being installed indoors and having proper maintenance done and components replaced when needed it is in fair condition. A total refurbishment of all internal components would renew the unit to a full life expectancy again.

Element State: Good

04.01.160 Central Station AHU – Event #1: SF-1

Event Type	*Event Year*	*Event Cost*	*Priority*
Refurbish	2038	$35,000	Low

Event Justification & Strategy
SF-1 was refurbished in 1999 and is beyond its useful life. Due to being installed indoors and having proper maintenance done and components replaced when needed it is in good condition. Another total refurbishment of all internal components would renew these units to a full life expectancy again.

04.01.180 HVAC Pumps
Description Central pumps circulate heating hot water from the geo-thermal heat exchanger throughout the building to provide the necessary heating.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2033	$12,000	Medium

Event Justification & Strategy
Both circulating pumps were installed in 1999 and nearing their end of useful life of 25 years. Units are in fair condition but exhibit corrosion on pump body and motor. Regular maintenance and replacement of parts have allowed these pumps to continue to operate.

04.01.190 Terminal Units
Description 20 Variable air volume terminal units serve the varies spaces throughout the building.

Condition Assessment Equipment is in good condition.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Replace	2038	$50,000	Low

Event Justification & Strategy
Terminal units were installed in 1999 and are still in good condition due to regular maintenance. Units are at the end of their useful life expectancy; replacement will be needed in the next 10-15 years.

04.01.240 Ventilation Fans
Description 10 exhaust fans serve this building. All fans except EF-7 are vintage to the building.

Condition Assessment Equipment is in fair condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$50,000	Medium

Event Justification & Strategy
All exhaust fans except EF-7 are vintage to the building. EF-7 was installed in 1999 now also at the end of its useful life. Replace all with ERVs for significant energy savings.

2. Plumbing Executive Summary
The College Union Building is a mixture of newer and original plumbing fixtures. The water source to the building's non-potable with point-of-use filters are used where potable water is required and a central water filter system that serves the commercial kitchen. Central hot water is provided for most of the building using plate and frame heat exchangers connected to the campus geo-thermal system as primary heat and a gas boiler providing secondary heat.

05 Plumbing
05.03 Plumbing Systems

Water, Sanitary, and Storm Piping

Description:
Water Piping: the building water supply is served by what appears to be a 4" copper line. Water piping appears to be primarily fiberglass-wrapped copper piping.

Sanitary Piping: only a small portion of the sanitary waste and vent piping was able to be directly observed, piping appears to be cast iron bell and spigot with lead and oakum joints with newer portions being no-hub cast iron. A major leak was repaired recently under the auditorium, and extending outdoors.

Storm Piping: Only a small portion of the storm piping was able to be directly observed and it appears to be galvanized steel. Roof drain piping has been reported to be a problem with sporadic leaks requiring replacement of pipe sections.

Grease Waste: Grease waste appears to be cast iron and goes to a building level grease interceptor outside the building before connecting back to sanitary waste.

Condition Assessment: Portions of copper piping that were able to be observed appear to be in decent condition. Copper pipe, depending on water quality typically lasts between 70 and 80 years. Portions of the sanitary waste piping that were able to be observed appear to be in decent condition with some no signs of past leaks. Cast Iron pipe can last between 50 and 75 years depending on water quality and climate. A portion of the plumbing was replaced around 2018 when the central hot water system was upgraded and looks to be in good condition. The remainder of the facility looks to be original.

Element State: Good

Recommendations and Additional Observations

- It is recommended that water, sanitary, and storm lines be scoped to assess the internal condition of the pipe to get a better idea of life expectancy.

Water Heaters

Description: Central hot water is provided for most of the building using plate and frame heat exchangers connected to the campus geo-thermal system as primary heat and a gas boiler providing secondary heat.

Condition Assessment Equipment appears to be from 2018 and is in good working order.

Element State: Good

Water Filtration

Description site domestic water is not suitable for consumption, point-of-use filters are used where potable water is required and a central water filter system serves the commercial kitchen.

Condition Assessment Equipment appears to be being serviced regularly and all filters have dates when the last filter was installed.

Element State: Good

Plumbing Fixtures

Description: Plumbing fixtures appear to be original with water closets and urinals having their manual flush valves.

Condition Assessment Fixtures themselves appear to be in serviceable condition.

Element State: Fair

1. Electrical Executive Summary
The College Union Building electrical systems consists of 480/277V and 208/120V electrical distribution equipment of varying vintage to serve building loads. Normal and emergency power systems serve the building, with a standby natural gas generator providing emergency power to egress lighting and fire alarm loads. The building has undergone several renovations since originally constructed in 1964 and includes electrical equipment of varying vintages and condition.

05 Electrical
05.02 Secondary Electrical
05.02.10 Secondary Switchgear
Description: The College Union Building is served via a 1200A, 480/277V electrical service to a main switchboard in the main electrical room. The main switchboard serves mechanical equipment, lighting panelboards, and step-down transformers to multiple 208/120V panelboards. The 208/120V panelboards serve receptacle and equipment loads. Electrical equipment throughout the building appears to be of three different vintages and installed in 1964 (original construction), 1978, or 2003.

Condition Assessment The electrical distribution equipment, including the main switchboard and panelboards, are installed indoors. No ongoing electrical maintenance program or testing of equipment and terminations was reported. An arc flash study was performed in 2013 and corresponding shock hazard labels applied to all distribution equipment.

The main switchboard was replaced in 2003, along with multiple distribution panels and branch circuit panelboards. This equipment is primarily located in the main electrical/mechanical room and kitchen area and is in fair condition. Note that environmental conditions in the main electrical/mechanical room appears to potentially be impacting the overall condition of this equipment and may impact overall life span.

It was observed that additional electrical distribution was installed in 1978 and includes 480/277V and 208/120V distribution panels and panelboards. This equipment is primarily located in the lower-level south equipment room and was observed to be in fair condition, but is beyond its expected useful life.

The electrical equipment of original vintage included distribution panels and branch circuit panels manufactured by General Electric. This equipment is located in the main equipment room and other various electrical closets throughout the building. This equipment was observed to be in poor conditions and has exceeded its useful life.

Element State: Poor-Fair

05.02.10 Secondary Switchgear – Event #1

Event Type	*Event Year*	*Event Cost*	*Priority*
Testing	2025	$5,000	High

Event Justification & Strategy
There is not currently an ongoing maintenance program or routine testing of electrical systems to ensure safe and properly functioning equipment. As equipment ages and reaches the end of its expected useful life, ongoing inspection and maintenance is vital in maintaining safe and proper functioning equipment. Testing of all equipment is recommended to include visual and infrared inspections, tightening of terminations as required, lubrication, cleaning of electrical equipment.

Implication of Event Deferral
Failure to maintain and inspect equipment can result in preventable equipment failure, power outages, and potential safety and/or fire hazards.

05.02.10 Secondary Switchgear – Event #2

Event Type	*Event Year*	*Event Cost*	*Priority*
Study	All	$5,000	High

Event Justification & Strategy
For any modifications made to the building electrical distribution, perform an updated system coordination study and arc flash analysis, and revised labeling provided on all equipment as required. Modifications to the electrical distribution system can impact the available fault currents and thus arc fault current at each piece of equipment.

Implication of Even Deferral
This is a code compliance safety issue.

05.02.10 Secondary Switchgear – Event #3

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$100,000	High

Event Justification & Strategy
Replace electrical distribution equipment that has exceeded useful life, including distribution panels, panelboards, disconnect switches, motor starters, circuit breakers, and other components installed prior to the 2003 renovation. This equipment has reached the end of their expected life span and should be replaced.

Implication of Event Deferral
A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.10 Secondary Switchgear – Event #4

Event Type	Event Year	Event Cost	Priority
Replace	2038	$75,000	Moderate

Event Justification & Strategy
The electrical distribution equipment in the building installed in 2003, including the main switchboard, distribution panels, and panelboards, will be nearing the end of their expected life span and should be considered for replacement in near future.

Implication of Event Deferral
A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.20 Secondary Transformers
Description Step down 480V:208/120V, 3-phase transformers are provided to serve receptacle, lighting and equipment loads.

Condition Assessment: The transformers in the building are of varying vintage and range from fair to good condition.

Element State: Transformers are in fair condition.

05.02.20 Secondary Transformers – Event #1

Event Type	Event Year	Event Cost	Priority
Replace	2025	$15,000	High

Event Justification & Strategy
The transformers installed prior to 2003 renovation have exceeded the expected useful life and should be replaced.

Implication of Event Deferral
Failure of transformer would result in loss of power to downstream loads.

05.02.20 Secondary Transformers – Event #2

Event Type	Event Year	Event Cost	Priority
Replace	2038	$20,000	High

Event Justification & Strategy
The transformers installed in the 2003 renovation will be nearing the end of their expected life span and should be considered for replacement in the near future.

Implication of Event Deferral
Failure of transformer would result in loss of power to downstream loads.

05.02.60 Cabling, Raceway & Bus Ducts
Description EMT, rigid, flexible metal, and non-metallic liquid-tight conduit, as well as gutter raceway, were observed in the electrical rooms. It was reported that copper conductors are used throughout the building/campus.

Condition Assessment Equipment conduits observed in the electrical room appear to be in fair condition and of varying vintages based on age of equipment and associated feeder. Feeders/conductors were not readily visibly observable. The 480V conductors serving the building from the campus medium voltage distribution were reported to have been updated in the past -5-6 years and are in good condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Test/Replace	2025	$60,000	High

Event Justification & Strategy
At the time of future equipment replacements, any feeders/conductors found to be original to the building shall be replaced with new. Existing conductors installed during the 2003 renovation proposed to be reused shall be megger tested to confirm there has not been any degradation or damage to the conductor insulation.

Implication of Event Deferral
Conductors with worn, frayed or damaged insulation present safety and fire hazards.

05.03 Lighting Fixtures
05.03.10 Interior Lighting
Description Interior lighting includes primarily fluorescent lighting throughout the building. Some lighting has been replaced and/or retrofitted with LED lighting in recent years. Lighting controls were updated in 2003 to provide relay-based timeclock control for lighting throughout public common areas.

Condition Assessment The interior fluorescent lighting is in fair condition but at end of expected life.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$1,370,000	Low

Event Justification & Strategy
Replace existing fluorescent lighting with new LED light fixtures.

05.03.20 Exterior Lighting
Description Exterior lighting consist of fixtures located at canopies at building exits. Metal halide pole mounted area lights are installed in surrounding pedestrian areas.

Condition Assessment Exterior building mounted and poled mounted area lighting is in fair condition but utilizes inefficient and outdated lighting technologies and is nearing the end of its life span.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$40,000	Low

Event Justification & Strategy
Provide new LED exterior building and pole mounted lights.

05.03.40 Emergency Lighting
Description Emergency lighting is provided throughout the building via battery ballast integral to light fixtures and via remote emergency lighting units (bug-eyes).

Condition Assessment: Emergency lighting provided via battery ballast integral to fluorescent light fixtures has exceeded its life span.

Element State: Fair

Event Justification & Strategy
During replacement of interior lighting with new LED lighting, new fixtures should be provided with integral battery backup to meet emergency egress lighting requirements.

Implication of Event Deferral
Potential failure of emergency lighting is a life safety issue.

05.05 Electrical Systems
05.05.30 Emergency Power Systems
Description: A 15kW natural gas generator supplies standby power to the College Union Building. The generator was installed in 1975 and serves emergency loads via an automatic transfer switch located in the main electrical room. The existing generator appears to currently serve an emergency panel feeding fire alarm system loads.

Condition Assessment: The generator is installed in the main electrical room. The generator and ATS are in poor condition and have exceeded their expected life span.

If the fire alarm system relies on the generator to provide secondary power source, than a backup power source should be maintained.

Element State: Poor

Event Type	***Event Year***	***Event Cost***	***Priority***
Remove	2025	$25,000	High

Event Justification & Strategy

The generator and ATS have exceeded their useful life and should be replaced by alternative means to maintain reliable backup power source to supported loads.

It was observed that building emergency lighting requirements are met via integral battery packs and bug eye emergency lighting units. The observable loads connected to the emergency panelboard fed from the panelboard included only fire alarm system loads. Pending contractor field verification that the existing emergency panel does not serve any life safety loads, the generator and ATS can be removed and eliminated. The fire alarm system battery sizing will to be increased as required to meet code required backup requirements.

Implication of Event Deferral

Potential failure of generator which is a life safety issue as to meeting fire alarm system code requirements.

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
02.03.010	Exterior walls	Repair damaged ramp			$10,000	$10,000		
02.23.011	Entry Retaining Wall	Replace wall		$25,000		$25,000		
02.23.012	Exterior walls	Paint exposed structural steel		$25,000		$25,000		
04.01.120	Rooftop AHU	SF-5			$15,000	$15,000		
04.01.160	Central Station AHU	Event #1 - Replace ASU-1	$35,000			$35,000		
		Event #2 - Replace SF-1			$35,000	$35,000		
04.01.180	HVAC pumps	Replace			$12,000	$12,000		
04.01.240	Exhaust fans	Replace with ERVs	$50,000			$50,000		
05.02.10	Secondary Switchgear	Event #1 - Testing	$5,000			$5,000		
		Event #2 - Arc Flash & Coordination	$5,000			$5,000		
		Event #3 - Replace distribution panels	$100,000			$100,000		
		Event #4 - replace main switchboard			$75,000	$75,000		
05.02.20	Transformers	Event #1 - Replace older transformers	$15,000			$15,000		
		Event #2 - Replace newer transformers			$20,000	$20,000		
05.02.60	Cable, Raceway a& Bus Ducts	Test/Replace	$60,000			$60,000		
05.03.10	Interior Lighting	Replace	$1,370,000			$1,370,000		
05.03.20	Exterior Lighting	Replace	$40,000			$40,000		
05.05.30	Emergency Power Systems	Replace	$25,000			$25,000		
							85,634 SF	
							$600/SF	
Totals			$1,705,000	$50,000	$167,000	$1,922,000	$51,380,400	0.037

Portland-Metro Building

A facilities assessment was completed in 2019, led by Fluent Engineers. This has been included here with updated costs for capital repair and replacement items. Costs have been updated using the Turner Construction Cost Index, published quarterly by Turner Construction. According to the index construction costs have increased 18% since 2019.

The assessment for the Portland-Metro Building was carried out in more detail than the other assessments in this master plan, which were done in accordance with ASTM E2018. The Metro Building assessment therefore has discussions of elements that are not in compliance with current building codes, especially related to seismic resistance and accessibility, and costs of bringing the facility into code compliance. However, upgrades to satisfy changes to building codes since the building was constructed are not required by law, unless the building is being significantly renovated. The building could continue in its current use without these upgrades. These items are typically not included in the calculation of the facilities condition index.

In contrast, items which require maintenance or capital replacement are or will be necessary to continued use of the building. These items are included in the facilities condition index. The original Portland-Metro Building assessment has therefore been reviewed and a revised facilities expense spreadsheet has been developed which includes only items needed for the continued maintenance and use of the building without adding costs for voluntary upgrades.

The following pages include the 2019 assessment at the end of which is a summary table of capital repair and replacement costs updated for inflation, and with items solely needed for code updates removed.

2019 OIT – Wilsonville Campus Summary

-Facilities Condition Assessment-

December 20, 2019

Assessment provided by:

Fluent Engineering in association with:

MSC Engineers

PAE Engineers

-Table of Contents-

-Project Description-

The Oregon Institute of Technology ("Oregon Tech") retained Fluent Engineering to perform inspections and analyses of reasonably accessible components and elements on the Wilsonville campus building located at 27500 SW Parkway Ave, Wilsonville, OR. This Facilities Conditions Assessment (FCA) includes analysis of the building's architectural, structural, mechanical, electrical, and plumbing systems. Concealed and site systems are not included in this assessment.

The primary objectives of this assessment are as follows:

1. Identify and highlight any condition requiring immediate action (safety concerns)
2. Identify elements or equipment at or near the end of its expected life
3. Identify issues that would limit operations and issues that would impact occupancy.
4. Prioritize list of recommended actions to resolve deficiencies, improve building operation/efficiency, and improve building longevity.
5. Provide detailed descriptions of each recommended action.
6. Review building "oddities" such as water heater locations, intrusion detection/security systems, plumbing valve locations, and identify opportunities for improvement.
7. Observe existing building exterior conditions and list areas of distress and disrepair.
   - Review report outlining recommendations and provide opinion regarding the existing report.
8. Review existing roof condition and make recommendations on costs and timeline for replacement

-Summary of Findings-

General Notes and Limitations

- All costs are presented in 2019 Dollars

Primary Structural Concerns

- The primary electrical transformer located adjacent to the exterior of the building is not anchored to the concrete pad exposing the building to an electrical failure is even a modest seismic event. This is extremely cheap and timely to resolve. Similar issues abound throughout the building with electrical panel and mechanical equipment anchored in many instances and others not. A thorough examination and remedial repairs will eliminate this risk efficiently.

- The entire building appears to lack seismic bracing of non-structural elements such as ceiling grids, lights, ductwork, piping, fire sprinkler, etc. All of this was specified in original documents and re-iterated in 2011 retrofit documents but appears to have been overlooked. These should be remediated in one effort since access and disruption is common to all, nearly all are above suspended ceiling and below structure above.

- We have elicited every effort to pursue a copy of the structural analysis performed by KPFF Consulting Engineers in 2011 and drawn a blank. In coordination with Trish Hower, we have agreed that absent this information for review that we will proceed under the premise that the findings were valid and remain applicable since it was authored by a reputable engineering firm and was approved at the time by the City of Wilsonville. Please reference the letter dated October 17, 2011 by Jeffrey R. Diephuis, P.E. with KPFF Consulting Engineering and communication with Michael Shea with Soderstrom Architects.

Primary Architectural (with ADA)

- Architecturally the condition of the Building exterior envelope will need to be addressed: cleaning and resealing the masonry veneer, replacing the seals and sealant around the windows to keep weather intrusion from the interior.

- The immediate site concern, easily correctable, is to update the ADA Parking signs to meet current accessibility compliance.

- In the not too distant future, the roof will need to be replaced along with adding rigid insulation to raise low areas for adequate drainage. Replace curbs, flashing, boots at roof penetrations and parapet cap.

- The steel structure for the masonry screens on the roof need re-finished to eliminate the rusting. The masonry veneer needs re-attached in areas.

Primary Mechanical & Plumbing Concerns

- DDC Controls are not operating per the desired sequence of operations. Multiple system changes by different contractors have modified the controls programming, and it has been set to run with constant temperature setpoints building-wide. Restoring the correct sequence will save energy and improve comfort for all occupants.

- HVAC air systems are likely out of balance, and the building pressurization tracking sensors have been relocated or disabled. Performing testing and balancing on the building systems will improve energy efficiency and will help to diagnose and correct thermal comfort issues.

Primary Electrical Concerns

- Upgrade existing lighting to LED with new Controls to meet current energy code. In addition to meeting code, saving energy, and saving maintenance costs; new lighting can enhance the occupant's experience and elevate spaces.

- Several emergency lighting fixtures appear to be inoperative. A regular testing program is recommended and required by code. Because a normal power shutdown would be disruptive, a count of fixtures that were in-operative was not taken; however, an allowance cost is indicated to address.

- Upgrade Access Control system to add digital intrusion detection if this function is still desired. The existing, intrusion detection system is causing operational problems, wiring is not organized well, and should be removed.

- Adjust breaker settings based on an arc-flash and coordination study so that breakers trip when needed, most optimized, and as fast as practical to limit let-through current during a fault.

Wilsonville Campus Building

GSF	138,762
No. of Floors	4
Year Built (Renovated)*	2000 (2001, 2012)

* Based on provided as-built drawings.

System Element (Uniformat II)	System Notes
STRUCTURAL: A. Substructure (Basement & Foundations) B10. Superstructure B20. Exterior Closure B30. Roofing	A. Substructure Originally designed for 2500 psf soil bearing allowable per Geotechnical Engineer with conventional concrete pad footing and 5" reinforced concrete slab-on-grade. No issues pertinent to foundation at this time. B10. Superstructure Originally designed in accordance with 1997 Uniform Building Code employing an LRFS of Steel Concentric Steel Braced Frame for a Risk Category II structure. This 135,000 sq. ft. four-story steel-framed building was designed for B occupancy, Type II Construction. Primary system is composite concrete on metal deck on steel beams and girders on steel columns. In 2011, the building was purchased by OIT for use as Higher Education facility in accordance with 2010 Oregon Structural Specialty Code. A letter was authored by KPFF Consulting Engineers and approved by the City of Wilsonville authenticating the adequacy as a Risk Category III structural per 1604.5 and 3408.4. B20. Exterior Closure The building facade is comprised of metal panels with glazing and spandrels of tile and brick veneer. The tile and brick veneer is slated to be replaced as a suspect for water intrusion. We strongly suspect that the facade is adequate but the flashing is the culprit. Please refer to the Architectural comments below for more information. The water has not been sufficient to compromise the integrity of the structure at this time. B30. Roofing Roof is a built-up system with a granular topcoat. The number or types of ply are unknown. The built-up system is over a protection board over tapered rigid insulation. Rigid insulation is over a mineral board on a structural metal deck or over concrete on structural metal deck. Built-in roof drains with secondary overflow drains are recessed in the roof at low points. Roof system is carried up cants at perimeter parapet walls and curbs for HVAC units and other roof penetrations. Sheet metal flashing and counter-flashing are continuous on the parapet walls with a sheet metal wall cap. Some drainage slope issues but overall roof is in pretty good condition with a few years of life left with annual maintenance. Screen walls on roof consist of a structural steel frame with a backer board and thin

	brick veneer units adhered to the board. Exposed structural steel finish is rusting.
ARCHITECTURAL: B. Shell (Superstructures, Exterior Enclosures, & Roofing) C. Interiors (Interior Construction, Stairs, Interior Finishes) D10 Conveyance Systems (Elevators and Lifts) E. Equipment & Furnishings G. Sitework	B. Shell Exterior masonry façade composed of brick and tile veneer: Brick is assembled with airspace, weather barrier on gypsum sheathing on metal studs, studs have batt insulation and gypsum board on interior face. Brick masonry is supported on lintels with ties to sheathing and studs. Tile is assembled with adhesive over glass mesh board over weather barrier over gyp sheathing on metal studs, studs have batt insulation and gypsum board on interior face. Moss is growing on grout joints and masonry. This needs to be cleaned off and resealed. Aluminum Storefront Window System with insulated glass is located within the plain of the frame wall. There is flashing at the head and sill. Backer rod and sealant is provided around entire window unit. Vertical mullions are reinforced or supported by a vertical structural member. A Window unit is made up of multiple windows. Multiple Units are attached to vertical and horizontal structural steel. Some window units have metal wall panels in lieu of glass. Entries are the same aluminum storefront system as the windows. Doors are swing type with accessibility assists at the main entry. Various seals and sealants appear to be allowing water intrusion and should be replaced. C. Interiors Floors: Flooring in hallways and public spaces is typically carpet tile with some areas having sheet vinyl. Restrooms are quarry tile. Main Entry has an area of slate. Labs have a poured floor system. Carpet Tile will need replacing in the next couple of years. Slate at entry should be replaced soon to minimize more chipping and shearing. Rubber base except at the main entry where stained wood base used. Some rubber base need re-attached to wall. Ceilings are primarily suspended ACT systems but some areas without the seismic wiring. Wet areas and some architectural features are gypsum ceilings painted. System in good condition except water damaged tile needs to be replaced. Walls are primarily gypsum board painted. Ceramic tile and gyp with epoxy paint in restrooms. Main public areas have wood paneled wainscot. Stairs are concrete and gyp painted walls with concrete floors, landings and concrete treads in steel pans. Painted steel handrails. Interior doors are stained wood with hollow steel welded frames. Good condition. Hardware is ADA compliant. D10 Conveyance Systems Elevator maintenance is contracted. Follow recommendations from Elevator maintenance annual inspection. Speed of elevator is in question; request should be made of maintenance team to increase speed where possible. Interior co cab beginning to show wear, recommend an interior cab finish upgrade.

	E. Equipment & Furnishings Labs have built in cabinetry workstations. They need to have at least one ADA workstations built in like others. There are temporary ADA work areas, not adequate. G. Sitework Asphalt parking lot was recently resealed and restriped. Common entry to complex is concrete driveway. The landscaping is maintained. Grade up against the building is too high and needs pulled away from masonry so weeps can work. Concrete walks are primarily in good condition. Brick pavers are inset at main entry to building. Some need replaced and lowered and re-grouted. Some concrete curbs have been damaged and need replaced. ADA parking is substantially identified. ADA parking signs are out of date and need replaced. Building entry has a glass, steel and aluminum canopy for bicycles and entry approach. Sloped glass drains but splashes on people around it. Drain system needs modified.
MECHANICAL & PLUMBING: D20 Plumbing Systems (Fixtures, Domestic Water, Sanitary,& Storm Water) D30 HVAC	D20 Plumbing Systems Two gas water heaters on the third floor supply the majority of the building's domestic hot water. These water heaters were originally installed in 2001. The recirculation pumps and balance valves for the primary system have been replaced within the last 2 years. The gas water heaters are nearing the end of their service life but are currently operating without issue. The third-floor location is inconvenient due to the security/access restrictions implemented by the tenant Rockwell/Collins. Two additional electric water heaters with dedicated mixing valves were installed in 2011 to serve emergency eyewash stations and showers in the labs. The electric water heaters and associated valves are in very good condition. Restroom fixtures in general are original to the 2001 build, except the lavatories that have been replaced with sensor-operated faucets within the past year. All fixtures observed, including laboratory fixtures installed in the 2011 renovation, are in very good to excellent condition. The original building did not include branch shutoff valves on the domestic water supply system, requiring the entire building to be shut off for major maintenance or repairs. The building operations team has added shutoffs in a few locations as available to isolate smaller regions of the building. Additional shutoff valves are recommended on each floor at the two restroom cores to facilitate maintenance activities. D30 HVAC There are three primary air handling units serving the building; each consisting of a packaged DX cooling system, gas furnace heating, single centrifugal supply fan and a single centrifugal return fan. All three units are located on the roof and were initially installed in 2001. The units are nearing the end of their service life but are largely in good condition for their age. Patches of corrosion were observed on the curb caps, and gas trains. Interior components that could be observed were clean and in good condition. Major issues with the units are related to the cooling systems: Compressor failures requiring unit downtime and repairs are common. Also, the R-22 refrigerant

	used in the cooling systems is being phased out (no production or import allowed) by the EPA in 2020. This will likely lead to increased difficulty and cost of future repairs. Four general exhaust fans were installed in the original build in 2001. Five additional exhaust fans have been installed from 2011 to present to serve various lab spaces. All exhaust fans are in good condition. EF-6 is not mounted to the roof; instead, it is attached to wooden rails resting on the roof. Nine separate split systems provide individual cooling to electrical rooms, an elevator equipment room, and other spaces not served by the primary system. All condensing units are located on the roof and were initially installed in 2001. These units have reached the end of their design life and are prone to frequent failures. The Alerton DDC control system is physically in good condition, however there are a number of operational controls issues related to programming, zoning, and balancing: 1. Programming has been altered so that the systems no longer operate on an occupancy/setback schedule. The same temperature setpoints are kept 24/7 in all spaces. 2. Some thermostats are not located in the zones they serve, or are controlled by the incorrect zone: ○ The 2nd floor Admin office area 230,231 Tstat is located in kitchen corridor next to room 255. ○ The thermostat for offices 130/130A on 1st floor stat is located outside of the offices. ○ 4th floor room 435 shares a thermostat with classroom 434. 3. The building pressurization sensors were located in the return plenum above the ceiling on the third floor. Two were disabled and the third was pushed through the ceiling into the third floor space. 4. Fire smoke dampers require a manual reset in the field after an alarm. They cannot be reset from the panel.

ELECTRICAL: D10 Distribution D20 Lighting and Lighting Controls D30 Communication and Security D90 Other Electrical Systems	D10 Electrical Distribution The Building is served from the utility by a 480/277V 3-Phase 4-wire system. The building electrical service is rated at 3000Amps 480V. Several step-down transformers are throughout to change from 480/277V to 120/208V 3-Phase. All voltages are distributed throughout the building with 480/277V primarily serving lighting, and mechanical equipment. Each floor has 480/277V and 120/208V distribution. The existing breakers and distribution equipment is primarily by GE (General Electric). It was observed that some Arc-Flash labels were present; however, breaker settings were all set to maximum default values. The breakers should be adjusted so their maximum default settings do not allow more energy through during a fault than is absolutely needed for coordination purposes. Backup power via automatic transfer switches and on-site generation is provided and discussed later in this summary. Most loads fed from the MDP are sub-panel, mechanical loads, and transformer feeders, with the exception of the elevators that are directly fed from the MDP. The electrical distribution system is in good condition, with equipment still in manufacturer, replacement parts readily available, and less than ½ of its expected service life exhausted. Breaker maintenance should be scheduled to make sure equipment is properly lubricated, springs/contacts are pliable, and equipment mechanically functions as intended. In the next 10+ years, breaker testing can be performed to verify the breakers operate as indented via on-site breaker testing/verification test. D20 Lighting and Lighting Controls Fluorescent lighting is provided throughout the building; with occupancy sensors located in some common areas only. Switching appears to be functional and in good repair. Both lighting and lighting controls should be upgraded to improve energy usage and reduce maintenance requirements. Some automatic lighting controls are integrated into the building; however, they are independent and require individual area-by-area programming. D30 Communication and Security The Instruction Detection system is not fully functional, and has caused operational problems since Oregon Tech purchased and renovated the building. The Intrusion detection system wiring is unorganized, and excessive (see photo in priority list descriptions). Intrusion Detection is not well interconnected with Access Control, so automatic arming/disarming occurs with valid card keys/disarm by area, etc. The intrusion detection system is also interconnected with the fire alarm system for the fire doors. We recommend the intrusion detection system (as a separate system) be removed from the building, including the control wiring, keypads, alarms, and communicators. The Access Control system is operating as needed; our recommendation is to upgrade the access control system to include intrusion detection if intrusion security is a concern. The access control system consists of magnetic held doors, some electronic strikes, along with central card-reader processing. The access control system secures both the perimeter and interior of the building. The fire alarm is Siemens (EST) Agogee with other various power supplies, notification appliance circuit panels (NAC's) and dialers. The system as a whole appears to be functioning well. Some equipment does not clearly indicate red enclosures, labeling, etc.). As a long-term priority, we recommend updating the fire alarm dialer to indicate

	more than just a zone/or alarm type. A fully addressable dialer will help convey important early information in the event of a fire/emergency. Additionally, the fire alarm system should be disconnected from the intrusion detection system (i.e. fire doors close upon intrusion alarm). The fire alarm system consists of horn/strobes, and does not include voice evacuation. Since the building is not an "E" occupancy, voice evacuation is not required. We recommend any future upgrades to include voice evacuation both for flexibility with occupancy types and for safety to allow for overall inter-building communications and emergency messages given that there is no PA system. **D90 Other Electrical** There are (2) existing generators on site. The larger generator is not utilized. It is recommended to decommission this generator and collect its salvage value. The smaller generator is being used for emergency back up and should remain as is. We recommend the emergency generator enclosure be locked. The existing Information Technology (IT) Uninterrupted Power Supply (UPS) utilizes a Trapped Key Interlock (Kirk key system) for transfer of UPS power for maintenance bypass for redundancy. The UPS's have been dismantled, and therefore the Kirk key system can be removed/only adds a possible confusion/failure point. This is a long-term priority and it can remain as is for some time unless any adverse/maintenance conditions arise on the system.

