

Oldham County High School

HVAC Assessment Report



Oldham County High School HVAC Assessment Report

Building: Oldham County High School
Location: Bedford, KY
Assessment Date: June 6th – July 10th, 2024
Report Issued: July 18th, 2024

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PURPOSE

The purpose of this assessment was to determine and document the existing HVAC air handling equipment: age, expected useful life, condition, operational deficiencies, capacity, area served, safety and code compliance. The information gathered during the onsite assessment was used to evaluate and prioritize the necessary upgrades to meet the long-term operational goals.

EXECUTIVE SUMMARY

The existing air handling equipment in Oldham County High School is a culmination of systems installed and/or replaced during the 1998 renovation of "The Core", originally constructed in 1966, the addition of the Administrative Offices in 2007, and renovation of "The '84 Wing", named for its original construction in 1984, also renovated in 2007.¹

The air handling equipment is properly sized for the buildings' needs and envelope, with comfort complaints primarily occurring in The Core during change heating and cooling mode changeovers. Plant operators voiced frustration with increased occupant complaints and system downtimes in recent years due to equipment conditions.

A renovation of The Core main mechanical room took place over the Summer of 2023, replacing aged equipment. The boilers, chillers, cooling tower, and all associated pumps were replaced, to reinforce the aging air handling equipment.

Approximately half of the air handling systems have exceeded their life cycle with the other half three years away from the end of the same cycle.² The age of the equipment, while well maintained, has been showing its age through recent school years, resulting in lack of occupant conform and less than optimal learning conditions for the students. Maintenance costs and system downtime will continue to increase the longer the existing equipment remains in service.

¹The Original structure, now known as Buckner Alternative, was not assessed due to scheduled demolition and replacement.

²For the purposes of this assessment, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Equipment Life Expectancy Chart was used as a basis for determining equipment age and need for replacement. ASHRAE is the leading organization for determining HVAC design, procedures and testing methods.

In addition to the difficulty of maintaining the existing air handling systems, the energy efficiency of the equipment has fallen below today's standards, driving up energy costs. Overall, majority of the current equipment types fall in line with today's energy savings strategies used in renovations of schools similar to Oldham County High School (restrained by existing building envelope); however, newer higher efficiency equipment and improved controls would increase dependability, occupant comfort while decreasing energy costs.

Mechanical Systems

- The current HVAC system is a mix of a 2-pipe and 4-pipe systems:
 - The two-pipe systems serve the majority of The Core, '84 Wing and Kitchen.
 - In 2007, the addition along with renovation of the Auditorium, Band/Choir Wing and Gym took advantage of the 4-pipe strategy.
- Approximately half of the mechanical equipment is past the ASHRAE useful life expectancy, with the other half passing the same benchmark in three years.
- The engineering design of the current systems (1997 and 2007) takes advantage of current performance design practices as renovations have occurred (e.g. four-pipe systems, installing VFDs on water loops, insulation of piping, automatic balancing valves, energy recovery, higher efficiency equipment), but a revised holistic approach of the entire facility as it sits needs to be implemented to aid in comfort and efficiency.
- Digital Controls of the systems are in good working order and the maintenance staff has visibility to the facility along with alarm notifications. The school would still benefit from new controls as hardware has become aged and unsupported as well as communication protocols now centered around to BACnet/MSTP.
- The Core Main Mechanical Room was renovated in Summer of 2023 to provide a more robust and higher efficiency backbone to the current air handling strategy (2-pipe fan coils, air handlers and Energy Ventilation Units), with anticipation of future replacement of air handling equipment in mind and possible change to four-pipe systems in the future.
- Current code minimum for outside air is being met in majority of the spaces with minor changes in room occupancy types being the driver behind the few outdoor air deficiencies, (e.g. 106A which was previously used as an office for one now being used as a broadcast booth with up to five occupants).
- The building was also struck by an EF-2 tornado on April 2nd, 2024. This resulted in complete removal of the relief air fans on the gym used to control pressurization of the school, substantial damage to two roof-mounted Outdoor Air Ventilators which provide outdoor air, and multiple exhaust fans which exhaust the restrooms.
- All damaged systems will need to be replaced.

General Building Construction

- Windows represent up to 30% of the HVAC loads. The current windows appear to be original to the school and do not feature the energy performance of modern windows. A significant source of the current HVAC load is due to the windows.
- The building envelope is assumed to have not been modified since each area's original construction. Sealing openings and adding insulation would assist in saving energy by minimizing losses through walls and roof.
- The tornado mentioned in the section above also resulted in damage to the window systems on the east side of the 1966 structure which has been repaired.

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GENERAL

General Oldham County High School Building Information

The existing Oldham County High School building is the result of additions in 1966, 1984 and 2007 to the original structure, the now soon-to-be demolished and replaced Buckner Alternative School (BAHS).

