



City of Louisville

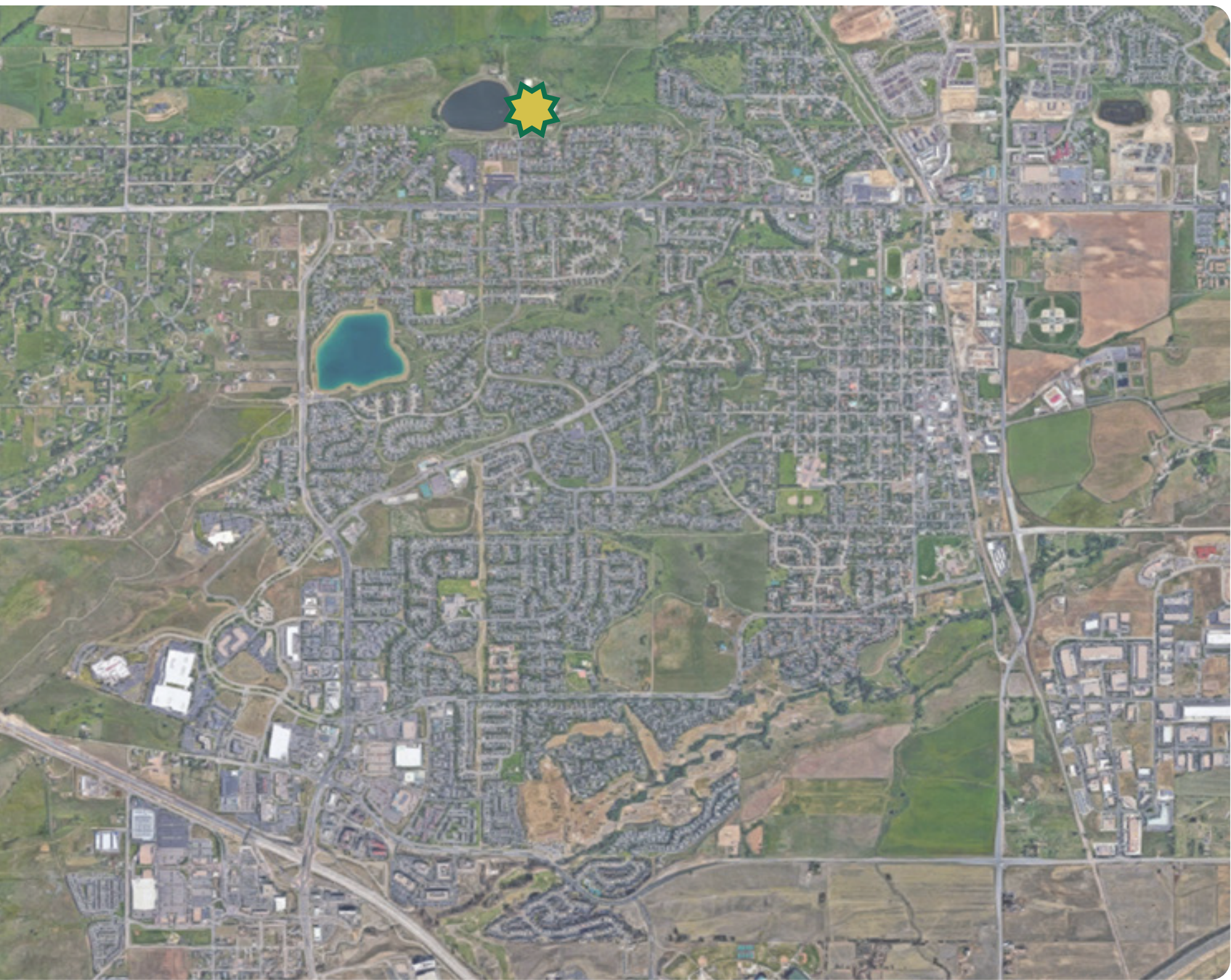
Internal Decarbonization Plan

SID COPELAND WATER TREATMENT PLANT DECARBONIZATION AUDIT REPORT

1955 WASHINGTON AVE
LOUISVILLE, COLORADO
AUGUST 18, 2023



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Date	Version History
5/12/2023	Version 1 - Issued for City Review and Input
8/18/2023	Version 2 - Issued to City