OIT - Wilsonville Campus Facilities Conditions Assessment - Project Priority Matrix

Overall Priority Recommendation	Reference Number	Recommended Corrective/Preventative Action Description of recommended action to resolve deficiency	Deficiency Category Affects possible funding streams	Priority Class Priority Class	Cost to Implement (in 2019 Dollars) Round to nearest $5,000 increment	Life Safety Risk Rank 1-5 (1 = Highest, 5=Lowest risk)	Impact to other Systems Rank 1-5 (1=Greatest impact, 5=Least)	Ease of Implementation Rank 1-5 (1=Complicated, 5=Easy)	Impact to Building Operations Rank 1-5 (1=Wide Spread or Lengthy Shutdowns, 5=No Impact)	Discipline
1	A-13	EXTERIOR BUILDING ENVELOPE: Entry Doors - adjust doors pressure to meet code for accessibility	Routine Maintenance	Priority 1: Immediate Action Required	$ 5,000	1	4	5	4	ARCH
2	S-4	EXTERIOR: Anchor existing electrical transformer for seismic forces	Capital Renewal	Priority 1: Immediate Action Required	$ 5,000	1	5	5	5	STRUC
3	A-4	SITE: Replace ADA Signs with current Code required text	Deferred Maintenance	Priority 1: Immediate Action Required	$ 7,500	1	5	5	5	ARCH
4	A-32	INTERIOR: HVAC Lab 428 - Add fireproofing per code to the plywood box opening or remove the box and replace with code approved fireproofing	Capital Renewal	Priority 1: Immediate Action Required	$ 7,500	1	3	2	4	ARCH
5	A-3	SITE: Grind down and fill cracks in all concrete walks around the building greater than 1/4 inch in elevation difference	Deferred Maintenance	Priority 1: Immediate Action Required	$ 15,000	1	5	5	3	ARCH
6	A-2	SITE: Replace Grout sunken or missing in Masonry inset in concrete walk at entry, remove and reset any masonry raised greater than 1/4"	Deferred Maintenance	Priority 1: Immediate Action Required	$ 20,000	1	5	5	3	ARCH
7	M-5	HVAC: Anchor EF-6 fan and motor	Deferred Maintenance	Priority 1: Immediate Action Required	$ 5,000	2	5	5	5	MECH
8	E-8	ELECTRICAL: Lock generator housing	Plant Adaptation	Priority 1: Immediate Action Required	$ -	4	5	5	5	ELEC
9	S-2	INTERIOR: Laterally brace fire sprinkler system for Risk Category III	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 150,000	1	2	2	3	STRUC
10	A-7	SITE: Entry Canopy nearest side to Entry Doors - add gutter along low edge of glass	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 15,000	2	4	2	3	ARCH
11	A-6	SITE: Pull finish grade away from building to expose weeps and one course below all around building	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 25,000	2	5	4	5	ARCH
12	E-6	ELECTRICAL: Perform study to coordinate breaker settings	Plant Adaptation	Priority 2: Recommend Action within 1 yr	$ 30,000	2	4	5	4	ELEC
13	A-1	SITE: Repair broken Curbs	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 35,000	2	5	5	4	ARCH
14	A-19	INTERIOR: Entry floor slate shearing and chipping, should be replaced	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 45,000	2	4	4	4	ARCH
15	A-11	EXTERIOR BUILDING ENVELOPE: Aluminum covered beam over entry: Replace aluminum sheeting with stainless steel, flat seams at joints, gauge adequate to minimize oilcanning, reflash and seal as it enters building wall both ends.	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 75,000	2	4	2	4	ARCH
16	A-12	EXTERIOR BUILDING ENVELOPE: Storefront window system - replace rubber gaskets around glass where separated	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 150,000	2	4	3	4	ARCH
17	S-3	INTERIOR: Laterally brace mech ducts, piping and suspended equipment	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 150,000	2	2	2	3	STRUC
18	A-9	EXTERIOR BUILDING ENVELOPE: Window Head Flashing -Remove and replace sealant	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 190,000	2	4	3	4	ARCH
19	A-10	EXTERIOR BUILDING ENVELOPE: Window Sill - replace backer rod and sealant under sill flashing, replace joint covers, reseal at ends of flashing	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 225,000	2	4	3	4	ARCH

20	S-1	INTERIOR: Augment existing suspended ceiling and lights for seismic bracing	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 300,000	2	2	2	3	STRUC
21	A-8	EXTERIOR BUILDING ENVELOPE: Pressure wash and clean off all moss and similar materials from Masonry and joints. Clean out all weeps in walls. Reseal Masonry.	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 350,000	2	4	3	4	ARCH
22	A-31	INTERIOR: Men's & Women's Shower Rm opposite Room 150 are not completely accessible, needs further upgrading	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 10,000	3	2	3	5	ARCH
23	A-22	INTERIOR: ADA Stall in Restrooms need vertical grab bar added	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 7,500	4	5	5	5	ARCH
24	M-1	HVAC: Reprogram building controls and relocate/replace thermostats that serve incorrect thermal zones.	Capital Renewal	Priority 2: Recommend Action within 1 yr	$ 50,000	4	2	4	3	MECH
25	A-30	INTERIOR: Add chair rail for furniture at entry seating area, repair wall damage	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 5,000	5	5	5	5	ARCH
26	A-29	INTERIOR: Replace ceiling tile with water damage from HVAC and water intrusion leaks, all floors	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 10,000	5	4	5	5	ARCH
27	M-4	HVAC: Add reheat coils to terminal units.	Plant Adaptation	Priority 2: Recommend Action within 1 yr	$ 10,000	5	5	4	5	MECH
28	A-24	INTERIOR: 3rd Floor, south side of Building at west wing intersection to north/south wing: the window bay towards the west has water intrusion at the window sill. Replace sealant under sill pan, repair and paint sill, patch wall damage an repaint.	Deferred Maintenance	Priority 2: Recommend Action within 1 yr	$ 10,000	5	3	3	5	ARCH
29	M-2	HVAC: Rebalance building air systems and correct building pressurization.	Plant Adaptation	Priority 2: Recommend Action within 1 yr	$ 25,000	5	4	4	4	MECH
30	A-25	INTERIOR: Entry Stair - Straighten and resecure brackets holding glass panels in railing	Routine Maintenance	Priority 3: Recommend Action within 2-5 yrs	$ 5,000	2	4	5	5	ARCH
31	S-5	INTERIOR: Anchor existing mechanical equipment for seismic forces.	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 25,000	2	5	3	5	STRUC
32	A-23	INTERIOR: Room each side of sheet metal wrapped beam over Entry (Rms 201,250,402, 466) patch and repair walls, sill and ceiling around leak damage from beam. Work to occur **after** beam re-wrapped	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 30,000	2	4	3	4	ARCH
33	A-5	SITE: Replace concrete light base near west side of west end entry	Deferred Maintenance	Priority 3: Recommend Action within 2-5 yrs	$ 12,500	3	5	5	5	ARCH
34	A-20	INTERIOR: Drinking Fountains- most are single fountains with some height ok, some too high. Replace 50% per floor with dual DF, others remain as they are.	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 60,000	3	3	4	4	ARCH
35	A-21	INTERIOR: Labs need an ADA station built in like others (Rms 152,153,452,456)	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 60,000	3	3	3	5	ARCH
36	A-27	INTERIOR: 2nd Floor public hallway, replace carpet showing wear	Deferred Maintenance	Priority 3: Recommend Action within 2-5 yrs	$ 45,000	4	4	3	3	ARCH
37	A-28	INTERIOR: 4th Floor public hallway, replace carpet showing wear	Deferred Maintenance	Priority 3: Recommend Action within 2-5 yrs	$ 50,000	4	4	3	3	ARCH
38	M-3	HVAC: Replace all original 2001 split air-conditioning systems.	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 70,000	4	5	3	4	MECH
39	A-26	INTERIOR: 1st Floor Entry and public hallways, replace carpet showing wear	Deferred Maintenance	Priority 3: Recommend Action within 2-5 yrs	$ 85,000	4	4	3	3	ARCH
40	A-34	INTERIOR: Steel above ceiling along exterior wall (around building, all floors) mitigate condensation from assembly. Remove batt insulation, imped corrosion with rust inhibiting coating, provide spray foam insulation (Leak investigation Report)	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 125,000	4	2	2	4	ARCH
41	E-1	ELECTRICAL: Replace fluorescent lighting with new LED fixtures and lighting controls	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 1,250,000	4	5	3	3	ELEC

42	E-3	ELECTRICAL: Decommission existing generator for resale	Plant Adaptation	Priority 3: Recommend Action within 2-5 yrs	$ 5,000	5	5	5	5	ELEC
43	M-9	HVAC: Replace IT room 255 portable AC unit with Fixed Smini-Split System	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 5,000	5	5	3	4	MECH
44	A-14	ROOF: Repair broken corners at roof curb penetration	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 25,000	5	3	4	5	ARCH
45	A-15	ROOF: Low corners (water stains) raise with rigid insulation to drain OR with reroof	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 25,000	5	3	4	5	ARCH
46	M-8	PLUMBING: Add shutoff valves to plumbing systems	Plant Adaptation	Priority 3: Recommend Action within 2-5 yrs	$ 25,000	5	3	4	3	MECH
47	A-33	INTERIOR: Window sills in some areas will need to have existing sealant replaced after the exterior window work is completed	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 35,000	5	3	3	5	ARCH
48	A-16	ROOF: Repaint structural steel framework to prevent further rusting	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 50,000	5	4	4	5	ARCH
49	E-2	ELECTRICAL: Remove existing unused cable throughout the building with the exception of main trunklines	Deferred Maintenance	Priority 3: Recommend Action within 2-5 yrs	$ 100,000	5	5	3	4	ELEC
50	M-6	HVAC: Replace rooftop air handling units	Capital Renewal	Priority 3: Recommend Action within 2-5 yrs	$ 1,000,000	5	2	2	2	MECH
51	E-5	FIRE ALARM: Unify all fire alarm equipment to the same company	Plant Adaptation	Priority 4: Recommend Action within 5-9 yrs	$ 75,000	3	4	4	3	ELEC
52	E-9	ELECTRICAL: Replace Fire Alarm Dialer	Plant Adaptation	Priority 4: Recommend Action within 5-9 yrs	$ 5,000	4	3	3	4	ELEC
53	E-4	SECURITY: Remove independent intrusion detection system & upgrade access control to include intrusion detection	Plant Adaptation	Priority 4: Recommend Action within 5-9 yrs	$ 250,000	4	3	2	2	ELEC
54	A-17	ROOF: Replace wall cap with reroof, currenting allowing leaks into upper level ceiling/walls	Capital Renewal	Priority 4: Recommend Action within 5-9 yrs	$ 35,000	5	4	4	5	ARCH
55	M-7	PLUMBING: Replace water heaters	Capital Renewal	Priority 4: Recommend Action within 5-9 yrs	$ 40,000	5	5	3	5	MECH
56	A-18	ROOF: Replace roofing, with EPDM single ply (60mil), wall caps and all flashing - stainless . Adjust slope of low points to drain and rework around roof drains to be low points. New boots at all roof penetrations.	Capital Renewal	Priority 4: Recommend Action within 5-9 yrs	$ 275,000	5	3	4	5	ARCH
57	E-7	IT: Remove Trapped Key Interlock (Kirk key) System	Plant Adaptation	Priority 5: Recommend Action within 10+ yrs	$ 20,000	4	3	3	3	ELEC

Total	**$ 5,720,000**
Priority 1 - Total	$ 65,000
Priority 2 - Total	$ 1,867,500
Priority 3 - Total	$ 3,087,500
Priority 4 - Total	$ 680,000
Priority 5 - Total	$ 20,000
Breakdown Total	$ 5,720,000

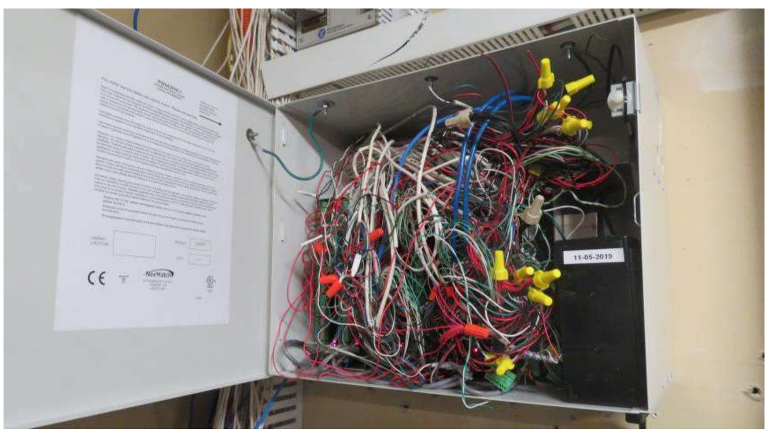
Priority List Matrix Appendix

The list below provides more detailed descriptions of the items listed in the Project Priority Matrix. See the Project Priority Matrix for estimated measure costs in 2019 dollars.

Ref #	Measure Description
A-1	Site: Repair broken Curbs: Remove existing broken curbs, form and pour concrete curbs t match existing.
A-2	Site: Brick masonry pavers at entry, inset in concrete walk; remove and replace Grout that has sunken or is missing. Remove and replace masonry pavers and grout that are raised above the adjacent concrete walk surface more than ¼ inch.
A-3	Site: Grind down and fill cracks in all concrete walks around the building greater than 1/4 inch in elevation difference. Fill any cracks greater than 1/8inch.
A-4	Site: Current metal signs on pole at ADA parking spaces are out of date. Replace Signs with current Code required text.
A-5	Site: Existing Site light near the entry: west side of the entry near west end of the north accessible spaces is in a concrete base that has deteriorated. Remove light and replace concrete light base, re-install light.
A-6	Site: Existing soil and planting beds up against the building are covering some of the weep holes at the brick masonry walls. Pull finish grade away from building to expose weeps and at least one course below that, all around building
A-7	Site: Glass and steel entry canopy nearest to Entry Doors allows the water to run directly off onto the sidewalk and splash nearby individuals. It needs to be caught by gutters or drop into a splash area similar to the other canopy. Add a gutter form along low edge of glass and into a downspout or modify ground and create a splash container.
A-8	Exterior Building Envelope: Pressure wash and clean off all moss, dirt and similar materials from building wall brick and tile masonry and joints. Clean out all weeps in walls. Repoint any area where grout is missing or loose. Provide a clear matte sealant on all masonry walls.
A-9	Exterior Building Envelope: All exterior windows - Remove Window Head Flashing; replace flashing, backer rod and failing sealant
A-10	Exterior Building Envelope: All exterior windows – remove and replace backer rod and failing sealant under sill flashing, replace joint cover and reseal ends of flashing.
A-11	Exterior Building Envelope: Aluminum covered beam over entry: Attachment to building wall at each end is creating water intrusion at each floor and both ends. Replace aluminum sheeting with 304 stainless steel sheeting, flat seams at joints, gage adequate to minimize oil canning. Re-flash and seal as it enters building wall both ends, each floor.
A-12	Exterior Building Envelope: Storefront Window System -Existing rubber gaskets around the glass are loose, separating and coming out. Replace rubber gaskets around glass to allow expansion /contraction without pushing out or gapping.
A-13	Exterior Building Envelope: Entry Doors - adjust doors pressure to meet code for accessibility.
A-14	Roof: Short-term repair- Replace broken corners at roof curbs for HVAC equipment.
A-15	Roof: Low areas of room with ponding water need to be raised. Requires additional tapered insulation over an area to maintain drainage. Should be done when re-roofing occurs

A-16	Roof: Scrape, wire brush and prepare structural steel framework for new rust-inhibiting primer and coating. Clean masonry wall panels.
A-17	Roof: Some leaking occurs from exterior wall parapet and flashing. Parapet cap, flashing and counter flashing should be replaced with reroofing with joint covers to be best type for condition or material.
A-18	Roof: Replace entire roof with EPDM single-ply (60mil), Adjust slope of low points with additional tapered rigid insulation. Ensure positive drainage from low points. Rework roof drain areas to make them low points. Provide new boots and curbs at all roof penetrations. Replace flashing and counterflashing with stainless.
A-19	Interior: Main entry to the building has a slate floor that is shearing and chipping. It should be replaced with a manmade product that won't damage as easily.
A-20	Interior: Drinking Fountains- Most are single fountains with some where the height is okay but some are too high. Replace 50% per floor with code required dual height drinking fountains. Other drinking fountains may remain.
A-21	Interior: Labs (Rooms 152,153,452,456) with fixed furniture workstations need to provide an ADA workstation. It should be built-in like other stations not a temporary table. All equipment and storage to be provided as well addressing accessibility.
A-22	Interior: Existing restrooms have ADA stalls with grab bars. The vertical grab bar now required by code is missing and needs to be installed in each ADA stall.
A-23	Interior: Rooms 201,250,402, and 466 are at each end of exterior aluminum wrapped beam over the main Entry. See A11 above. Water intrusion from the beam has caused interior damage. Patch and repair walls, sill and ceiling around the beam location **after** exterior work completed.
A-24	Interior: 3rd Floor, south side of Building at west wing intersection to north/south wing: the window bay towards the west has water intrusion at the window sill. Replace sealant under sill pan, repair and paint sill, patch wall damage and repaint.
A-25	Interior: Entry Stair - The brackets holding glass panels in the railing are not all solid. Adjust and re-tighten steel brackets.
A-26	Interior: 1st Floor Entry and public hallways on 1st, 2nd and 4th floors, the carpet flooring is showing wear and needs to be replaced with carpet tile. Replace carpet in common halls and areas of Public Use. This can be done on a floor-by-floor basis or throughout the building.
A-27	Interior: 2nd Floor public hallway: the carpet flooring is showing wear and needs to be replaced with carpet tile. Replace carpet in common halls and areas of Public Use. See matrix
A-28	Interior: 4th Floor public hallway: the carpet flooring is showing wear and needs to be replaced with carpet tile. Replace carpet in common halls and areas of Public Use. See matrix
A-29	Interior: All ceiling tile, all floors, that has water stains from HVAC or other water intrusion or is damaged needs to be replaced.
A-30	Interior: Main Entry: Add chair rail for furniture on the walls in the seating area that are being damaged. Match other wainscot and rail used in First Floor Common area. Repair wall damage.
A-31	Interior: Men's & Women's Shower Rm C111 & C112 - showers are not completely accessible, there needs further upgrading for a turning area, grab bars and bench for transfer area.
A-32	Interior: H Lab 428 has no ceiling. This area has been left exposed. The deck and steel beams are fireproofed. There is a non-rated plywood boxed opening in one area of the ceiling that needs to become fire rated. Remove plywood box and patch fireproofing or fireproof the plywood-boxed area per code.

A-33	Interior: Window sills in some areas will need to have existing sealant replaced after the exterior window work is completed. Windows will shift and create separation at the sills and possible jambs. All windows to be inspected. Construction is not as shown on construction drawings in all parts of the building. There is sealant involved. Once the exterior sill pan work is done it will be more evident as the windows will have moved and sealant opened. See Photo below. 
A-34	Interior: At the exterior perimeter walls, above the suspended ceiling, condensation has been forming and is causing rust on the steel members and damaging and soaking the insulation. To mitigate the condensation the dew point needs to be relocated. Remove the batt insulation, imped any corrosion on steel and other materials with rust-inhibiting paint and provide spray foam insulation equal to or greater than the value of the batt insulation. (See Leak investigation Report)
S-1	Interior: The suspended ceiling grids and lighting throughout the building lack the appropriate lateral sway bracing and compression struts originally specified in construction documents. This is particularly inadequate as a Risk Category III building.
S-2	Interior: The existing fire sprinkler system lacks the lateral seismic bracing necessary to comply with a Risk Category III building.
S-3	Interior: The mechanical ductwork, in-line equipment and suspended equipment and piping lack the lateral seismic bracing appropriate to comply with a Risk Category III building.
S-4	Exterior: The existing electrical transformer located outside the building is not bolted to the supporting concrete pad. Add bolting with post-drilled anchors to concrete. Immediate safety measure.
S-5	Interior: All existing electrical and mechanical equipment need to be anchored and/or braced to the floor system and/or wall system to secure in the event of an earthquake.
M-1	Hire Alerton representative to reprogram the DDC system to conform to the desired sequence of operations. The building controls system is currently set to run with constant temperature setpoints in all spaces. This has a negative impact on energy use and thermal comfort. Relocate or add thermostats serving Admin office area 230 and 231, offices 130/130A, and room 435. The thermostats for these zones are currently located outside of the zones they are controlling, generating complaints about room temperatures.

M-2	Hire test & balance contractor to rebalance problem zones, air handlers, and reset building pressurization tracking in air handler control sequence. Relocate building pressurization sensors to a consistent location (above or below the 3^{rd} Floor ceiling plenum) so that all 3 sensors may be active. Incorrect airflows are a leading cause of thermal comfort and ventilation issues and should be ruled out or corrected before any more intensive system modifications are pursued.
M-3	Total replacement of original split systems still in use: CU1-1, CU1-2, CU1-3, CU1-4, CU2-1, CU3-1, and CU4-1. These units are at the end of their service life and experiencing frequent failures. Failures have potential to impact the building electrical system.
M-4	Add reheat coils to the terminal units serving 2nd floor classrooms 256 and 257. These terminal units as configured can only deliver air at the primary air handler temperature (typically 55^{o}F), leading to frequent overcooling of the classrooms.
M-5	Mount EF-6 to the roof with a structural curb or anchors compliant with current building code. The fan is currently mounted on 4x4 beams lying on the roof and has no attachment points, making it susceptible to movement from vibration and wind loading.
M-6	Total replacement of AC-1, AC-2, and AC-3. These units are nearing the end of their service life and experiencing frequent compressor failures. R-22 refrigerant used in the cooling section is undergoing a phase-out in 2020, which will increase maintenance cost and difficulty.
M-7	Total replacement of original water heaters WH-1 and WH-2. Water heaters are nearing the end of their service life.
M-8	Add shutoff valves to domestic cold water, hot water, and hot water recirculation at entries to restroom cores on each floor. There are currently only a few shutoff valves throughout the system, so large portions of the building must be shut down for fixture maintenance or repair.
M-9	Service IT room 255 AC unit due to failing fuses. A portable unit is now cooling the space due to failing fuses in the fixed unit.
E-1	Existing fluorescent lighting should be replaced with new LED luminaires throughout the building to improve energy efficiency and reduce maintenance requirements.
E-2	Remove existing unused cabling throughout the building to improve maintenance troubleshooting efforts.
E-3	Existing large generator is not being utilized. Recommend decommissioning this generator for resale. Small generator shall remain in use for emergency purposes.
E-4	Intrusion Detection is not interconnected with Access Control , but is interconnected with the fire alarm system for the fire doors. Remove the intrusion detection system (as a separate system) from the building, including the control wiring, keypads, alarms, and communicators. We also recommend cleaning up wiring. See photo 

E-5	Update fire alarm system to a single brand of components to minimize future risk of incompatibility.
E-6	Recommend a coordination study be conducted to determine proper breaker settings. The study will increase safety by allowing faster breaker clear times as well as possibly lowering arc-flash energy/exposure. The arc-flash values should be updated with the coordination study (arc-flash and coordination study performed at the same time).
E-7	Remove Kirk Key System for transferring UPS power. This redundant UPS has been dismantled, and therefore the Kirk Key system can be removed/only adds a possible confusion/failure point.
E-8	Lock generator housing. The generator should have its housing secured to prevent unauthorized entry. This is the actual generator, not the brick exterior enclosure.
E-9	Replace fire alarm dialer. The existing system gives very limited information compared to newer systems. A fully addressable dialer will help convey important early information in the event of a fire/emergency.

Measurements	°F
Sp1	68.8
Sp2	66.9
Sp3	69.8

Parameters	
Emissivity	0.95
Refl. temp.	70 °F
Distance	10 ft
Atmospheric temp.	73 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	40 %

Image Description

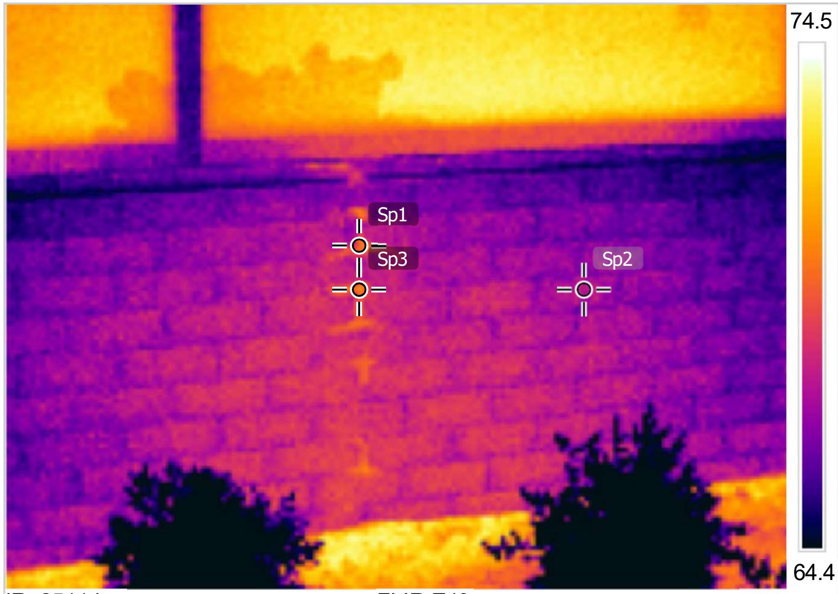
Brick Veneer

These Infrared images were taken on August 30, 2019. Weather conditions are partly cloudy with high temperatures in the low 70'sF. Rain showers passed through the area a couple days prior to the site visit.

This image shows moisture in the brick veneer. Spot Tool 1 and 3 indicate moisture retention where moss is growing. Spot Tool 2 shows the ambient wall temperature. This condition occurs in numerous locations.

Refer to architect report for remediation

8/30/2019 8:11:06 AM



IR_2511.jpg FLIR E40 49034688

8/30/2019 8:11:06 AM

DC_2512.jpg FLIR E40

Measurements	°F
Sp1	84.1
Sp2	72.5
Sp3	75.8

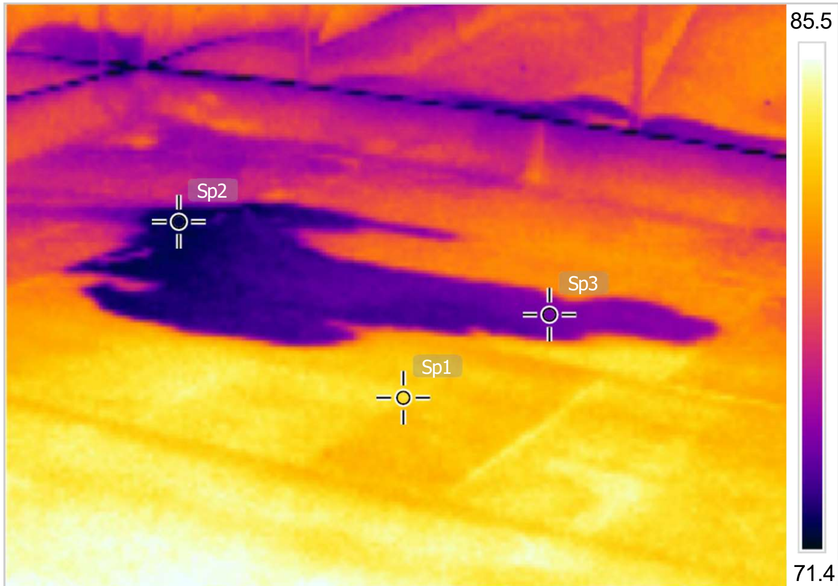
Parameters	
Emissivity	0.95
Refl. temp.	75 °F
Distance	10 ft
Atmospheric temp.	70 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	40 %

Image Description

Roof Ponding

The following series of images were taken during the roofing system inspection. The roofing system is generally in good condition. There are several locations where moisture is accumulating. There is no standing water in this image. Thermography shows latent heat of vaporization where moisture is retained. Spot Tool 1 indicates the ambient temperature of the roofing material is 84.1F. Spot Tool 2 and 3 show the area is significantly cooler where moisture is retained.

8/30/2019 8:40:35 AM



IR_2517.jpg FLIR E40 49034688

8/30/2019 8:40:35 AM

DC_2518.jpg FLIR E40

8/30/2019 8:43:24 AM

Measurements	°F
Sp1	72.8
Sp2	82.9

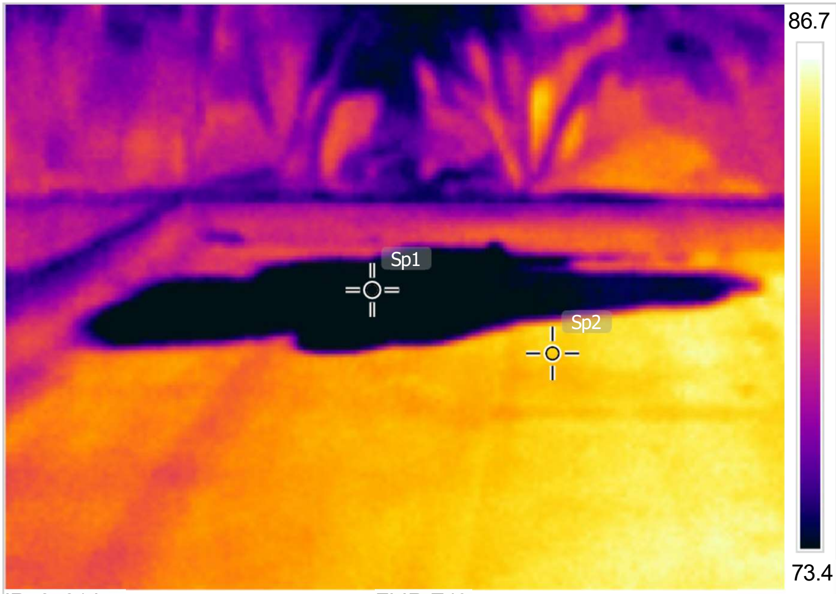
Parameters

Emissivity	0.95
Refl. temp.	75 °F
Distance	10 ft
Atmospheric temp.	70 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	40 %

Image Description

Roof Ponding

This image shows latent heat of vaporization in roofing materials.



IR_2521.jpg FLIR E40 49034688

8/30/2019 8:43:24 AM

DC_2522.jpg FLIR E40

Measurements	°F
Sp1	72.0
Sp2	84.9

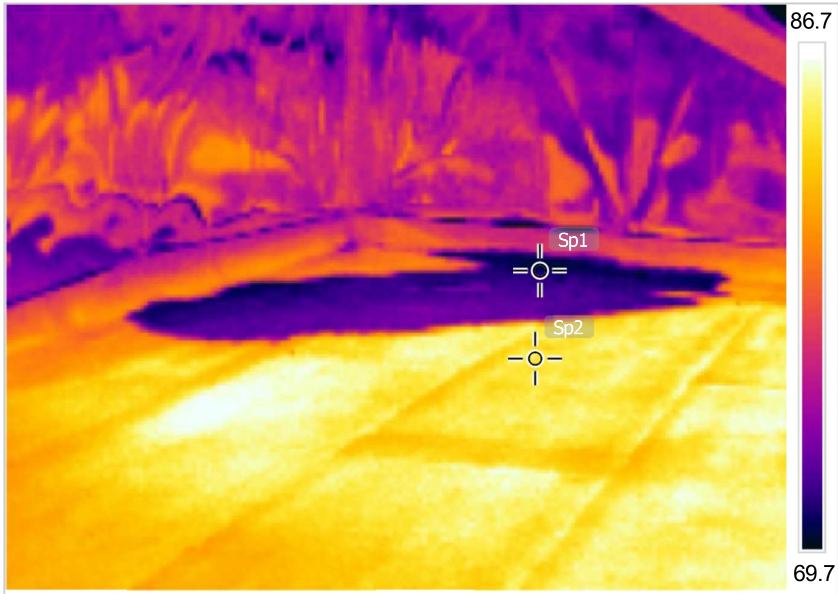
Parameters	
Emissivity	0.95
Refl. temp.	75 °F
Distance	10 ft
Atmospheric temp.	70 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	40 %

Image Description

Roof Ponding

This image also shows moisture retention in roofing materials. Refer to architect report for recommended remediation.

8/30/2019 8:47:33 AM



IR_2527.jpg FLIR E40 49034688

8/30/2019 8:47:33 AM

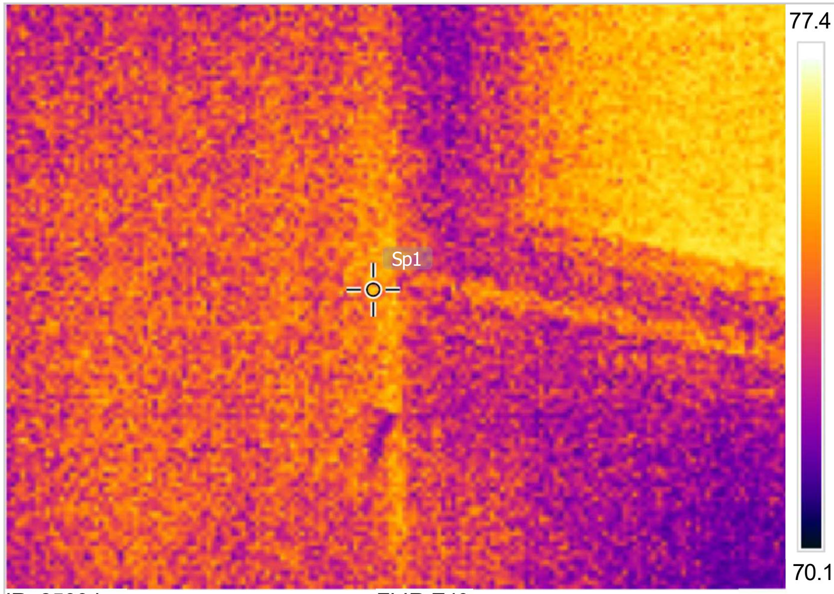
DC_2528.jpg FLIR E40

Measurements	°F
Sp1	74.3

Parameters	
Emissivity	0.95
Refl. temp.	75 °F
Distance	0.8 ft
Atmospheric temp.	74 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	34 %

This image shows the location of a glazing leak. Thermography shows the area is dry. The digital images shows peeling paint where the condition occurs intermittently. There are several locations affected by this condition. Refer to architect report for recommended repair.

8/30/2019 9:00:51 AM



IR_2533.jpg FLIR E40 49034688

8/30/2019 9:00:51 AM

DC_2534.jpg FLIR E40

Measurements

Measurements	°F
Sp1	75.8
Sp2	76.6

Parameters

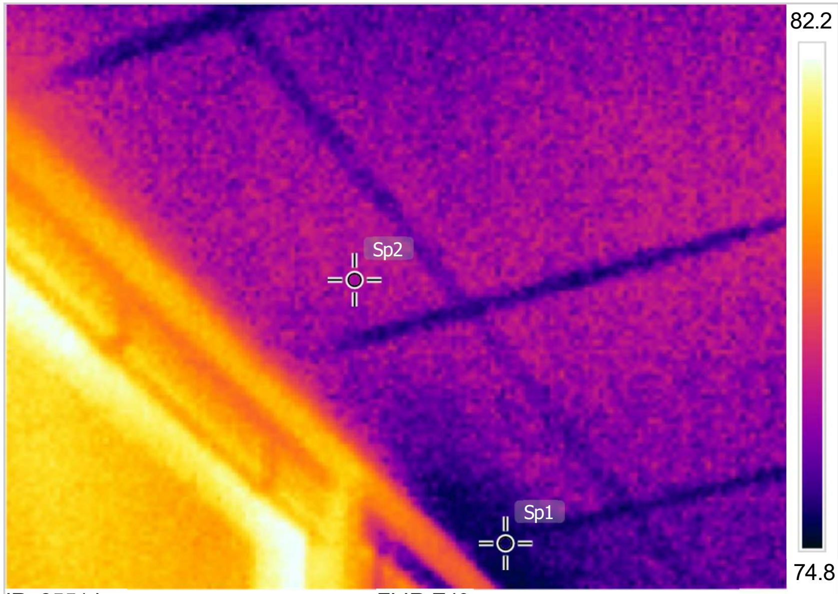
Emissivity	0.95
Refl. temp.	75 °F
Distance	6 ft
Atmospheric temp.	74 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	34 %

Image Description

Envelope Leak

This image shows a building envelope or glazing leak. Spot Tool 1 shows moisture retention in these ceiling tiles.