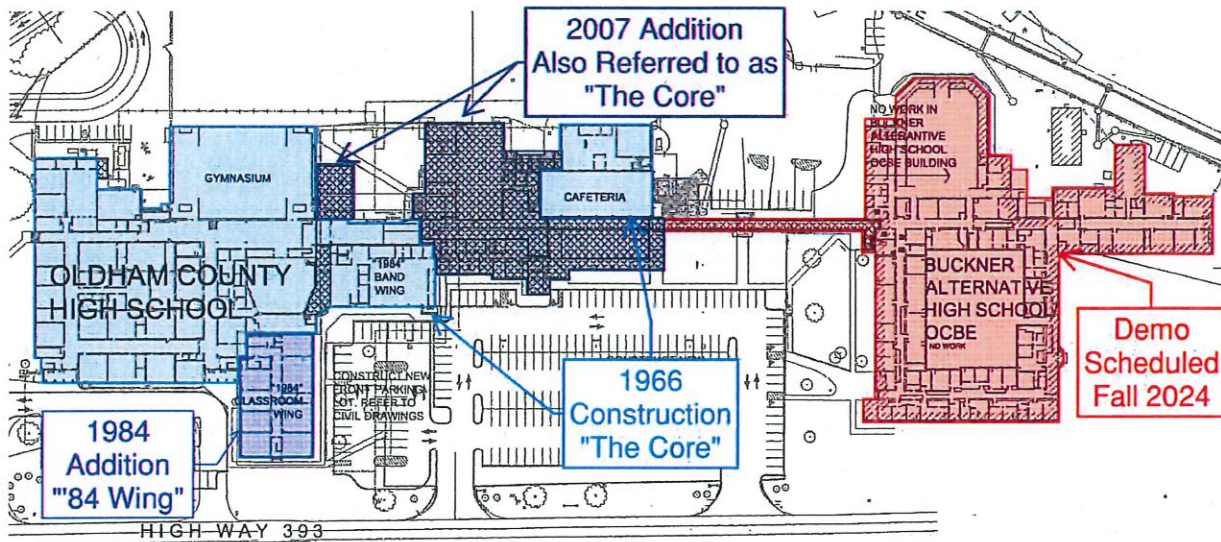


Figure 1 | Oldham County High School

The school, as it will sit after demolition of BAHS, will be approximately 240,000 square feet. The school currently houses 1,725 students.

HVAC SUMMARY

Oldham County High Schools is a mixture of two systems, two-pipe fan coil/energy recovery ventilator and four-pipe air handling units. The two-pipe system is original to the building, with four-pipe installed during the 2007 addition and renovation of the center of the building.

Two-pipe systems use one pipe to provide tempered water to the air handling systems, fan coils and unit ventilators in this case, and one pipe to return the water back to the central plant to be heated by boilers or cooled through chillers and cooling tower before being sent back out to the building again. The fan coils and unit ventilators on a two-pipe system only have one coil which serves to heat or cool the room. The major disadvantage to this system is that the entire system must be in heating or cooling. Historically, these types of systems must be manually changed over by maintenance, once during the Fall from cooling to heating, and once in the Spring, from heating to cooling. Recent projects in the mechanical room have eliminated the manual changeover by making it automatic based on outdoor air temperature, which allows for the entire system to bounce back and forth during days that are unseasonably warm or cool. Even with this new automatic changeover, this type of system has issues with occupant comfort, which Oldham County High School is experiencing. Two-pipe systems are the cause, as the entire system heats or cools based on the overall system mode and individual rooms cannot be controlled based on that room's requirement. (e.g. a room cannot cool when the system is heating.)

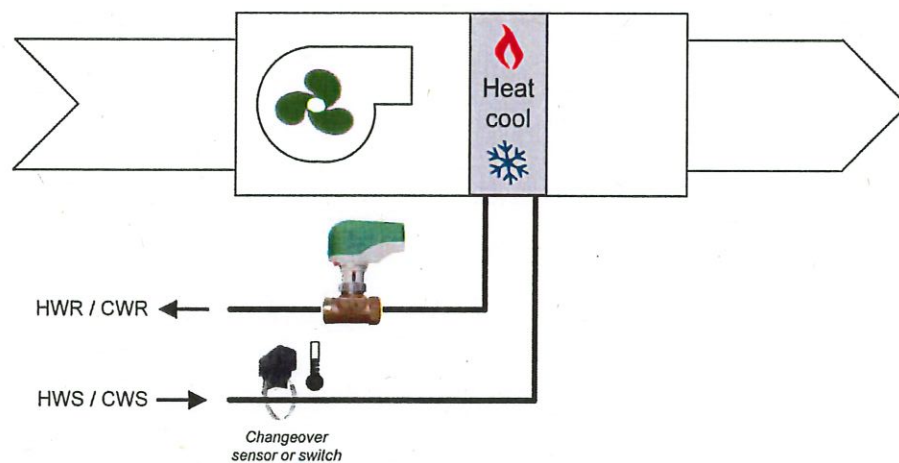


Figure 2 | Two-Pipe System Coil

Four-pipe systems are a better solution to the challenges described above with two-pipes systems. Four-pipe systems utilize one pipe for cooling water supply, one pipe for cooling water return, one pipe for heating water supply and one pipe for heating water return. Fan coils, energy recovery ventilators and air handling units in this system type utilize two sets of coils which allow for heating and cooling, simultaneously, based on the rooms requirements, not the buildings. There are no changeover periods. Both systems run in concert.

