Poudre School District Air Conditioning Study - 2023

During the fall of 2022, the Poudre School District Board requested an external audit and report for the feasibility of adding Air Conditioning (mechanical cooling) to all buildings where it did not currently exist. At the time, thirty-six sites were included to be reviewed. A scope for the project was developed that focused on updating a previous Air Conditioning study done in 2015, that was commissioned as part of the preparation for the 2016 Bond measure.

The following document combines the individual A/C reports for each of the thirty-six sites. The individual reports recommend the way to mechanically cool the building, the associated costs, and comparisons to the 2015 study. The first page of this combined document is a pricing table that shows the pricing for all schools side by side.

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Bauder ES	63,156	Yes	$ 6,747,900	$ 9,109,665	$ 106.84	$ 144.24
Beattie ES	45,535	Yes	$ 4,188,400	$ 5,654,340	$ 91.98	$ 124.18
Bennett ES	50,492	No	$ 2,033,900	$ 2,745,765	$ 40.28	$ 54.38
Bethke ES	62,691	Yes	$ 3,716,200	$ 5,016,870	$ 59.28	$ 80.03
Boltz MS	85,120	No	$ 7,529,500	$ 10,164,825	$ 88.46	$ 119.42
Cache La Poudre, IB World ES	53,193	Yes	$ 5,207,300	$ 7,029,855	$ 97.89	$ 132.16
Cache La Poudre, IB World MS	73,913	Yes	$ 6,382,400	$ 8,616,240	$ 86.35	$ 116.57
Centennial HS	39,967	No	$ 4,712,600	$ 6,362,010	$ 117.91	$ 159.18
Dunn ES	45,957	No	$ 1,804,700	$ 2,436,345	$ 39.27	$ 53.01
Eyestone ES (North and South)	64,228	Yes	$ 6,006,400	$ 8,108,640	$ 93.52	$ 126.25
Fullana Learning Center-Headstart	24,109	No	$ 533,900	$ 720,765	$ 22.15	$ 29.90
Harris Billingual ES	38,599	No	$ 3,423,600	$ 4,621,860	$ 88.70	$ 119.74
Irish ES	52,291	Yes	$ 5,418,800	$ 7,315,380	$ 103.63	$ 139.90
Johnson ES	56,396	Yes	$ 4,779,700	$ 6,452,595	$ 84.75	$ 114.42
Kruse ES	51,384	Yes	$ 5,113,900	$ 6,903,765	$ 99.52	$ 134.36
Laurel School of Arts & Tech ES	51,384	Yes	$ 5,110,800	$ 6,899,580	$ 99.46	$ 134.27
Lesher, IB World School	93,686	Yes	$ 8,213,700	$ 11,088,495	$ 87.67	$ 118.36
Linton ES	51,384	Yes	$ 4,646,500	$ 6,272,775	$ 90.43	$ 122.08
Livermore ES	11,441	Yes	$ 720,700	$ 972,945	$ 62.99	$ 85.04
Lopez ES	57,639	Yes	$ 4,332,000	$ 5,848,200	$ 75.16	$ 101.46
McGraw, IB World School ES	51,384	Yes	$ 5,118,200	$ 6,909,570	$ 99.61	$ 134.47
O'Dea Core Knowledge ES	48,018	Yes	$ 4,722,100	$ 6,374,835	$ 98.34	$ 132.76
Olander School for Project Based Learning ES	51,384	Yes	$ 4,857,300	$ 6,557,355	$ 94.53	$ 127.61
Polaris Expeditionary Learning K-12	51,670	Yes	$ 5,574,000	$ 7,524,900	$ 107.88	$ 145.63
Poudre Community Academy HS	22,434	No	$ 1,781,220	$ 2,404,647	$ 79.40	$ 107.19
Preston MS	127,966	No	$ 8,050,300	$ 10,867,905	$ 62.91	$ 84.93
Putnam ES	59,101	Yes	$ 5,867,000	$ 7,920,450	$ 99.27	$ 134.02
Red Feather ES	9,416	Yes	$ 662,800	$ 894,780	$ 70.39	$ 95.03
Rice ES	63,092	Yes	$ 3,753,362	$ 5,067,039	$ 59.49	$ 80.31
Riffenburgh, IB World School ES	48,433	Yes	$ 5,131,000	$ 6,926,850	$ 105.94	$ 143.02
Shepardson STEM ES	50,516	Yes	$ 4,628,800	$ 6,248,880	$ 91.63	$ 123.70
Tavelli ES	62,537	Yes	$ 4,945,000	$ 6,675,750	$ 79.07	$ 106.75
Timnath ES	74,265	Yes	$ 4,492,800	$ 6,065,280	$ 60.50	$ 81.67
Traut Core Knowledge ES	50,871	Yes	$ 4,710,900	$ 6,359,715	$ 92.60	$ 125.02
Webber MS	122,787	No	$ 7,397,400	$ 9,986,490	$ 60.25	$ 81.33
Werner ES	50,300	Yes	$ 4,321,800	$ 5,834,430	$ 85.92	$ 115.99

Opinion of Probable Cost		
Estimated Low	Estimated High	Description
$ 166,636,882	$ 224,959,791	Full AC Implementation of all schools in June 2023 dollars
$ 198,823,600	$ 268,411,860	Assuming 3% inflation, 7 year duration, starting in 2025

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

POUDRE SCHOOL DISTRICT

BAUDER ELEMENTARY SCHOOL

AC STUDY

2345 W. PROSPECT RD.

FORT COLLINS, CO 80526

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
For The Life Of Your Building

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AC Study: Bauder Elementary School

Bauder Elementary School AC Study

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AC Study: Bauder Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored ranged from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Bauder Elementary School

BUILDING SUMMARY

General:

Bauder Elementary School is a single-story 63,156 square foot school located at 2345 West Prospect Road, in Fort Collins, Colorado. Originally built in 1967, the building has seen multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The majority of the building has a "tempered air" system served by Dedicated Outdoor Air System (DOAS) Rooftop Units (RTUs) with energy recovery ventilators ducted to Variable Air Volume (VAV) boxes with hydronic reheat. 4 of the existing 10 RTUs have DX cooling, including the units serving the IT room and computer room.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment, including VAV boxes and RTUs.

Ventilation: Ventilation for the building is provided by the 10 RTUs, including the DOAS RTUs serving the classrooms and other interior spaces, many with VAV boxes, and RTUs serving the computer room, IT room and computer lab.

Existing Electrical Systems:

The building has an existing 2000 amp, 208Y/120V 3-phase, 4-wire service.

Existing Structural Systems:

The initial building was constructed in 1967 with additions in 1970, 1988 and 1992 and a renovation completed in 2013. The building consists of concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete spread footing and strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of open web steel trusses supporting corrugated metal deck. The roof framing was originally designed for nominal 30 psf live load per 1970 structural drawings.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *2012 HVAC updates installed a "tempered air" system utilizing indirect evaporative cooling Dedicated Outside Air Systems (DOAS)*
    - *This strategy is to deliver outside air into the classrooms that is approximately 15 degrees cooler than the outside air temperature during the warmer parts of the year. For instance – at 88 degrees outside, the air delivered to the classroom is 73 degrees.*
    - *VAV boxes regulate air flow quantity into each zone/classroom. Maximum air quantity for each classroom is between 1,200 and 2,000 cfm.*
    - *Air is supplied via ceiling diffusers.*

  - *Return air is at the ceiling.*
  - *Packaged DX RTUs were installed for each computer lab.*
  - *Heating water piping and boilers were installed in 1993 and were all reused in the 2012 HVAC updates.*
- *In 1992 a significant remodel and addition was constructed. Classrooms were added to the northwest, southeast and southwest. All the classrooms are now served by the system installed in 2012. A gym addition was constructed to the east part of the building. The gym is served by a heating and ventilation only RTU.*
- *In 1988 a Media Center addition was constructed on the north end. This area is now served by the system installed in 2012.*
- *An addition in 1970 to the northeast was served by a MZ RTU. Also, one classroom was added east of the cafeteria. These areas are now served from equipment installed in the 2012 HVAC updates project.*
- *The original construction of the building is believed to be in 1967 – the same time as Irish, Riffenburgh and Tavelli. The MZs serving the classrooms and office areas were removed during the 2012 HVAC project. The MZ serving the cafeteria and kitchen remains in place; this unit provides heating and ventilation only.*
- *Kitchen make-up air is provided by transfer air from the cafeteria – no dedicated make-up air unit is installed.*

AC Study: Bauder Elementary School

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Bauder ES	63,156	Yes	$ 6,747,900	$ 9,109,665	$ 106.84	$ 144.24

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.
    - Pros:
        - Highly efficient
        - Resilient, comfortable
        - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs

- Likely can re-use some of the existing heating water piping for condenser water
- Condenser water lines do not require insulation
- System can very effectively provide heating and cooling simultaneously
- This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.

- Cons:
    - High capital cost for new mechanical system retrofit
    - Heat pump equipment has compressors, which can sometimes require additional maintenance
    - Heat pump units may be louder than other HW/CW hydronic systems
    - Requires an upgrade to the building electrical service, details provided below.
    - Will most likely trigger structural upgrades, details provided below.
- Implementation:
    - Install a new 150-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
    - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system.
    - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
    - Replace all existing equipment with water-sourced heat pump equipment
        - All RTUs in the building would require replacement with new heat pump equipment, except those that serve admin and IT spaces, or spaces that are expected to operate year-round while students are not in school.
        - All CUHs will require replacement with electrical unit heaters.
    - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
    - Install a new Kitchen MAU with evaporative cooling.

- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 2000A service is 622 Amps. There is capacity to add cooling loads to the existing service but adding 150 tons of cooling would require a service upgrade to 2500 Amps or 3000 Amps.
    - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
    - Costs for this upgrade is included.
- **Structural Implications:**
    - Rooftop equipment: The existing bar joist, H and LH truss support framing will likely trigger reinforcing.
        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
    - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.

        - Thickened lip = 12"tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
        - Reinforcing = (2) #4's top and bottom.
        - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
    - Costs for these upgrades are included.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install cooling coils in 2012 RTUs.*
    - McKinstry Comment: RTUs would be replaced with new heat pump RTUs
- *Install chiller and route chilled water piping to new RTUs.*
    - McKinstry Comment: RTUs would be replaced with new heat pump RTUs
- *Install a new RTU for the cafeteria. Route chilled water to the new RTU.*
    - McKinstry Comment: RTUs would be replaced with new heat pump RTUs
- *Install new make-up air unit with evaporative cooling for the kitchen*
    - McKinstry Comment: Included

POUDRE SCHOOL DISTRICT

BEATTIE ELEMENTARY SCHOOL

AC STUDY

3000 MEADOWLARK AVE.

FORT COLLINS, CO 80526

SEPTEMBER 2023

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AC Study: Beattie Elementary School

Beattie Elementary School AC Study

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AC Study: Beattie Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to “refresh” the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building’s construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry’s team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to “best case scenario” options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Beattie Elementary School

BUILDING SUMMARY

General:

Beattie Elementary School is a single-story 45,535 square foot school located at 3000 Meadowlark Avenue, in Fort Collins, Colorado. Originally built in 1971, the building has seen two additions in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building has no central AC system. It has a "tempered air" system provided by a cooling tower with tempered water routed to cooling coils in rooftop multi-zone units. Two Rooftop Units (RTUs) that have packaged DX-cooling were added in 1995 to serve the music and art classrooms.

Heating: Heating is served by gas-fired boilers, with hot water piping routed to RTUs.

Ventilation: Ventilation is provided through ducting and supply grilles that are connected to the rooftop units. One RTU, MZ-6, that was replaced in 2014, has VAV boxes connected to it.

Existing Electrical Systems:

The building has an existing 1200 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1971 with renovation completed in 2014. The building consists of HSS columns supported by concrete piers or spread footings, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete spread footing, strip footings and grade beams. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses supporting corrugated metal deck, there are a few locations where the open web steel trusses frame into wide flange beams.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2014 HVAC updates installed a "tempered air" system utilizing a cooling tower to create cool water that was routed via roof mounted piping to a number of rooftop units.*
    - *This strategy is able to deliver 65 to 70 degree air into the classrooms during the hottest days of the year.*
    - *Heating water piping and boilers were installed in 1997 and were all reused in the 2014 HVAC updates.*
    - *The existing RTU serving the 1979 area of the building was replaced with a new RTU because it was not able to be retrofitted with a cooling coil. The area served by this unit now has VAV zoning and some new ductwork. Existing ductwork downstream of the new VAVs was reused. Sections of duct in this area that remain from 1979 are nearing the age were they should be replaced. The RTU and zoning scheme is air conditioning ready.*

- *Existing MZ RTUs from 1971 were retrofitted with cooling coils and all ductwork was reused. These units and the associated ductwork should be replaced. Budget constraints and prioritization of improved comfort resulted in these RTUs remaining in place during the 2014 HVAC updates project.*
- *Kitchen make-up air unit was installed in 2014.*

- *A packaged DX RTU serves the Music and Art classrooms that were added in 1995. This area is already air conditioned. Unit replacement should be anticipated in the next 3-5 years.*
- *The RTU serving the gym is original from 1971. The gym is also used as the cafeteria. This unit should be replaced and piping extended to this area to provide air conditioning.*

AC Study: Beattie Elementary School

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Beattie ES	45,535	Yes	$ 4,188,400	$ 5,654,340	$ 91.98	$ 124.18

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.
    - Pros:
        - Highly efficient
        - Resilient, comfortable
        - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs

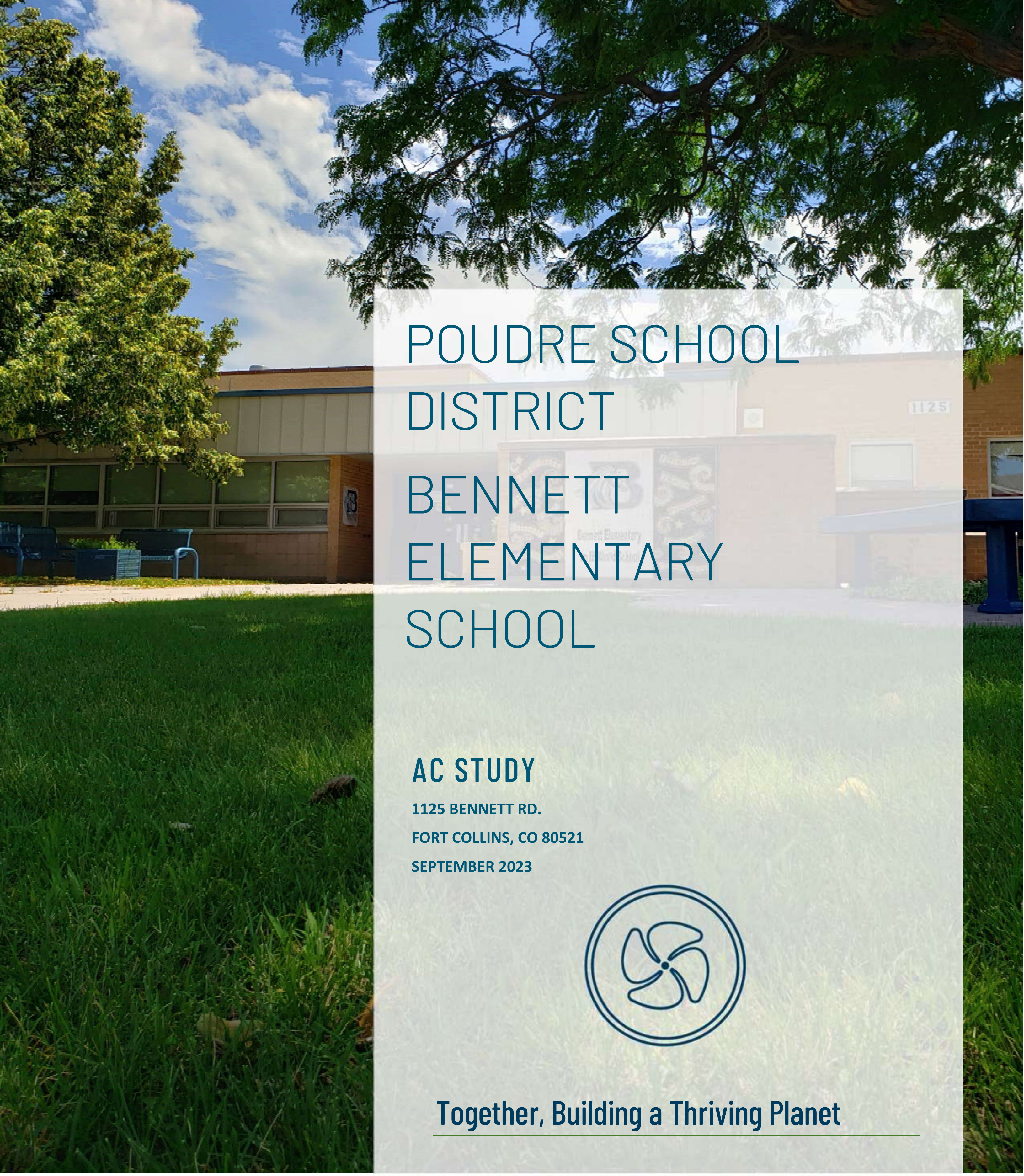
        - Likely can re-use some of the existing heating water piping for condenser water
        - Condenser water lines do not require insulation
        - System can very effectively provide heating and cooling simultaneously
        - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
    - Cons:
        - High capital cost for new mechanical system retrofit
        - Heat pump equipment have compressors, which can sometimes require additional maintenance
        - Heat pump units may be louder than other HW/CW hydronic systems
        - Requires an upgrade to the building electrical service, details provided below
        - Will most likely trigger structural upgrades, details provided below
    - Implementation:
        - Install a new 125-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
        - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system.
        - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
        - Replace all existing equipment with water-sourced heat pump equipment
            - Replace existing RTUs with new heat pump RTUs
                - Provide zoning and VAVs for 1971 area.
            - Replace existing AHUs with new heat pump AHUs
        - Install evaporative cooling on Kitchen MAU
        - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1200A service is 447 Amps. There is capacity to add cooling loads to the existing service but adding 125 tons of cooling would require a service upgrade to 2000 Amps or 2500 Amps.
    - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
    - Costs for this upgrade is included
- **Structural Implications:**
    - Rooftop equipment: The existing bar joist, LH and H truss support framing will likely trigger reinforcing.
        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
    - Air-Source Heat Pump Pad
        - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.