8/30/2019 10:32:10 AM



IR_2551.jpg FLIR E40 49034688

8/30/2019 10:32:10 AM

DC_2552.jpg FLIR E40

Measurements	°F
Sp1	71.4
Sp2	76.4

Parameters

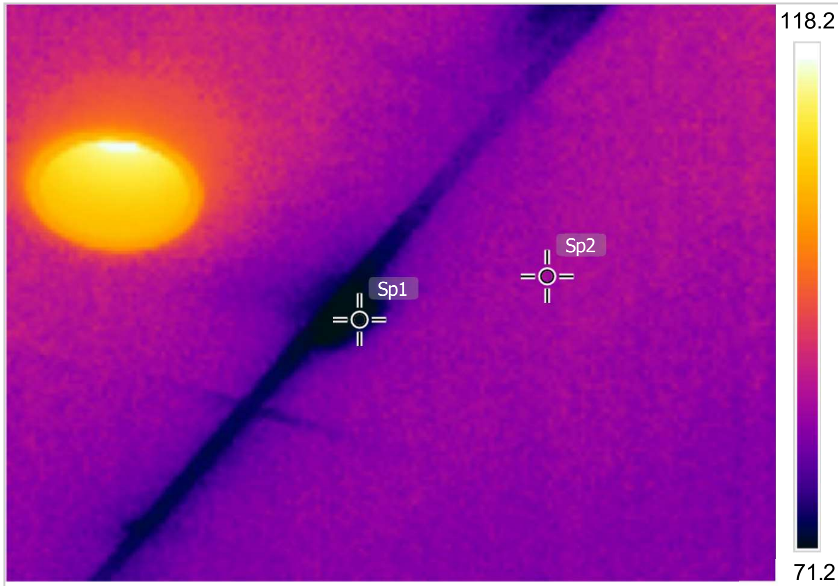
Emissivity	0.95
Refl. temp.	75 °F
Distance	4.5 ft
Atmospheric temp.	74 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	34 %

Image Description

Hydronic Piping Water Leak, Active

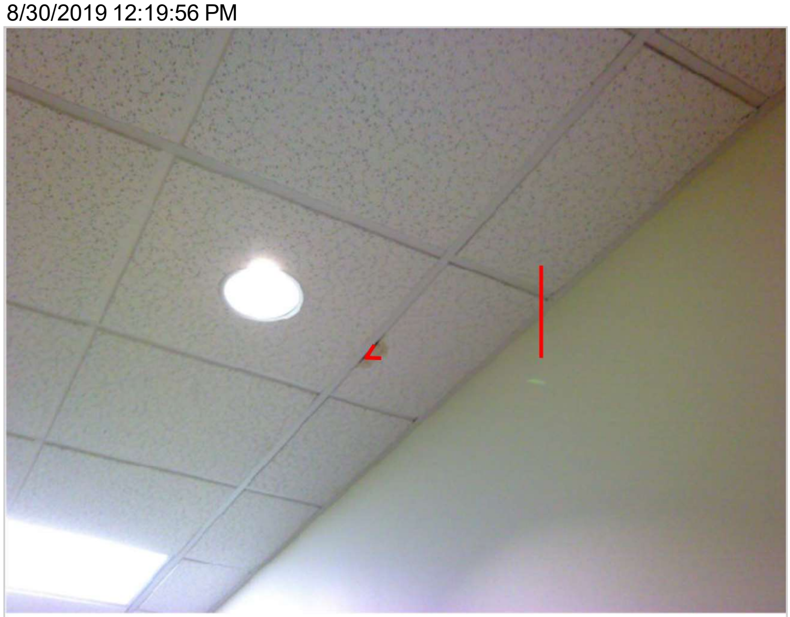
Spot Tool 1 shows an active hydronic piping leak. This is a maintenance item and occurs in several locations.

8/30/2019 12:19:56 PM



IR_2555.jpg FLIR E40 49034688

8/30/2019 12:19:56 PM



DC_2556.jpg FLIR E40

Measurements	°F
Sp1	74.0

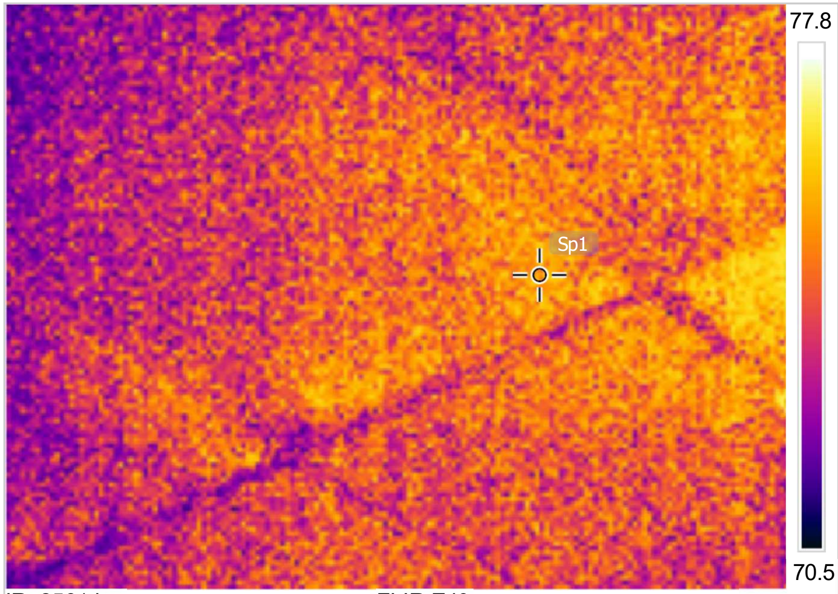
Parameters	
Emissivity	0.95
Refl. temp.	75 °F
Distance	5 ft
Atmospheric temp.	74 °F
Ext. optics temp.	68 °F
Ext. optics trans.	1
Relative humidity	34 %

Image Description

Hydronc Piping Leak, Inactive

Inactive hydronic piping leak.

8/30/2019 12:36:48 PM



IR_2561.jpg FLIR E40 49034688

8/30/2019 12:36:48 PM

DC_2562.jpg FLIR E40

Portland Metro

15 Year Expected Building Repair Replacement Costs

Costs in 2023 dollars

Number	Name	Event	Year 2 2023-2025	Year 10 2026-2033	Year 15 2034-2038	Combined Total Repair & Replacement (a)	Building Replacement Cost (b)	Facility Condition Index (a/b)
A6	Perimeter planting beds	Regrade to expose weeps in brick		$ 25,000				
A12	Exterior windows	Repair or replace window gaskets		$ 150,000				
A9, A10	Exterior windows	Repair/replace sealant		$ 200,000				
A16	Rooftop RTU screens	repaint steel framing		$ 50,000				
A17,A18	Roofing and parapet cap	Replace	$ 975,000			$ 975,000		
A23	Ext wall at canopy penetrations	Seal leaks	$ 35,000			$ 35,000		
A24	Ext wall at 3rd floor south wall	Seal Leaks	$ 11,000			$ 11,000		
M1	Controls	Reprogram and relocate thermostats	$ 50,000					
M2	HVAC	Retest & rebalance system	$ 35,000			$ 35,000		
M3	Split system AC	Replace 7 units	$ 83,000			$ 83,000		
M4	Terminal Units	Add reheat coils at rooms 256, 257	$ 11,000			$ 11,000		
M6	Rooftop HVAC units	Replace	$ 1,180,000			$ 1,180,000		
M7	Water heaters	Replace		$ 47,000		$ 47,000		
M9	HVAC	Replace AC at room 255	$ 6,000			$ 6,000		
E1	Lighting	Replace with LED (1)	$ 600,000			$ 600,000		
E5	Fire alarm system	Replace with parts by a single mfr			$ 75,000			
E6	Coordination Study	Study to adjust breakers		$ 30,000				
E9	Fire alarm dialer	Replace			$ 5,000			
(1) assumes 50% cost Energy Trust incentive rebate							139, 268 SF	
							$600/SF	
Totals			$2,986,000	$502,000	$80,000	$3,568,000	$83,560,800	0.043

Snell Hall

02 Architectural - General

Snell Hall is a steel framed building with glass and metal panel exterior cladding. The metal panels were recently replaced and the exterior was painted. The interiors are typical gypsum board partition fabrication. Because the architectural components were recently upgraded an architectural assessment was not made.

The Snell Hall structure is a two-story steel structure consisting of steel wide flange (WF) roof beams and metal decking. The floor framing consists of WF beams supporting a slab on metal deck. Floor beams are supported by first level concrete columns. The basement is created with cast-in-place concrete retaining walls and a concrete slab-on-grade.

The building contains some administrative offices, but not all of them. Some are internally university related such as human resources, and some are student related such as the registrar's office and cashier. Information Technology is located here but is moving their equipment to Boivin.

02 Architectural & Structural
02.01 Foundations
02.01.10 Footings & Foundations
Description Foundation appears to be in good condition based on our visual observation of the superstructure.

Condition Assessment Good.

02.02 Superstructure
02.02.10 Structural Framing

Description Steel structure supported by concrete columns.

Condition Assessment Good

1.Mechanical Executive Summary

Snell Hall mechanical systems consists of one central dual-duct air handling system that serves terminal units at the space level. Heating hot water is provided through a plate and frame heat exchanger connected to the campus geo-thermal system. It was reported that all equipment is vintage to the building.

04 Mechanical
04.01 HVAC

04.01.040 (HW/S) Heat Exchangers

Description Heat Exchanger connected to campus geothermal system provides heating hot water for the building.

Condition Assessment Heat exchanger appeared vintage to the building and past its useful life.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$12,000	High

04.01.160 Central Station AHU

Description There is one central station, dual-duct, air handling unit serving the building. This unit was reported to be vintage to the building and internal components are all original.

Condition Assessment Equipment is all installed indoors, and regular maintenance and replacement of parts has all be done throughout the equipment’s life. Equipment is in fair condition, but past its useful life and is an outdated system type.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Refurbish	2025	$50,000	High

Event Justification & Strategy

This unit and its components are beyond their useful life along with being an outdated system type. Unit’s components should be refurbished to restore equipment life expectancy. At the time of component replacement, unit should be converted to a variable volume air handling system.

04.01.180 HVAC Pumps

Description A Central pump circulates heating hot water from the geo-thermal heat exchanger throughout the building to provide the necessary heating.

Condition Assessment Heating Water Pump: The heating water pump was reported vintage to the building however appeared to be recently replaced within the last five years. If pump has been recently replaced it is at the beginning of its useful life.

Element State: New

04.01.190 Terminal Units

Description 18 dual-duct terminal units serve the varies spaces throughout the building.

Condition Assessment Equipment is in fair condition with regular maintenance having been performed, but equipment is beyond its useful life and an outdated system type.

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$65,000	High

Event Justification & Strategy

Terminal units are vintage to the building and beyond their useful life. They are also an outdated system type. Terminal units should be replaced at the same time that work is performed on the air handling unit and everything converted to a variable volume system type.

1. Electrical Executive Summary

Element State: Fair

Snell Hall electrical systems consists of 480/277V and 208/120V electrical distribution equipment of varying vintage to serve building loads. Normal and emergency power systems serve the building, with a standby diesel generator providing emergency power to egress lighting and fire alarm loads. The building also houses campus main IT equipment room and includes an Uninterrupted Power Supply (UPS) for backup for these loads.

05 Electrical
05.02 Secondary Electrical
05.02.10 Secondary Switchgear

Description: Snell Hall is served via a 600A, 480/277V electrical service to a main switchboard in the lower-level main electrical room. The main switchboard includes a motor control section to serve mechanical equipment, integral step-down transformer, and 208/120V distribution panelboard to serve receptacle, lighting and equipment loads. Additional 208/120V panelboards located in the electrical room and IT room serve additional lighting and receptacle loads throughout the building. Much of the electrical distribution equipment, including the main switchboard, was reported to be replaced in 2005. Some panelboards, equipment disconnects, and other distribution equipment appear to be of earlier vintage.

Condition Assessment The electrical distribution equipment including the main switchboard and panelboards are installed indoors. No ongoing electrical maintenance program or testing of equipment and terminations was reported. An arc flash study was performed in 2013 and corresponding shock hazard labels applied to all distribution equipment.

The majority of the electrical equipment, including the main switchboard/MCC and several panelboards were replaced in 2005 and were noted to be in good condition. The emergency system 208/120V panelboard appeared to be installed in 1995 and is in fair condition.

Other Observations: The building main water and sewer lines were observed to be installed directly over the main switchboard/MCC within the code required dedicated equipment space and with no physical separation/protection. Foreign systems within this dedicated space such as these presents safety and system reliability concerns should a pipe leak on to live electrical equipment.

Element State: Fair

05.02.10 Secondary Switchgear – Event #1

Event Type	***Event Year***	***Event Cost***	***Priority***
Testing	2025	$5,000	High

Event Justification & Strategy

There is not currently an ongoing maintenance program or routine testing of electrical systems to ensure safe and properly functioning equipment. As equipment ages and reaches the end of its expected useful life, ongoing inspection and maintenance is vital in maintaining safe and proper functioning equipment. Testing of all equipment is recommended to include visual and infrared inspections, tightening of terminations as required, lubrication, cleaning of electrical equipment.

Implication of Even Deferral

Failure to maintain and inspect equipment can result in preventable equipment failure, power outages, and potential safety and/or fire hazards.

05.02.10 Secondary Switchgear – Event #2

Event Type	***Event Year***	***Event Cost***	***Priority***
Study	All	$5,000	High

Event Justification & Strategy

For any modifications made to the building electrical distribution, perform an updated system coordination study and arc flash analysis, and revised labeling provided on all equipment as required. Modifications to the electrical distribution system can impact the available fault currents and thus arc fault current at each piece of equipment.

Implication of Even Deferral

This is a code compliance safety issue.

Event Type	Event Year	Event Cost	Priority
Replace	2033	$50,000	Moderate

Event Justification & Strategy
Replace electrical distribution equipment, including panelboards, disconnect switches, circuit breakers, and other components installed prior to the 2005 renovation. This equipment has reached the end of their expected life span and should be replaced in the near future.

Implication of Event Deferral
A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.10 Secondary Switchgear – Event #4

Event Type	Event Year	Event Cost	Priority
Replace	2038	$100,000	Moderate

Event Justification & Strategy
The electrical distribution equipment in the building installed in 2005 will be nearing the end of their expected life span and should be considered for replacement in near future.

Implication of Event Deferral
A failure in electrical equipment, and/or proper functioning circuit breakers present safety and fire hazards should a breaker fail to clear a fault as intended.

05.02.20 Secondary Transformers
Description Step down 480V:208/120V, 3-phase transformers are provided to serve receptacle, lighting and equipment loads. The IT equipment is served via a dedicated transformer, as are emergency lighting and fire alarm loads.

Condition Assessment –The transformers in the building are of varying vintage and range from fair to good condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2033	$5,000	High

Event Justification & Strategy
The transformer serving the emergency lighting panelboard is nearing the end of its useful life and should be replaced to prevent failure of life safety equipment.

Implication of Event Deferral
Failure of transformer would result in loss of power to downstream loads, including life safety lighting.

05.02.40 Inverters
Description Two 30kVA Uninterruptible Power Supply (UPS) located in the IT room serving equipment racks.

Condition Assessment The UPS equipment appears to be in good condition and newly installed (exact installation date was not noted).

Element State: Good

05.02.60 Cabling, Raceway & Bus Ducts

05.02.10 Secondary Switchgear – Event #3

Description EMT, rigid, flexible metal, and non-metallic liquid-tight conduit, as well as gutter raceway, were observed in the main electrical room. It was reported that copper conductors are used throughout the building/campus.

Condition Assessment Equipment conduits observed in the electrical room appear to be in fair condition and of varying vintages based on age of equipment and associated feeder. Feeders/conductors were not readily visibly observable. The 480V conductors serving the building from the campus medium voltage distribution were reported to have been updated in the past 2-3 years and in good condition.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Test/Replace	2033	$40,000	High

Event Justification & Strategy
At the time of future equipment replacements, any feeders/conductors found to be original to the building shall be replaced with new. Existing conductors installed during the 2005 renovation proposed to be reused shall be megger tested to confirm there has not been any degradation or damage to the conductor insulation.

Implication of Event Deferral
Conductors with worn, frayed or damaged insulation present safety and fire hazards.

05.03 Lighting Fixtures

05.03.10 Interior Lighting

Description Interior lighting includes LED light fixtures in offices, corridors, and other finished spaces. Fluorescent lighting is provided in equipment rooms and back of house areas.

Condition Assessment Interior lighting is in good condition and has recently been upgraded throughout the occupied areas of the building. The lighting in equipment rooms and other non-public areas continues to utilize outdated fluorescent lighting technology. The fluorescent lighting is in fair condition, but at end of expected life span.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$5,000-10,000	Low

Event Justification & Strategy
Replace existing fluorescent lighting with new LED light fixtures. At time of lighting replacement, upgrade the lighting controls in respective areas to provide occupancy sensors for additional energy savings, as appropriate for use, functionality, and safety.

05.03.20 Exterior Lighting

Description Exterior lighting consist of LED canopy fixtures located under building overhang along perimeter of the building.

Condition Assessment Exterior lighting was recently replaced with the new LED fixtures in an exterior renovation in 2021 and is in good condition.

Element State: Good

05.03.40 Emergency Lighting

Description Emergency lighting is provided throughout the building via generator backup of interior and exterior light fixtures. Refer to previous Interior and Exterior lighting sections and 05.05.30 Emergency Power Systems for additional information.

Condition Assessment Emergency lighting is in good condition.

Element State: Good

05.05 Electrical Systems

05.05.30 Emergency Power Systems

Description: A 40kW diesel generator supplies emergency power to Snell Hall to serve emergency lighting, fire alarm, IT equipment and select HVAC equipment. This unit was reported to be installed in 1995 and serves emergency loads via an automatic transfer switch located in the main electrical room.

Condition Assessment The generator is installed in an exterior shelter located on the north side of the building. The generator is regularly tested as required for life safety requirements. The generator enclosure is missing side and end panels, making the internal components, and wiring susceptible to damage from the elements. Equipment appears to be in fair condition but is nearing the end of its expected useful life.

Element State: Fair

05.05.30 Emergency Power Systems – Event #1

Event Type	Event Year	Event Cost	Priority
Repair	2025	$5,000	High

Event Justification & Strategy

Provide new weatherproof enclosure for exterior generator to ensure all components and wiring are protected from the elements.

Implication of Event Deferral

Potential failure of generator which is a life safety issue.

05.05.30 Emergency Power Systems – Event #2

Event Type	Event Year	Event Cost	Priority
Replace	2033	$15,000	High

Event Justification & Strategy

The generator and ATS are nearing the end of their useful life and should be replaced to maintain reliable backup power. The current configuration does not meet code because it serves both IT equipment, HVAC equipment which serves that IT and also emergency lighting and fire alarms. IT will move to Boivin Hall in 2023, however, so this situation will resolve itself. At the time of generator replacement, since the load will be much smaller, an emergency lighting inverter should be implemented to address life safety requirements. This will draw power from the campus grid and eliminate the use of fossil fuel for backup, with associated diesel engine testing and maintenance costs.

Implication of Event Deferral

Potential failure of generator which is a life safety issue.

15 Year Expected Building Repair Replacement Costs

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
04.01.040	Heat Exchangers	Replace	$12,000			$12,000		
04.01.160	Central Station AHU	Refurbish	$50,000			$50,000		
04.01.190	Terminal Units	Replace	$65,000			$65,000		
04.01.240	Exhaust fans	Replace with ERVs	$30,000			$30,000		
04.03	Plumbing - Water Heater	Replace	$50,000			$50,000		
04.03	Plumbing - Fixtures	Replace	$50,000			$50,000		
05.02.10	Secondary Switchgear	Event #1 - Testing	$5,000			$5,000		
		Event #2 - Arc Flash & Coordination	$5,000			$5,000		
		Event #3 - Replace Panels		$50,000		$50,000		
		Event #4 - Replace switchgear			$100,000	$100,000		
05.02.20	Transformers	Replace	$5,000			$5,000		
05.02.60	Cable, Raceway a& Bus Ducts	Test/Replace		$40,000		$40,000		
05.03.10	Interior Lighting	Replace	$10,000			$10,000		
05.05.30	Emergency Power Systems	Event #1 - Replace genset enclosure	$5,000			$5,000		
		Event #2 - Replace genset & ATS		$15,000		$15,000		
							24,375 SF	
							$600/SF	
Totals			$287,000	$105,000	$100,000	$492,000	$14,625,000	0.034

Athletics Building

02 Architectural - General

The Athletics Building is a steel and concrete structure. The roof framing consists of steel wide flange (WF) beams and metal decking. The floor framing consists of WF beams supporting a reinforced concrete slab. The basement floor is a reinforced concrete slab-on-grade. Four stair wells, constructed with reinforced concrete walls, provide the primary roof bearings. First floor bearings are provided by interior concrete basement walls and columns.

02 Architectural & Structural
02.01 Foundations
02.01.10 Footings & Foundations

Description The main emergency egress from the second floor gymnasium is on the north side over a concrete bridge spanning a driveway at the ground level.

Condition Assessment The bridge, located at the north side of the building, was observed to be exhibiting signs of significant freeze/thaw moisture damage.

Figure 1: Bridge Corrosion at top surface

Figure 2: Concrete Deterioration at underside, exposing rebar

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Repair	2025	$375,000	High

Event Justification & Strategy Damage is probably due to 60 years of salt application for snow melting. The bridge must be kept clear for egress from athletic events in the gymnasium. The bridge should be examined with non destructive testing to determine the extent of rebar corrosion. If not excessive, the bridge can be patched and repaired. However, highly rusted guard rails should be replaced. In addition, an electric snowmelt system should be added under a 2" topping slab. This will keep the exit way clear in winter without use of corroding salt. If rebar corrosion is extensive, the bridge should be replaced with either a new bridge or stairs to the driveway at ground level.

02.01.11 Footings & Foundations

Description Access ramp retaining walls at the west side of the building.

Condition Assessment Vertical and horizontal cracks were observed on the access ramp retaining walls at the west side of the building. Additionally, a small amount of surface moisture damaged was also observed on interior basement walls below glazing units.

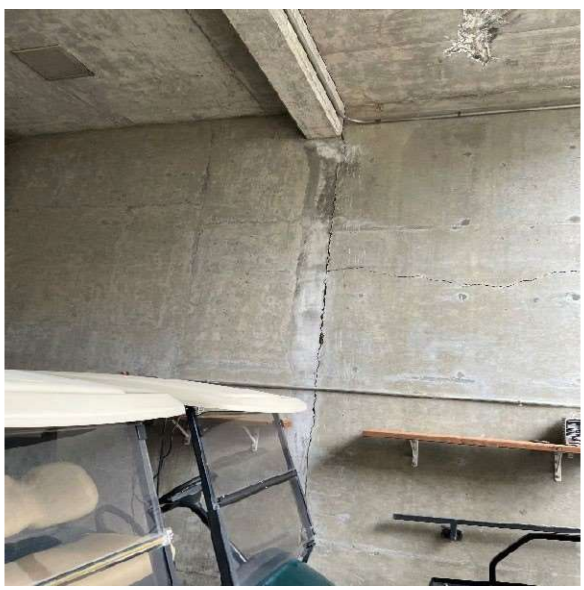


Figure 3: Retaining Wall Vertical Crack

Element State: Good

Event Type	Event Year	Event Cost	Priority
Repair	2025	$5,000	Low

Event Justification & Strategy Apply a concrete repair mortar to seal existing cracks and prevent water intrusion.

02.04 Roofing

Description The athletics building has 60 mil EPDM roof installed in 1986.

Condition Assessment Facilities staff report that the condition is poor but that there are no leaks yet. A roof of this age – almost 40 years old - can be expected to start leaking soon.

Element State: Poor

Event Type	*Event Year*	*Event Cost*	*Priority*
Repair	2025	$316,000	High

Event Justification & Strategy Replace existing roof with new 60 mil EPDM or TPO. Roof of this age will start to deteriorate and leak.

1. Mechanical Executive Summary

The mechanical systems in the athletics building consist of Energy Recovery Ventilators and variable refrigerant direct expansion systems. Heating hot water is provided by a plate and frame heat exchanger connected to the campus geo-thermal system.

All mechanical equipment has been recently updated and replaced with new equipment in the last 2-3 years. Provided regular routine maintenance of equipment, all equipment should last beyond 15 years before needing replacement.

04 Mechanical

04.01 HVAC

04.01.040 (HW/S) Heat Exchangers

Description Heat Exchanger connected to campus geothermal system provides heating hot water for the building.

Condition Assessment Equipment is at the beginning of its useful life.

Element State: Good

04.01.100 DX Split AHU - Cooling

Description Multi-zone variable refrigerant systems provide heating/cooling to the office and administration spaces.

Condition Assessment Equipment is at the beginning of its useful life.

Element State: Good

04.01.160 Central Station AHU

Description A central energy recovery air handling unit provides the heating, cooling and ventilation to the areas not served by the VRF system; these spaces include locker room areas and the arena areas.

Condition Assessment Equipment is at the beginning of its useful life.

Element State: Good

04.01.180 HVAC Pumps

Description Central pumps circulate heating hot water from the geo-thermal heat exchanger throughout the building to provide the necessary heating.

Element State: Good

Event Type	Event Year	Event Cost	Priority
Replace	2038	$29,000	Medium

Event Justification & Strategy
Efficiency losses and maintenance costs will eventually outweigh replacement costs as units age. Associated costs include replacement of both indoor and outdoor units plus all related refrigerant and drain piping. Units installed in 2000. Maximum unit life is 20 years.

Implication of Event Deferral Each unit serves a single zone. When these units fail, the zone will not have either cooling or ventilation air capabilities.

04.01.130 Window A/C Unit - Heating & Cooling
Description 11 separate units at varying ages, none of which is newer than five years old.

Condition Assessment Most window units are at the end of their economic life and are in need of replacement.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Study	2025	$11,000	High

Event Justification & Strategy
These units were added for supplemental cooling and have a relatively short economic life. Their replacement is not recommended due to efficiencies now required for code compliance. The building HVAC system should be reviewed to determine why supplemental cooling is needed, and the correction should be made at the building wide level. Possibly the solution could be as simple as rebalancing, but a study is needed to diagnose the underlying problem.

Implication of Event Deferral Partial loss of cooling in local zone when unit fails.

04.01.170 Heating & Cooling Piping Systems
Description Old and/or original and heating water piping - black steel. Heating water piping and control valves serve radiator units at building windows.

Condition Assessment Heating water mains are at the end of their economic life and are in need of replacement. Branch connections and control valves are in fair condition.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2025	$350,000	Medium

Event Justification & Strategy
The replacement and upgrading of original heating water mains will force the shut down of the entire building service.

Implication of Event Deferral If a failure occurs in piping mains, the entire building system may require shut down depending on the main riser locations

Condition Assessment Equipment is at the beginning of its useful life.

Plumbing Executive Summary

The Athletics Building is a mixture of newer and original plumbing fixtures. The water source to the building's non-potable with point-of-use filters where potable water is required. Central hot water is provided for most of the building using storage tanks and circulation pumps connected to plate and frame heat exchangers connected to the campus geo-thermal system.

04Plumbing

04.03 Plumbing Systems

Water, Sanitary, and Storm Piping

Description:

Water Piping: the building water supply is served by what appears to be a 3" copper line. Water piping appears to be primarily fiberglass-wrapped copper piping.

Sanitary Piping: only a small portion of the sanitary waste and vent piping was able to be directly observed, piping appears to be cast iron bell and spigot with lead and oakum joints. There is also a sanitary sump pump located in the basement that pumps up to the ground floor gravity sanitary system.

Storm Piping: Only a small portion of the storm piping was able to be directly observed and it appears to be cast iron. There is also a storm drain sump pump in the basement.

Condition Assessment: Portions of copper piping that were able to be observed appear to be in decent condition. Copper pipe, depending on water quality typically lasts between 70 and 80 years. Portions of the sanitary waste piping that were able to be observed appear to be in decent condition with some signs of past leaks. Cast Iron pipe can last between 50 and 75 years depending on water quality and climate. A large portion of the plumbing was replaced around 2018 and looks to be in good condition. The remainder of the facility looks to be original.

Element State: Good*

Recommendations and Additional Observations

It is recommended that water, sanitary, and storm lines be scoped to assess the internal condition of the pipe to get a better idea of life expectancy.

Water Heaters

Description: Central hot water is provided for most of the building using storage tanks and circulation pumps connected to plate and frame heat exchangers connected to the campus geo-thermal system.

Condition Assessment Equipment appears to be from 2018 and is in good working order.

Element State: Good

Water Filtration

Description site domestic water is not suitable for consumption, where potable water is required fixtures have been provided with point-of-use cartridge style water filters.

Condition Assessment Equipment appears to be being serviced regularly and all filters have dates when the last filter was installed.

Plumbing Fixtures

Description Plumbing fixtures on the first floor have largely been replaced with sensor-operated flush valves and updated sinks, faucets, and drinking fountains. Plumbing fixtures in the rest of the building and locker rooms appear to be original with water closets and urinals having their manual flush valves. Gang showers in the locker rooms show significant corrosion, wear, and some leak. Additionally, it looks like the tile floor was sealed with some type of epoxy at some point that is now starting to peal.

Condition Assessment Some of the stops/ shutoff valves on upper floors at some of the fixtures are showing signs of corrosion the fixtures themselves appear to be in serviceable condition.

Element State: First floor Good, original fixtures Fair.

Electrical Executive Summary

The Athletics Building electrical systems consists of 480/277V and 208/120V electrical distribution equipment of varying vintage to serve building loads. Normal and emergency power systems serve the building, with a standby natural gas generator providing emergency power to egress lighting and fire alarm loads, in addition to a central lighting inverter. The building programming has undergone several renovations since originally constructed in 1964 and includes electrical equipment of varying vintages and condition to serve the fitness center, locker rooms, and the main basketball gymnasium spaces.

05 Electrical

05.02 Secondary Electrical

05.02.10 Secondary Switchgear

Description: The Athletics Building is served via a 600A, 480/277V, electrical service to a main switchboard in the basement main electrical room. The main switchboard serves mechanical equipment, lighting panelboards, and a step-down transformers to multiple 208/120V panelboard. The 208/120V panelboards serve receptacle and equipment loads.

The main switchboard and 208/120V distribution panel were replaced in 2020. A new panelboard to serve the concessions and office space at the second floor gym area was added in 2022. The remainder of the electrical distribution equipment, including panelboards, equipment disconnects, and other distribution equipment appear to be of varying vintage ranging from 1964 (original building construction) to 2003 when the building was renovated for a fitness center addition.

Condition Assessment The building electrical distribution equipment, including the main switchboard and panelboards, are installed indoors. No ongoing electrical maintenance program or testing of equipment and terminations was reported. An arc flash study was performed in 2013 and corresponding shock hazard labels applied to all distribution equipment.

The main switchboard and 208/120V distribution panel installed in 2020 are relatively new and were noted to be in good condition. The equipment of earlier vintage, including distribution panel GM1, branch circuit panelboards, equipment disconnects, and motor starters have exceeded their useful life and were noted to be in poor to fair condition.

Other Observations: Significant amounts of piping were observed to be installed directly over the ATS, emergency panelboard, and fire alarm equipment. This piping is located within the code required dedicated equipment space and with no physical separation/protection. Foreign systems within this dedicated space such as these presents safety and system reliability concerns should a pipe leak on to live electrical equipment.

Element State: Good
Element State: Poor-Fair

05.02.10 Secondary Switchgear – Event #1

Event Type	***Event Year***	***Event Cost***	***Priority***
Testing	2025	$5,000	High

Event Justification & Strategy
There is not currently an ongoing maintenance program or routine testing of electrical systems to ensure safe and properly functioning equipment. As equipment ages and reaches the end of its expected useful life, ongoing inspection and maintenance is vital in maintaining safe and proper functioning equipment. Testing of all equipment is recommended to include visual and infrared inspections, tightening of terminations as required, lubrication, cleaning of electrical equipment.

Implication of Event Deferral
Failure to maintain and inspect equipment can result in preventable equipment failure, power outages, and potential safety and/or fire hazards.

05.02.10 Secondary Switchgear – Event #2

Event Type	***Event Year***	***Event Cost***	***Priority***
Study	All	$5,000	High

Event Justification & Strategy
For any modifications made to the building electrical distribution, perform an updated system coordination study and arc flash analysis, and revised labeling provided on all equipment as required. Modifications to the electrical distribution system can impact the available fault currents and thus arc fault current at each piece of equipment.

Implication of Even Deferral
This is a code compliance safety issue.

05.02.10 Secondary Switchgear – Event #3

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$50,000	High

Event Justification & Strategy
Replace remaining original electrical equipment, which is nearly 60 years old.

05.02.60 Cabling, Raceway & Bus Ducts
Description EMT, flexible metal conduit, and gutter raceway were observed in the main electrical room. It was reported that copper conductors are used throughout the building/campus.

Condition Assessment Equipment conduits observed in the electrical room appear to be in fair condition and of varying vintages based on age of equipment and associated feeder. Feeders/conductors were not readily visibly observable. The 480V building service conductors serving the building from the campus medium voltage distribution were reported to have been updated in the past -1-2 years and are in good condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Test/Replace	2025	$40,000	High

Event Justification & Strategy
At the time of electrical equipment replacements, any feeders/conductors found to be original to the building shall be replaced with new. Existing conductors installed during the 2003 renovation proposed to be reused shall be megger tested to confirm there has not been any degradation or damage to the conductor insulation.

Implication of Event Deferral
Conductors with worn, frayed or damaged insulation present safety and fire hazards.

05.02 Lighting Fixtures
05.03.10 Interior Lighting
Description Interior lighting includes LED light fixtures in the fitness center area, mechanical rooms, lobby, and over the basketball court. Fluorescent light fixtures in locker rooms have been retrofitted with LED tubes. Additionally, the lighting over the bleacher areas at the second-floor basketball court are fluorescent fixtures. Occupancy sensors control lighting in the lobby and office areas, and lighting in the gym and locker room areas is controlled by wall switches

Condition Assessment Interior LED lighting is in good condition and has recently been upgraded throughout the fitness center, basketball court, lobby, offices, and mechanical areas. The lighting in the locker rooms and over the bleacher areas utilize fluorescent fixtures that are in fair condition, but at end of expected life span.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$25,000	Low

Event Justification & Strategy
Replace existing fluorescent lighting with new LED light fixtures.