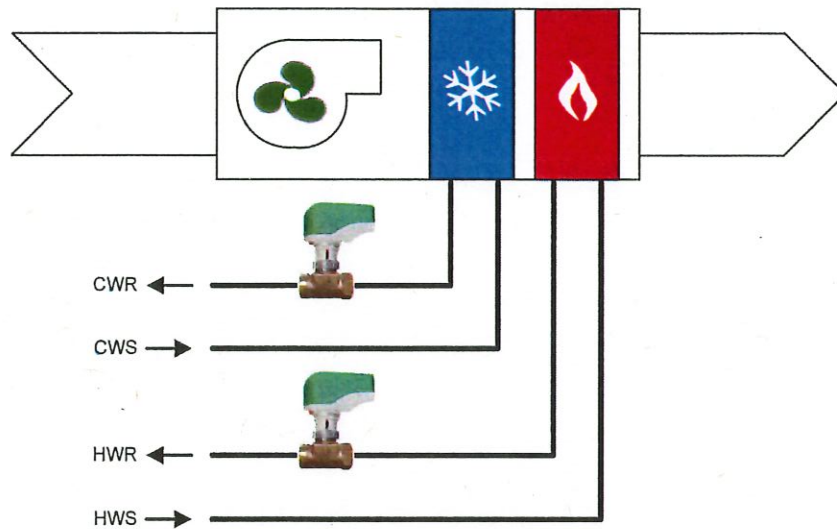


Figure 3 | Four-Pipe System Coil

Below shows the areas served by each system, two-pipe system and the mixed two-pipe and four-pipe systems.

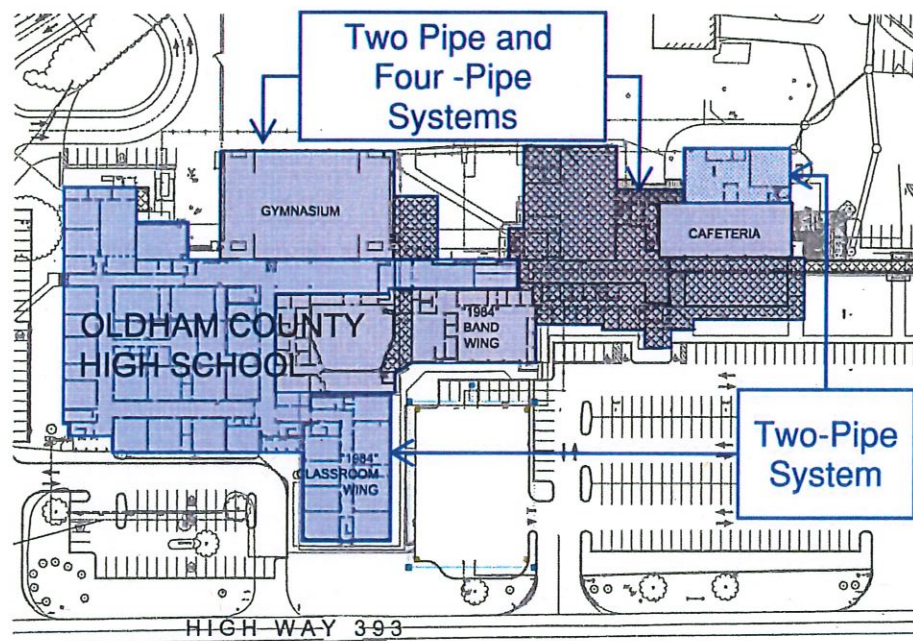


Figure 4 | Area System Types

In either case, during cooling mode, chilled water is provided by chillers or by a combination of chillers and a cooling tower. In heating mode, hot water for heating is provided by six gas-fired boilers, spread between three mechanical rooms. The heated/chilled water is circulated by pumps located in the two mechanical rooms throughout the building to various air

handling systems to condition the spaces. Throughout the building there are air handlers, fan coils, unit heaters and energy recovery ventilators which use the tempered water to heat and cool their respective areas.

I. Introduction

The focus of this assessment is the air handling systems of Oldham County High School. Investigations involved visual observations, extensive review of documentation as well as discussions with facilities personnel and staff. The focus of the investigations was to:

1. Identify the age and condition of the equipment.
2. Note any outdoor air deficiencies needed to meet code.
3. Determine maintenance issues.
4. Identify energy efficiency opportunities.

CMTA surveyed all air handling systems, and results are included in this assessment. These include Air Handling Units, Fan Coils (vertical and horizontal), Exhaust Fans, and Energy Recovery Ventilators.