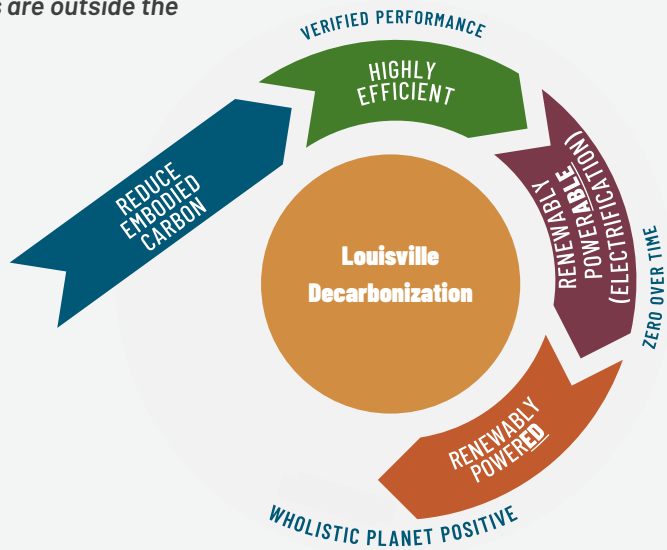
Background

In August of 2019, City Council passed Resolution 25, Series 2019, which set clean energy and carbon emission reduction goals for the municipality and larger community. This resolution sets goals to meet all of Louisville’s municipal electric needs with 100% carbon-free sources by 2025, and to reduce core municipal greenhouse gas emissions annually below the 2016 baseline through 2025. The City of Louisville has demonstrated its commitment toward creating a healthy and sustainable environment for its residents, evident through Resolution 25-2019 (Setting Clean Energy and Carbon Emission Reduction Goals), as well as their Sustainability Action Plan (adopted in October 6, 2020). In support of these goals, McKinstry was contracted to identify a strategic roadmap for electrification and decarbonization of all City buildings, fleet, equipment and operations* by 2030, and recommend an alternative target if appropriate.

This is an interim report, providing initial directions, findings, as well as a draft set of detailed decarbonization approaches for the Sid Copeland Water Treatment Plant.

**Process water treatment energy, process wastewater energy, and street lighting/signals are outside the scope of this study.*

There are many possible pathways for decarbonizing Louisville. With guidance from City staff, this report focuses on identification of strategies that provide the highest value, most fiscally responsible path forward to achieve Louisville’s decarbonization goals.



Decarbonization Recommendation

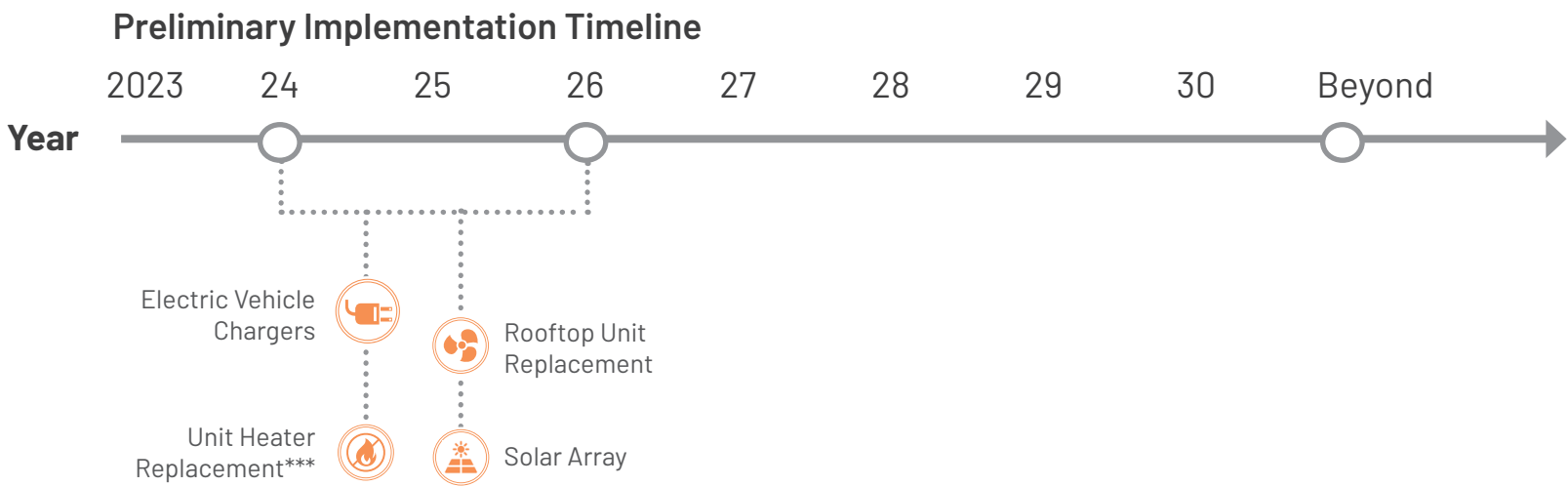
The table below outlines the findings of the study, and highlights the opportunity to use hybrid electrification as a viable and cost-effective path towards carbon neutrality. While the carbon reduction for the hybrid option may appear insufficient, it is still a viable option since this building only accounts for 3% of total City carbon. The total cost is the total amount of money that will need to be allocated for budgetary purposes. The net cost is the total construction costs minus the replacement costs that would’ve been spent to replace the existing units with like-for-like fossil fuel units. The net cost represents the true cost of this decarbonization effort. All information included in this table is explained in greater detail in this report. **These are “all-in costs” and represent the total cost of construction. They are also Rough Order of Magnitude (ROM) numbers, with a +/-20% range.** See “Construction Pricing Context” section for more detail.