05.03.20 Exterior Lighting
Description Exterior lighting consist of LED fixtures located under building overhang.

Condition Assessment Exterior lighting appears to be LED fixtures and in good condition.

Element State: Good

05.03.40 Emergency Lighting
Description Emergency lighting is provided throughout the building via generator backup and central lighting inverter. Refer to previous Interior and Exterior lighting sections, 05.02.40 Inverters, and 05.05.30 Emergency Power Systems for additional information.

Condition Assessment Emergency lighting is in good condition.

Element State: Good

05.05 Electrical Systems
05.05.30 Emergency Power Systems
Description: A 20kW natural gas generator supplies emergency power to the Athletics Building to primarily serve emergency lighting and fire alarm loads. This generator was installed in 2009 and serves emergency loads via an automatic transfer switch located in the main electrical room.

Condition Assessment: The open genset is installed in the main electrical room. The generator is regularly tested as required for life safety requirements. The generator appears to be in fair condition.

Element State: Fair

15 Year Expected Building Repair Replacement Costs

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
02.01.010	Concrete Structure	Replace bridge at north egress	$120,000					
02.01.011	Exterior walls	Seal concrete joints	$5,000					
02.04	Roofing	Replace	$316,000					
04.01.130	Window AC Units	Remove & Reconfigure HVAC	$11,000					
04.01.170	HVAC piping	Replace	$350,000					
05.02.10	Secondary Switchgear	Event #1 - Testing	$5,000					
		Event #2 - Arc Flash & Coordination	$5,000					
		Event #3 - Replace	$50,000					
05.02.20	Transformers	Replace	$25,000					
05.02.60	Cable, Raceway & Bus Ducts	Test/Replace	$40,000					
05.03.10	Interior Lighting	Replace	$25,000					
							$51,760	
							$600/SF	
Totals			$952,000	$0	$0	$952,000	$31,056,000	0.031

Utilities Infrastructure

Property

01.01 Site

01.01.10 Underground Utilities

Underground utilities including all pipes, fittings, risers to grade, and buried structures for domestic/fire water, geothermal, sanitary sewer, and storm drain.

01.01.10.10 Wells

Description Multiple wells on site

Condition Assessment: Recent rehab of well #1 including replacement of pump. Recent rehab of well #4 which is used for irrigation. No additional items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

01.01.10.11 Water Pipe Systems

Description All water pipes throughout campus. Size and material vary.

Condition Assessment: Discussions with OT Facilities indicate that a connection to the City water system near the southeast corner of the property would be helpful in the event of emergency. No additional items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	Event Year	Event Cost	Priority
New	2025	$25,000	Low

Event Justification & Strategy

Coordination with City Public Works required.

01.01.10.20 Geothermal Wells

Description By others

Condition Assessment: No items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

01.01.10.21 Geothermal Pipe Systems

Description All geothermal pipes throughout campus. Size varies.

Condition Assessment: Replacement of existing supply and return main lines should be completed at time of Lot A/B replacement. No additional items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

01.01.10.22 Geothermal Snowmelt Systems
Description All snowmelt mains and under-sidewalk tubing throughout campus. Size varies.

Condition Assessment: OT Facilities indicated that there are areas of sidewalk which have tubing under the concrete but do not have service supply/return. Expansion of existing snowmelt systems desired in areas of heavy pedestrian traffic. No additional items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.10.30 Stormwater Structures
Description All catch basins and area drains throughout campus. Size and materials varies.

Condition Assessment: Scoping required to determine if basin near the southeast corner of Owens Hall currently discharges to the storm drain or sanitary sewer system. If line drains to sanitary sewer, the pipe must be capped and a connection to the adjacent storm drain line must be installed. No additional items of interest or problems identified by OT Facilities. All storm infrastructure within parking lots should be assumed to be replaced at time of construction – applicable only to lots with full replacement.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Investigation	2025	$5,000	Low

Event Justification & Strategy
Coordinate scoping of line with local plumbing contractor.

01.01.10.31 Stormwater At-Grade Conveyance & Detention Facilities
Description All rocky conveyance swales, roadside ditches, and detention ponds throughout campus. Size and materials varies.

Condition Assessment: No items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.10.32 Stormwater Pipe Systems
Description All storm drain piping throughout campus. Size and materials varies.

01.01.10.32.01 Dobs Way Storm Main
Description Storm drain main line running north to south along east side of Dobs Way; size varies 12"-18", approximately 600 lineal feet of pipe.

Condition Assessment: Problems with pipe known to OT Facilities; replacement requested.

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Replacement	2025	$75,000	Medium

Event Justification & Strategy
Coordinate work with repaving of Dobs Way.

01.01.10.32.02 Campus Way/Dan O'Brien Storm Main
Description Storm drain main line pipes running east to west south of Boivin Hall; 36" to 48" typical, approximately 450 lineal feet of pipe.

Condition Assessment: Problems with pipe known to OT Facilities; replacement requested.

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Replacement	2025	$110,000	Medium

Event Justification & Strategy
Coordinate work with replacement of Campus Way crossings or provide stubs for future connection of crossings.

01.01.10.32.03 Campus Way Storm Main Crossing (east)
Description Storm drain main line pipes running southeast to northwest from Lot D to existing storm main; 18" typical, approximately 125 lineal feet of pipe.

Condition Assessment: Problems with pipe known to OT Facilities; replacement requested.

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Replacement	2025	$15,000	Medium

Event Justification & Strategy
Coordinate work with replacement of Campus Way main line.

01.01.10.32.04 Campus Way Storm Main Crossing (west)
Description Storm drain main line pipes running southeast to northwest from Lot D to existing storm main; 36" typical, approximately 175 lineal feet of pipe.

Condition Assessment: Problems with pipe known to OT Facilities; replacement requested.

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Replacement	2025	$35,000	Medium

Event Justification & Strategy
Coordinate work with replacement of Campus Way main line.

01.01.10.32.05 Parking Lot A/B Storm Main
Description Storm drain main line pipes running east to west along north side of main drive aisle; 18" typical, approximately 750 lineal feet of pipe.

Condition Assessment: Problems with pipe known to OT Facilities; replacement requested.

Element State: Poor

Event Type	***Event Year***	***Event Cost***	***Priority***
Replacement	2025	$95,000	Medium

Event Justification & Strategy
Coordinate work with replacement of Parking Lots A/B and provide capacity for new residence hall currently in early stages of design.

01.01.10.32.06 Geothermal Building Storm Culvert
Description Storm drain culvert running east to west near southeast corner of geothermal building.

Condition Assessment: Problems with pipe known to OT Facilities; replacement requested.

Element State: Poor

Event Type	***Event Year***	***Event Cost***	***Priority***
Replacement	2025	$30,000	Medium

Event Justification & Strategy
Replacement required.

01.01.10.40 Sanitary Sewer Structures
Description Sanitary sewer meter, vault, and solar power connection south of Boivin Hall. C

Condition Assessment: City of Klamath Falls installed a meter within the last a couple of years but was inaccurately recording flows resulting in steep bill increases. OT solicited an analysis and recommendations report from HPH Engineers. As a result of the report findings and subsequent conversations between OT and City, OT purchased a new meter and vault to be installed upstream of the City meter system; this work is slated for construction before March 2023.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.10.41 Sanitary Sewer Pressure Pipe Systems
Description All sanitary sewer pressure pipes throughout campus. Size varies.

Condition Assessment: No items of interest or problems identified by OT Facilities; all sewer pumps understood to be located within building footprints and therefore covered under different scope.

Element State: Good

01.01.10.42 Sanitary Sewer Gravity Pipe Systems
Description All sanitary sewer gravity pipes throughout campus. Size varies.

Condition Assessment: Recent replacement of sanitary sewer service for CU to be routed around exterior of the building as part of Marquess storm improvements on campus. No additional items of interest or problems identified by OT Facilities.

Element State: Good

01.01.11 Aboveground Utilities
Aboveground utilities including all storage tanks and water facilities.

01.01.11.10 Water Storage Tanks
Description Above ground corrugated steel 100,000-gal storage tank near northeast corner of property

Condition Assessment: Storage tank in need of rehab/replacement. Per Mark Miller assessment report, the top 10-ft of the existing tank and roof require replacement, the bottom of the tank can be welded to rehab. Requires complete drain of the system.

Element State: Poor

Event Type	Event Year	Event Cost	Priority
Rehab/Replace	2024	$75,000	High

Event Justification & Strategy
OT has already solicited and received a report for assessment of the existing storage tank. Per the report, the tank is in poor condition and necessitates partial rehab/partial replacement soon. A temporary storage tank would need to be procured for use during the primary tank's rehab.

01.01.11.11 Fire Hydrants
Description All private fire hydrants throughout campus.

Condition Assessment: No items of interest or problems identified by OT Facilities.

Element State: Good

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

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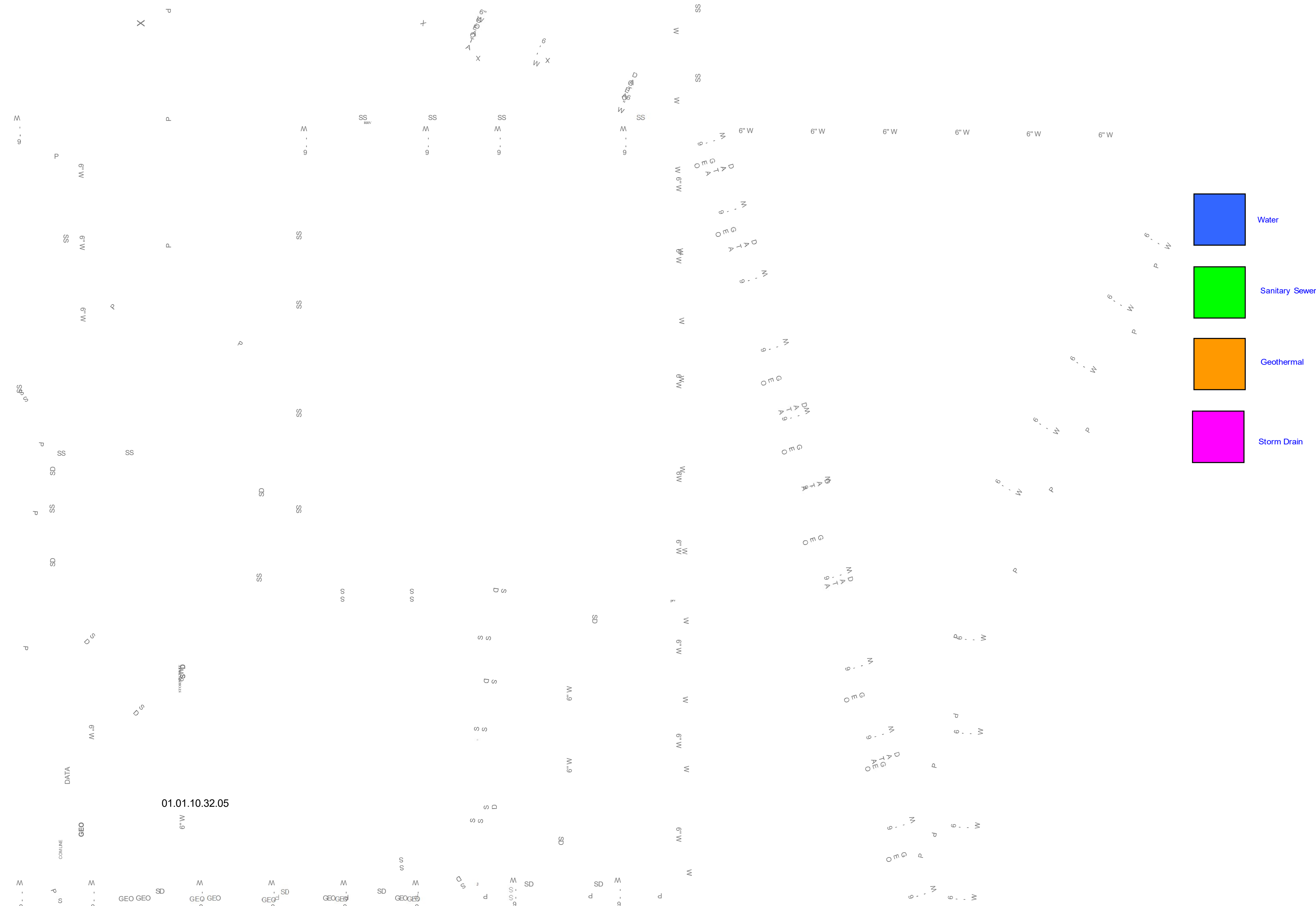
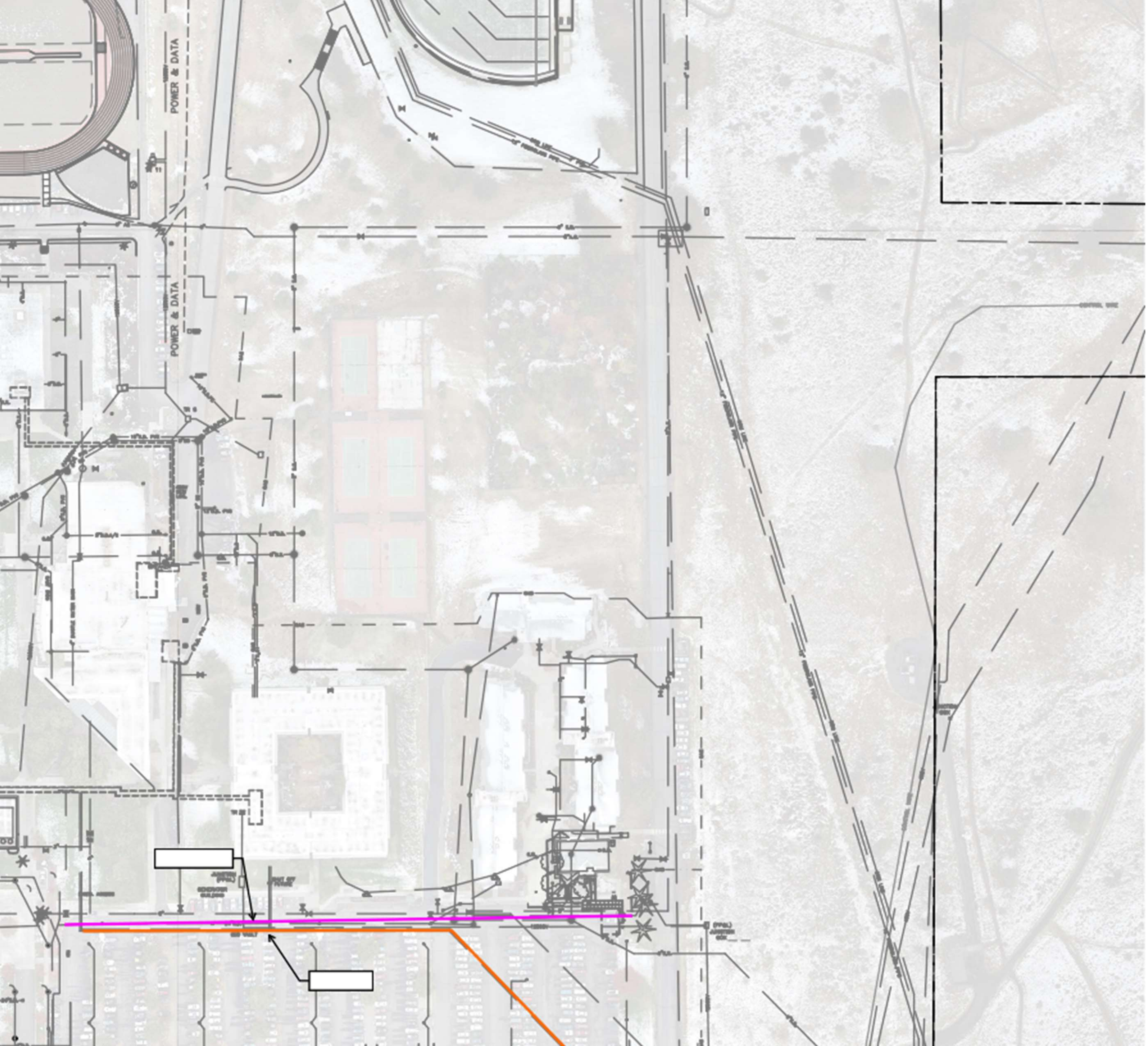
OIT FACILITIES MASTER PLAN

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01 Property
01.01 Site
01.01.14 Site Related Stairs
Stairs have been named based on location and proximity to adjacent parking lots and/or buildings. Each stair is understood to include concrete cheek walls, concrete stairs, concrete landings and handrails.

01.01.14.01 Yates Drive to Softball Field
Description See map.

Condition Assessment: Monumental concrete stair configuration in good condition. Limited rust staining visible at handrail connection to cheek walls.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.02 E University Drive to Sustainable Village (north)
Description See map.

Condition Assessment: Monumental concrete stair configuration in good condition. No cracking or rust staining at handrails.

Element State: Excellent

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.03 E University Drive to Sustainable Village (south)
Description See map.

Condition Assessment: Monumental concrete stair configuration in good condition. No cracking or rust staining at handrails.

Element State: Excellent

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.04 Sustainable Village (north)
Description See map.

Condition Assessment: Small concrete stair configuration in good condition. No cracking or rust staining at handrails.

Element State: Excellent

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.05 Sustainable Village (south)
Description See map.

Condition Assessment: Small concrete stair configuration in good condition.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.06 Student Health Center (west)
Description See map.

Condition Assessment: Large staircase in good condition. No staining visible at handrails.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.08 Residence Hall (east)
Description See map.

Condition Assessment: Large switchback stair configuration at building; drainage issues and ponding water present, staircase in poor condition. Large monumental stair configuration to adjacent fire lane; in good condition, limited cracking.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$100,000	Medium

Event Justification & Strategy
While the stairs leading to the fire lane are in serviceable condition, the switchback configuration at the building warrants replacement and widening to meet current egress standards. Anticipated changes to the switchback configuration will necessitate full replacement of the entire stair configuration. Extensive retaining walls and excavation and/or shoring will increase replacement cost expected for a more standard stair replacement.

01.01.14.09 Residence Hall (west)
Description See map.

Condition Assessment: Double width monumental stair configuration adjacent to concrete ramp. Minimal cracking and rust staining at handrails.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.10 Lot 'L' to College Union (north)
Description See map.

Condition Assessment: Small concrete stair configuration in good condition. No cracking or rust staining at handrails.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.11 Lot 'L' to College Union (south)
Description See map.

Condition Assessment: Double width monumental stair configuration adjacent to concrete ramp. Minimal cracking and rust staining at handrails.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.12 College Union (south)
Description See map.

Condition Assessment: Two large staircase configurations immediately adjacent to one another. Northerly configuration is roughly triangular and leads up to CU, southerly configuration leads to plaza at lower level of CU. Both are in good condition with normal wear and tear.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.13 College Union (northwest)
Description See map.

Condition Assessment: Two double width multi-tiered monumental stair configurations. North configuration is in poor condition and warrants replacement. The south configuration is in good condition with normal wear and tear.

Element State: Poor (north only)

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$40,000	Medium

Event Justification & Strategy
Location at CU and extensive daily foot traffic warrants replacement. Replace in kind.

01.01.14.14 College Union (southwest, 2-pair)
Description See map.

Condition Assessment: Large staircase in good condition. No staining visible at handrails.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.15 Lot 'L' to Athletics
Description See map.

Condition Assessment: Large staircase in good condition. No staining visible at handrails.

Element State: Good

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

01.01.14.16 Lot 'N' to Athletics
Description See map.

Condition Assessment: Large staircase in good condition. No staining visible at handrails.

Element State: Good

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

01.01.14.17 Athletics (west)
Description See map.

Condition Assessment: Condition Assessment: Large staircase in fair condition. Some cracking in concrete and rust staining at the handrails.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2035	$30,000	Low

01.01.14.18 Athletics to LRC
Description See map.

Condition Assessment: Condition Assessment: Small staircase in fair condition. Some cracking in concrete and rust staining at the handrails.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2035	$15,000	Low

01.01.14.19 Lot 'K' to LRC (east)
Description See map.

Condition Assessment: Condition Assessment: Large staircase in fair condition, adjacent to switchback ramp. Some cracking in concrete and rust staining at the handrails. Recommend concurrent ramp configuration replacement.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Replace	2030	$30,000	Low

01.01.14.20 Lot 'K' to LRC (west)
Description See map.

Condition Assessment: Condition Assessment: Large staircase in poor condition. Significant cracking in concrete and rust staining at the handrails.

Element State: Poor

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$25,000	Medium

Event Justification & Strategy
Stairs are located within the dripline of a large mature deciduous tree; roots may be partially to blame for the concrete failure. Recommend reviewing conditions and viability of tree with an arborist prior to replacement. May warrant relocation of stairs to the west, outside the dripline of the tree.

01.01.14.21 Lot 'K' to Cornett
Description See map.

Condition Assessment: Large monumental stair configuration in fair condition. Normal wear and tear, with some cracking.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2030	$20,000	Low

Event Justification & Strategy
Stairs are in serviceable condition but warrant replacement within the next 10 years based on anticipated lifespan of existing stairs.

01.01.14.22 Lot 'H' to Lot 'I'
Description See map.

Condition Assessment: Small staircase configuration in excellent condition.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.23 Cornett (north)
Description See map.

Condition Assessment: Small staircase configuration in good condition.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.24 Lot 'G' to Cornett
Description See map.

Condition Assessment: Small staircase configuration in good condition.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.25 Lot 'Q' to Lot 'H'
Description See map.

Condition Assessment: Small staircase configuration in excellent condition.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.26 CEET (south)
Description See map.

Condition Assessment: Small double width staircase configuration in excellent condition.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.27 Purvine (south)
Description See map.

Condition Assessment: Large staircase configuration in good condition.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.14.28 Owens to Semon (2-pair)
Description See map.

Condition Assessment: Pair of two small staircases with handrails. Both stairs are in fair condition.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2030	$10,000 (each)	Low

01.01.14.29 Central Pedestrian Corridor (west)
Description See map.

Condition Assessment: Double width small staircase in fair condition. Normal wear and tear.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2030	$15,000	Low

01.01.14.30 LRC to Central Pedestrian Corridor
Description See map.

Condition Assessment: Small staircase in good condition.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.31 Central Pedestrian Corridor (east)
Description See map.

Condition Assessment: Double width small staircase in fair condition. Normal wear and tear.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2030	$15,000	Low

01.01.14.32 Owens to Quad (4-pair)
Description See map.

Condition Assessment: Four small staircases, all in similar good condition.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.33 Quad toward DOW
Description See map.

Condition Assessment: Medium staircase in good condition.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.34 Dobs Way to Semon/Boivin Plaza (2-pair)
Description See map.

Condition Assessment: 2 separated small width staircases in excellent condition.

Element State: Excellent

01.01.14.35 Dobs Way to Boivin
Description See map.

Condition Assessment: Medium staircase configuration in good condition.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.36 Campus Circle to DOW
Description See map.

Condition Assessment: Double width medium stair configuration in good condition.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.37 Owens to Snell
Description See map.

Condition Assessment: Monumental stair configuration with intermediate landing in good condition. Limited cracking and staining at handrails.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.38 Snell (north)
Description See map.

Condition Assessment: Medium stair configuration in good condition. Limited cracking and staining at handrails.

Element State: Good

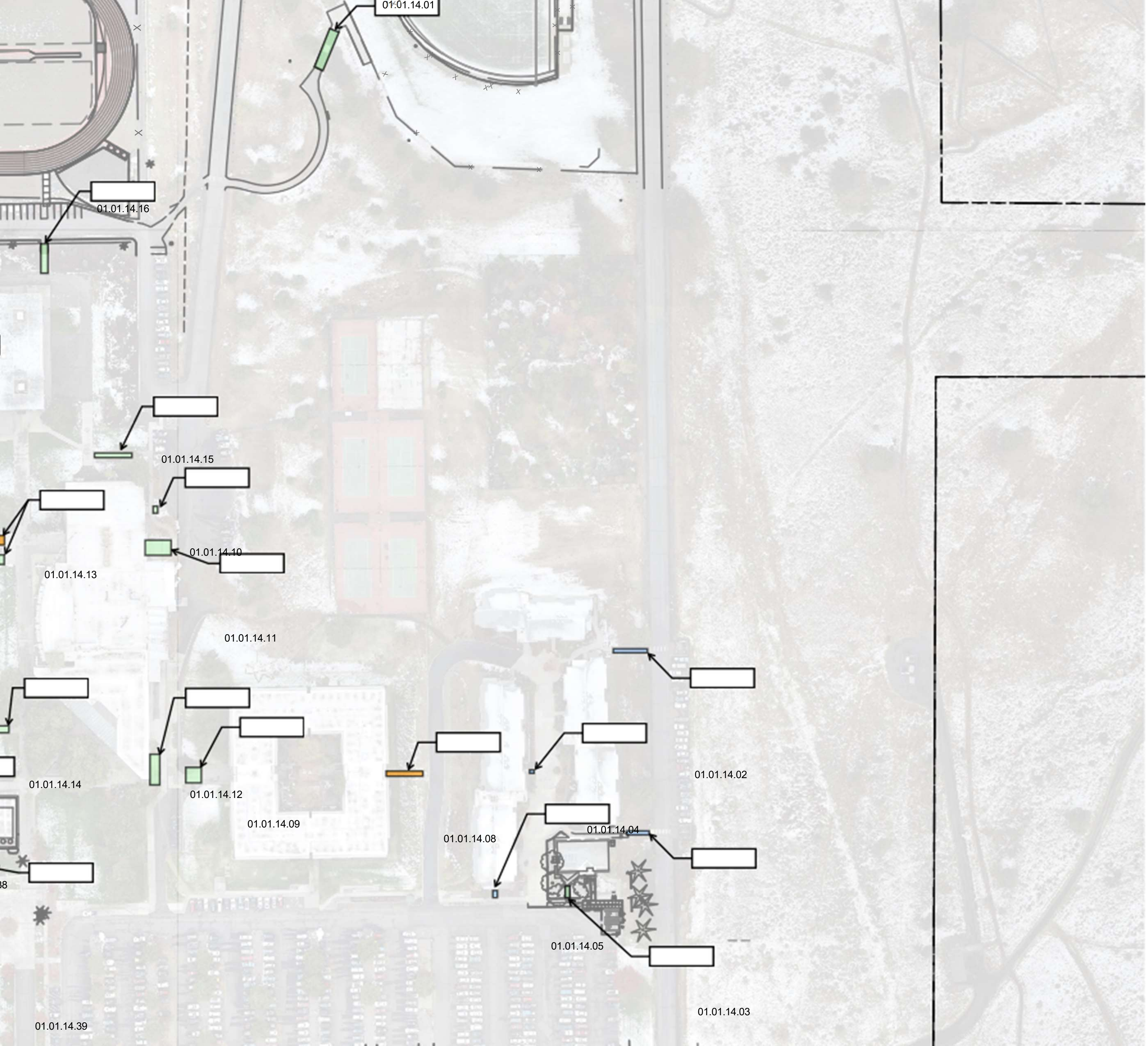
Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.14.39 Campus Circle to Snell
Description See map.

Condition Assessment: Medium stair configuration in good condition. Limited cracking and staining at handrails.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A



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Excellent

Good

Fair

Poor

Failed

01 Property
01.01 Site
01.01.17 Site Improvements (Ramps)

Ramps have been named based on location and proximity to adjacent parking lots and/or buildings. Each ramp is understood to include concrete cheek or retaining walls, concrete ramp surface, concrete landings, and handrail/guardrail.

01.01.17.01 Athletics

Description See map.

Condition Assessment: Switchback (2 runs) concrete ramp configuration in poor condition. Significant cracks on ramp and landings. Currently blocked. Event # 02.01.10 recommends replacement of the adjacent bridge to the egress doors of the Athletics Building. Rather than replace this switchback ramp, the new bridge should be configured with a slope so as to avoid the need for a ramp.

Element State: Failed

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2025	$0	High

Event Justification & Strategy

Ramp is in failed condition and unsafe for student use but cost is assigned to rebuilding of the bridge.

01.01.17.02 LRC

Description See map.

Condition Assessment: Switchback (3 runs) concrete ramp configuration in fair condition. Area gets little sunlight so snow sits on the ramp for extended periods; signs of pooling water.

Element State: Fair

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2030	$90,000	Medium

Event Justification & Strategy

Recommend snowmelt under new ramp configuration.

01.01.17.03 College Union (northeast-a)

Description See map.

Condition Assessment: Straight concrete ramp configuration in good condition. Signs of grass at panel joints, otherwise minimal cracking.

Element State: Good

Event Type	*Event Year*	*Event Cost*	*Priority*
Replace	2035	$30,000	Low

01.01.17.04 College Union (northeast-b)

Description See map.

Condition Assessment: Curved concrete ramp configuration in good condition. Minimal cracking.

Event Type	*Event Year*	*Event Cost*	*Priority*
N/A	N/A	N/A	N/A

01.01.17.05 College Union (southeast)
Description See map.

Condition Assessment: Building tight straight concrete ramp configuration in fair condition. Minimal cracking but edges are spalling and exposing rebar.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Repair	2025	$20,000	Medium

01.01.17.06 Residence Hall (west)
Description See map.

Condition Assessment: L-shaped (2 runs) concrete ramp configuration in good condition. Minimal cracking.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.17.07 Residence Hall (south)
Description See map.

Condition Assessment: Switchback (2 runs) concrete ramp configuration in good condition. Minimal cracking.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.17.08 Sustainable Village
Description See map.

Condition Assessment: Building tight straight concrete ramp configuration in good condition. Minimal cracking.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.17.09 Boivin Hall
Description See map.

Condition Assessment: Switchback (2 runs) concrete ramp configuration in poor condition with areas of failing retaining wall (leaning).

Element State: Poor

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$75,000	High

Element State: Good
Event Justification & Strategy
Replacement understood to be part of Boivin Hall renovation project currently under construction.

01.01.17.10 Semon Hall
Description See map.

Condition Assessment: Straight concrete ramp configuration in fair condition. Area gets little sunlight so snow sits on the ramp for extended periods; signs of pooling water.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2030	$25,000	Medium

Event Justification & Strategy
Recommend snowmelt under new ramp configuration.

01.01.17.11 Central Fire Lane (west)
Description See map.

Condition Assessment: Straight concrete ramp configuration in good condition. Minimal cracking.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.17.12 LRC/Owens (north)
Description See map.

Condition Assessment: Straight concrete ramp configuration in good condition. Minimal cracking.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.17.13 LRC/Owens (south)
Description See map.

Condition Assessment: Straight concrete ramp configuration in good condition. Minimal cracking.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.01.17.01

01.01.17.03

01.01.17.04

01.01.17.05

01.01.17.06

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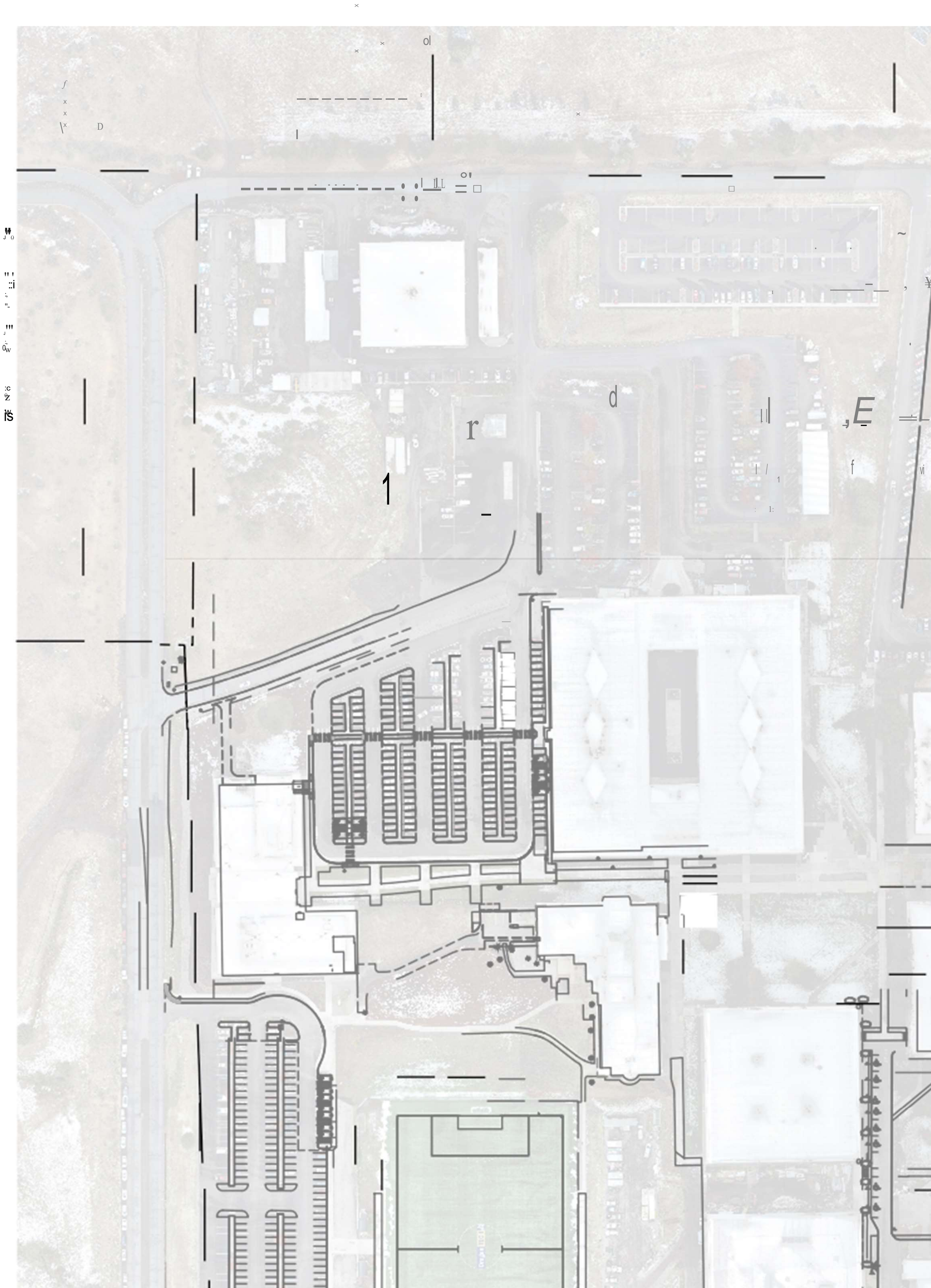

01 Property
01.02 Paved Surface Systems
01.02.10 Paved Parking Area
Each parking lot described herein is named in accordance with the 2023 Oregon Tech Campus Map (map). Each parking lot consists of perimeter curb (as applicable), asphalt pavement and underlying aggregate base, surface markings including stalls and directional arrows, parking bumpers (as applicable), ADA parking markings/signs (as applicable), site lighting, and drainage facilities (including underground piping, surface conveyance channels, area drains, etc.).