II. Summary of Findings

a) Air Handling Systems

- i) Two-Pipe Fan Coils: Approximately 120 of the two-pipe fan coil units (75% serving classrooms and offices throughout The Core) are twenty-six years old, six years past the twenty-year ASHRAE expected lifecycle. There are an additional nineteen serving the '84 Addition classrooms that are now at the twenty-year ASHRAE expected lifecycle.
- ii) Energy Recovery Ventilators: The four ERVs on The Core are twenty-seven years old. Two of these four received substantial damage during the April 2nd tornado. The single unit on the '84 Wing was installed in 2007, seventeen years old. ASHRAE life expectancy of these units is twenty years.
- iii) Exhaust Fans: There are twenty-three exhaust fans on The Core and '84 Wing roofs that are seventeen years old. While they are within the ASHRAE expected lifecycle of twenty years, there was considerable damage noted on the fan/motor covers, potentially caused by the April 2nd tornado. One fan is missing the motor cover in its entirety.
- iv) Air Handling Units are seventeen years old and in good condition. Air Handling units have been known to exceed the ASHRAE life expectancy by ten years without issues in performance. There are nine of these that were installed in 2007. There is one on the lower level for the Weight Room that appears to be a 1999 unit.
- v) Several rooms have been repurposed from their original design intent which has left them deficient of proper outside air and the fan coils undersized. Two examples are

106A, which was designed as an office for one, is now a sound booth for Media Arts that can have as many as five people in the space. Additionally, A/V equipment in the room contributes additional cooling loads.

- vi) Hydronic piping for The Core is original to the building, making it fifty-eight years old, eight years past its ASHARE life expectancy. It was noted by facility operators that leaks had become an issue in the past couple of years, indicating the pipe is beginning to fail.
- vii) The insulation appears to be original to the installations. Insulation is typically good for twenty to twenty-four years. Leaks, as noted above, and punctures in the insulation which cause the insulation to get wet will dramatically shorten the life.

b) Building Automation System

- i) The Building Automation System, while mostly functional, is a combination of several renovations. Sensors and thermostats were observed to be in poor condition and functionality could not be verified. It is believed, through discussions with Johnson Controls, that portions of the building are operating using N2 protocol as opposed to today's BACnet/MSTP. Some of the hardware is now obsolete and unsupported as well.

AIR HANDLING SYSTEMS

Fan Coil Units

The fan coil units located in The Core, while well maintained, are showing their twenty-six years of usage. Access doors are bent, access panels difficult to take off and put back on, making maintenance challenging and timely. The heating/cooling coils are also in poor shape.



Figure 5 | The Core Fan Coils General Conditions – Installed 1997



Figure 6 | Heating Cooling Coils



Figure 7 | The Core – Lack of Occupant Comfort Evidence

Fan coils throughout the building installed in 2007 are in better condition, which is to be expected from a unit ten years newer than in The Core; however, they still show evidence of lack of comfort in the spaces they are conditioning due to be two-pipe.



Figure 8 | 2007 Fan Coil



Figure 9 | '84 Wing Fan Coil – Lack of Occupant Comfort Evidence

Energy Recovery Ventilators

Energy Recovery Ventilators installed in 1997 have also been maintained for twenty-six years, but exposure to the elements for a quarter century of use is showing.