        - Thickened lip = 12"tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
        - Reinforcing = (2) #4's top and bottom.
        - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
    - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Rebalance chilled water flows at new RTU installed in 2014.*
    - McKinstry Comment: TAB recommended at all RTUs.
- *Install new RTUs for the 3 RTUs serving the 1971 area. Energy Code and best practice will require zoning control in these areas to be revised to VAV. All ductwork in these areas to be removed and replaced.*
    - McKinstry Comment: Included.
- *Install new RTU on gym/cafeteria and install a new branch from the existing roof mounted chilled water piping to the gym roof. Remove and replace existing duct in gym/cafeteria.*
    - McKinstry Comment: All RTUs to be changed to heat pump RTUs.
- *Replace 1995 DX RTU with chilled water RTU.*
    - McKinstry Comment: Replaced with Heat Pump RTU.
- *Packaged DX RTU for admin*
    - McKinstry Comment: Included in all options – but with an ASHP RTU in lieu of DX to allow for heat pump heating.
- *Install evaporative cooling on kitchen MAU installed in 2014.*
    - McKinstry Comment: Included in all options.



POUDRE SCHOOL DISTRICT

BENNETT ELEMENTARY SCHOOL

AC STUDY

1125 BENNETT RD.

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

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AC Study: Bennett Elementary School

Bennett Elementary School AC Study

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AC Study: Bennett Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Bennett Elementary School

BUILDING SUMMARY

General:

Bennett Elementary School is a single-story 50,748 square foot school located at 1125 Bennett Road, in Fort Collins, Colorado. Originally built in 1962, the building has seen multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The west classrooms that were added in 1966 are cooled with two roof top units (RTU) with DX cooling. The administration area is also cooled with RTUs with DX coils. The computer lab is cooled by a DX coil installed in the branch ductwork of the RTU that it is served by. The original east classrooms are cooled by VUVs with DX cooling.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment, this includes RTUs, AHU, VUVs, UVs, and cabinet unit heaters (CUH).

Ventilation: The ventilation system consists primarily of Vertical Unit Ventilators (VUVs) serving the East Classrooms, with some spaces served by RTUs including the West Classrooms, Data Room, Flex Room, and Media Center.

Existing Electrical Systems:

The building has an existing 1600 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1962 with additions in 1966, 1984, 1991, 1994 and 2002 renovation completed in 2016. The building consists of reinforced masonry, HSS and pipe columns supported by spread footings, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete spread footings and strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses supporting corrugated metal deck, there are a few locations where wood joists frame into bearing walls in corridors.

BUILDING HISTORY

Building Updates since 2015 Study

In 2016 there was a major renovation where cooling was added to the majority of the building. Vertical unit ventilators with DX cooling and hot water heating coils were added to the East Classrooms and two new RTUs with HWC and DX were added to the West Classrooms.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2002 a classroom addition was constructed on the south side. This area is served by a CV RTU providing heating and ventilating only. An adjacent existing classroom is also served by this unit. The administration area was also remodeled, a packaged DX RTU now serves this space. 1994 consisted of a small addition and an infill.*

- *A portion of building was constructed to connect the original 1962 construction to the 1966 building. This infill area is served by a CV RTU with heating and ventilating only.*
- *The flex room, which was the library constructed in 1984, was expanded slightly to the south. It now serves as the cafeteria. In 1984 a media center addition was constructed on the south side, adjacent to the kitchen. This area is served by two unit ventilators that were relocated in the 1994 expansion of this space. UVs are from 1984.*

- *In 1966 an annex was built to the west of the building. It is served by two MZ RTUs.*
- *1962 was the original construction of the building.*
  - *All classrooms are served by UVs.*
  - *Some interior rooms have ceiling hung UVs.*
  - *The gym is served by an indoor AHU in the boiler room. It provides supply air via underground duct.*
- *PSD has installed a split system DX fan coil for the computer lab in the 1962 area.*
- *Kitchen has no make-up air unit. It relies only on transfer air from the gym.*

AC Study: Bennett Elementary School

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART							
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)		
			Low	High	Low	High	
Bennett ES	50,492	No	$ 2,033,900	$ 2,745,765	$ 40.28	$ 54.38	

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

- **Heat Pump RTU**
  Replacing the remaining RTUs with no cooling will be the lowest first cost to implement cooling to the remaining parts of the building.
    - Pros:
        - Lowest first cost
        - Does not require replacing most equipment in the school; utilizes existing infrastructure.
        - Utilizes the existing hot water and hot water piping.
        - Cooling will be provided.
    - Cons:
        - Not as energy efficient has switching to a central plant or heat pump system.
        - Will most likely trigger structural upgrades, details provided below.
    - Implementation:
        - Replace RTU-5 with a new HW/ASHP RTU to add cooling to the south classrooms.
        - Replace AHU-1 with a new HW/ASHP AHU to add cooling to the gym.
        - Install ASHP RTU for cafeteria.
        - Install additional ASHP coils and condensing unit to RTU-3 to add cooling to spaces served by RTU-3 other than the media center.
- **Electrical Implications of AC Addition:**

    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1600A service is 441 Amps. There is capacity to add cooling loads to the existing service adding 55 tons of cooling.
    - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
    - Costs for this upgrade is included
- **Structural Implications:**
    - Rooftop equipment: The existing bar joist, LA and H truss support framing will likely trigger reinforcing.
        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16" x 16" square.
    - AHU: Will not trigger structural upgrades, unit is located on slab on grade in a storage room.
    - Costs for this upgrade is included
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install a new RTU to serve the cafeteria.*
    - McKinstry Comment: Included

POUDRE SCHOOL DISTRICT

BETHKE ELEMENTARY SCHOOL

AC STUDY

5100 SCHOOL HOUSE RD.

TIMNATH, CO 80547

JUNE 2023

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AC Study: Bethke Elementary School

Bethke Elementary School AC Study

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AC Study: Bethke Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to “refresh” the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building’s construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry’s team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to “best case scenario” options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Bethke Elementary School

BUILDING SUMMARY

General:

Bethke Elementary School is a single-story 62,691 square foot school located at 5100 School House Road, in Timnath, Colorado. This school was built in 2008 and has not undergone any major renovations since. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building is served by a "tempered air" system, utilizing a cooling tower connected to the heating water piping in a 2-pipe changeover strategy to deliver cool water to all units in the building. All parts of the building connected to the heating water system are also able to use the tempered water; however, the entire system can only be operated in either heating or cooling mode. There are 5 RTUs connected to the tempering system. One rooftop unit has DX cooling serving the computer lab.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment.

Ventilation: The ventilation system consists primarily of 6 RTUs and 1 AHU.

Existing Electrical Systems:

The building has an existing 600 amp, 480Y/277V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 2008. The building consists of HSS columns supported by spread footings, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses framing into wide flange beams supporting corrugated metal deck, there are a few locations where joists frame into CMU bearing walls.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *This school was built in 2008. It is not "air-conditioned" in the traditional sense. However, with the sustainable building construction and system installed – it has, according to PSD personnel, consistently provided adequate comfort in the warmer times of the year.*
- *The 2008 system consists of the following*
    - *VAV RTUs – 3 of which utilize a heat wheel for energy recovery.*
    - *VAV reheat zoning at each classroom, office area, etc*
    - *Cooling tower to create cool water coupled with a flat plate heat exchanger.*
    - *Chilled water piping routed to all RTUs except the gym and administration area.*
    - *The administration area is served by DX cooling*
    - *The gym is provided with heating and ventilation only.*

AC Study: Bethke Elementary School

- *High efficiency boilers were installed in 2008 as well.*
- *Kitchen does not have any dedicated make-up air unit. Make-up air is via transfer air from the adjacent cafeteria RTU.*

AC Study: Bethke Elementary School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During interviews with the building management team, it was noted that the tempered system for Bethke is more effective than many of the others. As such, this school should be less prioritized than many other buildings. This building has still been shown with a central heat pump mechanical system for comparison with other schools, but implementation of air conditioning could alternatively be accomplished by replacing existing rooftop units with new ASHP or DX units.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Bethke ES	62,691	Yes	$ 3,716,200	$ 5,016,870	$ 59.28	$ 80.03

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be

more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.