01.02.10.01 Lot 'A'
Description See map.

Condition Assessment: Eastern portion of largest parking lot on campus, at intersection of E University Drive and Campus Drive. Most of the parking lot is open paving without parking islands. Overall, parking lot is in poor/failing condition. Asphalt pavement that is failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand new asphalt pavement placed. Overlaying these areas are not recommended. Anticipate replacement to cost roughly $12/sf including all required landscaping, lighting, curbs, and full asphalt pavement section.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$1,100,000	High

Event Justification & Strategy
Parking lot is past it's expected lifespan and is due for full replacement.

01.02.10.02 Lot 'B' (main)
Description See map.

Condition Assessment: Western portion of largest parking lot on campus, at intersection of E University Drive and Campus Drive. Parking lot has center islands with cobble and limited plantings running the length of each parking aisle. Overall, parking lot is in poor/failing condition. Asphalt pavement that is failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand new asphalt pavement placed. Overlaying these areas are not recommended. Anticipate replacement to cost roughly $12/sf including all required landscaping, lighting, curbs, and full asphalt pavement section.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$1,600,000	High

Event Justification & Strategy
Parking lot is past it's expected lifespan and is due for full replacement.

01.02.10.03 Lot 'B' (ADA annex)
Description See map.

Condition Assessment: Western portion of largest parking lot on campus, at intersection of E University Drive and Campus Drive. Parking lot has center islands with cobble and limited plantings running the length of each parking aisle. Overall, parking lot is in fair condition. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed. Anticipate crack seal maintenance to cost roughly $3/sf including all required pavement markings.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$13,500	Medium

Event Justification & Strategy
Recommend asphalt maintenance to correspond with replacement of lots A/B.

01.02.10.04 Lot 'D'
Description See map.

Condition Assessment: Parking lot is recently constructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.05 Lot 'E'
Description See map.

Condition Assessment: Parking lot was recently reconstructed as part of the CEET project and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.06 Lot 'F1'
Description See map.

Condition Assessment: Parking lot was recently reconstructed as part of the CEET project and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.07 Lot 'F2'
Description See map.

Condition Assessment: Parking lot was recently reconstructed as part of the CEET project and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.08 Lot 'G'
Description See map.

Condition Assessment: Parking lot is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has moderate cracking or joint separation (transverse cracks are space 10 to 30-feet apart, longitudinal crack on joint greater than 1-inch, secondary cracking, crack/edge raveling, possible longitudinal cracking at edges), still holds its structural integrity, but hasn't been regularly maintained. Needs minor patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Good to fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$80,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.10.09 Lot 'H'
Description See map.

Condition Assessment: Parking lot is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has minor cracking or joint separation (transverse cracks are spaced 40 to 50-feet apart, longitudinal crack on joint less than 1-inch, hairline cracks, first signs of wear but little to no raveling or rutting), still holds its structural integrity, and appears to have been regularly maintained. Is due for typical preventative maintenance (standard crack seal and seal coat).

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$90,000	Low

Event Justification & Strategy

Routine maintenance recommended based on age of facility.

01.02.10.10 Lot 'I'
Description See map.

Condition Assessment: Parking lot was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.11 Lot 'J' (north)
Description See map.

Condition Assessment: Parking lot was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.12 Lot 'J' (south)
Description See map.

Condition Assessment: Parking lot was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.13 Lot 'K'
Description See map.

Condition Assessment: Parking lot was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.14 Lot 'L'
Description See map.

Condition Assessment: Parking lot is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has minor cracking or joint separation (transverse cracks are spaced 40 to 50-feet apart, longitudinal crack on joint less than 1-inch, hairline cracks, first signs of wear but little to no raveling or rutting), still holds its structural integrity, and appears to have been regularly maintained. Is due for typical preventative maintenance (standard crack seal and seal coat).

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$35,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.10.15 Lot 'M'
Description See map.

Condition Assessment: Parking lot is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has minor cracking or joint separation (transverse cracks are spaced 40 to 50-feet apart, longitudinal crack on joint less than 1-inch, hairline cracks, first signs of wear but little to no raveling or rutting), still holds its structural integrity, and appears to have been regularly maintained. Is due for typical preventative maintenance (standard crack seal and seal coat).

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$18,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.10.16 Lot 'N'
Description See map.

Condition Assessment: Pavement is in fair condition and maintenance is recommended. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$20,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.10.17 Lot 'O'
Description See map.

Condition Assessment: Pavement is in fair condition and maintenance is recommended. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$16,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.10.18 Lot 'P'
Description See map.

Condition Assessment: Gravel paved parking lot in excellent condition. Paving not required per OT.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.10.19 Lot 'Q'
Description See map.

Condition Assessment: Parking lot was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

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- [ ] Excellent
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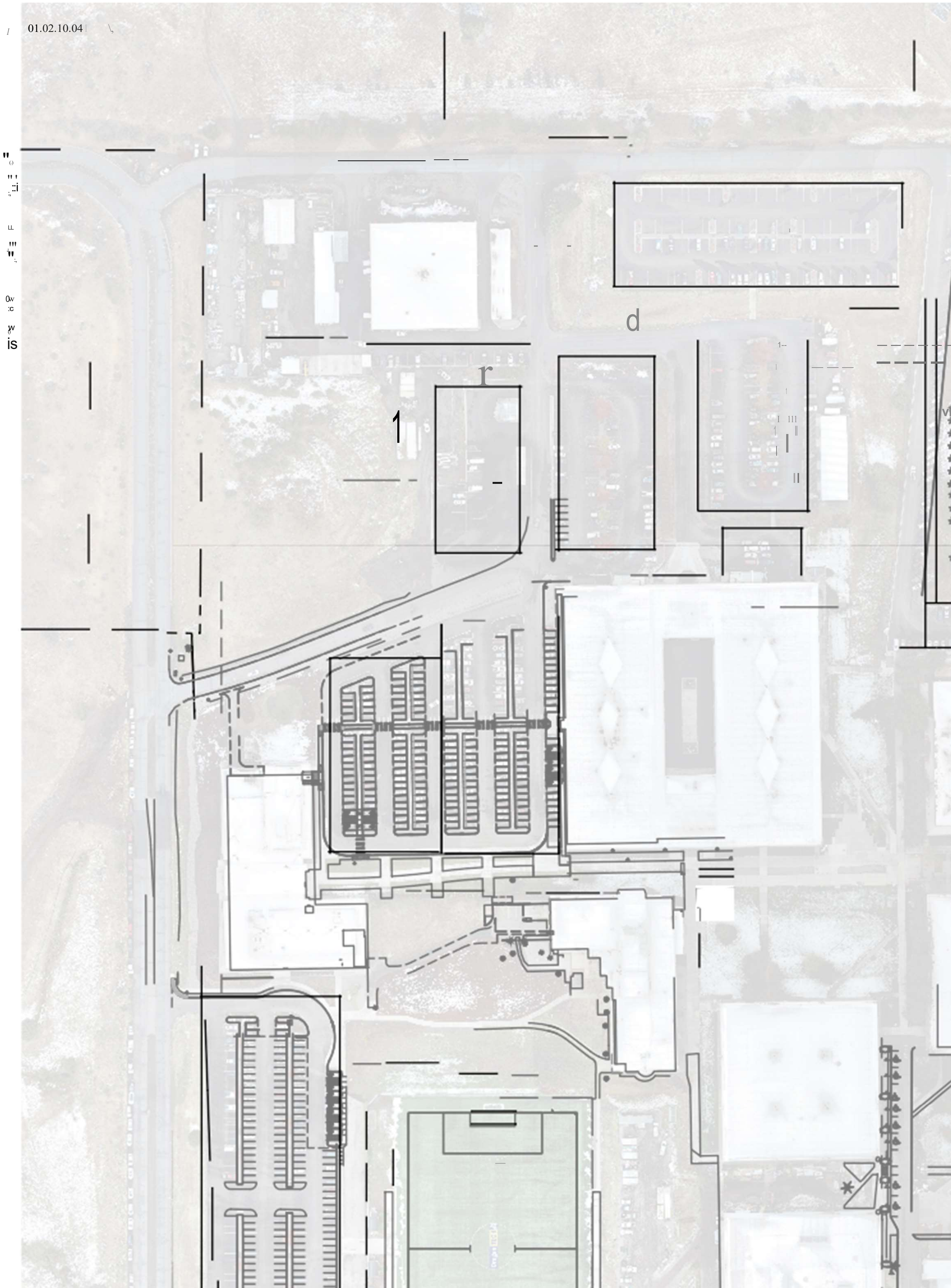
01.02.10.04

01 Property
01.01 Site
01.02.11 Paved Roadway
Each roadway described herein is named in accordance with the 2023 Oregon Tech campus Map (map). Each road consists of perimeter curb (as applicable), asphalt pavement and underlying aggregate base, surface markings including lane striping and directional arrows, and drainage facilities (including underground piping, surface conveyance channels, area drains, etc.).

01.02.11.01 Campus Drive
Description See map.

Condition Assessment: Asphalt pavement has failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand-new asphalt pavement placed. Overlaying these areas is not recommended. Anticipate replacement of the West section of road (to first Sky Lakes Medical Center driveway) to cost $750/lf with a deduction of $35/lf if the sidewalk on the south side of the road is not replaced. Anticipate replacement of the East section of road to cost $750/lf with a deduction of $275/lf if sidewalk, curb and gutter, and storm drainage facilities are excluded on the south side; these savings will likely $25,000 and $113,000 respectively.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$1,260,000	High

Event Justification & Strategy
Roadway is past it’s expected lifespan and is due for full replacement.

01.02.11.02 Campus Circle (loop)
Description See map.

Condition Assessment: Asphalt pavement has failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand new asphalt pavement placed. Overlaying these areas are not recommended. Anticipate replacement to cost roughly $10/sf including all required curbs, storm drainage facilities, and full asphalt pavement section.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$90,000	High

Event Justification & Strategy
Roadway is past it’s expected lifespan and is due for full replacement. Recommend replacement concurrent with replacement of Lots A/B.

01.02.11.03 Campus Circle (north)
Description See map.

Condition Assessment: north end of Campus Circle, constructed as part of the Dow project, is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has moderate cracking or joint separation (transverse cracks are space 10 to 30-feet apart, longitudinal crack on joint greater than 1-inch, secondary cracking, crack/edge raveling, possible longitudinal cracking at edges), still holds its structural integrity, but hasn't been regularly maintained. Needs minor patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$6,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.11.04 Dobs Way (south)
Description See map.

Condition Assessment: Pavement is in fair condition and maintenance is recommended. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$16,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.11.05 Dobs Way (north)
Description See map.

Condition Assessment: Pavement is in fair condition and maintenance is recommended. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$20,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.11.06 Lot 'E' Access Road from Campus Drive
Description See map.

Condition Assessment: Pavement is in fair condition. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

However, rather than repair, the removal of this road is recommended. It gets little use, is redundant to access to Lot E from Industrial drive and has an awkward and possibly dangerous intersection with Dan O'Brien Way. The asphalt should be removed and the slope regraded and replanted

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Demolition	2033	$5,500	Low

Event Justification & Strategy
Avoid future maintenance costs on a component not needed. Simplify traffic connection at Campus Drive.

01.02.11.07 Purvine Access Road
Description See map.

Condition Assessment: Access Road was paved as part of the CEET project. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.08 Purvine Mechanical Yard
Description See map.

Condition Assessment: Mechanical yard is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has minor cracking or joint separation (transverse cracks are spaced 40 to 50-feet apart, longitudinal crack on joint less than 1-inch, hairline cracks, first signs of wear but little to no raveling or rutting), still holds its structural integrity, and appears to have been regularly maintained. Is due for typical preventative maintenance (standard crack seal and seal coat).

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$90,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.11.09 CEET Access Road
Description See map.

Condition Assessment: Access Road was paved as part of the CEET project. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.10 Industrial Park Drive (south)
Description See map.

Condition Assessment: Asphalt pavement has failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand-new asphalt pavement placed. Overlaying these areas is not recommended. Anticipate replacement to cost roughly $750/lf including all required curbs and sidewalks, storm drainage facilities, center median, and full asphalt pavement section.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$805,000	High

Event Justification & Strategy
Roadway is past it's expected lifespan and is due for full replacement.

01.02.11.11 Industrial Park Drive (central)
Description See map.

Condition Assessment: Section of pavement at Facilities Loop intersection was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.13 Facilities Loop
Description See map.

Condition Assessment: Section of pavement at Facilities Loop intersection was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.14 Engineering Court
Description See map.

Condition Assessment: Engineering Court was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.15 N University Drive
Description See map.

Condition Assessment: Asphalt pavement has failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand-new asphalt pavement placed. Overlaying these areas is not recommended. Anticipate replacement to cost roughly $650/lf including all required curbs, storm drainage facilities, and full asphalt pavement section.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$1,580,000	High

Event Justification & Strategy
Roadway is past it's expected lifespan and is due for full replacement.

01.02.11.16 Danny Miles Way
Description See map.

Condition Assessment: Danny Miles Way was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.17 Athletics Access Road
Description See map.

Condition Assessment: Access road is in good condition and is in need of routine maintenance. Asphalt paving in good condition that is older and has minor cracking or joint separation (transverse cracks are spaced 40 to 50-feet apart, longitudinal crack on joint less than 1-inch, hairline cracks, first signs of wear but little to no raveling or rutting), still holds its structural integrity, and appears to have been regularly maintained. Is due for typical preventative maintenance (standard crack seal and seal coat).

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$90,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.11.18 Yates Drive
Description See map.

Condition Assessment: Pavement is in fair condition and maintenance is recommended. Asphalt pavement considered to be in fair condition (beginning to rut in the normal wheel paths greater than ½-inch and/or longitudinal cracking in the wheel paths). Pavement is starting to show the first signs of structural weakening with severe surfacing raveling, longitudinal and transverse cracks with crack erosion, has previously been patched and patching is in fair condition. Needs major patching and/or wedging in isolated locations. Then typical preventative maintenance (standard crack seal and seal coat) performed.

Element State: Fair

Event Type	***Event Year***	***Event Cost***	***Priority***
Maintenance	2025	$20,000	Low

Event Justification & Strategy
Routine maintenance recommended based on age of facility.

01.02.11.19 E University Drive
Description See map.

Condition Assessment: Asphalt pavement has failed (alligator cracking greater than 25%, severe rutting and/or distortion greater than 2-inches in wheel paths and other miscellaneous areas, edges breaking off, loss of positive surface drainage). Full loss of structural integrity and severe potholes throughout. Extensive patching that is in poor condition. These areas require full removal of the existing asphalt, possible reconstruction of the base rock section, and brand-new asphalt pavement placed. Overlaying these areas is not recommended. Anticipate replacement to cost roughly $650/lf including all required curbs, storm drainage facilities, and full asphalt pavement section.

Element State: Failed

Event Type	***Event Year***	***Event Cost***	***Priority***
Replace	2025	$1,280,000	High

Event Justification & Strategy
Roadway is past it’s expected lifespan and is due for full replacement.

01.02.11.20 Sustainable Village Fire Lane (west)
Description See map.

Condition Assessment: Sustainable Village Fire Lane was recently reconstructed and is in excellent condition. Brand new asphalt pavement in excellent condition (placed or overlaid within the last 2 to 3 years with no defects). Average lifespan is roughly 15 to 20 years, with regular, preventative maintenance (standard crack seal and seal coat every three to five years).

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.30 Engineering Court
Description See map.

Condition Assessment: Recently reconstructed reinforced concrete pavement at vehicular entry points on north side of Cornett Hall. Concrete is in excellent condition with no differential settling or cracking.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.31 Central Fire Lane (at access from Parking Lot F1/F2)
Description See map.

Condition Assessment: Recently reconstructed reinforced concrete pavement at vehicular entry points on north side of Cornett Hall. Concrete is in excellent condition with no differential settling or cracking.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.32 Central Fire Lane
Description See map.

Condition Assessment: Reinforced concrete pavement fire lane south of Cornett. Concrete is in good condition with no obvious differential settling, some cracking/normal wear and tear. Various ages of concrete indicate that areas of damage have been replaced as necessary.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.35 Purvine Access Road (south)
Description See map.

Condition Assessment: Recently reconstructed reinforced concrete pavement at vehicular entry point to Purvine access road at southeast corner of CEET. Concrete is in excellent condition with no differential settling or cracking.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.36 Soccer Field Access Road
Description See map.

Condition Assessment: Recently reconstructed reinforced concrete pavement at vehicular entry point on west side of soccer field. Concrete is in excellent condition with no differential settling or cracking.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.37 Dobs Way / DOW Fire Lane (west)
Description See map.

Condition Assessment: Reinforced concrete pavement at northeast corner of DOW Building. Concrete is in good condition with no obvious differential settling, some cracking/normal wear and tear.

Element State: Good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.38 DOW Fire Lane & Campus Circle
Description See map.

Condition Assessment: Reinforced concrete pavement at DOW drop-off loop/fire lane. Concrete is in very good condition with no differential settling and minimal cracking/normal wear and tear.

Element State: Very good

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.11.39 Sustainable Village (east)
Description See map.

Condition Assessment: Recently reconstructed reinforced concrete pavement at fire lane between 2 primary buildings at Sustainable Village. Concrete is in excellent condition with no differential settling or cracking.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

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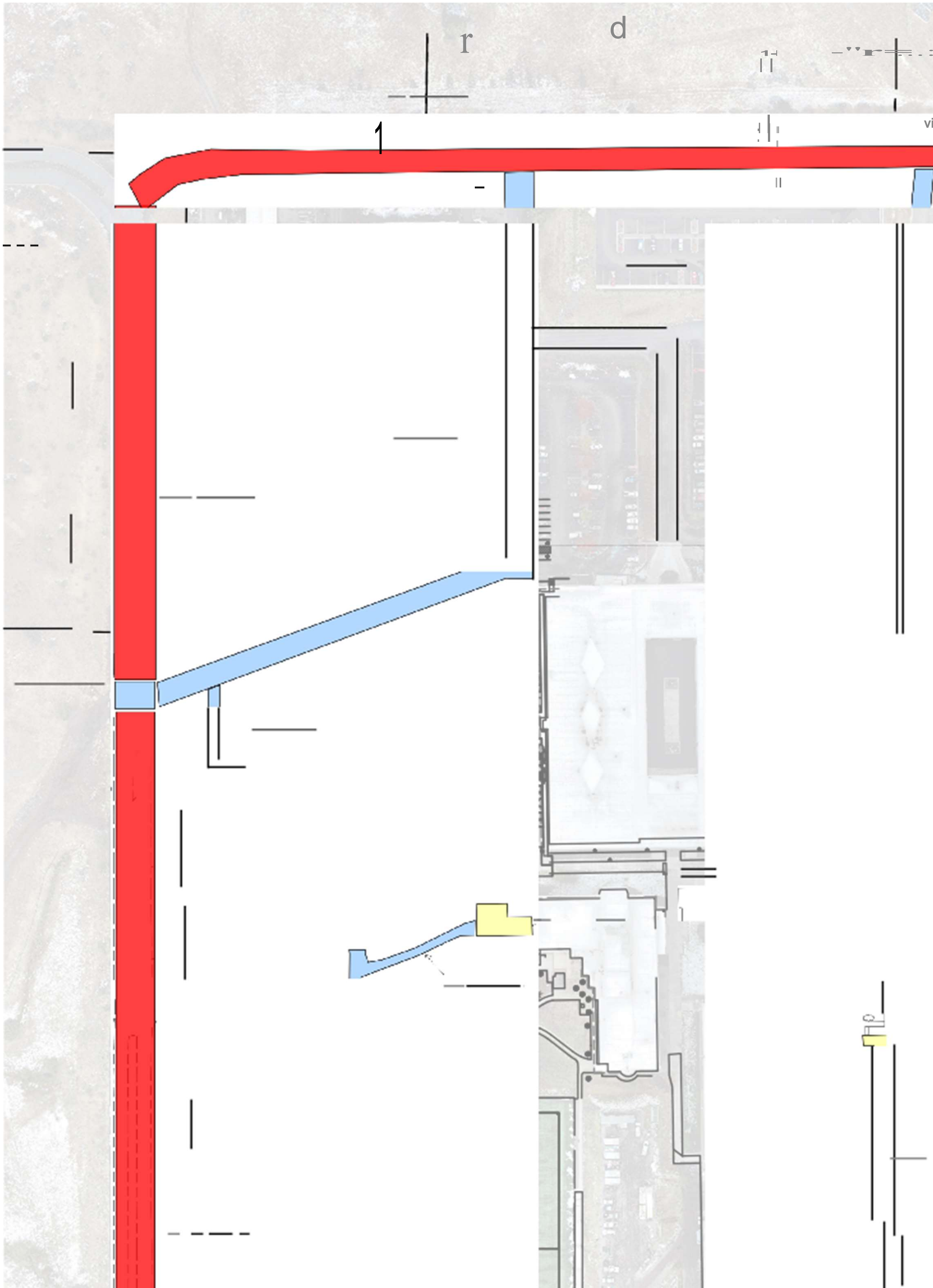

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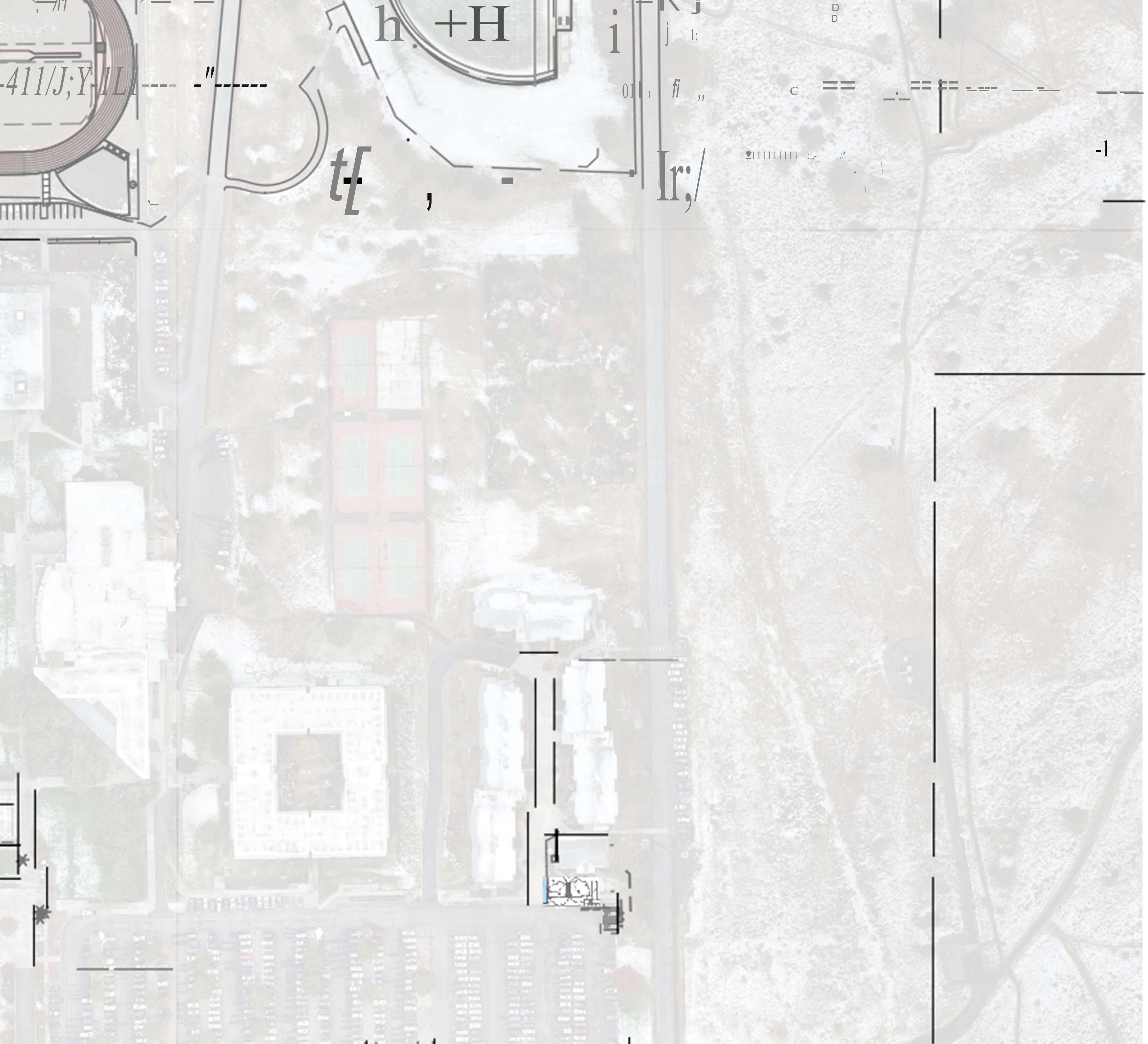

SECTION 01.02.11

PAVED ROADWAYS (CONCRETE)

01 Property
01.02 Paved Surface Systems
01.02.13 Paved Sports & Recreational Spaces
Outdoor sports and recreational areas have been included in this section.

01.02.13.01 Softball Field
Description See map.

Condition Assessment: Recently constructed synthetic turf field with perimeter curb and fencing. Includes new batting cages, dugouts, and team/concessions building. Also includes new concrete sidewalks, aluminum bleacher configuration with crow's nest, and field lighting. Facility in excellent condition.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.13.02 Football Field
Description See map.

Condition Assessment: Irrigation at football field was replaced in 2022 and field was regraded. Seeding to be completed spring 2023. After grass establishment field will be in excellent condition. Grandstand analysis by others.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.13.03 Track & Track Events
Description See map.

Condition Assessment: Running track and all field events including javelin, high jump, steeple chase, long/triple jump, shotput, and discus were completed reconstructed 2021-2022. Entire facility is in excellent condition.

Element State: Excellent

Event Type	***Event Year***	***Event Cost***	***Priority***
N/A	N/A	N/A	N/A

01.02.13.04 Outdoor Basketball Court
Description See map.

Condition Assessment: Asphalt paved basketball court east of Athletics building is in fair condition. Some large longitudinal cracks throughout the pavement. Striping has faded significantly.

The master plan recommends a new field house on this site so upgrades to the court will be deferred to that project.

Element State: Fair

Event Type	Event Year	Event Cost	Priority
Maintenance	2025	$10,000	Low

Event Justification & Strategy
Recommend crack seal/seal coat over existing pavement with new basketball court striping. Basketball hoops can remain.

01.02.13.05 Tennis Courts
Description See map.

Condition Assessment: Tennis courts have significant differential settlement and cracking throughout. Pavement and subgrade have failed.

Element State: Failed

Event Type	Event Year	Event Cost	Priority
N/A	N/A	N/A	N/A

Event Justification & Strategy
OT Facilities indicated that the tennis courts do not need to be replaced as part of the master plan and will be removed as part of the construction of the new residence hall.

01.02.13.06 Soccer Field
Description See map.

Condition Assessment: Synthetic turf soccer field with perimeter curb and fencing, constructed 2020. OT Facilities staff expressed desire for replacement of all remaining natural turf within the fence limits (replace with synthetic). Existing bleacher seating capacity is insufficient; total seating capacity should roughly match the track/football grandstands. Restrooms and possibly changing rooms are also needed.

Element State: Excellent (field), poor (seating), new (restrooms)

Event Type	Event Year	Event Cost	Priority
Field: Add to existing turf	2025	$200,000	Low
Seating: New	2025	$500,000	Low
Restrooms: New	2025	$350,000	Low

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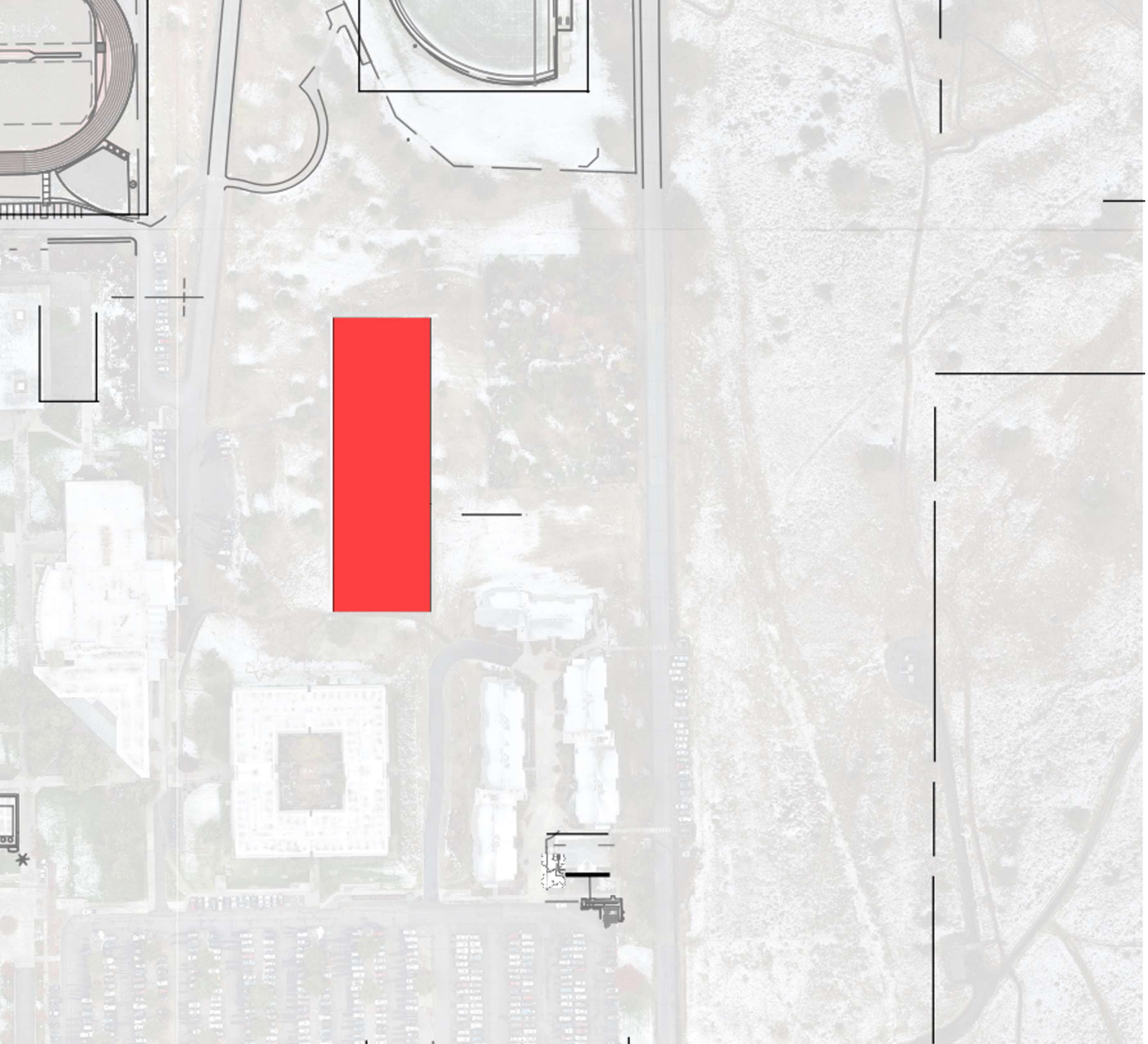


Summary

1. Geothermal System Summary

The Oregon Tech campus site was originally selected to utilize the local geothermal (GEO) resource for campus heating. Direct-use geothermal fluids at a temperature of 193-196°F are pumped from near-surface aquifers and used for campus space heating, domestic hot water, and sidewalk snowmelt. The cooled geothermal fluid is then collected and pumped back into the same or similar aquifer through injection wells.

For most buildings, there is no alternative heat source. Loss of geothermal heat during the heating season would require shutting down campus buildings. In colder weather, there would also be a risk of building damage due to freezing. Geothermal heat is required year-round for domestic hot water.

The system has reliably heated the campus since construction in the 1960s. Much of the system is showing its age. Within the past year, there have been three pipeline breaks that have interrupted the operation of the system. Fortunately, the breaks did not occur in extremely cold weather and they did not result in personnel injuries or significant collateral damage. However, the risk is there and it is prudent to repair and upgrade the system for extended reliable, and safe operation.

This section assesses the condition and recommended upgrades to the geothermal production, injection, and distribution systems. Recommended upgrades include:

- Repair of production wells #5 and #6 and associated pumps and piping
- Repair of injection wells #1 and #2
- Replacement and upsizing of the geothermal storage tank
- Replacement and reconfiguration of piping in the GEO mechanical building
- Repair of piping in the GEO supply and return systems as needed
- Replacement and reconfiguration of isolation valves in the GEO supply and collection systems for improved isolation and resiliency
- Addition of new buried GEO supply and return piping to serve the proposed new residence hall and create a looped supply system for improved system resiliency.

2. Chilled Water System Summary

The Oregon Tech campus includes a central chilled water system that supplies chilled water through piping in the utility tunnels to several campus buildings, including:

- East Branch:

- Snell
    - College Union (CU)
    - Athletics (Limited coverage)
- West Branch:
    - Owens
    - Dow
    - Semon
    - Boivin
    - Cornett
    - Learning Resource Center (LRC)

Separate local chillers supply Sustainable Village student housing, Purvine, and CEET. No chilled water is provided to the old Residence Hall or to Facilities Services.

The central chiller plant consists of two Trane centrifugal chillers, three cooling towers, and associated pumps, piping, and controls.