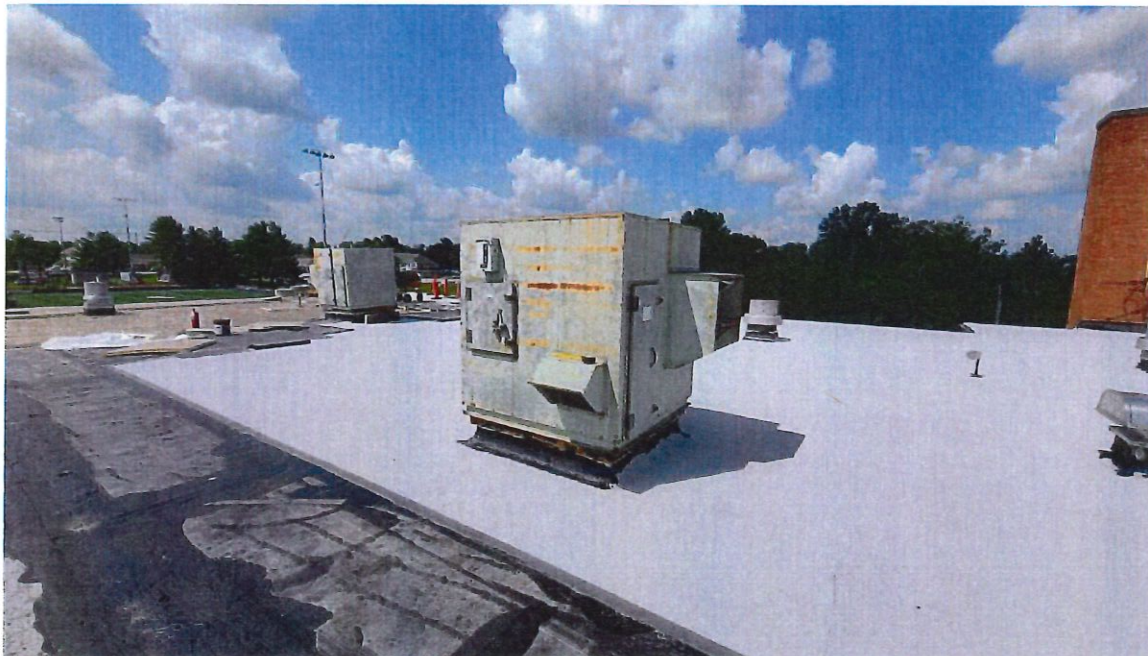


Figure 10 | The Core ERVs – Installed 1997



Figure 11 | The Core ERV Intake Screens



Figure 12 | The Core ERV Energy Recovery Wheel Conditions



Figure 13 | The Core ERV Energy Recovery Wheel Conditions

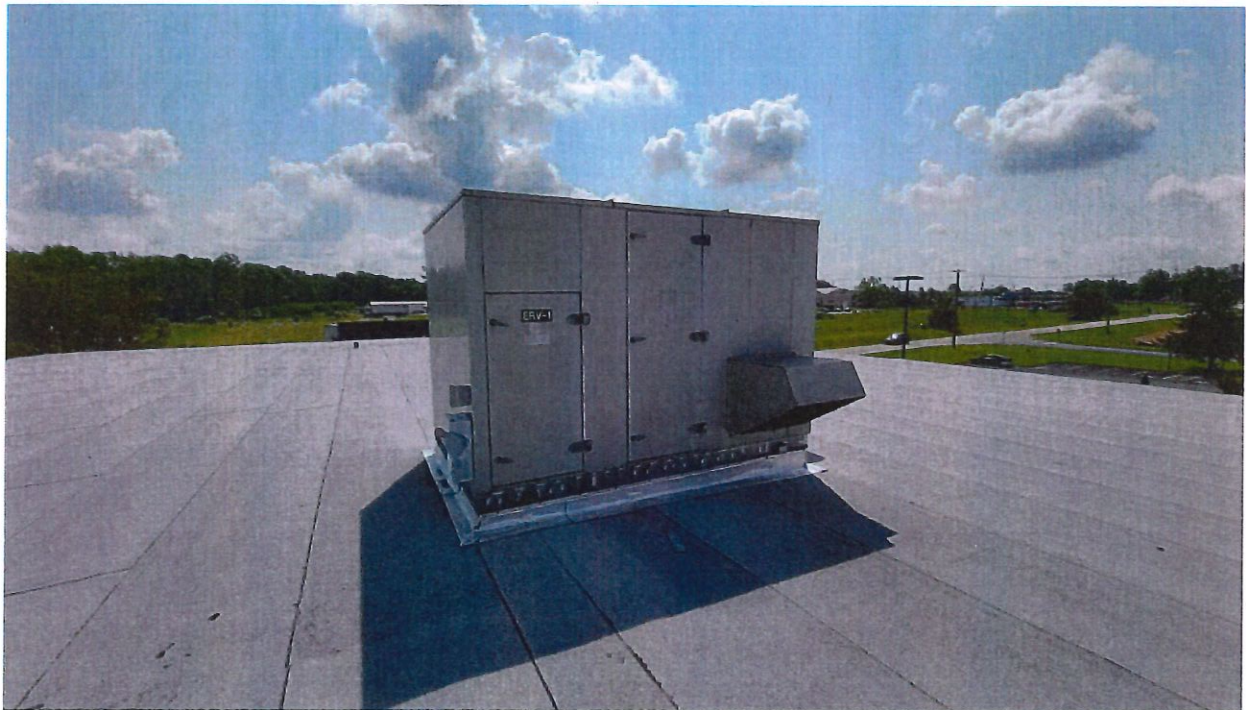


Figure 14 | '84 Wing ERV Exterior – Installed 2007

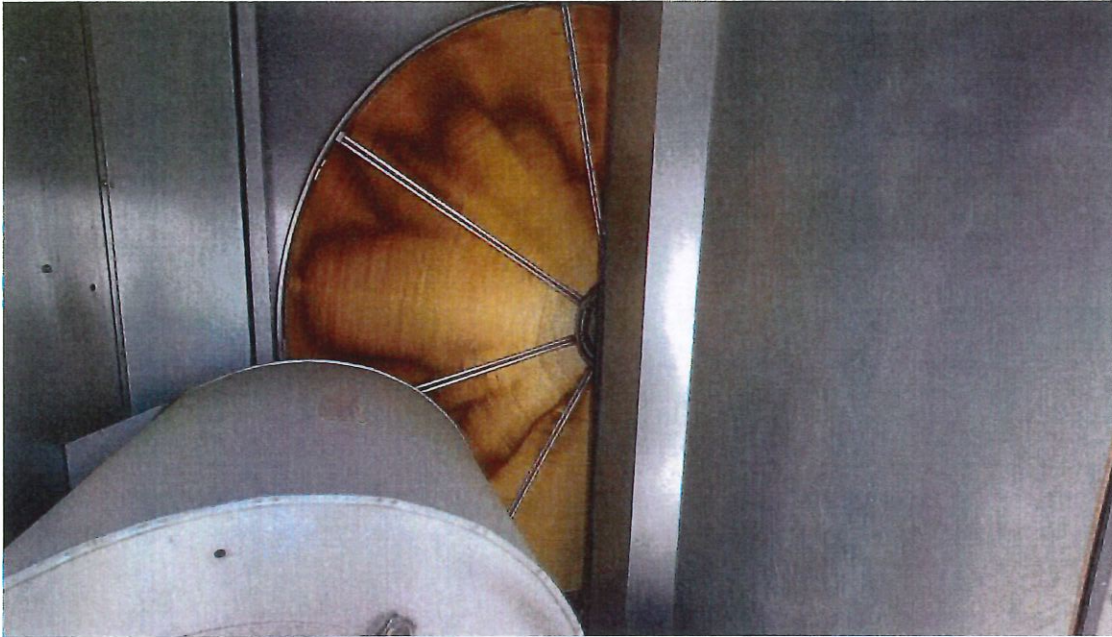


Figure 15 | '84 Wing ERV Energy Recovery Wheel Condition

Exhaust Fans

There are twenty-three exhaust fans on The Core and '84 Wing roofs that are seventeen years old. There was considerable damage noted on the fan/motor covers, potentially caused by the April 2nd tornado. One fan is missing the motor cover in its entirety.

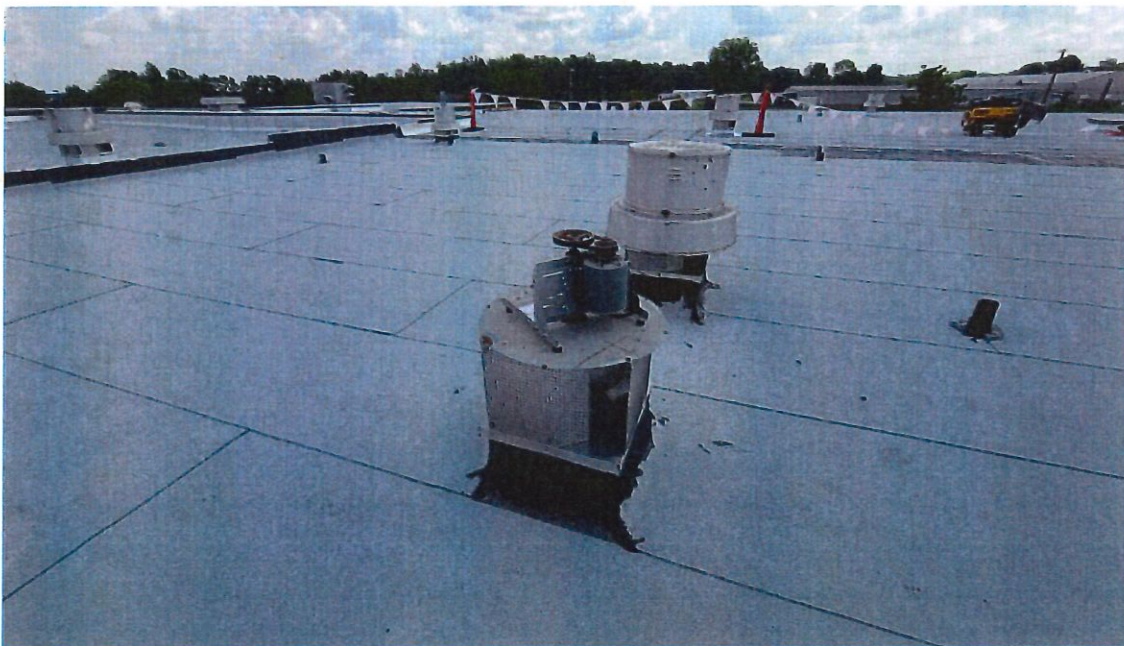


Figure 16 | Damaged Fan



Figure 17 | Damaged Fan

Air Handling Units

All of the Air Handling Units were installed in 2007 and are four-pipe units. There have been no complaints in the areas conditioned by these units. The units are currently seventeen years old with an ASHRAE life expectancy of twenty years. Historically, these units, due to being inside have lasted as long as thirty years before needing replacement. The air handlers in Oldham County High School are no exception. They are well maintained and look to be in good working order.



Figure 18 | Gym Air Handler 1A



Figure 19 | Air Handlers Installed in 2007

Relief Air Fans

As noted in earlier sections, the Relief Air Fans on the gymnasium, which are integral for proper pressurization of the building were severely damaged, and in one case blown off the roof during the April 2nd Tornado. The remaining units on the building were subsequently removed and need to be replaced for proper building balance.



Figure 20 | Relief Air Fans

RECOMMENDATIONS

Taking into consideration the condition of equipment, age of equipment, and the previously completed projects, the subsequent list is provided as recommendations for upcoming facility improvements with occupancy comfort being a priority. These items, not listed in order of priority, may be combined as funds are available.

