POUDRE SCHOOL DISTRICT
AIR CONDITIONING STUDY

PHASE I

HORSETOOTH ENGINEERING, LLC

6/18/2015

GOALS

The goals of the Phase I study is as follows:

- Establish feasible options to install air conditioning in all Poudre School District (PSD) schools which do not currently have air conditioning. The options will then be carried forward into Phase II to establish a budget estimate for installation.
- Establish feasible alternative options to air conditioning that could improve the comfort in the warmer times of the school year – but not incur the cost and energy use increase that industry standard air conditioning would require. The options will then be carried forward into Phase II to establish a budget estimate for installation.
- Evaluate installations that have recently been completed under the 2010 Bond Project to recommend how they can be improved in the near term, and adapted to air conditioning in the long term.

APPROACH

Due to the differences in age, architecture, remodels and mechanical system type among the schools in Poudre School District, Horsetooth Engineering has grouped schools into five categories. The grouping allows similarities amongst schools to establish common recommendation paths. The goal in creating common recommendation paths is for similar schools to achieve similar results in comfort improvement, energy use and equipment longevity. The five categories are as follows:

- No Tempering or AC schools that are still to have HVAC improvements installed under the 2010 Bond Project, or will remain Non-Tempered after the 2010 Bond Projects are complete.
- Tempered schools that are more than 30 years old and relatively adaptable to adding air conditioning.
- Tempered schools that are less than 30 years old and relatively adaptable to adding air conditioning
- 2012/2013 DOAS installations.
- Air conditioned or partially air conditioned schools that have upcoming work planned, or need improvement.

Schools have been broken into age ranges so that a systems thinking approach can be taken as the Study moves into Phase II. PSD and Horsetooth Engineering believe it would be irresponsible to not consider the age of the building infrastructure as a factor in undergoing a significant building modification such as adding air conditioning. The age definition of thirty (30) years has been chosen since it is a median age representing the life cycle of most equipment. Ductwork and pipe

often last 40 years if well maintained, air handling equipment often lasts 20-30 years if well maintained, and central plant equipment such as boiler and chillers often last 30-40 years if well maintained. Building Automation Systems will be included for the analysis when the Study moves into Phase II.

DEFINITIONS

AIR CONDITIONING (AC) – A system capable of delivering 55 degree air into a space in sufficient quantity to keep room temperatures at or below 75 degrees on an ASHRAE summer design day. For the purpose of this study, the ASHRAE 1% Cooling Design has been selected. 91º F dry bulb and 60º F wet bulb. 1% criteria indicates that 1% of the hours of the year exceed this criteria. Therefore 87.6 hours of the year, this design temperature will be exceeded. It should be noted that some of these 87.6 hours will occur in July and the beginning of August before school starts.

TEMPERED AIR – A system capable of reducing outside air or a mixture of return air/outside air temperatures before the air is introduced into the space.

AC Spaces – Space types to be air conditioned

- Classrooms
- Office areas
- Corridors
- Cafeterias

Non-AC Spaces – Space types not to be air conditioned

- Gyms (unless they are also used as the cafeteria)
- Locker Rooms
- Kitchens

MZ – Multizone air handling unit.
UV – Under the window type unit ventilator
VUV – Vertical Unit Ventilator with ducted supply
VAV – Variable Air Volume
CV – Constant Volume
RTU- Rooftop unit air handling system
AHU – indoor air handling system
DX – Direct expansion refrigerant mechanical cooling