The existing central chilled water system appears to have adequate capacity to serve the connected buildings but has been struggling to meet the load and maintain the setpoint chilled water temperature. The problems appear to be caused by:

- Failing cooling towers which result in higher condensing water temperatures
- Problems with piping, controls, and a chilled water booster pump (P-8) in College Union, inadequate cooling in CU
- Control problems with the chiller.

Fixing those problems should allow the chiller to operate at nominal capacity and improve energy efficiency.

When the chiller is working properly, there is likely some reserve capacity that could be used to serve additional load. One factor that may complicate that is inadequate pipe sizes in the tunnels.

3. Site Electrical System Summary

The electrical system at the Oregon Tech Campus consists of three-phase 12,470 Volt primary utility metered system. The campus owns the distribution network and has steadily been improving the system to modern standards. There is a mixture of older, and newer equipment, and particularly the feeders have the most assortment as to newer and older. The above-grade electrical equipment distributed around the campus for the most part is modern, newer, and ready for automation.

It appears much of the modern equipment needs to be programmed, particularly the VISTA distribution gear. Although the VISTA gear may have been programmed properly, it appears the programming is unknown. The programming of the equipment is what controls the protection values, and mis-programmed equipment may result in major asset damage, and/or injury/death as a result of failing to clear a fault. Improperly programmed equipment may result in millions of dollars in damages and campus disruption for months or over a year with the complete destruction of the campus power distribution system should the equipment not be programmed correctly. i.e. the “fuses” or “circuit breaker” settings are via programming, and if not programmed properly can result in, in the best case, nuisance tripping, and worst case an uncleared/uncontrolled fault that can cascade throughout the campus.

Most Arc-Flash labels have not been included on new equipment, or are worn, and most have expired. We recommend an updated Arc Flash Analysis.

05 Electrical

05.01 Primary Electrical

05.01.10 Primary Switchgear

05.01.10.01 Scott Sectionalizing Cabinet SSA

Description	Scott Sectionalizing Cabinet SSA (Located by Geothermal Plant)
Condition Assessment	Good condition. Sectionalizing Cabinet SSA is the first 12kV distribution node after PacifiCorp Service from Utility Pole 01438009. SSA supplies 12kV to the following equipment: Sectionalizing Cabinet SSB, Well #7, and Well #4. The cabinet exterior green finish is starting to show signs of erosion from the elements; however, the cabinet is still effectively protecting the terminated 12kV elements. If the Cabinet fails, the entire 12kV service will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***

05.01.10.01 Scott Sectionalizing Cabinet SSA – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2028	$5000	Low	Field Observations

Brief Description	Re-finish and Re-seal Cabinet Exterior.
Event Justification & Strategy	Refinishing the exterior of the cabinet will help extend the life of the cabinet and 12kV connections.
Implication of Event Deferral	The Cabinet and 12kV connections will reach their end of life sooner.

05.01.10.02 Scott Sectionalizing Cabinet SSB

Description	Scott Sectionalizing Cabinet SSB (Located by Geothermal Plant)
Condition Assessment	Poor Condition. Sectionalizing Cabinet SSB is the Second 12kV distribution node after PacifiCorp Service from Utility Pole 01438009. SSB supplies 12kV to the following equipment: Sectionalizing Cabinet SSC, and Geothermal Power Plant. The Sectionalizing Cabinet was installed in July of 1995, and has reached the end of its service life. If the Cabinet fails, the majority of the 12kV service will experience an outage
Element State:	Poor

Assessment Criteria	***Existence***	***Comments***

05.01.10.02 Scott Sectionalizing Cabinet SSB – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replacement	2025	$10000	High	Field Observations

Brief Description	Replace Cabinet with new Distribution Node
Event Justification & Strategy	The cabinet exterior is showing significant signs of failure, and is no longer effectively protecting the terminated 12kV elements.
Implication of Event Deferral	Failure of equipment, which can lead to a prolonged outage.

05.01.10.03 Scott Sectionalizing Cabinet SSC

Description

Scott Sectionalizing Cabinet SSC (Located by Student Health Center)

Condition Assessment

Fair Condition. Sectionalizing Cabinet SSC is the Third 12kV distribution node after PacifiCorp Service from Utility Pole 01438009. SSC supplies 12kV to the following equipment: Student Health Center Building Transformer, Villages Sectionalizing Cabinet, and the Arboretum. The Sectionalizing Cabinet's manufacturing label has worn and it's not clear when exactly this gear was installed. Based on observations, we guess the equipment is 16 to 20 years of age and is nearing its service life. The cabinet exterior is starting to show signs of erosion, and will no longer effectively protect the terminated 12kV elements in near future. If the Cabinet fails, the Student Residential Hall/Villages, Student Health Center, and Arboretum will experience an outage.

Element State: Fair

<u>Assessment Criteria</u>	***<u>Existence</u>***	***<u>Comments</u>***

05.01.10.03 Scott Sectionalizing Cabinet SSC – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2028	$5000	Medium	Field Observations

Brief Description

Re-finish and Re-seal Cabinet Exterior. Additionally, a bolt is missing from the vault lid and is currently unlocked. A bolt should be provided to prevent the public from opening the vault.

Event Justification & Strategy

Refinishing the exterior of the cabinet will help extend the life of the cabinet and 12kV connections.

Implication of Event Deferral

The Cabinet and 12kV connections will reach their end of life sooner.

05.01.10.04 Scott Sectionalizing Cabinet Villages

Description

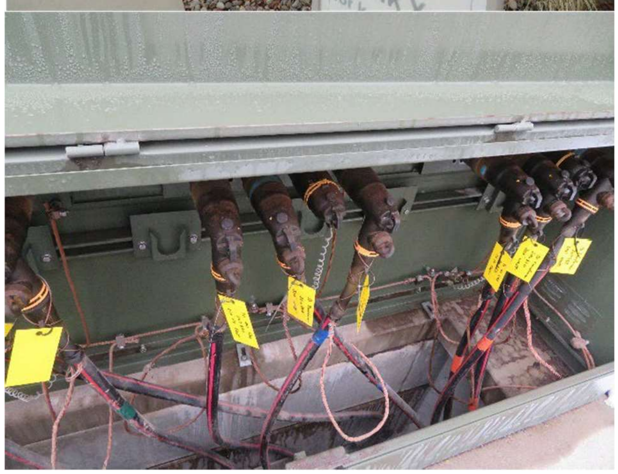
Scott Sectionalizing Cabinet Villages (Located by Villages)

Condition Assessment

Fair Condition. Sectionalizing Cabinet Village is the Forth 12kV distribution node after PacifiCorp Service from Utility Pole 01438009. The Village Cabinet supplies 12kV to the following equipment: Villages Building Transformer and Resident Hall Building Transformer. The Sectionalizing Cabinet’s manufacturing label has worn and it’s not clear when exactly this gear was installed. Based on observations, we guess the equipment is 16 to 20 years of age and is nearing its service life. The cabinet exterior is starting to show signs of erosion, and will no longer effectively protect the terminated 12kV elements in near future. If the Cabinet fails, the Villages and Resident Hall will experience an outage.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***



05.01.10.04 Scott Sectionalizing Cabinet Villages – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2028	$5000	Medium	Field Observations

Brief Description	Re-finish and Re-seal Cabinet Exterior.
Event Justification & Strategy	Refinishing the exterior of the cabinet will help extend the life of the cabinet and 12kV connections.
Implication of Event Deferral	The Cabinet and 12kV connections will reach their end of life sooner.

05.01.10.05 Scott Sectionalizing Chiller Building

Description	Scott Sectionalizing Cabinet Chiller Building (Located by Chiller Building entrance)
Condition Assessment	Poor Condition. Sectionalizing Cabinet Chiller Building is the First 12kV distribution node after PacifiCorp Service from Utility Meter 41049841. The cabinet supplies 12kV to the main campus distribution in the Chiller Building. The Sectionalizing Cabinet was installed in March of 1992 and has reached the end of its service life. If the Cabinet fails, the entire 12kV service will experience an outage.
Element State:	Poor

<u>Assessment Criteria</u>	***<u>Existence</u>***	***<u>Comments</u>***

05.01.10.05 Scott Sectionalizing Chiller Building – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replace	2023	$20000	Very High	Field Observations

Brief Description	Replace existing cabinet and 12kV connections.
Event Justification & Strategy	The cabinet exterior is showing significant signs of failure and is no longer effectively protecting the terminated 12kV elements.
Implication of Event Deferral	Potential outages to the entire campus.

05.01.10.06 12kV Distribution Gear Chiller Building

Description	12kV Main Distribution Gear (Located inside the Chiller Building)
Condition Assessment	Fair Condition. The 12kV Main Distribution Gear is the primary distribution node from the PacifiCorp Service Meter 41049841. This gear creates a loop feed redundant system that energizes the following: Owens, Snell, Boivin, Semon, Purvine, Cornett, Physical Plant, PE Building, Library, College Union, Stadium, DOW, Softball Field, Facilities, and CEET. 12kV Main Distribution equipment was installed in August of 1994 and is quickly reaching the end of its service life. If the Main Distribution equipment fails, the entire 12kV service will experience an outage.
Element State:	Fair

<u>Assessment Criteria</u>	***<u>Existence</u>***	***<u>Comments</u>***


05.01.10.06 12kV Distribution Gear Chiller Building – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replacement	2033	$2.25M	Medium	Field Observations

Brief Description	Replacement and relocate 12kV Main Distribution Gear.
Event Justification & Strategy	The cabinet exterior is showing signs of flood damage and is approaching its end of life. See the 2022 Geothermal FCA study for additional information.
Implication of Event Deferral	Potential campus-wide outages.

05.01.10.07 Vista Gear Soccer Field

Description	Soccer Field Vista Gear (Located near Soccer Field)
Condition Assessment	Good Condition. The Soccer Vista Gear supplies 12kV to the Bovin/Semon Building Transformer, Purvine Building Transformer, and Cornett Vista Gear. The Soccer Vista Gear is fed from 12kV Main Distribution Gear in the Chiller Building. The Vista Gear was installed in September 2020, and still has substantial service life remaining. If the Vista Gear fails, Bovin, Semon, Purvine, and CEET experience an outage. Note that the Cornett Vista Gear can back-feed this equipment in the event the 12kV feeder to the Soccer Vista Gear fails.
Element State:	Good

05.01.10.07 Vista Gear Soccer Field – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Adjustment	2023	$5000	High	Field Observations

Brief Description	Verify system configuration/programming parameters and adjust as recommended to provide adequate protection/functionality.
Event Justification & Strategy	The Vista Gear appears to be relatively new and installed recently. At the time of observation, we were not able to confirm the Vista Gear's Programming/Settings. We did notice that spare connections indicated as energized on display, even though they were in the open position.
Implication of Event Deferral	Potential damage to 12kV equipment.

05.01.10.08 Purvine S & C PMS-6 Cabinet

Description	S & C PMS-6 Cabinet Purvine (Located near Purvine)
Condition Assessment	Fair Condition. S & C PMS-6 Cabinet is a 12kV distribution node that is fed from the Soccer Vista Gear. The S & C Cabinet supplies 12kV to the Purvine Building Transformer, and CEET S & C Cabinet. The Cabinet's manufacturing does not list when the equipment was manufactured, we guess the equipment is 16 to 20 years of age and is nearing its service life. If the Cabinet fails, Purvine and CEET will experience an outage.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

05.01.10.08 Purvine S & C PMS-6 Cabinet – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Replacement	2033	$150000	Low	Field Observations

Brief Description	Replace with dead front type gear at end of existing service life.
Event Justification & Strategy	Live front equipment presents additional risk and is being phased out of the campus.
Implication of Event Deferral	Outside of standard practice, antiquated.

05.01.10.09 CEET S & C Cabinet

Description	S & C Cabinet CEET (Located near CEET)
Condition Assessment	Good Condition. S & C Cabinet is a 12kV distribution node that is fed from the Purvine S & C PMS-6 Cabinet. The S & C Cabinet supplies 12kV to the CEET Building Transformer. The Transformer was installed in March of 2021, and still has substantial service life remaining. If the Cabinet fails CEET will experience an outage.
Element State:	Good

Assessment Criteria ***Existence*** ***Comments***


05.01.10.09 CEET S & C Cabinet – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Repair	2028	$5000	Low	Field Observations

Brief Description	Re-finish and Re-seal Cabinet Exterior.
Event Justification & Strategy	The S & C Cabinet appears to be relatively new and installed recently. At the time of observation, it appears the enclosure seal has failed and is allowing the interior side of the cabinet to start corroding.
Implication of Event Deferral	The Cabinet and 12kV connections will reach their end of life sooner.

05.01.10.10 Vista Gear College Union

Description	College Union Vista Gear (College Union Parking Lot)
Condition Assessment	Good Condition. The College Union Vista Gear supplies 12kV to the College Union Building Transformer, Solar

Field Sectionalizing Cabinet, and Cornett Vista Gear. The College Union Vista Gear is fed from 12kV Main Distribution Gear in the Chiller Building. The Vista Gear was installed in January 2020, and still has substantial service life remaining. If the Vista Gear fails, College Union, Softball Field, Stadium, Track, LRC, PE, and Cornett Vista Gear experience an outage. Note that the Cornett Vista Gear can back-feed this equipment in the event the 12kV feeder to the College Union Vista Gear fails.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

05.01.10.10 Vista Gear College Union – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Adjustment	2023	$5000	High	Field Observations

Brief Description	Verify system configuration/programming parameters and adjust as recommended to provide adequate protection/functionality. Additionally, we recommend locking the gear.
Event Justification & Strategy	The Vista Gear appears to be relatively new and installed recently. At the time of observation, we were not able to confirm the Vista Gear's Programming/Settings. We did notice that spare connections appeared to be energized, even though they were in the open position. Lastly, the gear was unlocked, we recommend locking the cabinet from public use.
Implication of Event Deferral	Potential damage to 12kV equipment.

05.01.10.11 Scott Sectionalizing Dog House

Description	Sectionalizing Cabinet Dog House (Located in Fenced Area Near Stadium)
Condition Assessment	Good Condition. Sectionalizing Cabinet Dog House is a 12kV distribution node that supplies 12kV to the Stadium and Softball Field Transformers. Additionally, there is a connection to the 2MW Solar array to another cabinet that we were not able to gain access too. The Sectionalizing Cabinet's manufacturing label is not present and it's not clear when exactly this gear was installed. Based on observations, we guess the equipment is 5 to 10 years of age and still has a significant service life. If the Cabinet fails the Stadium and Softball Field will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***

05.01.10.11 Scott Sectionalizing Dog House – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Inspection	Annually	$1000	Low	Field Observations

Brief Description To provide continued annual inspect to ensure the longevity of equipment.

Event Justification & Strategy Providing annual inspections will help identify potential issues before they become critical to the equipment.

Implication of Event Deferral Potential reduction to the service life of the equipment.

05.01.10.12 Vista Gear Cornett

Description Cornett Vista Gear (Located between LRC and Cornett)

Condition Assessment Good Condition. The College Union Vista Gear supplies 12kV to the College Union Building Transformer, Solar Field Sectionalizing Cabinet, and Cornett Vista Gear. The College Union Vista Gear is fed from 12kV Main Distribution Gear in the Chiller Building. The Vista Gear was installed in January 2020, and still has substantial service life remaining. If the Vista Gear fails, College Union, Softball Field, Stadium, Track, LRC, PE, and Cornett Vista Gear experience an outage. Note that the Cornett Vista Gear can back-feed this equipment in the event the 12kV feeder to the College Union Vista Gear fails.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

05.01.10.12 Vista Gear Cornett – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Adjustment	2023	$5000	High	Field Observations

Brief Description

Verify system configuration/programming parameters and adjust as recommended to provide adequate protection/functionality. Additionally, we recommend restoring/repairing the motor operator controls.

Event Justification & Strategy

The Vista Gear appears to be relatively new and installed recently. At the time of observation, we were not able to confirm the Vista Gear's Programming/Settings. We observed that Motor Operator Controls were off, disabled, and not functional. Battery condition is unknown. In an emergency, there is no way to operate the gear remotely/from the side which is the intent of the motor operators. Only manual operation is available and requires leaning over the equipment, etc.

Implication of Event Deferral

Potential life safety concerns and damage to 12kV equipment.

05.01.20 Primary Transformers

05.01.20.01 Well #7 Transformer

Description

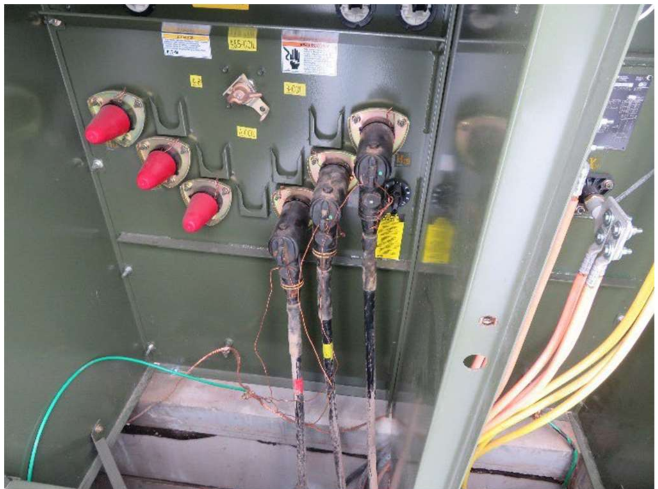
Well #7 Transformer (Located by Resident Hall Parking Lot)

Condition Assessment

Good Condition. The Building Transformer was installed in June of 2022 and has significant service life remaining. The transformer is a 500kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.2%. The Well #7 Transformer supplies 480/277V to Well #7, and is fed from Scott Sectionalizing Cabinet SSA. If the Transformer fails, Well #7 will experience an outage.

Element State: Good

Assessment Criteria	***Existence***	***Comments***



05.01.20.01 Well #7 Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Repair	2023	$1000	High	Field Observations

Brief Description	The grounding at the time of inspection was not complete, loose exposed wiring was observed and presents an arc flash hazard. Additionally, the medium voltage conductor shielding has not been properly connected. Lastly, the transformer pressure does not appear to be in conformance with the manufacturer.
Event Justification & Strategy	We recommend correct actions to address the items noted above to preserve life safety and the service life of the transformer.
Implication of Event Deferral	Potential damage to equipment, and personnel.

05.01.20.02 Student Health Transformer

Description	Transformer 2N-XFMR-A - Student Health Building Transformer (Located by Student Health Center)
Condition Assessment	Good Condition. The Building Transformer was installed in June of 2022 and has significant service life remaining. The Student Health Building Transformer supplies 120/208V to the Student Health Center and is fed from Scott Sectionalizing Cabinet SSC. The transformer is a 112.5kVA 3-Phase 120/208V rated step-down transformer, with an impedance of 3.5%. If the Building Transformer fails, the Student Health Center will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.02 Student Health Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***

Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.03 Arboretum Transformer

Description

Transformer Arboretum (Located by Arboretum exterior fence)

Condition Assessment

Good Condition. The Arboretum Transformer supplies 120/240V to the Arboretum panel located near the transformer and is fed from Scott Sectionalizing Cabinet SSC. The Arboretum Transformer was installed in December of 2007, and still has service life remaining before requiring replacement. The transformer exterior green finish is starting to show signs of erosion from the elements; however, internal terminations are still effectively protected. It does appear that a rodent has started moving into the transformer vault. The transformer is a 25kVA 1-Phase 120/240V rated step-down transformer, with an impedance of 1.6%. If the Transformer fails, the Arboretum will experience an outage.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.03 Arboretum Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replacement	2033+	$10000	Low	Field Observations

Brief Description	Replace the Transformer as it reaches its end of service life ~2040.
Event Justification & Strategy	As the transformer reaches end-of-life, the maintenance costs will become unfeasible, and will become more economical to replace it.
Implication of Event Deferral	Potential outage at the Arboretum.

05.01.20.04 Resident Hall Transformer

Description	Resident Hall Building Transformer (Located by Resident Hall)

Condition Assessment	Good Condition. The Resident Hall Building Transformer supplies 480/277V to Well #7 and is fed from the Village Scott Sectionalizing Cabinet. The Building Transformer was installed in June of 2022 and has significant service life remaining. The transformer is a 500kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.1%. If the Transformer fails, the Resident Hall will experience an outage.	
Element State:	Good	
<u>Assessment Criteria</u>	***<u>Existence</u>***	***<u>Comments</u>***

05.01.20.04 Resident Hall Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Repair	2025	$1000	High	Field Observations

Brief Description

The grounding at the time of inspection was not complete, loose exposed wiring was observed and presents an arc flash hazard. Additionally, the medium voltage conductor shielding has not been properly connected. Lastly, the transformer pressure does not appear to be in conformance with the manufacturer. Correct coloring of conductors, conductor coloring at the transformer doe not meet NEC and is misusing white and green. Coloring may not comply at the MDP as well.

Event Justification & Strategy

We recommend correct actions to address the items noted above to preserve life safety and the service life of the transformer.

Implication of Event Deferral Potential damage to equipment, and personnel.

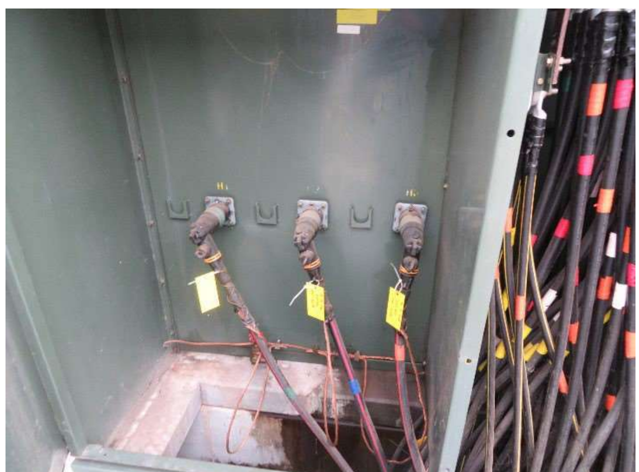
05.01.20.05 Villages Transformer

Description Villages Building Transformer (Located in Villages Courtyard)

Condition Assessment Poor Condition. The Resident Hall Building Transformer supplies 480/277V to Village A, B, and C, and is fed from the Village Scott Sectionalizing Cabinet. The Building Transformer was installed in August of 1986 and is past its remaining service life. The transformer is a 750kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.96%. If the Transformer fails, the Resident Hall will experience an outage.

Element State: Poor

Assessment Criteria	***Existence***	***Comments***



05.01.20.05 Villages Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replacement	2028	$75000	Medium	Field Observations

Brief Description Replace Transformers and secondary conductors. It appears that there is an oil leak inside the transformer.

Event Justification & Strategy The Transformer has reached its end of life and will start presenting a higher risk of potential outages.

Implication of Event Deferral Outages at the Villages.

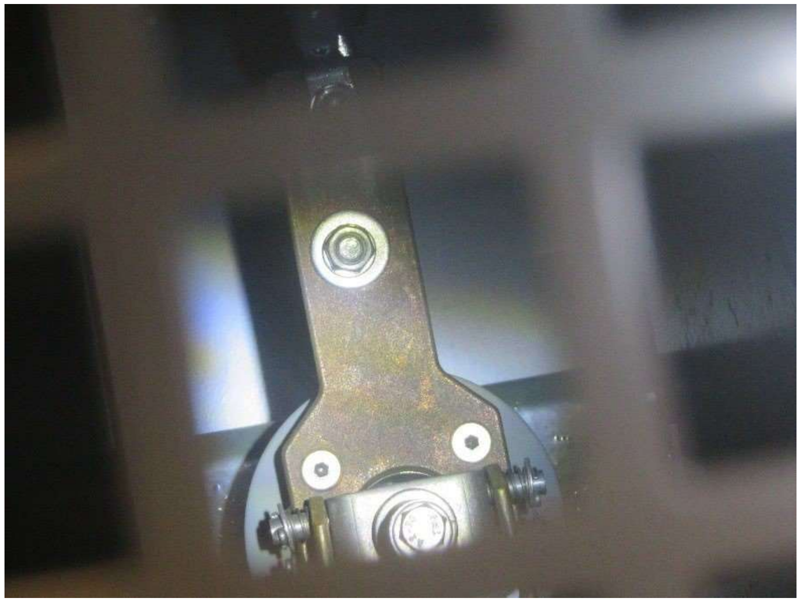
05.01.20.06 Snell & Owens Transformer

Description Transformer TR2 – Snell and Owens Building Transformer (Located Inside Chiller Building)

Condition Assessment Fair Condition. The Transformer supplies 480/277V to Snell and Owens and is fed from the 12kV Main Distribution Cabinet. The Transformer was installed in May of 1999 and is quickly reaching the end of its service life. The transformer is a 300kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 4.98%. If the Transformer fails, Snell and Owens will experience an outage.

Element State: Fair

<u>Assessment Criteria</u> ***<u>Existence</u>*** ***<u>Comments</u>***



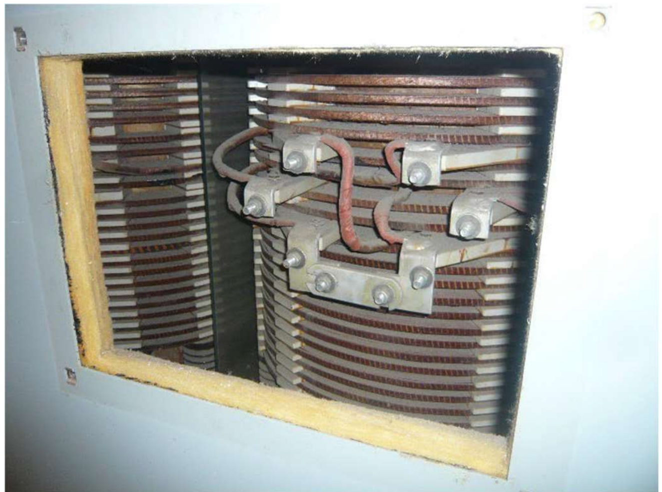
05.01.20.06 Snell & Owens Transformer – Event 1

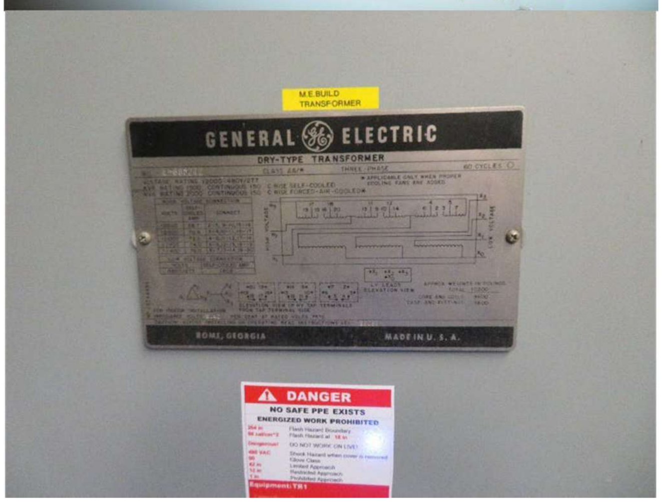
Event Type	Event Year	Event Cost	Priority	Data Origin
Replacement	2033	$500000	Medium	Field Observations

Brief Description	Replace Transformer and supporting equipment.
Event Justification & Strategy	The Transformer exterior is showing signs of flood damage and is approaching its end of life. Additionally, Terminations appear to have burns or thermal wear marks
Implication of Event Deferral	Potential outages to Snell and Owens.

05.01.20.07 Chiller Building Transformer

Description	Transformer TR1 – Chiller Building Transformer (Located Inside Chiller Building)
Condition Assessment	Fair Condition. The Transformer supplies 480/277V to the Chiller Building and is fed from the 12kV Main Distribution Cabinet. The Transformer was installed in May of 1999 and is quickly reaching the end of its service life. The transformer is a 1500kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.42%. If the Transformer fails, Chiller Building will experience an outage.
Element State:	Fair





05.01.20.07 Chiller Building Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replacement	2033	$100000	Medium	Field Observations

Brief Description	Replace Transformer and supporting equipment.
Event Justification & Strategy	The Transformer exterior is showing signs of flood damage and is approaching its end of life.
Implication of Event Deferral	Potential outages to Chiller Building equipment.

05.01.20.08 DOW Transformer

Description	Building Transformer DOW (Located in the courtyard near DOW)

Condition Assessment

Good Condition. The Transformer supplies 480/277V to the Chiller Building and is fed from the 12kV Main Distribution Cabinet. The Transformer was installed in November of 2006 and is quickly reaching the end of its service life. The transformer is a 1000kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.88%. If the Transformer fails, DOW will experience an outage.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.08 DOW Transformer – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2033	$500	Low	Field Observations

Brief Description Repair the locking mechanism.

Event Justification & Strategy The Transformer is still in great shape, and terminations show no sign of exposure. The locking mechanism seems to be in rough shape and is difficult to lock and unlock.

Implication of Event Deferral Potential to be stuck in an unlocked or locked position.

05.01.20.09 Bovin & Semon Transformer

Description Building Transformer Bovin/Semon (Located near Soccer Field)

Condition Assessment Good Condition. The Transformer supplies 480/277V to Bovin and Semon and is fed from the Soccer Field Vista Distribution Gear. The Transformer was installed in September 2020, and still has substantial service life remaining. The transformer is a 1500kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.9%. If the Transformer fails, Bovin and Semon will experience an outage.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.09 Bovin & Semon Transformer – Event 1

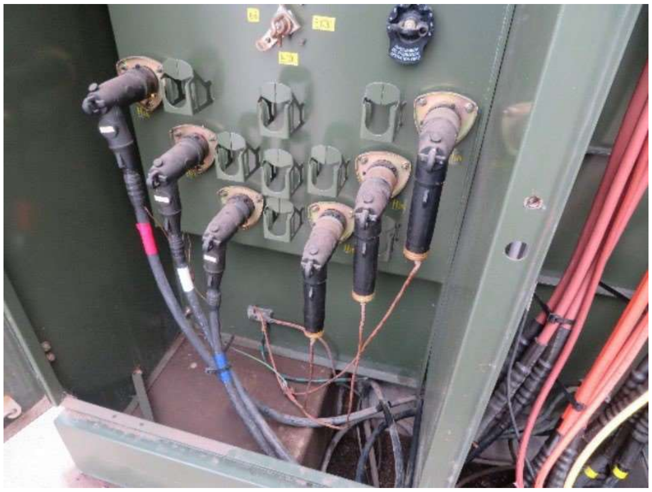
Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Adjustment	2023	$5000	High	Field Observations

Brief Description	The voltage tap appears to be set incorrectly, resulting in lower secondary voltage underload. Manifesting in Semon (autoclaves).
Event Justification & Strategy	Tap adjustments shall be made with qualified testing equipment, by qualified personnel.
Implication of Event Deferral	Potential damage to equipment in Semon/Bovin.

05.01.20.10 Purvine Transformer

Description	Building Transformer Purvine (Located near Purvine)
Condition Assessment	Good Condition. The Transformer supplies 480/277V to Purvine and is fed from the Purvine S & C PMS-6 Distribution Gear. The Transformer was installed in February of 2021, and still has substantial service life remaining. The transformer is a 750kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 6.0%. If the Transformer fails Purvine will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.10 Purvine Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

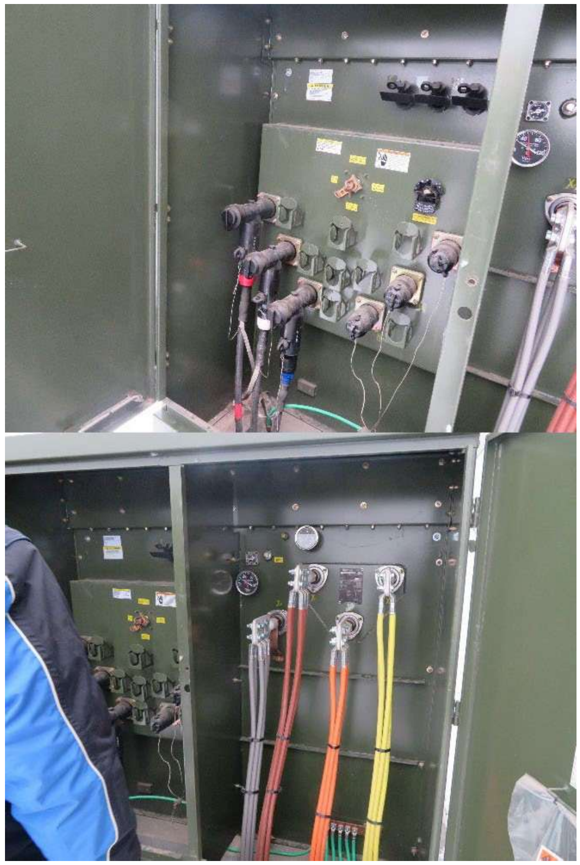
05.01.20.11 CEET Transformer

Description Building Transformer CEET (Located near CEET)

Condition Assessment Good Condition. The Transformer supplies 480/277V to CEET and is fed from the CEET S & C Distribution Gear. The Transformer was installed in March of 2021, and still has substantial service life remaining. The transformer is a 1000kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.7%. If the Transformer fails CEET will experience an outage.