Below is a one-for-one replacement baseline to be used as a comparison. This is not a recommendation as it does not improve comfort and control for the occupants.

Baseline

Replace all fan coils and energy recovery ventilators in The Core classrooms and '84 Wing with new two-pipe units. This would include replacement of all piping and insulation, minimal electrical work to install new units, removal and replacement of the ceilings as required to replace all heating/cooling piping as well as adjusting sprinkler heads for the new ceiling.

Estimated Cost – \$ 5,432,000

Recommendation

Replace all fan coils with new console or vertical four pipe fan coils, replace energy recovery ventilators in The Core classrooms and '84 Wing with new four-pipe units. Installing new piping and insulation to accommodate new four-pipe design, minimal electrical work to install new units, removal and replacement of the ceilings as required to replace all heating/cooling piping as well as adjusting sprinkler heads for the new ceiling. This recommendation utilizes the equipment installed during the mechanical room renovation that occurred in the Summer of 2023.

Estimated Cost – \$ 6,520,000

Commissioning of Air Handling Equipment

Following installation of new air handling equipment, these systems must be Commissioned to ensure they are installed and working properly, providing optimal comfort, control and efficiency.

Estimated Cost - \$50,000

Other Items to Consider**Lighting**

Replacing all lighting in areas where the ceiling would need replaced during recommended renovation with new LED fixtures.

Estimated Cost - \$1,640,000

Windows

Replacing Windows with high efficiency windows would improve occupancy comfort and energy savings.

Estimated Cost – To be determined by a qualified architect.

Insulation

Insulating the building envelope using spray foam insulation would significantly add to the R-value of the building and reduce energy costs while improving comfort.

Estimated Cost – To be determined by a qualified architect.

Oldham County High School

Plumbing Assessment Report





Oldham County High School Plumbing Assessment Report

Purpose

The Plumbing Assessment was conducted to evaluate the current condition, functionality, and safety of the plumbing system at Oldham County High School. The primary objectives were to identify potential risks, recommend necessary repairs, and propose upgrades to ensure compliance with relevant health and safety standards.

Executive Summary

The assessment highlights the need for significant updates and repairs to the plumbing system at Oldham County High School. By addressing these issues promptly, the school can ensure a safe, reliable, and efficient plumbing infrastructure that meets current standards and supports future sustainability goals to ensure continued use of the current facility.

Oldham County High School plumbing and piping fixtures and layout were originally installed during construction in 1966. However, significant portions of the system were replaced and renovated in a multitude of capital construction addition and renovation project dating 1984, 1998, 2007, 2009. Two restrooms received interior renovations include partitions in 2021.

The current quantity of functional plumbing fixtures exceeds the minimal requirements of today's plumbing code. However, as current fixtures and plumbing infrastructure reach the end-of-life cycle operation discomfort, inefficient layout and unintended space utilization will continue to create issues with day-to-day school functions.

The Facilities Department is recommending at minimal at total plumbing renovation of "the core" and isolated restroom facilities not scheduled for demolition or replacement with upcoming projects. The scope of the work is recommended to include replacement of all plumbing fixtures, sanitary lines, fittings and accessories. However, it should be noted that that this type of renovation will include extensive work in restrooms, corridors, above ceiling, below slab, and may make significant portions of the building unoccupiable until complete and should be done in coordination with other major system renovations/replacements to limit the time facilities are out of commission.

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PLUMBING SUMMARY & FINDINGS

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General Oldham County High School Building Information

The building as it stands is 3 levels: Lower Level, 1st Floor Level, Second Floor Level with restroom location adequately dispersed throughout the building and levels. Although there are no accessibility barriers preventing access to restrooms being of the same shape and for the most part layout as the original construction the facilities feel confined and of less quality material than typical construction today.

Demolition and replacement of the Buckner Alternative High School (BAHS) and creation of a new "spectator symnasium" is anticipated to begin in the next year. The new facility will relieve the majority of event or public access related issues with current restroom facilities and locations as well as facilitate a significant increase in restroom facilities conveniently located adjacent to existing cafeteria.

The building, as it will sit after demolition, will be approximately 240,000 square feet.

OCHS currently serve approximately 1750 students and 110 staff with approximately 86 operational "water closets" (1 per every 22 occupants) in 26 restroom or locker room locations. A "water closet" in this context is used to quantify access to a toilet or urinal and the shared use of a sink vanity per typical code requirements.

In general, the overall condition of the restroom facilities lack cleanliness, frequently demonstrate leaky or damaged faucets, smell of use and stagnant air. The daily wear and tear have become evident in almost every fixture. When evaluated several locations experienced slow or restricted drain flow. Several attempts have been made in the past 4-5 years to "jet" and "snake" sanitary lines servicing "the core" of OCHS with temporary or minimal improvement. This recurring issue is indicative of non-dissolvable being flush down toilets, improper pipe slope, or damage.