BUILDING ANALYIS AND RECOMMENDATIONS

NO TEMPERING OR AC

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces equipment due to age	Replace Non-AC spaces equipment due to age	Equipment required to Add AC	Alternative to AC	Remarks
Barton	Yes, abandon UG duct	New pipe required to implement VUVs	Yes	Yes	Chiller. Pipe. VUV per classroom. RTUs for gym and admin	Tower. Pipe. VUV per classroom. RTUs for gym and admin	1956 Basement MZ to be removed
Bennett	Yes, 1966 area and Gym	Yes	Yes	Yes	Chiller. Pipe. VUV per classroom. RTUs for media center and cafeteria	Tower. VUV per classroom. RTUs for media center and cafeteria	1962 UVs and 1967 MZs and Gym AHU to be removed
CLP Elementary	Yes, 1972 area	No	Only some, 2015 equip to remain	No	Chiller. Pipe. VAV RTUs for areas skipped in 2015	Tower. Pipe. VAV RTUs for areas skipped in 2015	1972 Duct reused in 2015 and UVs not replaced in 2015 to be removed
Dunn	No	No	No	No	Chiller. Pipe. VUVs in classrooms. RTUs for media and admin.	Tower. Pipe. VUVs in classrooms. RTUs for media and admin.	1987, 1992, 2006 equipment was not designed to have AC added, remove all.
Harris	No	Yes, in older parts of bldg	No	No	Chiller, RTUs, VUVs	Tower, New RTUs, VUVs.	VRV system should also be considered if AC is desired
Lab/Polaris	Yes, abandon UG duct and replace 1965 duct	No	Yes	Yes, 1956 Gym	Chiller. VUV per classroom. RTUs for cafeteria and media center	Tower. VUV per classroom. RTUs for cafeteria and media center	1956 and 1965 MZs and 1987, 1994 RTUs to be removed.

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces equipment due to age	Replace Non-AC spaces equipment due to age	Equipment required to Add AC	Alternative to AC	Remarks
Livermore	No	No	No	Yes	New AHUs with DX coils	Economizers only	VRV system should also be considered if AC is desired
O'Dea	Yes	Yes	Yes	Yes	Chiller. VUV for 1962/1966 areas. VAV box zoning, RTUs for 1994 areas	Tower. VUV for 1962/1966 areas. VAV box zoning, RTUs for 1994 areas	1962 UVs, AHU and 1966 MZs to be removed
Putnam	Yes, UG duct and 1966 area	No	Yes	No	Chiller. VUV for classrooms Add cooling coils to 1994 equip	Tower. VUV for classrooms Add cooling coils to 1994 equip	1955 bsmt MZ and 1966 MZs to be removed. Some 1994 DX units to be removed
Red Feather	No	No	No	No	Add DX coils to existing furnaces	Economizers only	VRV system should also be considered if AC is desired
Stove Prairie	No	No	No	No	Add DX coils to existing furnaces	Economizers only	VRV system should also be considered if AC is desired
Timnath	No	No	No	No	Chiller. VUVs. Improve building relief air	Tower. VUVs. Improve building relief air	1988 and 1992 UVs are approaching the end of their service life
Blevins	Yes	Yes	No	Yes	Chiller. Piping. Replace AHUs with RTUs. Duct in 1967 area. Reuse 2012 VAV boxes	Tower. Piping. Replace AHUs with RTUs. Duct in 1967 area. Reuse 2012 VAV boxes	Aside from the 2012 RTUs and boilers. Bldg is due for a total HVAC replacement

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces equipment due to age	Replace Non-AC spaces equipment due to age	Equipment required to Add AC	Alternative to AC	Remarks
CLP Middle	Yes, 1947 and 1988 areas	No	Yes	Yes	Chiller. VUVs in classrooms. RTUs for media, cafeteria and music	Tower. VUVs in classrooms. RTUs for media, cafeteria and music	1947 area will require extensive work outside of just HVAC
Lesher	Yes, 1959, 1976 areas	Yes, 1959, 1972, 1976 areas	Yes, some	Yes	Chiller, VUVs, RTUs and AHUs. Pipe and Duct	Tower, VUVs, RTUs and AHUs. Pipe and Duct	Bldg is due for a total HVAC upgrade
Lincoln	Yes	Yes	Yes	Yes	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	Bldg is due for a total HVAC upgrade
Webber	No	No	No	No	Chiller, piping, coils	Tower piping, coils	Bldg is generally AC ready.
Centennial High School	No	No	No	No	Chiller, RTUs, VUVs	NA – all other high schools have full AC	VRV system should also be considered if AC is desired in 1906 area
Poudre Community Academy	No	No	No	No	Furnaces, RTUs	VRV	