Element State: Good

<u>Assessment Criteria</u>	***<u>Existence</u>***	***<u>Comments</u>***



05.01.20.11 CEET Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment. Service Bonding Appears to occur at Transformer, and may also occur at MDP. If so, this is a code violation and should be corrected.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.12 College Union Transformer

Description	Building Transformer TR5 – College Union (Located near College Union Parking)
Condition Assessment	Good Condition. The Transformer supplies 480/277V to College Union and is fed from the College Union Vista Distribution Gear. The Transformer was installed in December 2017, and still has substantial service life remaining. The transformer is a 750kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 5.4%. If the Transformer fails College Union will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.12 College Union Transformer – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.13 Track Transformer

Description

Building Transformer TR-11 - Track (Located near Track)

Condition Assessment

Good Condition. The Transformer supplies 480/277V to Track and is fed from the College Union Vista Distribution Gear. The Transformer was installed in January 2018, and still has substantial service life remaining. The transformer is a 150kVA 3-Phase 480/277V rated step-down transformer, with an impedance of 3.7%. If the Transformer fails the Softball Field, Stadium, and Track will experience an outage.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

05.01.20.13 Track Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.14 Softball Field Transformer

Description	Building Transformer TR-12 - Softball Field (Located near Softball Field)
Condition Assessment	Good Condition. The Transformer supplies 480/277V to Softball Field and is fed from the Doghouse Sectionalizing Cabinet. The Transformer was installed in January 2018, and still has substantial service life remaining. The transformer is a 150kVA 3-Phase 480/277V rated step-down transformer. If the Transformer fails the Softball Field will experience an outage.
Element State:	Good

Assessment Criteria ***Existence*** ***Comments***

05.01.20.14 Softball Field Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

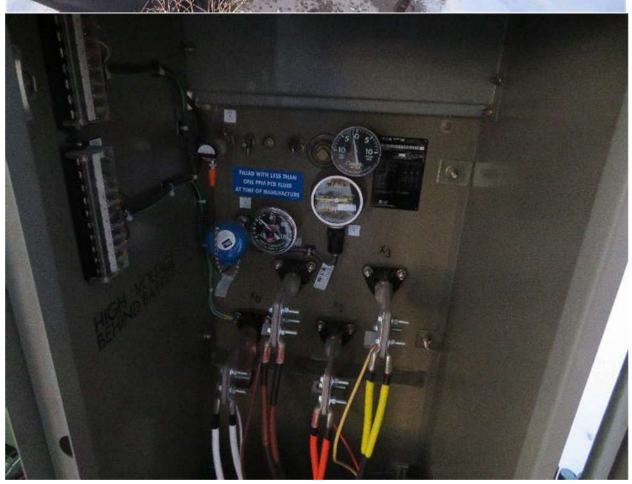
Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.15 Stadium Transformer

Description	Building Transformer TR-9 - Stadium (Located in Fenced Area Near Stadium)

Condition Assessment	Good Condition. The Transformer supplies 480/277V to Stadium and is fed from the Doghouse Sectionalizing Cabinet. The Transformer was installed in January 2018, and still has substantial service life remaining. The transformer is a 112.5kVA 3-Phase 480/277V rated step-down transformer. If the Transformer fails the Stadium will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***



05.01.20.15 Stadium Transformer – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

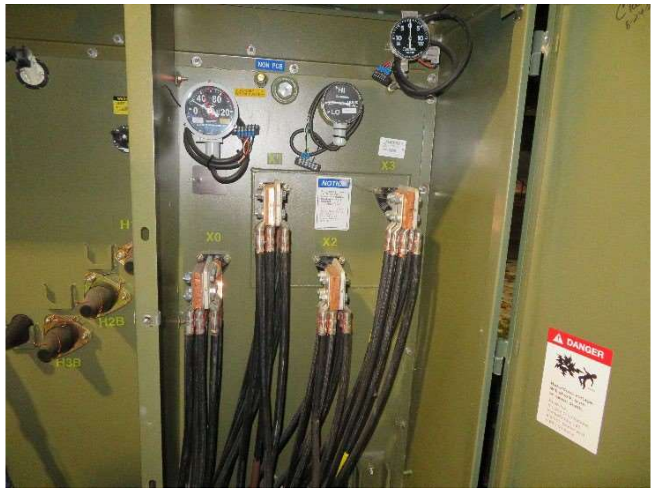
Brief Description	To provide continued annual testing to ensure the longevity of equipment.

Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.16 LRC & PE Transformer

Description	Building Transformer TR-10 – LRC & PE (Located between LRC and PE)
Condition Assessment	Good Condition. The Transformer supplies 480/277V to LRC and PE and is fed from the College Union Vista Gear. The Transformer was installed in January 2020, and still has substantial service life remaining. The transformer is a 750kVA 3-Phase 480/277V rated step-down transformer with a 5.94% impedance. If the Transformer fails, LRC and PE will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***



05.01.20.16 LRC & PE Transformer – Event 1

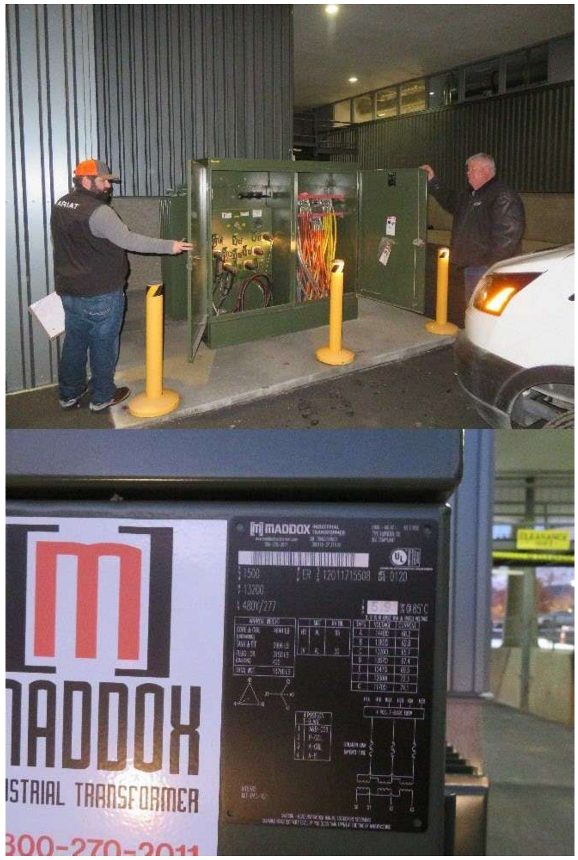
Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.17 Cornett Transformer

Description	Building Transformer Cornett (Located in Cornett quad)
Condition Assessment	Good Condition. The Transformer supplies 480/277V to Cornett and is fed from the Cornett Vista Gear. The Transformer was installed in January 2020, and still has substantial service life remaining. The transformer is a 1500kVA 3-Phase 480/277V rated step-down transformer with a 5.9% impedance. If the Transformer fails Cornett will experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***



05.01.20.17 Cornett Transformer – Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Testing	Annually	TBD – Existing Service Contract	Low	Field Observations

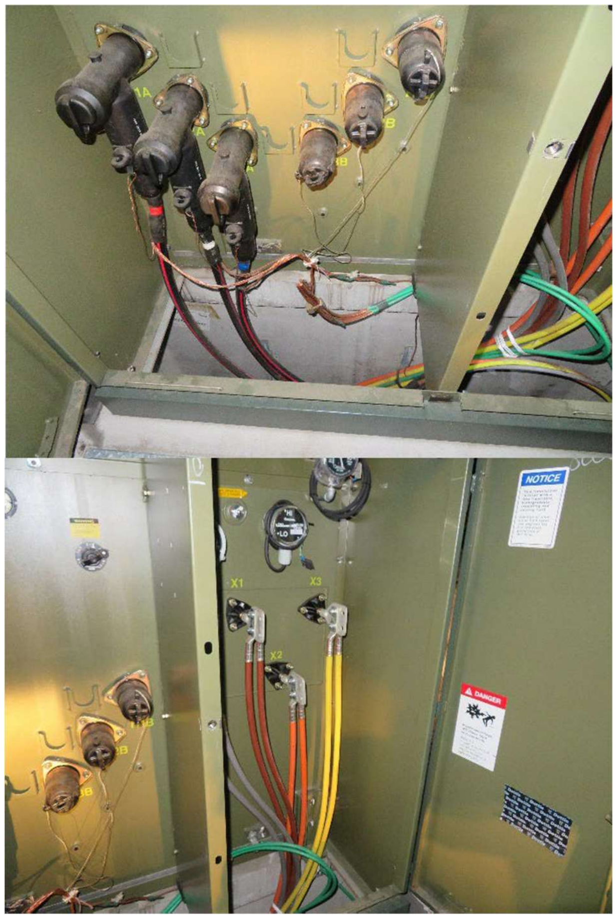
Brief Description	To provide continued annual testing to ensure the longevity of equipment.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.20.18 Facilities Transformer

Description	Building Transformer Facilities (Located by Facilities Retaining Wall)

Condition Assessment	Good Condition. The Transformer supplies 480/277V to Facilities and is fed from the Cornett Vista Gear. The Transformer was installed in January 2020, and still has substantial service life remaining. The transformer is a 3-Phase 480/277V rated step-down transformer with a 5.0% impedance. If the Transformer fails, Facilities experience an outage.
Element State:	Good

Assessment Criteria	***Existence***	***Comments***



05.01.20.18 Facilities Transformer – Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2023	$1000	High	Field Observations

Brief Description	To provide continued annual testing to ensure the longevity of equipment. Service Bonding Appears to occur at Transformer, and may also

	occur at MDP. If so, this is a code violation and should be corrected.
Event Justification & Strategy	Providing annual testing will help identify potential issues before they become critical to the equipment.
Implication of Event Deferral	Potential reduction to the service life of the equipment.

05.01.30 Primary Conductors

See Exhibit A – Primary Conductor Condition Schedule

EXHIBIT A: 05.01.30 Oregon Tech Primary Conductor Condition Schedule

Ref.	Description	System	Direct Buried	Concrete Encased	Conductor Material	Includes Ground	Approx. Age	Condition	Capacity (Amps)	Termination Type: ***Dead Break*** *Load Break* *Stress Cone* ***(Exposed terminal landing)***	Notes	Event	Event Cost	Event Year	Data Origin
A	Feed From Utility (Utility Pole to Mud-Hut)	Main Campus	X		Aluminum	X	50+	Poor	200	Load Break	Appears to be original to Campus	Replace	Part of 12kV MDP Relocation	2023	Field Observations, and Record Drawings dating back to 1994
B	Feed From Utility (Owned by Utility) to SSA	East Upper	N/A- Owned by Utility												
C	Feed from Chiller Building to West Distribution	Main Campus		X	Copper	X	13	Good	200	Stress Cone & Load Break		Maintain	None	None	Experience
D	West Distribution to Purvine Feed	Main Campus	X		Aluminum	Unknown	40+	Fair to Poor	100	Stress Cone & Dead Break		Replace	$50000	2028	Field Observations, and Record Drawings dating back to 1994
E	Purvine to CEET Feed	Main Campus			Aluminum	X	2	Good	100	Load Break		Maintain	None	None	Experience
F	West Distribution to Cornett Distribution	Main Campus			Copper	X	30+	Fair to Poor	100	Dead Break		Replace	$75000	2028	1994 Record Drawings
G	Cornett Distribution to Cornett Transformer	Main Campus			Aluminum	X	3	Good	100	Load Break & Dead Break		Maintain	None	None	Field Observations
H	Cornett Distribution to Facilities Transformer	Main Campus			Copper	X	3	Good	100	Load Break & Dead Break		Maintain	None	None	Field Observations & Experiences
I	Cornett Distribution to PE Distribution Link	Main Campus			Aluminum	Unknown	30+	Fair to Poor	150	Dead Break	When Vista Gear was installed load was redistributed improperly, potentially loading this and other feeders beyond their ratings, particularly with solar and utility services.	Replace	$50000	2023	Field Observations, and Record Drawings dating back to 1994
J	Feeder to PE & LRC Transformer	Main Campus			Aluminum	X	50+	Poor	100	Load Break & Dead Break		Replace	$15000	2025	Field Observations, and Record Drawings dating back to 1994
K	PE Distribution to Chiller Building	Main Campus		X	Copper	X	6 – 15	Good	300	Stress Cone & Dead Break	2009 Conductor was supplemented with parallel in 2017	Maintain	None	None	Experience
L	PE Distribution to College Union Transformer	Main Campus			Copper	X	6	Good	600	Dead Break		Maintain	None	None	Experience
M	PE Distribution to Field Lighting Transformer	Main Campus			Copper	X	6	Good	600	Dead Break		Maintain	None	None	Experience
N	Field Lighting Transformer to North 12kV Distribution	Main Campus			Copper	X	6	Good	600	Dead Break		Maintain	None	None	Experience
O	North 12 kV Distribution to Solar Field	Main Campus			Aluminum	X	10+	Good	100	Dead Break	Maintained by Tesla				2012 Solar Drawings from Interconnection Agreement
P	North 12 kV Distribution to Moehl Stadium Transformer	Main Campus			Copper	X	6	Good	600	Dead Break		Maintain	None	None	Experience
Q	North 12 kV Distribution to Softball Field Transformer	Main Campus			Copper	X	6	Good	600	Dead Break & Load Break	Transformer loop feed is not rated for 600A.	Maintain	None	None	Experience
R	SSA to Well #7	East Upper			Copper	X	10+	Good	100	Load Break		Maintain	None	None	Field Observations
S	SSA to SSB	East Upper			Copper	X	10+	Fair	200	Load Break	Replace terminations and inspect conductor at SSB due to water ingress	Repair	$2000	2028	Field Observation

T	SSB to Heat Exchange Transformer	East Upper			Copper	X	10+	Fair	200	Load Break	Replace terminations and inspect conductor at SSB due to water ingress	Repair	$2000	2028	Field Observation
U	SSB to SSC	East Upper			Copper	X	15+	Fair	200	Load Break	Replace terminations and inspect conductor at SSB & SSC due to water ingress	Repair	$4000	2028	Field Observation
V	SSC to Student Health Transformer	East Upper			Aluminum	X	2	Good	100	Load Break		Maintain	None	None	Field Observation
W	SSC to Arboretum Transformer	East Upper			Aluminum	X	15+	Good	100	Load Break	Single Phase	Maintain	None	None	Field Observation
X	SSC to Villages Distribution	East Upper			Copper	X	15+	Fair	200	Load Break	Replace terminations and inspect conductor at Village Distribution due to water ingress	Repair	$2000	2028	Field Observation
Y	Villages Distribution to Villages Transformer	East Upper			Copper	X	15+	Fair	200	Load Break	Replace terminations and inspect conductor at Village Distribution due to water ingress	Repair	$2000	2028	Field Observation
Z	Villages Distribution to Res. Hall Transformer	East Upper			Copper	X	15+	Fair to Poor	200	Load Break	Either at installation or in the subsequent period, conductor insulation may have been damaged during pull; however, due to excessive debris on conductors, the extent of damage was not observable. Clean conductors and observe conditions for all 2010 Village construction-era projects.	Maintain	$2000	2025	Field Observation

11.20 Geothermal

Description

The Oregon Tech campus geothermal system is comprised of geothermal production from hot near-surface aquifers, distribution for heating, collection of the cooled GEO fluids, and injection back into the same or similar aquifer.

After pumping from the production wells, the GEO fluid is stored in a vented tank and flows by gravity from there through supply piping to heat exchangers where the heat is extracted for space heating, domestic hot water heating, and sidewalk snowmelt. The cooled geothermal fluid is collected for return into the same or similar aquifer through injection wells.

GEO energy is also used for power generation, mostly as a demonstration project in concert with the school's mission to support renewable energy education. A small (280 kW) power plant at the GEO mechanical building offsets the electrical power needed to operate the GEO heating system, resulting in net-zero energy use for heating. Surplus power from that plant also helps offset campus electrical use.

A larger 2 MW power plant is located east of the GEO mechanical building. That plant is not currently functional and is not in the scope of this study.

11.20.01 Production and injection

Description

Production wells for campus heating are primarily Well-5 and Well-6, located on the southeast side of campus.

Production Well-7 is located in the south parking lot and was drilled primarily for power production. Well-7 can also be used as a backup for campus heating, but the pump capacity is much higher than is needed for heating. The result is higher power use than the primary wells. Well-7 is usually not used except for emergency backup because the large power plant is currently not functional.

Injection wells #1 and #2 are located at the south end of the soccer field on the southwest side of campus. Injection pumps located west of Purvine hall pump the cooled geothermal fluid into the injection wells.

11 Public Works

Injection well #3 is located north of the campus facilities building. This well was drilled to inject the geothermal fluid produced by production well-7 and used in power generation.

11.20.01.01 Production Well-5

Element Instance: 11.20.01.01 Production Well-5

Description

Production Well-5 is 1716 ft deep, with a 6-5/8" casing at the bottom, and a 10-3/4" casing from the surface to about 814 ft. The pump is a line-shaft deep well turbine pump with 9.25" OD bowls that are a tight fit to the casing. The pump is rated for 500 GPM, and has a 100 ho motor with VFD speed control

Production Well-5 was recently rebuilt, with a new casing, new pump, and reconditioned motor. The original design intent was to increase the casing size to 12" to better accommodate the pump size. Construction difficulties led to the original contractor failing to complete the job. The replacement contractor completed the project as directed by Oregon Water Resources, without following the original contract specifications. The casing installed was 10" rather than the specified 12" and the well was possibly not cleaned properly.

The original well temperature was 196°F. After reconstruction, the well temperature has dropped to 193°, and the well is not meeting the design flow. The indication is that there is debris in the well that is restricting flow.

Condition Assessment

The pump and casing are new, but performance is below design, indicating possible partial plugging of the well.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

Event Type	Event Year	Event Cost	Priority	Data Origin
Clean well	2025	$300,000	High	Field Observation

Brief Description	Remove the pump, clean the well to the original depth of 1716 ft with a bailer, develop the well to clear plugging, possibly deepen the well if indicated, and reinstall the pump.
Event Justification & Strategy	The decline in Well-5 temperature and flow reduces the ability to meet campus heating demand in cold weather.
Implication of Event Deferral	Continued operation at reduced flow and temperature, increased power requirement due to greater pumping depth.

11.20.01.02 Production Well-5 Piping

Element Instance: 11.20.01.02 Production Well-5 Piping

Description	Production Well-5 GEO water is conveyed about 500' to a storage tank in the geothermal (GEO) mechanical building through a buried 6" steel pipe. The pipe was originally installed in about 1965 and has the potential to be significantly corroded. About 20 ft of pipe at the GEO building was recently replaced due to corrosion damage.
Condition Assessment	The buried steel pipe is potentially compromised due to exterior corrosion. Both ends of the pipe as recently observed are still serviceable. The condition along the pipe is unknown.

Element State: Fair

Assessment Criteria	Existence	Comments

11.20.01.02 Production Well-5 Piping Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair/ clean well	2025	$200,000	High	Field Observation

Brief Description	Install about 500' of 6" pre-insulated fiberglass pipe from the existing new piping at the well to the new piping entering the GEO mechanical building. Also, include new power and control conduits in the trench.
Event Justification & Strategy	Replacement of the old steel pipe will improve system reliability.
Implication of Event Deferral	Possible loss of heat due to piping failure.

11.20.01.04 Production Well-6

Element Instance: 11.20.01.04 Production Well-6

Description

Production Well-6 is 1805 ft deep with a water temperature of about 196°F.

According to the 1963 well log, the well is cased to 1805 ft. Casing size with estimated depth:

Size	Start depth ft	End Depth ft
12-3/4	Surface	416
10-3/4	Surface	867
8-5/8	850	1144
6-5/8	1128	1805

According to the well log, the well casing is sealed with grout to a depth of 865 ft., which would comply with current well standards.

The condition of the casing in Well-6 is unknown. If the casing is good, the well likely can be cleaned and put back in service.

If the casing has deteriorated similarly to Well-5 then probably just the bad casing could be replaced, without the need to remove and replace good casing to seal the well as was required in Well-5

Condition Assessment The well as originally constructed is in compliance with the well code. The casing may have deteriorated, but the condition is unknown.

Element State: Unknown

Assessment Criteria	***Existence***	***Comments***

11.20.01.04 Production Well-6 Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Inspection	2025	$200,000	High	Field Observation

Brief Description

Remove the pump, run a temperature probe to the bottom of the well to evaluate temperature and production zones, cool the well to allow camera inspection, and inspect the well casing.

If indicated by the temperature probe and hydrogeology, consider deepening well to improve productivity.

If the casing is good and the well is not deepened, clean the well to the original depth of 1805 ft with a bailer, clean perforations, and prepare to put it back in service.

Event Justification & Strategy

Inspection of the well to evaluate repairs needed.

Implication of Event Deferral

Potential for further deterioration of the well that interrupts useful operation. Potential loss of heat for campus.

11.20.01.04 Production Well-6 Event 2

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2025	$300,000	High	Field Observation

Brief Description	If inspection reveals deteriorated 10-5/8" casing, remove the bad casing.(likely no deeper than static water level of 360ft, based on Well-5) With the 10-3/4" casing removed, inspect the 12-3/4" casing. If the 12-3/4" casing is bad, remove the bad casing (likely no deeper than ~100 ft based on Well-5). Install new 12-3/4" casing as indicated and re-grout. Install new 10-3/4" casing as indicated. Deepen well if indicated by evaluation and well design Clean well and develop to the original or new depth with the bailer and prepare to put it back in service.
Event Justification & Strategy	The deteriorated well casing needs to be replaced for continued reliable operation. Possibility of improved productivity by deepening well.
Implication of Event Deferral	Potential for further deterioration of the well that interrupts useful operation. Potential loss of heat for campus.

11.20.01.05 Production Well-6 Pump

Element Instance: 11.20.01.05 Production Well-6 Pump

Description	The Well-6 pump is a line-shaft deep well turbine pump, rated for about 350 GPM, with a 100 hp motor with VFD speed control. The exact pump size is unknown. Install new pump bowls, suitably sized for the capacity, drawdown, and casing diameter. Install new column pipe, line shaft, and bearings. Recondition or replace the motor.
Condition Assessment	The motor appears to be serviceable. The pump seems to be working normally, but the exact condition is unknown. There is likely wear that is affecting the capacity and efficiency of the pump.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

11.20.01.05 Production Well-6 Pump Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Replace Pump	2025	$200,000	High	Field Observation

Brief Description	Replace the pump with a new pump sized for the required flow, well diameter, and well drawdown.
Event Justification & Strategy	The existing pump is beyond the expected service life.
Implication of Event Deferral	Potential for failure and loss of campus heat.

11.20.01.06 Production Well-6 Piping

Element Instance: 11.20.01.06 Production Well-6 Piping

Description

Production Well-6 GEO water is conveyed about 540' to a storage tank in the geothermal (GEO) mechanical building through a buried 6" steel pipe. The pipe was originally installed in about 1965 and has the potential to be significantly corroded. Recently, a parking lot was built over the pipe route, and the pipe is totally inaccessible for maintenance or repair. When the parking lot was built, a 6" fiberglass line was installed outside the affected area from Well-6 to Well-5. That pipe needs to be extended about 500 ft to the GEO Mechanical building.

In 2022, the pipe started leaking near the GEO building, and. about 20 ft of pipe was replaced.

Condition Assessment

The buried steel pipe is potentially compromised due to exterior corrosion. The condition along the pipe is unknown.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

11.20.01.06 Production Well-6 Piping Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
New Pipe	2025	$200,000	High	Field Observation

Brief Description	Install about 500' of 6" pre-insulated fiberglass pipe from the existing new piping from the Well-6 to the new piping entering the GEO mechanical building. Also, include new power and control conduits in the trench.
Event Justification & Strategy	Replacement of the old steel pipe will improve system reliability.
Implication of Event Deferral	Possible loss of heat due to piping failure.

11.20.01.10 Injection Pump Station

Element Instance: 11.20.01.10 Injection Pump Station

Description

The injection pump station is located west of Purvine. The pump station consists of a storage tank and two end-suction centrifugal pumps that boost the GEO fluid from the tank through an 8" pipeline to the injection wells. The pumps are controlled with variable-speed VFD drives in a lead-lag operation, with one or both pumps operating based on flow.

If the pumps fail to operate, the GEO fluid overflows into the City storm drain.

Condition Assessment The pumps and controls are new and in good condition.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

11.20.01.10 Injection Pump Station Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*

Routine maintenance	2033	$20,000	Medium	Field Observation

Brief Description	Monitor pumps and controls; repair as needed
Event Justification & Strategy	Routine maintenance to maintain reliable operation
Implication of Event Deferral	Failure of injection pumps results in GEO discharge to the storm sewer, in violation of City code.

11.20.01.11 Injection Well-1

Element Instance: 11.20.01.11 Injection Well-1

Description

Injection Well-1 is about 2000 ft deep. Per the well log from 1988, the casing consists of a 14" casing from the surface to 75 ft and a 10" casing/ inner liner from the surface to 1685 ft. The 10" casing is grouted from 1350 ft to 1409 ft with cement, and is sealed from 9 ft to 1350 ft with bentonite. The 10" casing is intended to expand freely with temperature change during GEO injection.

The GEO injection fluid is discharged directly into the 10" casing pipe at the surface. Over time, the 10" pipe has become significantly plugged with scale, so a 3" camera could not be lowered to inspect the pipe. The 10" casing is significantly corroded to the extent that near-surface groundwater is leaking into the well.

The well is currently not being used due to the condition, with the entire injection flow going to injection Well 2.

Condition Assessment

Injection Well-1 is in poor condition at the surface. Cleaning and camera inspection are needed to assess the condition deeper in the well.

Element State: Poor at the surface; unknown below.

Assessment Criteria	***Existence***	***Comments***

11.20.01.11 Injection Well-1 Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Repair well	2025	$300,000	Medium	Field Observation

Brief Description

Repair well; possible sequence:

- Clean wellbore
- Camera inspection
- Remove damaged casing and replace
- Clean well and perforations
- Reconnect injection piping
- Reconditioning of the well will likely require the removal and replacement of the well vault.

Event Justification & Strategy

Well has failed and is required for injection.

Implication of Event Deferral

Potential injection failure if there is a problem with injection well-2. Loss of injection results in GEO discharge to the storm sewer, in violation of City code.

11.20.01.12 Injection Well-2

Element Instance: 11.20.01.12 Injection Well-2

Description

Injection Well-2 is about 1675' deep. Per the well log from 1991, construction is similar to Injection Well-1.

The well is currently being used for the entire injection flow, as injection Well-1 is out of service.

Condition Assessment

Camera inspection in 2018 showed that the well casing was in good condition, but there is some scale accumulation inside the casing.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

11.20.01.12 Injection Well-2 Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Clean well	2025	$100,000	Medium	Field Observation

Brief Description	Clean wellbore and perforations
Event Justification & Strategy	Well is required for GEO injection, especially with the failure of Well 1.
Implication of Event Deferral	Potential injection failure if there is a problem with injection Well 2, and Well 1 is out of service. Loss of injection results in GEO discharge to the storm sewer, in violation of City code.

11.20 Geothermal Heating

11.20.02 GEO Building

Description

The GEO water from the production wells is delivered to a GEO mechanical building, which includes:

- Piping from Wells 5,6,7
- GEO storage tank
- Pump and piping serving Crystal Terrace
- Pipe serving campus
- GEO power generator
- Electrical service and controls for Wells 5,6

11.20.02.01 GEO Storage Tank

Element Instance: 11.20.02.01 GEO Storage Tank

Description

All geothermal production used for campus heat is collected in a 4000-gal receiving/storage/settling tank and flows from there by gravity to the campus. The tank provides only about 5 minutes of storage at the campus design flow of 800 GPM.

Since the tank is not pressurized, the elevation of the water surface in the tank determines the head available to circulate water to campus heat loads. The highest elevation facility currently served is the "Center for Sustainable Living" student housing. At peak flow, there isn't adequate pressure head to supply that facility so a booster pump is required.

The existing tank is steel and is exposed to atmospheric oxygen through the tank vent. Hot, wet, steel exposed to oxygen can corrode rapidly. The tank is about 60 years old and could be significantly corroded.

Condition Assessment The existing tank could be significantly corroded, which could result in catastrophic failure.

Element State: Poor to fair

Assessment Criteria	***Existence***	***Comments***

11.20.02.01 GEO Storage Tank Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Construct a new GEO tank	2025	$250,000	High	Field Observation

Brief Description

Replace the existing tank with a larger insulated concrete tank buried up the hillside from the GEO building. Features/benefits:

- More storage volume, ~30 minutes at design flow.
- Higher head, better-supplying campus, and eliminating the need for booster pumps.
- Improved sediment separation, with a drain to waste
- Frees up space in the building.
- Accept flow from power plant returns, both 280 kW and 2 MW plants
- Water-tight, crack-resistant construction
- Insulation for heat retention

Event Justification & Strategy

The existing tank could be subject to unexpected failure, that would interrupt campus heating for an extended period. A new tank can be constructed while the existing tank remains in operation.

Implication of Event Deferral Chance of extended heating system disruption.

11.20.02.02 GEO Building Piping

Element Instance: 11.20.02.02 GEO Building Piping

Description

All geothermal production used for campus heat is routed through piping in the GEO building. Existing connections to be maintained:

- GEO production flow from Wells 5,6,7; with flow metering
- Piping supplying GEO to campus for heating
- Pump and piping to and from Crystal Terrace
- Connection to existing GEO power plant, with bypass when the plant is not operating.
- Strainer for GEO flow ahead of power plant
- Connection to existing GEO power plant cooling tower

Condition Assessment

The existing pipe could be significantly corroded, which could fail. Some existing valves are no longer operable.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

11.20.02.02 GEO Building Piping Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Replace and reconfigure piping	2025	$200,000	High	Field Observation

Brief Description

Redesign and replace existing piping and valves in the GEO building. Maintain existing functionality with the following additions:

- Reconfigure piping and pumps to Crystal Terrace to provide better pump suction conditions, eliminating the tendency to cavitate. install both existing pumps to operate in a lead/lag configuration.

- New GEO strainer ahead of the power plant, with dual strainers allowing cleaning while operating.
- Provide supply and return pipe connections to the remote storage tank
- Provide a visual stand-pipe within the building to indicate the tank level
- Modify piping to the power plant to accommodate the potential replacement GEO power generator.
- Provide connection for additional GEO feed line to campus

Event Justification & Strategy Existing piping could be subject to unexpected failure that would interrupt campus heating.

Implication of Event Deferral Chance of extended heating system disruption.

11.20 Geothermal Heating

11.20.03 GEO Distribution

Description

The GEO water is delivered to the campus buildings through a piping system that includes both direct buried pipe and pipe routed through utility tunnels. Supply water temperature is typically 192°F if the power plant is not running, or 165°F if the power plant is running.

Heat is extracted from the GEO supply (GEOS) water in heat exchangers to provide heat to building heating water loops or domestic hot water.

The return water from upper campus buildings flows by gravity through pipes in the tunnels to a collection tank in Purvine, at a typical temperature of 145°F.

The return water in Purvine is then pumped to heat exchangers in Purvine and CEET to provide heating for buildings, domestic hot water, and snowmelt.

The return water from Purvine and CEET heat exchangers flows to the injection tank, west of Purvine, where it is pumped into the injection wells.

11.20.03.01 GEO Piping

Element Instance: 11.20.03.01 GEO Piping

Description

Direct-buried piping conveys GEOS water to:

- Sustainable Village
- Residence hall
- Utility tunnel between Snell and College Union

The supply to Sustainable Village includes a booster pump station in a vault in the parking lot.

The direct-buried pipe is mostly pre-insulated fiberglass pipe although there may be some sections of steel or ductile iron pipe.

Valves at branch points in the buried piping are intended to allow the isolation of portions of the supply system for maintenance.

Supply piping in the tunnels conveys GEOS to:

- East Branch:
  - College Union (CU)
  - Athletics
- West Branch:
  - Snell
  - Owens
  - Dow
  - Semon
  - Boivin
  - Cornett
  - Facilities Services
  - Learning Resource Center (LRC)

Return piping is mostly fiberglass, although there is a short section of steel pipe in the tunnel near the Residence hall and CU. Return piping in the tunnels conveys all the GEOR flow to a receiving tank in Purvine, where the return water is used to heat Purvine and CEET.

Valves at branch points in the tunnels are intended to allow the isolation of portions of the supply and return systems for maintenance. Those valves are mostly inoperable.

Currently, a leak or failure anywhere in the system requires that the GEO heating system for the entire campus be shut down until the problem is repaired. It would be highly advantageous if the supply system were looped, similar to a fire water supply system so that a portion of the system could be isolated for repair without shutting off the entire system. It would also be beneficial to be able to isolate

	sections of the system through remote control rather than requiring entry into the tunnels. The tunnels are confined spaces, and the GEO water is hot. Leaks in the piping within the tunnels are a life and safety risk. It is important to provide the ability to quickly isolate leaks in the system without exposing personnel to that safety risk.
Condition Assessment	Condition of GEO distribution system components: • Buried fiberglass pipe is expected to be in good condition. • The fiberglass pipe in the tunnels is mostly in good condition; there have been stress cracks at some elbows that have been repaired. Other minor cracks and leaks may also exist but are readily repairable. • Isolation valves are mostly in poor condition and inoperable. The result is that any failure in the system cannot be isolated for repair, necessitating shutting off the entire GEO system.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

11.20.03.01 GEO Piping Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Repair	2025	$20,000	High	Field Observation

Brief Description	Replace 4" and 6" steel return pipes in the tunnel near the Residence hall with fiberglass.
Event Justification & Strategy	Steel pipe is subject to corrosion
Implication of Event Deferral	Chance of extended heating system disruption.

11.20.03.02 GEO Piping Event 2

Event Type	Event Year	Event Cost	Priority	Data Origin
Repair	2025	$20,000	High	Field Observation

Brief Description	Repair valves and piping thrust restraint in a valve vault east of Snell.
Event Justification & Strategy	Valves control GEOS connection to the Residence hall. The valve is non-functional and the connection is improperly restrained.
Implication of Event Deferral	Chance of extended heating system disruption.

11.20.03.03 GEO Piping Event 3

Event Type	Event Year	Event Cost	Priority	Data Origin
Repair/ Upgrade	2025	$400,000	High	Field Observation

Brief Description	Replace isolation valves in GEOS and GEOR piping at branch points and connections to buildings in the tunnels. Add valves to allow buildings to be fed from either direction in a looped supply system.
Event Justification & Strategy	Valves will provide improved resiliency and safety by allowing maintenance on portions of the system without shutting off the entire system.
Implication of Event Deferral	Chance of extended heating system disruption.

11.20.03.04 GEO Piping Event 4

Event Type	Event Year	Event Cost	Priority	Data Origin
New Construction	2028	$1,000,000	High	Field Observation

Brief Description	Add a new buried GEOS pipeline from the GEO building to the existing tunnel between LRC and Cornett, and a parallel return pipeline from Sustainable Village to the tunnel. This pipeline will create a looped GEOS system for most of the campus, allowing the isolation of a portion of the

system for maintenance. It will also add a GEO supply and return route for the proposed new residence hall.

Event Justification & Strategy

A looped system provides improved resiliency and safety by allowing maintenance on portions of e system without shutting off the entire system. The pipeline will also provide supply and return connections needed for the proposed Residence Hall.

Implication of Event Deferral

Chance of extended heating system disruption.