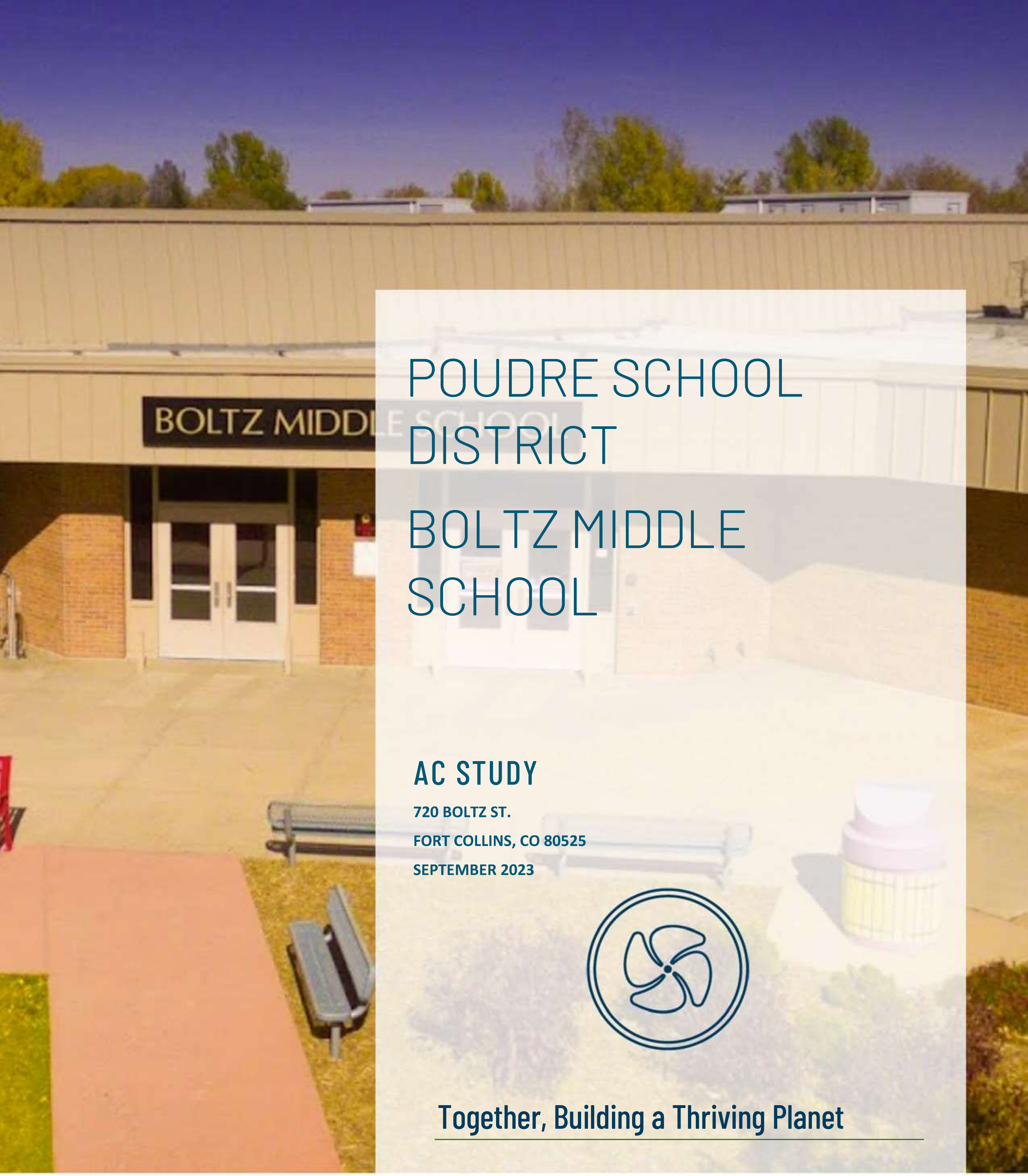
- Pros:
  - Highly efficient
  - Resilient, comfortable
  - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
  - Likely can re-use some of the existing heating water piping for condenser water
  - Condenser water lines do not require insulation
  - System can very effectively provide heating and cooling simultaneously
  - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
- Cons:
  - High capital cost for new mechanical system retrofit
  - Heat pump equipment has compressors, which can sometimes require additional maintenance
  - Heat pump units may be louder than other HW/CW hydronic systems
  - Requires an upgrade to the building electrical service, details provided below.
  - Will most likely trigger structural upgrades, details provided below.
- Implementation:
  - Install a new 125-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
  - Demolish existing baseboard heaters, cabinet unit heaters, and other radiant heaters
  - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system
  - Demo or abandon in place existing cooling tower
  - Replace all existing equipment with water-sourced heat pump equipment
    - All RTUs and FCUs in the building would require replacement with new heat pump equipment. All CUHs will require replacement with electrical unit heaters.
  - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).

- **Electrical Implications of AC Addition:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 600A service is 226 Amps. There is capacity to add cooling loads to the existing service but adding 125 tons of cooling would require a service upgrade to 1,000 Amps.
  - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
  - Costs for this upgrade is included.
- **Structural Implications:**
  - Rooftop equipment: The existing bar joist, LH, K and H truss support framing will likely trigger reinforcing.

        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
    - Water-Source Heat Pump Pad
        - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
            - Thickened lip = 12”tall x 10” deep perimeter footing with minimum size equal to the footprint of the equipment + 6” all-around.
            - Reinforcing = (2) #4’s top and bottom.
            - 6” slab-on-grade to span between thickened lip and configured with #4 at 16” OC each way centered.
    - Costs for this upgrade is included in above pricing.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4’-0”) with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10’ of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

- *None.*



POUDRE SCHOOL DISTRICT

BOLTZ MIDDLE SCHOOL

AC STUDY

720 BOLTZ ST.

FORT COLLINS, CO 80525

SEPTEMBER 2023

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AC Study: Boltz Middle School

Boltz Middle School AC Study

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AC Study: Boltz Middle School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Boltz Middle School

BUILDING SUMMARY

General:

Boltz Middle School is a single-story 85,120 square foot school located at 720 Boltz Street, in Fort Collins, Colorado. Originally built in 1971, the building has seen with multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building is served by a "tempered air" system, utilizing roof top units (RTU) on the roof with evaporative cooling and energy wheels delivering outside air to all classrooms. This system is not a formal cooling system and much of the school has no cooling at all.

Heating: Heating is served by a central hot water plant with a gas-fired boiler, piped throughout the building to all heating equipment, Fan Coil Units (FCUs), AHUs, and RTUs and VAV boxes. With a few spaces heated with gas fired RTUs.

Ventilation: Ventilation for the building is provided by the RTUs serving the classrooms via displacement ventilation diffusers and other interior spaces by RTUs and AHUs.

Existing Electrical Systems:

The building has an existing 1600 amp, 480Y/277V 3-phase, 4-wire service.

Existing Structural Systems:

The initial building was constructed in 1971 with additions in 1981 and 1993 and renovation completed in 2001, 2013 and 2021. The building consists of pipe columns supported by spread footings, concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web trusses framing into wide flange beams supporting plywood roofing.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2012 HVAC updates installed a "tempered air" system utilizing indirect evaporative cooling Dedicated Outside Air Systems (DOAS) for the northeast and northwest classroom areas.*
  - *This strategy is to deliver outside air into the classrooms that is approximately 17 degrees cooler than the outside air temperature during the warmer parts of the year. For instance – at 90 degrees outside, the air delivered to the classroom is 73 degrees.*
  - *VAV boxes regulate air flow quantity into each zone/classroom.*
  - *The northwest classroom air is delivered overhead in some rooms. In other rooms air is supplied via displacement ventilation diffusers. Return air is at the ceiling. Air quantity, depending on*

room size and purpose varies between 500 and 2,000 cfm. 1971 ductwork was reused downstream of the new VAV boxes.

  - *The northeast classroom air is delivered via displacement ventilation diffusers on the floor. Return air is also at floor level. The strategy is to deliver the air down in the occupant zone in lieu of overhead at the ceiling. Air quantity varies between 650 and 2,000 cfm, depending on room size, orientation and function. 1971 ductwork was reused downstream of the new VAV boxes.*
  - *RTUs do not have room for a future cooling coil.*
- *Heating water piping and boilers were installed in 1971 and were all reused in the 2012 HVAC updates.*
- *Four indoor heating and ventilating air handlers, installed in a mechanical mezzanine, above the acoustic tile ceiling serve areas such as cafeteria, stage, music rooms, and administration area. These units are original to the 1971 construction. Access is a maintenance nightmare.*
- *Heating and ventilating RTUs installed in 1971 serve the gyms and Tech Ed areas.*
- *A heating and ventilating RTU installed in 1971 serve the classroom pod just east of the administration area.*
- *The 1993 addition is served by a constant volume RTU.*
- *Computer labs are air conditioned with packaged DX RTUs.*
- *Existing structure is wood so ducted return is required.*
- *Locker rooms do not have direct fresh air supply, only exhaust.*

AC Study: Boltz Middle School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During interviews with the facility management team, it was noted that much of the duct system is in too poor of condition to be salvaged. It is likely that in the implementation of AC these systems would need to be replaced. During the design phase, the extent of ductwork replacement will be more thoroughly explored – for now, it is assumed that the duct systems need to be replaced entirely.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Boltz MS	85,120	No	$ 7,529,500	$ 10,164,825	$ 88.46	$ 119.42

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.

- Pros:
  - Highly efficient
  - Resilient, comfortable
  - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
  - Likely can re-use some of the existing heating water piping for condenser water
  - Condenser water lines do not require insulation
  - System can very effectively provide heating and cooling simultaneously
  - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
- Cons:
  - High capital cost for new mechanical system retrofit
  - Heat pump equipment have compressors, which can sometimes require additional maintenance
  - Heat pump units may be louder than other HW/CW hydronic systems
  - Will most likely trigger structural upgrades, details provided below.
- Implementation:
  - Install a new 175-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
  - Demolish existing baseboard heaters, cabinet unit heaters, and other radiant heaters
  - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system
  - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
  - Replace all existing equipment with water-sourced heat pump equipment
    - Replace existing RTUs with new heat pump RTUs
    - Replace existing FCUs with new horizontal heat pumps
    - Replace existing heating-only AHUs with new heat pump AHUs
  - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
  - Install new Kitchen MAU with evaporative cooling.

- **Electrical Implications of AC Addition:**
  - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1600A service is 331 Amps. There is capacity to add 175 tons of cooling load to the existing service.
  - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
  - Costs for this upgrade is included
- **Structural Implications:**
  - Rooftop equipment: The existing open web truss, TH-H, TJ-L and TJ-S truss support framing will likely trigger reinforcing.