TEMPERED – MORE THAN 30 YEARS OLD – RELATIVELY ADAPTABLE

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces AHU equipment due to age	Replace Non-AC spaces AHU equipment due to age	Equipment required to Add AC	Alternative to AC	Remarks
Beattie	Yes	No	Yes	N/A	Chiller. VAV box zoning, RTUs	Install new VAV RTUs, duct. connect to existing tower	1971 RTUs and duct need to be replaced

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces AHU equipment due to age	Replace Non-AC spaces AHU equipment due to age	Equipment required to Add AC	Alternative to AC	Remarks
Irish	Yes	No	Yes	N/A	Chiller. VAV box zoning, RTUs	Install new RTUs, duct. Connect to existing tower	1967 RTUs and duct need to be replaced
Riffenburgh	Yes	No	Yes	No	Chiller. VAV box zoning, RTUs	Install new RTUs, duct. connect to existing tower	1967 RTUs and duct need to be replaced

TEMPERED – LESS THAN 30 YEARS OLD – RELATIVELY ADAPTABLE

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces AHU equipment due to age	Replace Non-AC spaces AHU equipment due to age	Equipment required to Add AC	Remarks
Kruse	No	No	No	No	Chiller	VUV and Tower installation in 2014
McGraw	No	No	No	No	Chiller	VUV and Tower installation in 2014
Laurel	No	No	No	No	Chiller	VUV and Tower installation in 2015
Traut	No	No	No	No	Chiller	VUV and Tower installation in 2015
Preston	No	No	No	No	Chiller	VUV and Tower installation in 2015

TEMPERED – 2012/2013 DOAS INSTALLATIONS

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces AHU equipment due to age	Replace Non-AC spaces AHU equipment due to age	Equipment required to Add AC	Alternative to AC	Remarks
Bauder	Yes, downstream of VAV boxes	No	Yes, Cafeteria only	No	Chiller, coils in new RTUs	Tower, coils in new RTUs	Cafeteria RTU needs to be replaced. Bldg is AC ready
Eyestone	Yes, 1972 area	Yes, 1972 area	Yes, 1972 area	Yes	Chiller. RTUs, VAVs, duct pipe	Tower. RTUs, VAVs, duct pipe	1988 & 1992 RTUs, 1972 MZs need replaced
Johnson	No	No	No, due to size	No	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	DOAS RTUs, Displacement Ventilation 2012
Linton	No	No	No, due to size	No	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	DOAS RTUs, Displacement Ventilation 2013
Lopez	No. due to size	No	No, due to size	Yes	Chiller. RTUs and AHUs VAV zoning	Tower. RTUs and AHUs VAV zoning	DOAS RTUs, Displacement Ventilation 2013
Olander	No	No	No, due to size	No	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	DOAS RTUs, Displacement Ventilation 2013
Shepardson	No	No	No, due to size	Yes	Chiller. RTUs and AHUs VAV zoning	Tower. RTUs and AHUs VAV zoning	DOAS RTUs, Displacement Ventilation 2012
Tavelli	No	No	No, due to size	Yes	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	DOAS RTUs, Displacement Ventilation 2012
Werner	No	No	No, due to size	No	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	DOAS RTUs, Displacement Ventilation 2012
Boltz	Yes	Yes	Yes	Yes	Chiller. RTUs, VAV zoning	Tower. RTUs, VAV zoning	DOAS RTUs, 2012. Needs a complete HVAC replacement