	Scenario	Life Cycle Carbon Reduced	Life Cycle Carbon % Reduction	Total First Cost	Net First Cost Over Business as Usual Cost
⚡	Full Electrification	1,100 tons	100%	\$1.7M*	\$1.5M
⚡🔥	Hybrid Electrification	400 tons	36%	\$150k	\$20K
☀️	Renewables	N/A	N/A	\$1.3M**	N/A
🔌	EV Charging	N/A	N/A	\$150k	N/A

**Full electrification assumes like-like capacity replacements for unit heaters. Costs subject to further evaluation of required freeze protection and generator requirements.*
***Renewable costs do not account for funding from the Inflation Reduction Act (IRA).*

Implementation

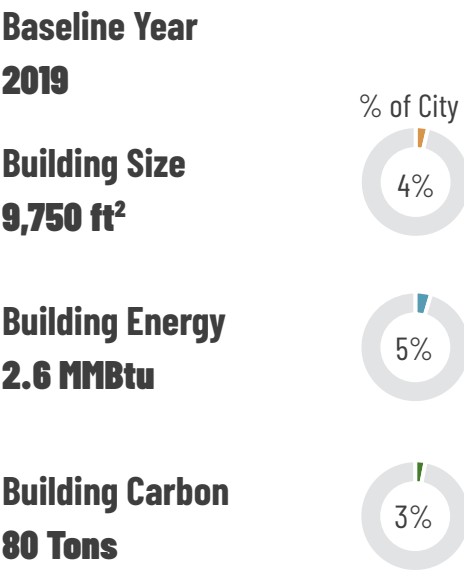
A preliminary implementation timeline is shown below, based on the 2023 Capital Improvement Plan (CIP).



****Equipment not included in 2023 CIP, estimated to be replaced in sequence with Rooftop Units.*

Baseline | Building Use & Energy and Carbon Analysis

Baseline Building Use

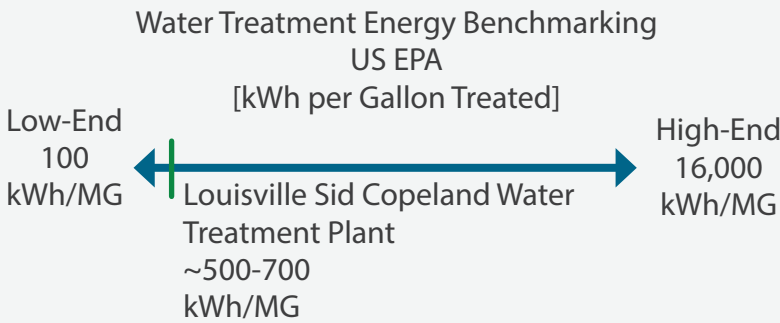


- Building Information
- Primary water treatment plant for Louisville.
 - Consists of multiple small support buildings.
 - The Administration Building is the only building with gas use. Other buildings utilize electric freeze protection.
 - Located at northern border of the city.
 - Not open to public.
- Recent Renovations and Energy Improvements
- Recently received new 80-gal domestic heat pump water heater.