        - Truss reinforcing to consist of bolted compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
    - Air-Source Heat Pump Pad
        - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
            - Thickened lip = 12”tall x 10” deep perimeter footing with minimum size equal to the footprint of the equipment + 6” all-around.
            - Reinforcing = (2) #4’s top and bottom.
            - 6” slab-on-grade to span between thickened lip and configured with #4 at 16” OC each way centered.
    - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4’-0”) with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10’ of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install chiller and chilled water piping and route to new RTUs*
    - McKinstry Comment: We have recommended Heat Pump RTUs.
- *Replace all existing RTUs, AHUs, piping and ductwork in the building, including work installed in 2012. Energy Code and best practice will require zoning control in these areas to be VAV.*
    - McKinstry Comment: We have recommended new RTUs with VAVs for zoning.
- *Install new RTUs with cooling for the Tech Ed rooms.*
    - McKinstry Comment: We have recommended new RTUs.
- *Packaged DX RTU for admin*
    - McKinstry Comment: Our solutions suggest installing new Heat Pump systems rather than DX.

AC Study: Boltz Middle School

- *Install new make-up air unit with evaporative cooling for the kitchen.*
    - McKinstry Comment: Included.
- *This building requires a total HVAC system removal and replacement. The extent of work required in this building will be so extensive that the work will not be able to be completed during a typical summer break. Moving of students and staff should be included in any plan to improve/update the HVAC system in this building.*
    - *To remove the air handlers installed in the mezzanine above the ceiling will requiring removing the roof.*
    - *Installing a roof capable of supporting RTUs is advised so that units are no longer installed in such an unfriendly maintenance location. In addition, modern units will not fit in the existing mezzanine, nor does access to install new units exist.*
        - McKinstry Comment: Included.
- *Consider reusing the DOAS units from 2012 in other locations that could utilize some tempered air – such as gyms that frequently hold spectator sports.*
    - McKinstry Comment: We have recommended new RTUs

POUDRE SCHOOL DISTRICT

CACHE LA POUDRE ELEMENTARY SCHOOL

AC STUDY

3511 W. COUNTRY RD. 54G

LAPORTE, CO 80535

SEPTEMBER 2023

Together, Building a Thriving Planet

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Cache La Poudre Elementary School AC Study

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AC Study: Cache La Poudre Elementary School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Cache La Poudre Elementary School

BUILDING SUMMARY

General:

Cache La Poudre Elementary School is a single-story 53,193 square foot school located at 3515 County Road, in Laporte, Colorado. Originally built in 1962, the building has seen with multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below.

Existing Mechanical Systems:

Cooling: Most of the building has no cooling system, with the exception being the DX rooftop unit RTU-2 serving admin and RTU-3 serving the computer lab.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment.

Ventilation: The ventilation system consists primarily of Roof Top Units (RTUs) with VAVs serving the classrooms, with some spaces served by Unit Ventilator and Vertical Unit Ventilators.

Existing Electrical Systems:

The building has an existing 1200 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1962 with additions in 1972 and 1992 and a renovation completed in 2015. The building consists of concrete-masonry unit bearing and shear walls that are supported by mild reinforced concrete strip footings. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of mostly open web steel trusses supporting tectum roof deck.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *2015 HVAC updates that were installed in the 1972 part of the building are air conditioning ready. Some of the original ductwork from 1972 was reused, if air conditioning is to be installed, it would be prudent to replace the ductwork that is reaching the end of its service life at that time.*
- *In 2007 an expansion of the cafeteria to the west was constructed. New and relocated UVs were part of the project.*
- *Equipment installed in the 1992 addition and renovation to the north part of the building, with the exception of the office area, is not air conditioning ready. All equipment will need to be replaced if air conditioning is to be installed. With the exception of the Gym RTU, all other equipment will reach the end of its service life in the next 5-7 years.*
    - *Office area is served by a packaged DX RTU provided air conditioning. Zone control is via reheat coils. At an age of 22 years, and to reduce energy consumption, it would be prudent to replace this unit in the next 3-5 years, regardless if air conditioning is installed in the rest of the building. Packaged VAV DX RTU should be installed and VAV boxes installed for zone control to meet current Energy Code.*

AC Study: Cache La Poudre Elementary School

- *1972 was a significant addition to the south of the building served by CV MZ units. These units are being replaced in 2015 under the 2010 Bond. Some ductwork from 1972 is being reused in the 2015 project.*
- *1962 was the original construction of the building. All equipment in this area has been replaced due to HVAC projects in 1992, 2007 and 2015. Kitchen make-up air unit and evaporative cooler should be replaced.*

AC Study: Cache La Poudre Elementary School

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Cache La Poudre, IB World ES	53,193	Yes	$ 5,207,300	$ 7,029,855	$ 97.89	$ 132.16

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers. It was noted during interviews with District facilities staff that heat plant replacement is a high priority.
    - Pros:
        - Highly efficient
        - Resilient, comfortable

        - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs.
        - Likely can re-use some of the existing heating water piping for condenser water
        - Condenser water lines do not require insulation.
        - System can very effectively provide heating and cooling simultaneously.
        - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
    - Cons:
        - High capital cost for new mechanical system retrofit.
        - Heat pump equipment have compressors, which can sometimes require additional maintenance.
        - Heat pump units may be louder than other HW/CW hydronic systems.
        - Requires an upgrade to the building electrical service, details provided below.
        - Will most likely trigger structural upgrades, details provided below.
    - Implementation:
        - Install a new 125-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
        - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system.
        - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
        - Replace all existing equipment with water-sourced heat pump equipment.
            - All VUVs, RTUs, VAVs and UVs in the building would require replacement with new heat pump equipment.
        - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
        - Install new MAU in kitchen with evaporative cooling.
- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1200A service is 416 Amps. There is capacity to add cooling loads to the existing service but adding 125 tons of cooling would require a service upgrade to 2000 Amps or 2500 Amps.
    - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
    - Costs for this upgrade is included in pricing above.
- **Structural Implications:**
    - Rooftop equipment: The existing bar joist, H truss support framing will likely trigger reinforcing.
        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
    - Air-Source Heat Pump Pad
        - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.

        - Thickened lip = 12"tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
        - Reinforcing = (2) #4's top and bottom.
        - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
    - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install chiller and route chilled water to 2015 RTUs and VUVs*
    - McKinstry Comment: All equipment will be replaced with heat pump equipment.
- *Replace ductwork in the 1972 area that the 2010 Bond project budget was unable to address*
    - McKinstry Comment: Included
- *Route chilled water on roof and drop into space when required.*
    - McKinstry Comment: Converting existing HW to CDW piping is the design intent.
- *Install new RTU, with VAV zoning and remove existing UVs for the NE corner 4 classrooms*
    - McKinstry Comment: New equipment is included.
- *Install new RTU and remove existing UVs for the cafeteria*
    - McKinstry Comment: New equipment is included.
- *Replace office area packaged DX RTU with a new VAV packaged DX RTU for operation during afternoon and summer times when no students are there to avoid running the chiller for only a portion of the school*
    - McKinstry Comment: Included, but with an ASHP RTU in lieu of DX for heat pump heat.
- *Kitchen makeup air unit with evap cooling*
    - McKinstry Comment: Included.

POUDRE SCHOOL DISTRICT

CACHE LA POUDRE MIDDLE SCHOOL

AC STUDY

3515 W. COUNTRY RD. 54G

LAPORTE, CO 80535

SEPTEMBER 2023

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Cache La Poudre Middle School AC Study

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AC Study: Cache La Poudre Middle School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to “refresh” the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building’s construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry’s team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to “best case scenario” options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Cache La Poudre Middle School

BUILDING SUMMARY

General:

Cache La Poudre Middle School is a single-story 73,913 square foot school located at 3515 County Road, in Laporte, Colorado. Originally built in 1947, the building has seen with multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: Most of the building has no cooling system, however (4) RTUs have DX cooling, including those serving the computer lab and the IT room, and 5 VUVs have DX cooling. The separate gym currently has no cooling.

Heating: Heating is served by a central hot water plant with gas-fired boilers, piped throughout the building to all heating equipment.

Ventilation: The ventilation system is primarily provided by RTUs and AHUs, some with VAVs, as well as a few VUVs.

Existing Electrical Systems:

The building has an existing 1600 amp, 208Y/120V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1947 with additions in 1962, 1982, 1988 and 2007 and a renovation completed in 2015. The building consists of concrete columns and concrete shear walls that are supported by mild reinforced concrete spread and strip footings, respectively. The main floor is supported by a nominal concrete slab-on-grade. The roof framing consists of concrete drop beams and steel roof trusses supporting a concrete slab roof.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2015 HVAC updates that were installed in the five southeast classrooms of the 1988 addition and are air conditioning ready.*
- *1997 the computer lab 128 and classrooms 109 through 111C were air conditioned with packaged DX units.*
- *1992 addition and remodel equipment is not air conditioning ready and should be replaced.*
- *1988 RTU has had a significant load removed from it during the 2015 HVAC updates. This unit should be removed and sized appropriately for the load that it now serves. Ductwork is fiber board and has been repaired many times. Duct should be removed and replaced.*
- *Indoor air handler serving the 1984 addition that functions as the cafeteria is not air conditioning ready and should be replaced. UVs serving the industrial science are also not air conditioning ready and should be replaced.*

AC Study: Cache La Poudre Middle School

- *North portion of the building was initially built in 1947 and is served by an air handling unit in the basement. It serves the gym as well as most of the classrooms in the original north part of the building.*
    - *The HVAC in this portion of the building needs to be completely removed and replaced. All ceiling systems, lights, and cabling above the ceiling should be removed. Asbestos abatement should be anticipated due to the age of the building and ceiling systems observed.*
    - *The extent of work required in this area will be so extensive that the work will not be able to be completed during a typical summer break. Moving of students and staff should be included in any plan to improve/update the HVAC system in this portion of the building.*
- *Kitchen make-up air unit and evaporative cooler should be replaced.*