11.20.04.01 Snowmelt

Description

Oregon Tech experiences several snowfall events each winter, and about seven months per year when conditions could be conducive to snow or ice accumulation on outdoor sidewalks and steps. Geothermally-heated thermal snowmelt/de-icing systems are installed in many of the sidewalks and steps which provide these benefits:

- Reduced risk of slip and fall due to icy walking surfaces
- Reduced concrete deterioration from freeze-thaw cycles
- Reduced concrete deterioration and environmental risk from de-icing salt

A thermal snowmelt system works by maintaining a concrete surface temperature of about 38°F, warm enough to melt fresh snow and prevent ice accumulation. The heat load to maintain a clear sidewalk depends on snowfall rate, wind speed, and temperature. The existing snowmelt systems at Oregon Tech and in Klamath Falls are designed for a heat output of about 80 Btu per square ft (Btu/sf). That heat output is not adequate to keep up with heavy snowfall but will catch up in a reasonable time. It does prevent ice from sticking to the concrete, making manual removal much easier if needed. 80 Btu/sf is also not able to keep the concrete surface above 32°F in extremely cold weather with high wind. However, snowfall in Klamath Falls does not usually occur in those conditions so the sidewalk would likely be dry.

Snowmelt is a lower priority than building heat, so in cold weather, it may be necessary to curtail snowmelt operations to adequately supply building heat. A standby mode snowmelt operation can maintain some heat in the concrete at a lower heat output than would be required for active melting.

The snowmelt mechanical system consists of a heat exchanger, circulation pump, supply and return mains, distribution headers, and pex tubing embedded in the sidewalk concrete. The mechanical equipment for the newer, larger, existing snowmelt systems is located in building mechanical rooms. These larger snowmelt systems total about 60,000 square feet (sf), and include:

- Dow Hall
- Cornett Hall
- CEET
- Center for Sustainable Living

Several smaller, generally older, snowmelt systems are supplied by mechanical equipment located in the utility tunnels. These systems total about 5,000 sf and include:

- Snell steps
- College union and residence hall steps
- Owens steps
- Bovin Ramp

About 40,000 sf of snowmelt tubing has been installed in sidewalks, but not connected to pumps or heat exchange equipment. Most of the supply mains are stubbed into the tunnels, with the original intent of installing equipment in the tunnel to supply the heat.

The total installed snowmelt system area is about 105,000 sf. As additional sidewalks are replaced over time, the intent is to include snowmelt in most of the sidewalks. It is likely that an additional 100,000 sf. of existing sidewalks could be added, bringing the total to about 200,000 sf., not including a new residence hall or other new buildings. At 80 Btu/sf., the potential snowmelt heat load would be 16,000,000 Btu/hr.

As buildings become more efficient and as snowmelt area is increased, snowmelt will likely be the largest heat load on the system. The location of the snowmelt systems centralized in building mechanical rooms provides more ability to control snowmelt operation or shed snowmelt load as needed to meet the higher priority building heating load. Also, the removal of snowmelt mechanical equipment from the tunnels will reduce the safety concern of a hot water leak in the tunnels' confined space. Snowmelt supply and return mains can be routed through the tunnels to the service snowmelt connections.

Snowmelt Recommendations:

- Supply snowmelt connections from building mechanical rooms, eliminating pumps and heat exchangers in tunnels

- Connect new and existing tunnel-fed snowmelt systems to new snowmelt supply and return mains routed through the tunnels.
- Generally supply snowmelt systems from GEO return piping, reducing the impact on required system GEO flow
- Provide controls with the ability to shed snowmelt heating load when required to meet building heating requirements.

Condition Assessment

Existing smaller snowmelt systems are generally installed in the tunnels with limited access, limited controls, and potential for leaks of hot GEO water in a confined space. Those systems are generally in poor to fair condition.

Newer, larger systems such as CEET are in good to excellent condition.

Element State: Poor to Good

Assessment Criteria	***Existence***	***Comments***

11.20.04.01 Snowmelt Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2025	$500,000	High	Field Observation

Brief Description

Consolidate about 2,000 sf. of separate snowmelt systems served from GEO supply in the tunnels to central systems in building mechanical rooms, served by GEO return.

Connect 40,000 sf. of snowmelt systems where the tubing is installed but not connected.

Design and install central snowmelt supply system(s) to serve the above loads, plus an additional 100,000 sf. of potential future sidewalk snowmelt.

Event Justification & Strategy

Snowmelt systems are valuable for winter safety but need to be managed better to properly utilize the limited geothermal resource.

Implication of Event Deferral

Snowmelt is not activated on existing sidewalks.

11.20.04.02 Snowmelt Event 2

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2028	$800,000	High	Field Observation

Brief Description	Install snowmelt in an additional 100,000 sf. of sidewalks and outside stairways.
Event Justification & Strategy	Snowmelt systems should be installed as sidewalks and stairs are replaced.
Implication of Event Deferral	No snowmelt in existing or future renovated sidewalks.

11.30 Site Chilled Water

11.30.01 Chillers (CH-1, CH-2)

Element Instance: 11.30.01.01 Chillers (CH-1, CH-2)

Description

The central chiller plant consists of two Trane centrifugal chillers Models CVHF640 (CH-1) and CVHE320 (CH-2)with nominal cooling capacities of 500 tons and 320 tons, for a total of 820 tons. The chillers are not operating to full capacity; likely due to problems with the cooling tower and chiller control. The combination of low chilled water setpoint and high condenser water temperature is pushing the compressor operation into surge conditions.

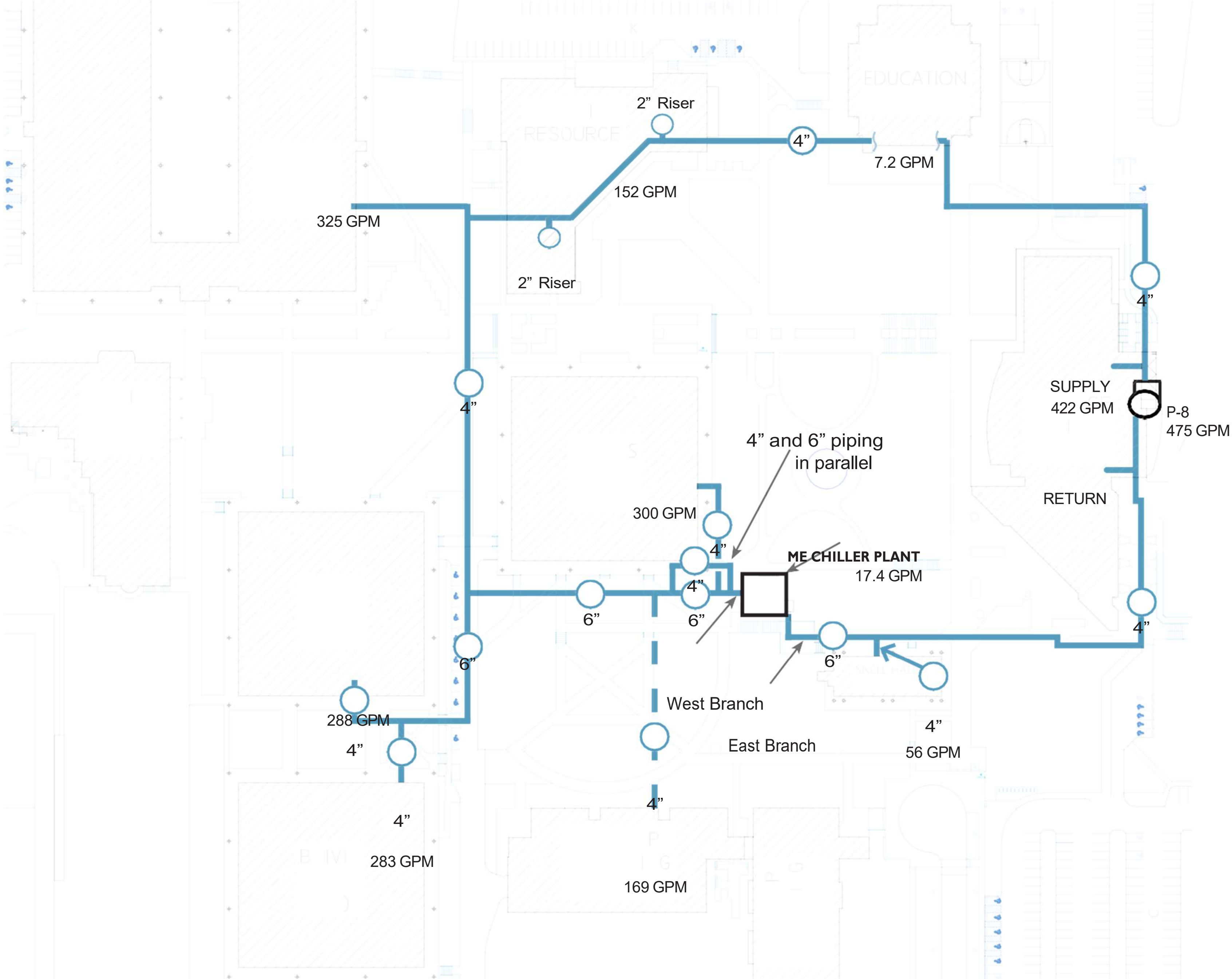
The chillers are currently operating with R123 refrigerant; which is scheduled for phase-out in 2030. Reclaimed refrigerant will likely continue to be available for service needs after that, but it would be prudent to plan to replace the refrigerant or chiller as the phase date approaches.

Condition Assessment

The chillers were rebuilt about 5 years ago, and are generally in good condition. Chiller controls are obsolete and should be upgraded

Element State:	Good		

Campus Chilled Water Piping diagram
Oregon tech 2023 master plan



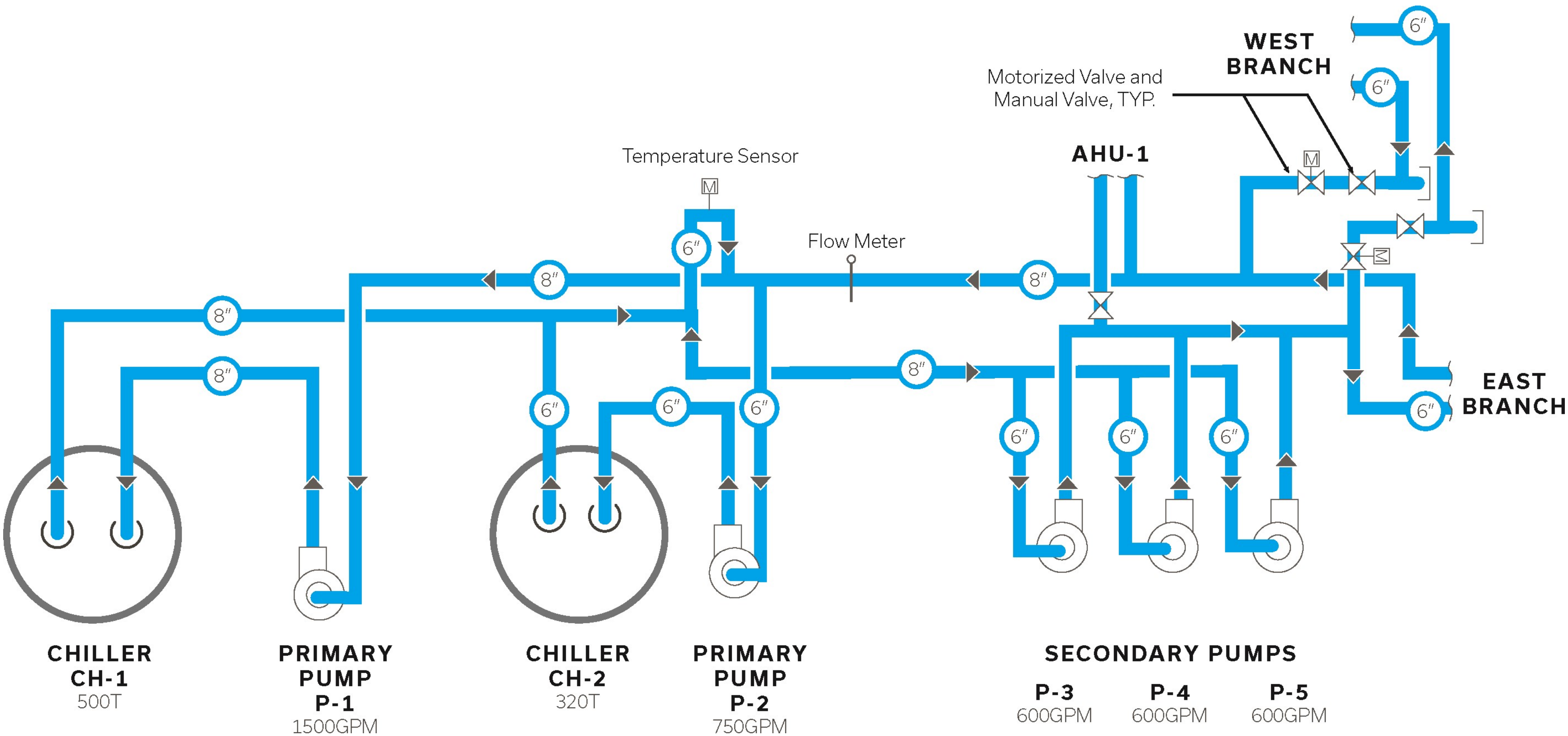
Supply & Return in Tunnels

Direct Buried Supply & Return Pipe

Rev 0, 1/9/2023

Plant Chilled Water Flow diagram

Oregon tech 2023 master plan



Rev 0, 1/9/2023


CH-1 CH-2

11.30.01.01 Chillers (CH-1, CH-2) Event 1

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replace chiller controls	2025	$100,000	High	Field Observation

Brief Description	Upgrade chiller controls to the latest version, with BacNet connectivity. Add VDF chiller compressor speed control. Implement ASHRAE chilled water temperature reset strategy.
Event Justification & Strategy	The upgrade would be accomplished by the existing chiller maintenance contractor. Benefits include more efficient operation and chiller longevity.
Implication of Event Deferral	The deferred benefit of more efficient operation is the risk of chiller failure if the operation in compressor surge continues.

11.30.01.02 Chillers (CH-1, CH-2) Event 2

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Replace chiller refrigerant	2033	$100,000	Medium	Field Observation

Brief Description	Replace the chiller refrigerant with a long-term approved refrigerant such as R1233ZD.
Event Justification & Strategy	The existing refrigerant R-123 is scheduled for phase-out starting in 2030. Would probably schedule replacement to coincide with a major rebuild unless the new refrigerant is a direct drop-in replacement.

Implication of Event Deferral	Phase-out of R-123 will make maintenance progressively more expensive as the refrigerant becomes less available.

11.30.02 Cooling Towers (CT-1,-2,-3)

Element Instance: 11.30.02 Cooling Towers (CT-1,-2,-3)

Description	Condenser water for the chillers is cooled by three Baltimore Air Coil model VTL-152NM cooling towers, each with 25 hp fans. Fans have VFD speed control. Cooling towers were installed in about 1999 and have not had significant maintenance since. Problems with the cooling tower are likely the primary cause of poor chiller performance.
Condition Assessment	The cooling towers are in poor condition with collapsing fill and debris accumulation. The result is poor cooling performance and higher energy use.

Element State: Poor

Assessment Criteria	***Existence***	***Comments***

Cooling Tower

11.30.02.01 Cooling Towers (CT-1,-2,-3) Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair cooling towers	2023	$100,000	High	

Brief Description	Remove tower fill, clean and repair tower casing, install new fill, and repair or replace water distribution piping and nozzles.
Event Justification & Strategy	Work is needed for the proper operation of the chillers. Work will likely be done by Maintenance staff this year.
Implication of Event Deferral	Continued poor performance of chillers; risk of chiller failure if the operation in compressor surge continues.

11.30.03 Condenser Water Tank

Element Instance: 11.30.03 Condenser Water Tank

Description	The cooling towers are located on the roof and operate with a dry sump. Cooled condenser water drains from the towers into a large steel storage tank in the chiller room. The major benefit of this configuration is that the condenser water is stored in a heated space rather than in the tower sump which is subject to freezing. The tank includes an access manway for inspection and cleaning. In the recollection of maintenance staff, the tank has never been opened.
Condition Assessment	From outward appearance, the tank is in good condition with no evidence of leaking. The internal inspection would require draining the tank and opening the manway flange.

Element State: Exterior: Good
Interior: Unknown

Assessment Criteria	***Existence***	***Comments***

Condenser water tank

11.30.03.01 Condenser Water Tank Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Clean and inspect tank	2023	$10,000	High	

Brief Description	Drain tank, clean, inspect internal coatings, and repair as indicated
Event Justification & Strategy	Coordinate with cooling tower maintenance
Implication of Event Deferral	Risk of tank failure if internal coatings are compromised.

11.30.04 Condenser Water Pumps (P-6,-7)

Element Instance: 11.30.04 Condenser Water Pumps (P-6,-7)

Description	Condenser water pumps P-6 (1250 GPM, 30hp)and P-7 (650 GPM, 15 hp) circulate condenser water to CH-1 and CH-2. Pump speed is controlled by VFDs which respond to the demand for condenser water from the respective chiller. The pumps pull from the condenser water tank through a common header and strainer and discharge to individual chillers. After the chillers, the flow recombines in a common header and discharges to the cooling tower spray nozzles.
Condition Assessment	The pumps are good quality and are in good condition. Pumps are fully rebuildable as needed.

Element State: Good

Assessment Criteria	***Existence***	***Comments***

Condenser Water Pumps

11.30.04.01 Condenser Water Pumps (P-6,-7) Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Monitor, repair as needed	2033	$5,000	High	

Brief Description	Monitor pump bearings and seals, and replace as needed.
Event Justification & Strategy	Routine maintenance
Implication of Event Deferral	Loss of cooling to campus buildings if pumps fail.

11.30.04.02 Condenser Water Pumps (P-6,-7) Event 2

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Replace VFDs	2028	$10,000	High	

Brief Description	Existing VFDs are more than 20 years old and are subject to possible failure at any time. The drives will likely need to be replaced in the next few years The pumps can operate at full speed in bypass mode but that can result in over-cooling the chillers in light load.
Event Justification & Strategy	Routine maintenance
Implication of Event Deferral	Loss of cooling to campus buildings if pumps fail.

11.30.05 Primary CHW Pumps (P-1,-2)

Element Instance: 11.30.05 Primary CHW Pumps (P-1,-2)

Description	Primary Chilled Water (CHW) pumps P-1 (1500 GPM, 25hp)and P-2 (750 GPM, 15 hp) circulate chilled water from CH-1 and CH-2 to the secondary CHW loop. Pumps operate at a fixed speed when the respective chiller is running.
Condition Assessment	The pumps are good quality and are in good condition. Pumps are fully rebuildable as needed.

Element State: Good

Assessment Criteria	Existence	Comments

11.30.05.01 Primary CHW Pumps (P-1,-2) Event 1

Event Type	Event Year	Event Cost	Priority	Data Origin
Monitor, repair as needed	2033	$5,000	High	

Brief Description	Monitor pump bearings and seals, and replace as needed.
Event Justification & Strategy	Routine maintenance
Implication of Event Deferral	Loss of cooling to campus buildings if pumps fail.

11.30.06 Secondary CHW Pumps (P-3,-4,-5)

Element Instance: 11.30.06 Secondary CHW Pumps (P-3,-4,-5)

Description	Secondary Chilled Water (CHW) pumps (600 GPM each, 30hp) circulate chilled water from the primary CHW loop to the campus buildings. Pump speed is controlled by a VFD based on the pressure differential between the CHWS and CHWR.
Condition Assessment	The pumps are good quality and are in good condition. Pumps are fully rebuildable as needed.

Element State: Good

Assessment Criteria	Existence	Comments

Secondary Chilled Water Pumps

11.30.06.01 Secondary CHW Pumps (P-3,-4,-5) Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Monitor, repair as needed	2033	$10,000	High	

Brief Description	Monitor pump bearings and seals, and replace as needed.
Event Justification & Strategy	Routine maintenance
Implication of Event Deferral	Loss of cooling to campus buildings if pumps fail. Generally, 2 pumps are adequate for campus demand, so loss on one pump is not an immediate crisis.

11.30.07 Booster CHW Pump (P-8)

Element Instance: 11.30.07 Booster CHW Pump (P-8)

Description	CHW P-8 is a booster pump (475 GPM, 7.5 hp) located on the first floor of the CU building. The original 4" chilled water line to the CU was inadequate for the CW demand as the building was expanded, so the pump was added to overcome the increased friction loss in the pipes at high CHW demand. The pump pulls from the CHWS line coming from the tunnel into CU and boosts the pressure supplied to CU. The boosted CHWS also feeds down the connector tunnel to the PE building, and thence into the CHWS line feeding around the west branch of the CHW loop. Pump speed is controlled by a VFD based on the pressure differential between the CHWS and CHWR lines.

The piping associated with the P-8 is very complicated and can result in bypassing CHWS into the CHWR line if isolation valves are not configured properly. The result can be poor delta-T for the building and inadequate pressure differential within the building to supply chilled water loads. That is apparently what was happening last summer. Large portions of the CU building were overheating due to inadequate CHW supply to the air handlers. Operations staff attempted to compensate by reducing the CHW temperature setpoint for the entire campus. That contributed to surge and capacity problems at the chillers .

Condition Assessment The pump is of good quality and in good condition. The pump is fully rebuildable as needed. Piping and controls associated with the pump are poorly designed and/or poorly understood by operations staff.

Element State: Poor

Assessment Criteria	***Existence***	***Comments***

11.30.07.01 Booster CHW Pump (P-8) Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2023	$30,000	High	

Brief Description Reconfigure piping and controls so the pump operates properly.

Event Justification & Strategy Current operation negatively impacts cooling in College Union and the entire chilled water system.

Implication of Event Deferral Continued poor operation of the chilled water system with ancillary impacts on chilled water energy use, capacity, and chiller longevity.

11.30.08 CHW Distribution Piping

Element Instance: 11.30.08 CHW Distribution Piping

Description

Chilled water is distributed to the campus buildings primarily through welded steel chilled water supply (CHWS) and return (CHWR) pipes routed through utility tunnels. Since the chilled water temperature when operating is usually below the dew point of moisture in the air, moisture will condense on the cold pipe surface. The pipe is insulated primarily to prevent that condensation and to resulting corrosion of wet steel pipe. A vapor barrier reduced the migration of moisture into the insulation.

Pipe size is marginally based on the existing load and system delta-T. That can affect the ability to add a new load. Increase if more load is added to the system.

Condition Assessment

The pipe is thought to be in generally good condition. The interior of the pipe is protected from corrosion by water treatment. The exterior is protected by the insulation and craft paper vapor barrier. There is surface rust where the insulation and vapor barrier are damaged, but it is not thought to be extensive yet.

Element State: Fair

Assessment Criteria	***Existence***	***Comments***

11.30.08.01 CHW Distribution Piping Event 1

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2025	$20,000	Medium	

Brief Description	Repair insulation and vapor barriers where damaged.
Event Justification & Strategy	Protects the steel pipe from external corrosion.
Implication of Event Deferral	Higher energy use, and potential failure of piping due to external corrosion.

11.30.08. CHW Piping to Dow

Element Instance: 11.30.08. CHW Piping to Dow

Description

Chilled water distribution piping from the tunnel to Dow in through buried Sch-80 PVC pipe. On multiple occasions, the pipe has failed because of a fracture of a pipe coupling. The most recent occasion was under the floor in a classroom lab. The result was flooding in the room and loss of cooling for the entire building until the leak could be repaired.

A better material choice for buried chilled water service would be a fusion-welded high-density polyethylene (HDPE) pipe. An accessible pipe within the building would be Victaulic-coupled steel or copper.

Condition Assessment

The PVC pipe is likely to continue to fail periodically until replaced.

Element State: Poor

Assessment Criteria	***Existence***	***Comments***

11.30.08.02 CHW Piping to Dow Event 2

Event Type	*Event Year*	*Event Cost*	*Priority*	*Data Origin*
Repair	2023	$40,000	High	

Brief Description	Re-route chilled water piping to eliminate active PVC piping under the slab.

Event Justification & Strategy	Pipe failure under the slab represents a major disruption of building operation and a significant risk of additional damage. The pipe could be rerouted up into the ceiling space starting outside the building foundation, or possibly buried to the outside of the below-grade mechanical room wall.
Implication of Event Deferral	Potential for failure with associated building use interruption and building damage.

11.30.08.03 CHW Piping to Dow Event 2

Event Type	***Event Year***	***Event Cost***	***Priority***	***Data Origin***
Repair	2025	$40,000	Medium	

Brief Description	Replace buried PVC pipe from the tunnel to Dow with HDPE pipe.
Event Justification & Strategy	Pipe failure under landscaping is much easier to access than under the slab inside a building. However, failure still is disruptive. The proposed HDPE replacement is much less susceptible to failure.
Implication of Event Deferral	Potential for failure with associated landscape damage and building use interruption.

			Costs in 2023 dollars			Combined Total Repair & Replacement	Building Replacement Cost	Facility Condition Index
			Year 2	Year 10	Year 15	(a)	(b)	(a/b)
Number	Name	Event	2023-2025	2026-2033	2034-2038			
05.01.10.01	Scott sectionalizing cabinet SSA	Repair		$5,000		$5,000		
05.01.10.02	Scott sectionalizing cabinet SSB	Repair	$10,000			$10,000		
05.01.10.03	Scott sectionalizing cabinet SSC	Repair		$5,000		$5,000		
05.01.10.04	Scott sectionalizing cabinet Village	Repair		$5,000		$5,000		
05.01.10.05	Scott sectionalizing cabinet Chiller Bldg	Replace	$20,000			$20,000		
05.01.10.06	12kV Main Distribution Gear	Replace	$2,250,000			$2,250,000		
05.01.10.07	Vista Gear Soccer Field	Adjust	$5,000			$5,000		
05.01.10.08	Purvine S&C PMS-6 Cabinet	Replace		$150,000		$150,000		
05.01.10.09	CEET S&C Cabinet	Seal leaks	$5,000			$5,000		
05.01.10.10	Vista gear college union	Adjust	$5,000			$5,000		
05.01.10.11	Scott sectionalizing dog house	Inspect annually	$1,000			$1,000		
05.01.10.12	Vista gear Cornett	Adjust	$5,000			$5,000		
05.01.20.01	Well #7 transformer	Repair	$1,000			$1,000		
05.01.20.03	Arboretum transformer	Replace			$10,000	$10,000		
05.01.20.04	Residence hall transformer	Repair	$1,000			$1,000		
05.01.20.05	Village transformer	Replace		$75,000		$75,000		
05.01.20.06	Snell & Owens transformer	Replace		$500,000		$500,000		
05.01.20.07	Chiller Bldg transformer	Replace		$100,000		$100,000		
05.01.20.08	Dow transformer	Repair	$500			$500		
05.01.20.09	Boivin & Semon transformer	Adjust	$5,000			$5,000		
05.01.30	Primary Conductors					$0		
05.01.30.D	West distribution feed to Purvine	Replace		$50,000		$50,000		
05.01.30.F	West distribution feed to Cornett	Replace		$75,000		$75,000		
05.30.01.I	Cornett distrib to PE distrib link	Replace	$50,000			$50,000		
05.30.01.J	Feeder to PE & LRC transformer	Replace	$15,000			$15,000		
11.20.01.01	Production well #5	Clean & Repair	$300,000			$300,000		
11.20.01.02	Production well #5 piping	Replace	$200,000			$200,000		
11.20.01.04	Production well #6	Clean & Repair	$300,000			$300,000		
11.20.01.05	Production well #6 pump	Replace	$200,000			$200,000		
11.20.01.06	Production well #6 piping	Replace	$200,000			$200,000		
11.20.01.10	Injection pump station	Periodic maintenance		$20,000		$20,000		
11.20.01.11	Injection well #1	Replace	$300,000			$300,000		
11.20.01.12	Injection well #2	Clean & Repair	$100,000			$100,000		
11.20.02.01	Geothermal water storage tank	Replace	$250,000			$250,000		
11.20.02.02	Geo building internal piping	Replace	$200,000			$200,000		
11.20.03.01	Geo return piping near residence hall	Replace	$20,000			$20,000		
11.20.03.02	Geo valves at vault east of Snell Hall	Repair	$20,000			$20,000		
11.20.03.03	Geo isolation valves	Replace and Reconfigure	$400,000			$400,000		
11.20.03.04	Geo piping loop	Add loop for resiliency		$1,000,000		$1,000,000		
11.20.04.01	Sidewalk snowmelt	Reconfigure & repair	$500,000			$500,000		
11.20.04.02	Sidewalk snowmelt	Add to new sidewalks		$800,000		$800,000		
11.30.01.01	Central chiller plant	Replace controls	$100,000			$100,000		
11.30.01.02	Central chller plant	Replace refrigerant		$100,000		$100,000		
11.30.02.01	Central cooling towers	Repair	$100,000			$100,000		
11.30.03.01	Condenser water tank	Inspect & clean	$10,000			$10,000		
11.30.04.01	Condenser water pumps	Periodic maintenance			$5,000	$5,000		
11.30.04.02	Condenser water pumps	Replace VFDs	$10,000			$10,000		
11.30.05.01	Chilled water pumps	Periodic maintenance			$5,000	$5,000		
11.30.06.01	Secondary chilled water pumps	Periodic maintenance			$10,000	$10,000		
11.30.07.01	CU chilled water booster pump	Reconfigure piping & controls	$30,000			$30,000		
11.30.08.01	Chilled water piping	Repair insulation	$20,000			$20,000		
11.30.08.02	CW piping to Dow	Replace underslab piping	$40,000			$40,000		
11.30.08.03	CW piping to Dow	Replace exterior piping	$40,000			$40,000		
Totals			$5,713,500	$2,885,000	$30,000	$8,628,500		

11.5 Appendices

Landscaping

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Name	Seasonal Interest	Native	Width x Height	Suggested Application
	Fall color	Yes	20' x 25'	Shady side of buildings
	Fall color		40' x 50'	Parking Lot
	Fall color		60' x 60'	Parking Lot, Campus Walk
	Spring Flowers, Fall color	Yes	20' x 40'	Hillside Grove
	Fall color		25' x 40'	Near bioswale, Hillside Grove
			50' x 50'	Parking Lot, Campus Walk
	Spring Flowers, Fall color		25' x 25'	Ornamental Grove, Single Specimen
	Spring Flowers, Fall color	Yes	15' x 15'	Ornamental Grove, Single Specimen
	Spring Flowers, Fall color		15' x 20'	Ornamental Grove, Single Specimen
	Spring Flowers, Fall Fruit		20' x 20'	Ornamental Grove, Single Specimen
	Fall color		35' x 60'	Single Specimen, Campus Walk
	Outstanding Fall color		35' x 50'	Single Specimen
	Fall color		35' x 35'	Campus Walk
	Spring Flowers, Fall Fruit, Winter Berries	Some Var.	25' x 25'	Ornamental Grove
	Fall color		30' x 60'	Hillside Grove
st	Spring Flowers, Fall color		30' x 40'	Hillside Grove
	Fall color		50' x 60'	Single Specimen
	Fall color		40' x 40'	Single Specimen
	Fall color		75' x 75'	Single Specimen, Parking Lot
sh	Spring Flowers, Fall color, Winter Berries		15' x 20'	Ornamental Grove
	Fall color		20' x 40'	Campus Walk
	Fall Color		50' x 70'	Campus Walk
	Summer Fragrance	Yes	20' x 70'	Single Specimen, Service Screening
	Grey Green Foliage	Yes	20' x 25'	Single Specimen
	Grey Green Foliage		35' x 80'	Single Specimen
		Yes	35' x 60'	Hillside Grove
			40' x 60'	Hillside Grove, Single Specimen
		Yes	30' x 100'	Hillside Grove
			40' x 100'	Hillside Grove, Single Specimen
		Yes	50' x 100'	Hillside Grove, Single Specimen
	Summer Flowers, Fall color, Winter Berries	Yes	15' x 18'	Near Bioswale
	Summer Flowers, Fall color, Winter Berries	Yes	5' x 10'	Hillsides, natural areas
	Summer Flowers	Yes	2' x 5'	Hillsides, natural areas
	Summer Flowers	Yes	5' x 5'	Hillsides, natural areas
	Spring Flowers	Yes	5' x 5'	Hillsides, natural areas
rry	Foliage color		4' x 5'	Barrier Plant, Accent planting
	Fall color		5' x 6'	Barrier Plant
	Summer/Fall Flowers		3' x 5'	Hillsides, natural areas
	Summer Flowers	Yes	4' x 5'	Hillsides, natural areas
	Early Spring Flowers		8' x 10'	Barrier Plant, Accent Plant
	Winter Red Stems	Yes	9' x 9'	Near Bioswale, Lower Hillsides
	Winter Yellow Stems		9' x 9'	Near Bioswale, Lower Hillsides
	Winter Red Stems		3' x 3'	Near Bioswale, Campus Walk
r	Winter Berries		3' x 6'	Steep Hillsides, Juniper Replacement
r	Spring Flowers, Fall Berries		7' x 8'	Parking Lot Screen
	Late Spring Flowers	Yes	3' x 3'	Native Hillsides
	Fall color		8' x 8'	Parking Lot Screen
	Early Spring Flowers		Varies	Hillsides or Accent Plant
	Early Spring Flowers, Fall color		10' x 15'	Accent Plant
	Spring Flowers, Fragrant		5' x 8'	Parking Lot Screen
	Spring Flowers, Fragrant	Yes	12' x 12'	Some shade. Accent Plant
	Spring Flowers, Fragrant		6' x 8'	Some shade. Accent Plant
	Spring Flowers, Fragrant		2' x 3'	Juniper Replacement
	Late Spring Flowers, Fall color	Yes	8' x 8'	Near Bioswale, Lower Hillsides
	Late Spring Flowers, Fall color		3' x 5'	Near Bioswale, Lower Hillsides
	Late Spring Flowers		Varies	Juniper Replacement
	Fall color	Yes	15' x 20'	Parking Lot Screen
	Outstanding Fall color		3' x 6'	Accent Plant or Hillsides
	Outstanding Fall color		15' x 15'	Accent Plant or Hillsides

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