AIR CONDITIONED

School	Replace Duct Due to Age	Replace Pipe Due to Age	Replace AC spaces AHU equipment due to age	Replace Non-AC spaces AHU equipment due to age	New Equipment required	Remarks
Bethke	No	No	No	No	None	School was only visited for an example of non-traditional AC that is working well.
Fullana	Yes	NA	Yes	NA	New Furnaces in Early Ed area. New AHUs in Gym and Annex	Scheduled for 2017 work related to 2010 Bond
Rice	No	No	No	No	None	School was only visited for an example of non-traditional AC that is working well.
Wellington Middle School	No	No	No	Yes	Chiller, RTUS, VAV zoning	Building will be up for a major replacement in 7-10 years
Rocky	Yes, 1971 areas	Yes, 1971 areas	Yes	Yes	Chiller, RTUs, Duct, VAVs, Pipe	The whole bldg is due for a mechanical replacement

SYSTEM AND ENERGY CONSIDERATIONS

Air cooled chiller

- For the current school calendar (no summer operation) this is an economical option that provides energy efficiency and a reasonable first cost. These systems will be carried into Phase II of the study.
- Ice storage systems will not be considered as this study moves into Phase II. Only $2,000 of savings is realized by adding ice storage. The

cost to add ice storage in a typical elementary or middle school would exceed a 20 year payback based on the current school calendar. Due to not operating in June and July, there is only one month where high peak demands costs due to cooling would be experienced (August).

Packaged VAV RTUs

- For the current school calendar (no summer operation) this is an economical option that provides redundancy and a reasonable first cost. These systems will be carried into Phase II of the study for schools that lend themselves to a centralized RTU solution in lieu of a VUV solution.

Water cooled chiller

- Water cooled chiller systems will not be considered as this study moves into Phase II, except for Rocky Mountain High School due to its size. Minimal savings is realized by utilizing a water cooled chiller. Due to not operating in June and July, there is only one month where high peak demands costs due to cooling would be experienced (August). Also, school is released before the hottest times of the day, and therefore largest chiller loads; most chillers see the maximum load between 3 and 6pm. Most schools are let out before or shortly after 3pm.

Ground Source Heat Pumps

- These systems will not be explored moving into Phase II of the study.
    - Initial costs do not pay back in a reasonable time frame with the current cost of natural gas being so low and very limited operation of the cooling system during the most expensive time of the year due to the school calendar.
    - Almost all schools have an existing boiler system that already provide heat.
    - Noise in the classrooms is likely to be an issue if unitary heat pumps were installed in the classroom.
    - If unitary heat pumps were installed above the ceiling, maintenance access would be a significant concern.
    - Well field space may not exist at all locations
    - If a geoexchange system is desired in the future and makes economic sense due to increased utility rates and/or a change in

the school calendar – then a water to water heat pump system could be installed and replace the boiler and proposed chiller plants.

Cooling Tower Tempering

- Due to the success of these systems at Irish, Riffenburgh, Kruse and McGraw, and because they are a less expensive and more energy efficient option than a traditional chiller plant, this alternative option will also be explored at most schools.

ADDITIONAL OPPORTUNITIES

Extensive HVAC retrofits have wide ranging impacts on other building systems, including but not limited to architectural, electrical, and fire alarm.

In some schools, where extensive ductwork removal is recommended, the existing ceiling will need to be demolished and new installed. While doing so, the existing lighting and fire alarm systems will need to be removed and reinstalled. Most schools have undergone recent Fire Alarm upgrades so these systems should be salvaged and reinstalled. Lighting, however, represents a great opportunity to improve the maintenance and energy cost. Replacing existing lighting with new LED lighting will only be an increase in cost of material; labor will be the same as reinstalling the old lights. New LED lights will reduce the heat gain into the space and help reduce the size of the new air conditioning system, reduce energy costs due to lighting, and lower maintenance costs due to the longevity of the bulbs. During Phase II a cost for this strategy will be established at schools where most of the ceiling will need to be removed in order for air conditioning to be installed.