AC Study: Cache La Poudre Middle School

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Cache La Poudre, IB World MS	73,913	Yes	$ 6,382,400	$ 8,616,240	$ 86.35	$ 116.57

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers. It was noted during interviews with District facilities staff that updating the heating plant is a high priority.
  - Pros:
    - Highly efficient
    - Resilient, comfortable

        - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs.
        - Likely can re-use some of the existing heating water piping for condenser water
        - Condenser water lines do not require insulation.
        - System can very effectively provide heating and cooling simultaneously.
        - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
    - Cons:
        - High capital cost for new mechanical system retrofit.
        - Heat pump equipment have compressors, which can sometimes require additional maintenance. Provide screening/sound barrier.
        - Heat pump units may be louder than other HW/CW hydronic systems.
        - Requires an upgrade to the building electrical service, details provided below.
        - Will most likely trigger structural upgrades, details provided below.
    - Implementation:
        - Install a new 100-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps.
        - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system.
        - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
        - Replace all existing equipment with water-sourced heat pump equipment.
            - All RTUs, AHUs, VAVs and VUVs in the building would require replacement with new heat pump equipment.
            - Provide heat pump VUVs in all classrooms.
        - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
        - Install new MAU in kitchen with evaporative cooling.
- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1600A service is 858 Amps. Adding 100 tons of cooling will require increasing the existing service size to 2500A.
    - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
    - Costs for this upgrade is included in the pricing above.
- **Structural Implications:**
    - Rooftop equipment: The existing steel trusses support framing will likely trigger reinforcing.
        - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
        - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
    - Air-Source Heat Pump Pad

        - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
            - Thickened lip = 12"tall x 10" deep perimeter footing with minimum size equal to the footprint of the equipment + 6" all-around.
            - Reinforcing = (2) #4's top and bottom.
            - 6" slab-on-grade to span between thickened lip and configured with #4 at 16" OC each way centered.
    - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

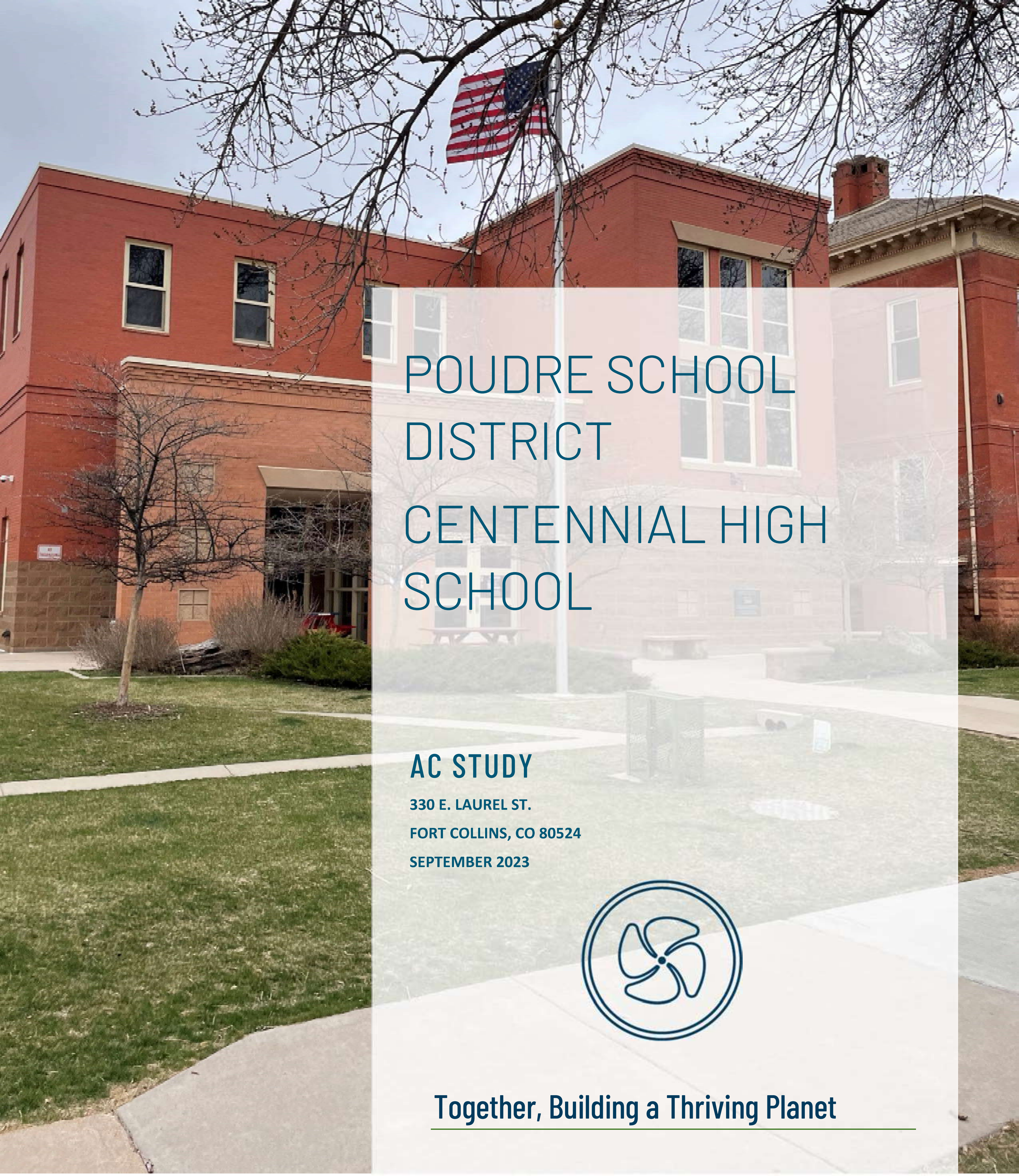
Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install chiller and route chilled water to 2015 VUVs and all other new equipment that will be required to air condition the building.*
    - McKinstry Comment: Heat Pump System is suggested in lieu of chilled water.
- *Install VUVs in the 1947/1962 areas of the building. Structure and space does not allow for other systems to be cost effectively installed. All other classrooms should also be served by VUVs.*
    - McKinstry Comment: Install heat pump VUVs in all classrooms for individual zone control
- *Route chilled water on roof and drop into space when required.*
    - McKinstry Comment: Existing HW piping to be reused as possible for CDW loop.
- *Install new RTUs, for media center, music room, and cafeteria.*
    - Areas that require cooling year-round should remain on ASHP RTU cooling
- *Provide Packaged DX RTU for the administration area.*
    - McKinstry Comment: Included, but with ASHP in lieu of DX.
- *New kitchen makeup air unit with evaporative cooling.*
    - McKinstry Comment: Included.

AC Study: Cache La Poudre Middle School

- *New control system for the whole school.*
    - McKinstry Comment: Included.



POUDRE SCHOOL DISTRICT

CENTENNIAL HIGH SCHOOL

AC STUDY

330 E. LAUREL ST.

FORT COLLINS, CO 80524

SEPTEMBER 2023

Together, Building a Thriving Planet

McKinstry
For The Life Of Your Building

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AC Study: Centennial High School

Centennial High School AC Study

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AC Study: Centennial High School

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Centennial High School

BUILDING SUMMARY

General:

Centennial High School is a three-story 39,967 square foot school located at 330 East Laurel Street, in Fort Collins, Colorado. Originally built in 1906, the building has seen one major expansion in 2004; these renovations are summarized in more detail in the history section below. A deeper dive on the conditions of the existing equipment, and estimated costs of replacement, can be found in McKinstry's FCA workbook and report.

Existing Mechanical Systems:

Cooling: The building has neither a central cooling system nor a "tempered air" system.

Heating: Heating is served by boilers, with hot water piping routed to RTUs in the 2004 additions and to baseboards in the 1906 section of the building.

Ventilation: Ventilation is provided through ducting and supply grilles that are connected to the rooftop units in the 2004 additions. In the 1906 original building, no mechanical ventilation is provided. Natural ventilation is provided through operable windows.

Existing Electrical Systems:

The building has an existing 800 amp, 480Y/277V 3-phase, 4-wire electrical service.

Existing Structural Systems:

The initial building was constructed in 1955 with an addition and renovation completed in 2004.

The original building is a single-story structure with a roof that is supported by 5/8" sheathing over 2x8 wood framing. The center of the roof is supported by a steel wide flange girder that runs over steel columns that are supported by typical spread concrete footings. The base foundation consists of a typical slab on grade.

The 2004 addition consists of a new gymnasium and classrooms. The gymnasium roof framing consists of glulam trusses and sawn lumber over framing with acoustical metal deck. The classroom roof framing consists of open web steel trusses supporting corrugated metal deck. Both additions are supported by concrete-masonry unit bearing and shear walls down to concrete grade beams and deep drilled piers with a typical slab on grade.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2004 a significant building addition was done. Some parts of this project were connected to the original 1906 structure. The remainder of the project was an activities building that was a separate structure.*
    - *New heating and ventilating only RTUs were installed on all of the 2004 construction.*
    - *New boilers and heating plant components were also installed. It is unclear if the piping in the 1906 portion of the building was also replaced at that time.*
- *1906 portion of the building is heated via baseboard radiation. Ventilation is from operable windows.*

AC Study: Centennial High School

AIR CONDITIONING STRATEGIES

Contextual Narrative

During the site visit, it was noted by the PSD staff that the building has heating issues. The 1906 building gets uncomfortably cold during winter. It is believed that the reason is the old leaky windows. In some places, the windows do not close completely, always allowing for infiltration. To raise the temperature and make it warmer during the cold season, the teachers run electrical element heaters which trip the circuit breaker. Also, note that this part of the building has no mechanical ventilation. On the other hand, in the 2004 section of building, the thermostat of the unit controlling the admin area is located in the principal's office in the southwest corner of the building. The opposite offices, especially the one on the northwest corner, do not get enough heat.