Plumbing Summary and Findings

General Condition:

The plumbing system is generally outdated, with many components reaching the end of their useful life.

Signs of wear and tear were evident, including rusted pipes, improper function and outdated fixtures.

Water Quality:

Staining, discoloration and calcium build-up suggest elevated levels of minerals indicating the need for improved water filtration systems.

Safety Concerns:

The evaluated condition were conducted during unoccupied season and may have yet to receive "summer deep clean" but still present sanitary concerns.

Leaks were found in multiple locations, posing potential risks for water damage and mold growth.

Efficiency and Sustainability:

The current system is not optimized for water efficiency, with older fixtures contributing to higher water usage.

Potential for water and energy savings through the installation of low-flow fixtures and modern water heaters.

The assessment and evidentiary photos noted on the following pages are consistent findings on each floor level and consistent within each restroom. Outdated fixtures and evidence of multiple generations of updates are consistent throughout.

Plumbing Fixtures Photos

Level one

Holes behind fixtures from plumbing repairs



Stained Urinals



Non functioning sinks and stained sinks



Stained Toilets



Second Level

Room 207 (No functional fixtures).



Unmaintained flooring and urine smell.



Leaking sinks, non-functioning or leaking faucets.



Stained and non-functioning toilets.

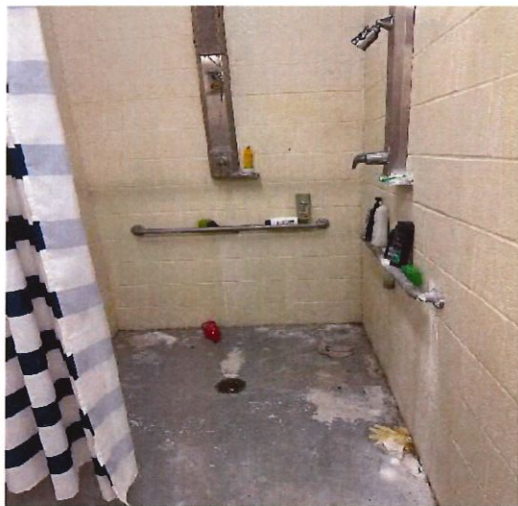


Lower Level

Stained, Leaking, and Non-functional sinks.



Leaking and poorly functioning showers.



Rusting Partitions and accessories.



Broken or Chipped tile base.



Single Valve for 8 Minimal functioning shower heads.



Leak above hard ceiling in the shower.



PLUMBING CODE ANALYSIS

Room Description No.	Fixture Count														Cosmetic Issues	General Notes	
	MENS							WOMENS									
	WC	Urinal	Lavatory	Shower	MF	WC	Urinal	Lavatory	Shower	MF	WC	Urinal	Lavatory	Shower			MF
Lower Level																	
007 Locker Room																	
017 Locker Room																	
038 Office Restroom																	
051 Mens																	
062 Womens																	
094 Men (Little Corridor)																	
095 Women (Little Corridor)																	
090 Office Restroom																	
091 Locker Restroom																	
First Floor																	
101 Storage																	
102B Womens																	
102C Mens																	
100E Schoolroom RR																	
100F Self RR																	
175 Womens																	
176 Mens																	
167B FMD RR																	
172 Mens																	
162A FMD RR																	
129A Single Use RR																	
125C Single Use RR																	
128 Womens																	
124 Mens																	
119 Single Use RR																	
131 Mens																	
132 Womens																	
Second Floor																	
201 Mens																	
202 Womens																	
215 Womens																	
216 Mens																	
207 Mens																	
206 Womens																	
FUNCTIONAL FIXTURE COUNT	20	22	24	4	33	6	21	3	11	4	9	2	23				

Code Review - 24 HRC		Male Water Cistels		Male Lavatory		Female Water Cistels		Female Lavatory		Unused Restrooms quantities are not required	
Current Provided & Functional	Required	23		24		39		24		by Code Failure Count is Female among M/F Count (not 2/3 F)	
		45		27		40		27			
	Failure Qty. Exceeds in Code Req.	13		3		1		3			



Recommendation

Taking into consideration the current condition of existing facilities, the continued issue with plumbing pipes and recent sanitary drainage “back-ups”, and on-going issues with fixture functionality, the subsequent list is provided as recommendations for upcoming improvements.

Replace all plumbing fixtures, accessories, associated sanitary lines as necessary in “the core” of Oldham County High School.

Replace all plumbing fixture and fittings located on the lower level of Oldham County high school.

Replace all fixtures and fittings in the remaining building locations.

Reroute sanitary lines as necessary in consideration of upcoming projects and future improvements.

Estimated Cost – 2,170,000

Complete demolition and replacement of all restroom facilities finishes providing a clean, sanitary, accessible facility. Including bathroom hardware, accessories, grab bars, mirrors and hand dryers.

Estimated Cost – 1,450,000

Removal and replacement of all ceilings and flooring required to replace plumbing pipes, fixtures and fittings. Paint

Estimated Cost – 450,000