During summertime, teachers run portable AC units. The school owns 17 of them. However, they are not enough to cool the place and most of the times only 2 units can run simultaneously in the 1906 building before tripping the circuit breaker.

Our options address these concerns, but due to the poor electrical infrastructure any upgrades to introduce AC will require significant electrical upgrades.

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Centennial HS	39,967	No	$ 4,712,600	$ 6,362,010	$ 117.91	$ 159.18

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump system**
  Heat pump systems are one of the most efficient systems available. These systems operate on a single condenser water loop, with each individual heat pump either rejecting or absorbing heat from the condenser water. These systems are particularly efficient during the shoulder seasons (Spring and Fall) when some spaces require cooling and others require heating, as the system allows that heat to be moved from one space to another. It is likely this system could utilize much of the existing piping, however it requires all the HVAC equipment to be replaced simultaneously to heat pump equipment to implement. This system also would also move towards the District goals of electrification, as it can be more easily converted to an electric-only solution via eventual implementation of ground-sourced heat pump or electric boilers.
    - Pros:
        - Highly efficient
        - Resilient, comfortable
        - Allows for central heat pump to provide heat most of the year, lowering carbon emissions and providing fuel flexibility to react to changing utility costs
        - Likely can re-use some of the existing heating water piping for condenser water
        - Condenser water lines do not require insulation
        - System can very effectively provide heating and cooling simultaneously
        - This system can also be used with a ground-sourced heat pump loop instead of an air-sourced heat pump for additional efficiency if there is opportunity or funding. The system can also be converted to ground-source at the end of life of the air-sourced heat pump.
    - Cons:
        - High capital cost for new mechanical system retrofit
        - Heat pump equipment have compressors, which can sometimes require additional maintenance
        - Heat pump units may be louder than other HW/CW hydronic systems
        - Will most likely trigger structural upgrades, details provided below.
    - Implementation:
        - Install a new 100-ton air-to-water heat pump system and connect to existing heating water piping. Provide new circulation pumps. Provide screening/sound barrier.
        - Provide new condenser water piping system loop. Utilize/reconfigure existing HW piping as possible for new condenser water system.
        - Replace existing boiler plant with new high-efficiency boilers. Reconfigure piping as necessary for new CDW loop.
        - Replace all existing equipment with water-sourced heat pump equipment
            - Replace existing RTUs with new heat pump RTUs
                - Provide VAVs where necessary by code for zoning
            - Replace existing baseboards with new heat pump VUVs. New VUVs to provide ventilation to the 1906 section of the building.
        - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
- **Electrical Implications of AC Addition:**

- Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 800A service is 126 Amps. There is capacity to add 100 tons of cooling load to the existing service.
- When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.

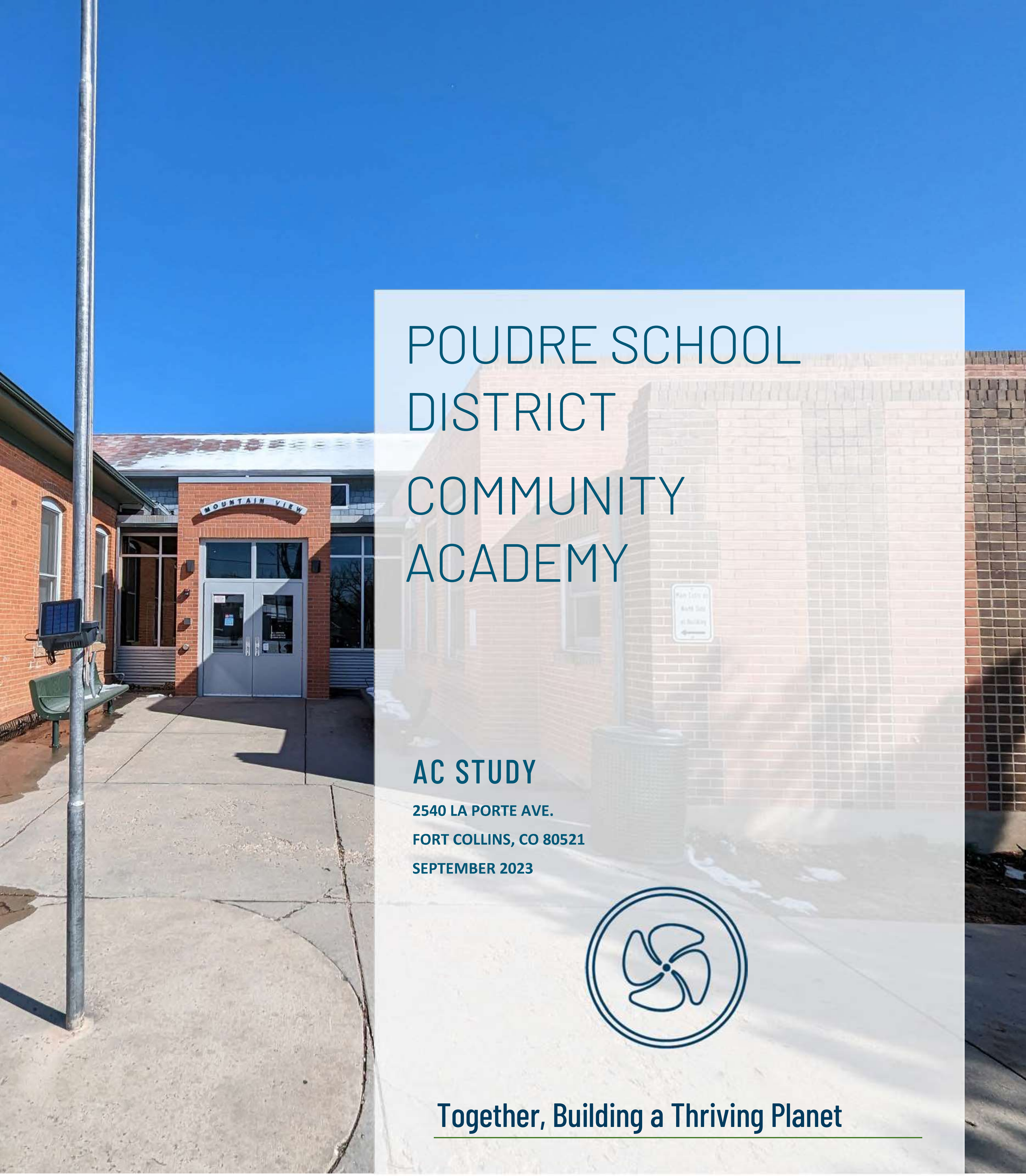
- **Structural Implications:**
  - Rooftop equipment: The existing bar joist, K truss support framing will likely trigger reinforcing.
    - Truss reinforcing to consist of welded compression strut angle members coordinated with mech unit curb location and truss panel points. Truss chord and web reinforcing will also be required.
    - Deck reinforcing will be required if new openings are larger than 16” x 16” square.
  - Air-Source Heat Pump Pad
    - The new ground mounted equipment will be supported by a down-turned thickened lip concrete footing.
      - Thickened lip = 12”tall x 10” deep perimeter footing with minimum size equal to the footprint of the equipment + 6” all-around.
      - Reinforcing = (2) #4’s top and bottom.
      - 6” slab-on-grade to span between thickened lip and configured with #4 at 16” OC each way centered.
  - Costs for these upgrades are included in the pricing above.
- **Architectural Implications:**
  - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4’-0”) with like material and installation techniques.
  - Where installation of new mechanical equipment is within 10’ of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
  - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
  - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
  - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
  - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
  - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Remove RTUs installed in 2004 and replace with VAV RTUs with a cooling coil.*

- McKinstry Comment: Included to replace with ASHP RTUs
- *Install VAV boxes in ductwork installed in 2004 for zoning and to meet current Energy Code.*
  - McKinstry Comment: Included
- *Install VUVS in each room in the 1906 area. Economizers will be difficult due to the historical status of this building. New penetrations in the façade should be carefully located.*
  - McKinstry Comment: Included
- *Install chiller and route piping to RTUs and VUVs*
  - McKinstry Comment: Existing HW piping to be reused as possible as CDW for heat pumps.
- *Packaged DX for administration.*
  - McKinstry Comment: Included, with ASHP RTU in lieu of DX.
- *New control system for the whole school*
  - McKinstry Comment: Included.



POUDRE SCHOOL DISTRICT

COMMUNITY ACADEMY

AC STUDY

2540 LA PORTE AVE.

FORT COLLINS, CO 80521

SEPTEMBER 2023

Together, Building a Thriving Planet

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For The Life Of Your Building

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AC Study: Community Academy

Community Academy AC Study

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AC Study: Community Academy

PURPOSE SUMMARY

The primary function of this Air Conditioning (AC) study is to "refresh" the original 2015 study performed by Horsetooth Engineering for Poudre School District (PSD). In addition to a summary, examination, and validation of the items in the original study, this report includes an analysis of the existing building conditions, an updated historical synopsis of the building's construction projects if applicable, and a high-level exploration of possible solutions to provide Air Conditioning to each building. McKinstry's team has performed a site investigation, has interviewed the facility operators and other relevant parties, and has reviewed available existing documentation in order to provide this analysis.

The goal of this study is to aid PSD in planning the implementation of AC in the various schools which do not currently have cooling. The report is intended to create a basis for which to build future projects and to guide decision making as to how to accomplish this goal. The solutions explored range from budget-aware to "best case scenario" options, but ultimately it was agreed that for the purposes of this study, a single, fully functional AC system option would be presented per school. The preferred system type can be developed further once PSD decides on the direction to move forward after considering District budget, building/system urgency, and overall feasibility. Equipment sizes, cooling tonnages, structural capacities, and other similar values have been estimated using industry best practices and will be confirmed/adjusted via load calculations during the design phase.

This report is intended to be read in tandem with the other McKinstry offerings for this building (RCx, FCA) to provide an integrated and holistic understanding of the building portfolio. While the other reports will focus on the existing systems and conditions in more detail, this report will focus on future implementation of AC in the building and their impacts to electrical, structural, and architectural systems.

AC Study: Community Academy

BUILDING SUMMARY

General:

Community Academy is a single-story 22,434 square foot school located at 2540 La Porte Avenue, in Fort Collins, Colorado. Originally built in 1968, the building has seen with multiple expansions and renovations in the last 50 years; these renovations are summarized in more detail in the history section below.

Existing Mechanical Systems:

Cooling: The building is served by a mix of many different system types. The admin area is cooled via DX Rooftop Unit (RTU). The computer room is served by a DX Split system. The mobile classrooms all have DX cooling in their furnaces. The rest of the building does not have cooling.

Heating: In the oldest part of the building (the Westernmost classrooms), heating is served by a central hot water plant piped to baseboard heat. For the other areas of the building, a gas-fired RTU (admin) or Furnaces provide heat.

Ventilation: Ventilation for the newer sections of the building are provided by the RTU (admin) or Furnaces. There does not appear to be any mechanical ventilation on in the original classrooms on the Western section of the building, and room 105 does not even have a window for natural ventilation. Any renovation should address the ventilation in this section of the building.

Existing Electrical Systems:

The building has an existing 1200 amp, 208Y/120 volt 3-phase, 4-wire service.

Existing Structural Systems:

The original building was constructed in 1968 with various additions/renovations over the next 50 years. The building consists primarily of concrete or concrete-masonry unit bearing and shear walls supported by continuous stem wall footings. The main floor is supported by a nominal concrete slab on grade. The roof system consists of pre-engineered wood trusses and 2X wood joists.

BUILDING HISTORY

Building Updates since 2015 Study

There have been no major additions or renovations since the 2015 study was conducted.

Historical Summary (Excerpt From the 2015 Study)

A description of the existing infrastructure and past remodels from the study performed in 2015 by Horsetooth Engineering is excerpted below:

- *In 2003 a project that consisted of connecting the 3 buildings on the site was undertaken.*
    - *Hallways, restrooms and offices were constructed that allowed connection of the 4 west classrooms, the 2 south facing eastern most classrooms and the cafeteria/gym structure.*
    - *The west classrooms did not appear to receive any HVAC updates at this time.*
    - *The furnace serving the 2 southeast classrooms was left in place.*
    - *A RTU providing heating and ventilation only was installed for the 2003 administration area.*
    - *2 furnaces were installed to heat and ventilate the gym/cafeteria. Supply and return air is delivered via sidewall diffusers – on the same wall.*
    - *1 furnace was installed to heat the kitchen/restrooms/corridor adjacent to the gym/cafeteria.*
    - *Another furnace was installed to heat the corridor/lobby/offices created in 2003.*

AC Study: Community Academy

- *Gym construction date is believed to be 1968.*
- *The 2 southeast classrooms appear to be built quite some time ago. Perhaps the 1940s or 1950s*
- *The 4 west classrooms were likely the original construction. This appears to be around the turn of the 20th century. These spaces are heated by baseboard heat. Ventilation is only provided via operable windows. One classroom that is now adjacent to the 2003 corridor no longer has operable windows to the outside.*

AC Study: Community Academy

AIR CONDITIONING STRATEGIES

Pricing Chart

POUDRE SCHOOL DISTRICT - AC STUDY COST SUMMARY CHART						
School Name	Square Footage	Electrical Service Upgrade	Estimated Cost Range ($)		Estimated Cost Range ($/SF)	
			Low	High	Low	High
Poudre Community Academy HS	22,434	No	$ 1,781,220	$ 2,404,647	$ 79.40	$ 107.19

Pricing Narrative

The cost estimation for this project was developed using industry best practices. Estimations have been prepared in June 2023 dollars. These prices are an opinion of probable cost for implementing AC, including Mechanical, Electrical, Structural, Plumbing, and Architectural costs. Pricing includes replacement of associated MEP systems that may not directly be related to AC such as boilers, ductwork, and heating water piping, when identified as necessary by the district. Pricing also includes a full controls overhaul at all schools. Note that these prices do not include abatement of asbestos outside of the scope of boiler replacements.

It is important to consider that prices for equipment, materials, and labor are still fluctuating heavily since the COVID-19 pandemic. In addition, lead times for equipment continue to be longer than pre-pandemic. These estimates are intended for use as a tool for PSD to facilitate conversations and for developing capital planning; they are not intended to be used as a quoted price to build these solutions. Instead, they should be interpreted as rough orders of magnitude required to accomplish the proposed AC solutions. As the formal design process has not yet been initiated, assumptions were made concerning the scale of renovations required, as well as building-specific details, including but not limited to: total pipe lengths, structural reinforcements, architectural amendments, and electrical system modifications.

AC Recommendation

In the process of determining the system to propose, some of the explored options included: 2-pipe Changeover, 4-pipe HW/CW, VAV Reheat, DX Unit Ventilators, HW/DX RTUs, Variable Refrigerant Flow (VRF), and Chilled Beams.

- **Heat Pump Cooling**
  Due to the small size of the building, and because it is a combination of so many different expansions, it is unlikely to be cost effective to demolish the existing system entirely and replace it with a new central system. Central systems require additional mechanical room space. On a floorplan of this size, it is difficult to reallocate enough square footage without significant alternations. For this reason, a full system replacement to a 4-pipe or heat pump system has not been suggested. Instead, unitary equipment to replace existing equipment is the most efficient scenario.
  - Pros:
    - Fully-functional, reliable AC system
    - Common solution with relatively inexpensive equipment
    - Lower first cost
  - Cons:
    - Not as energy efficient has switching to a central plant or heat pump system.
    - System has multiple different equipment types
  - Implementation

        - Demolish existing boiler, piping, and baseboard heat in Western side of school.
        - Provide (4) new ASHP VUVs, one in each classroom in the Western side of the school. Duct outside air from the roof into the classroom without an exterior wall.
        - Provide new furnaces with split system heat pumps for all existing furnaces (5).
            - Ductwork modifications will be required.
        - Install condensing units on grade outdoors for furnaces.
        - Route condensate lines to the nearest floor drain or sink branch tailpiece for all equipment with cooling. Provide condensate drain pumps if required.
    - For areas intended to be used year-round, such as the admin areas, provide a new ASHP RTU dedicated to those spaces (such as Admin and IT spaces).
- **Electrical Implications of AC Addition:**
    - Based on utility Peak Demand data and NEC required safety factors, the existing peak demand on the 1200A service is 244 Amps. There is capacity to add 30 tons of cooling load to the existing service.
    - When a heating only RTU is replaced with a DX unit, the existing electrical feeders & circuit breakers will need to be upsized to support the additional electrical load.
- **Structural Implications:**
    - No structural reinforcement is required if the existing unit is similar or same weight.
- **Architectural Implications:**
    - For installation of new mechanical equipment provide a new rooftop curb (w/appropriate structural reinforcement). Existing Roofing at new curb location to be removed. Then repair, replace, and patch roofing as required around new curb (min. 4'-0") with like material and installation techniques.
    - Where installation of new mechanical equipment is within 10' of parapet wall or edge of roof provide permanent fall protection and associated structural reinforcement railing per OSHA requirements.
    - Where existing structural members are protected with Fire-Resistive-Rated (FRR) assemblies, all new structural members must be protected with a FRR assembly of equal or greater protection.
    - All new pipe penetrations and roof mounted pipe equipment shall be flashed in a manner appropriate to the existing roofing.
    - Where new penetrations are designed through Fire-Resistive-Rated Assemblies (Roof, Wall, and Floor) appropriate Fire/Smoke Dampers, FRR sleeves, and/or Fire Caulking shall be provided.
    - All new wall penetrations for pipe, louvers, or equipment installation shall be flashed and caulked in a manner appropriate for the exterior material.
    - All new wall penetrations for louvers or equipment shall be braced with new structural headers appropriate for the existing structural system. Header sizing by a Licensed Structural Engineer.

Recommendations from 2015 Study

Below are excerpts of recommendations from the 2015 study. Recommendations that are no longer applicable, or that have already been implemented, have been removed. Recommendations related to the condition of existing equipment and systems are covered in the FCA report and have been removed.

- *Install new furnaces and condensing units for all the areas currently served by furnaces.*
    - McKinstry Comment: Included.
- *Install new packaged DX RTU for the administration area.*
    - McKinstry Comment: Included, but with a heat pump RTU in lieu of DX.

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- *Install VUVs in each of the 4 classrooms in the original building. Each VUV shall have a corresponding DX condensing unit.*
    - McKinstry Comment: Included, but with ASHP in lieu of DX.
- *Route DuctSox through the gym for improved air distribution.*
    - McKinstry Comment: Replacement of some ductwork has been included in pricing.
- *New control system for the whole school*
    - McKinstry Comment: Included.