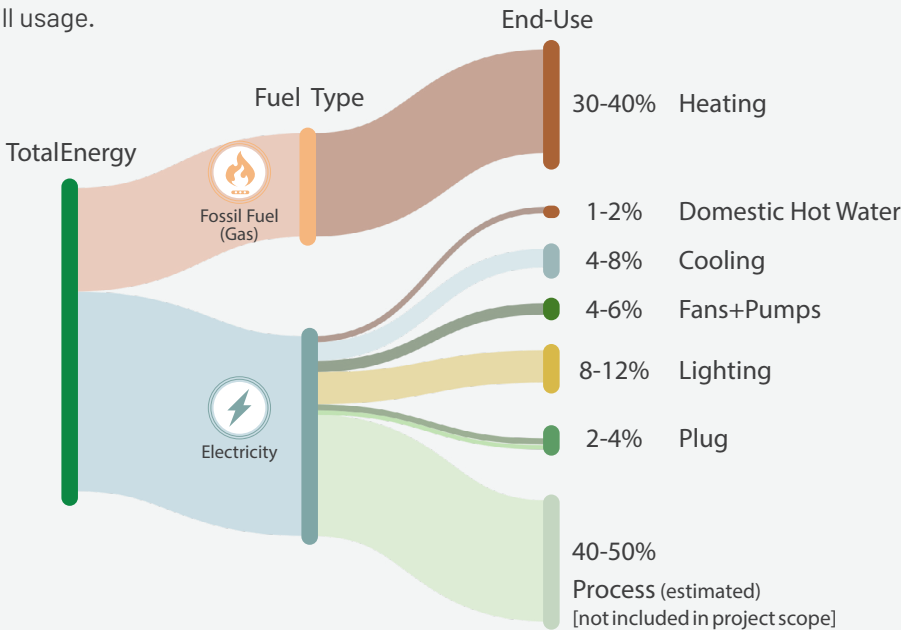
Baseline Energy Use

The Sid Copeland Water Treatment Plant performs well when compared to the expected ranges of energy use for water treatment plants per the Energy Efficiency in Water and Wastewater Facilities report by the US Environmental Protection Agency (EPA). Note that performance for water/wastewater treatment plants can vary significantly by the specific treatment processes of each plant.



Baseline Energy End-Use

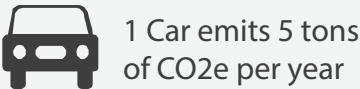
Energy end-use estimates are based on most recent available 2018 Commercial Building Energy Consumption Survey (CBECS) benchmarking data and site audit information. Pumping energy data for the site was provided but did not align with utility bill usage.



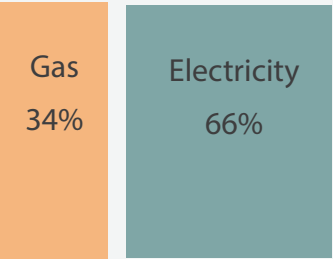
Baseline Carbon Use

The City of Louisville participates in programs to offset their existing electrical consumption with renewable sources. **Therefore, for the purposes of this study the total carbon emissions at Louisville will be solely driven by on-site fossil fuel combustion and emissions associated with electric consumption will be zero.**

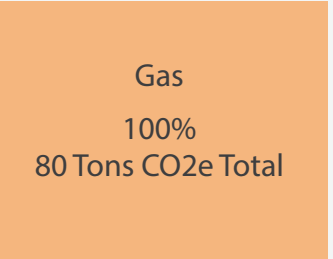
The amount of electric consumption offset needed for zero carbon will be addressed in future phases of this study, and will be evaluated at the portfolio level. The offset will be a function of post-decarbonization electrical consumption considering carbon and load reduction measures, on-site renewable energy provided, and the grid emissions of Xcel Energy and zero-carbon utility subscription programs.



Baseline Energy



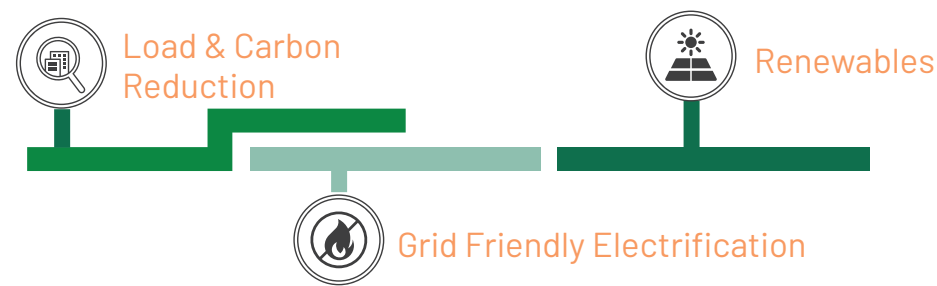
Baseline Carbon



Decarbonization Measures | Decarbonization Process, Load & Carbon Reductions

Decarbonization Process

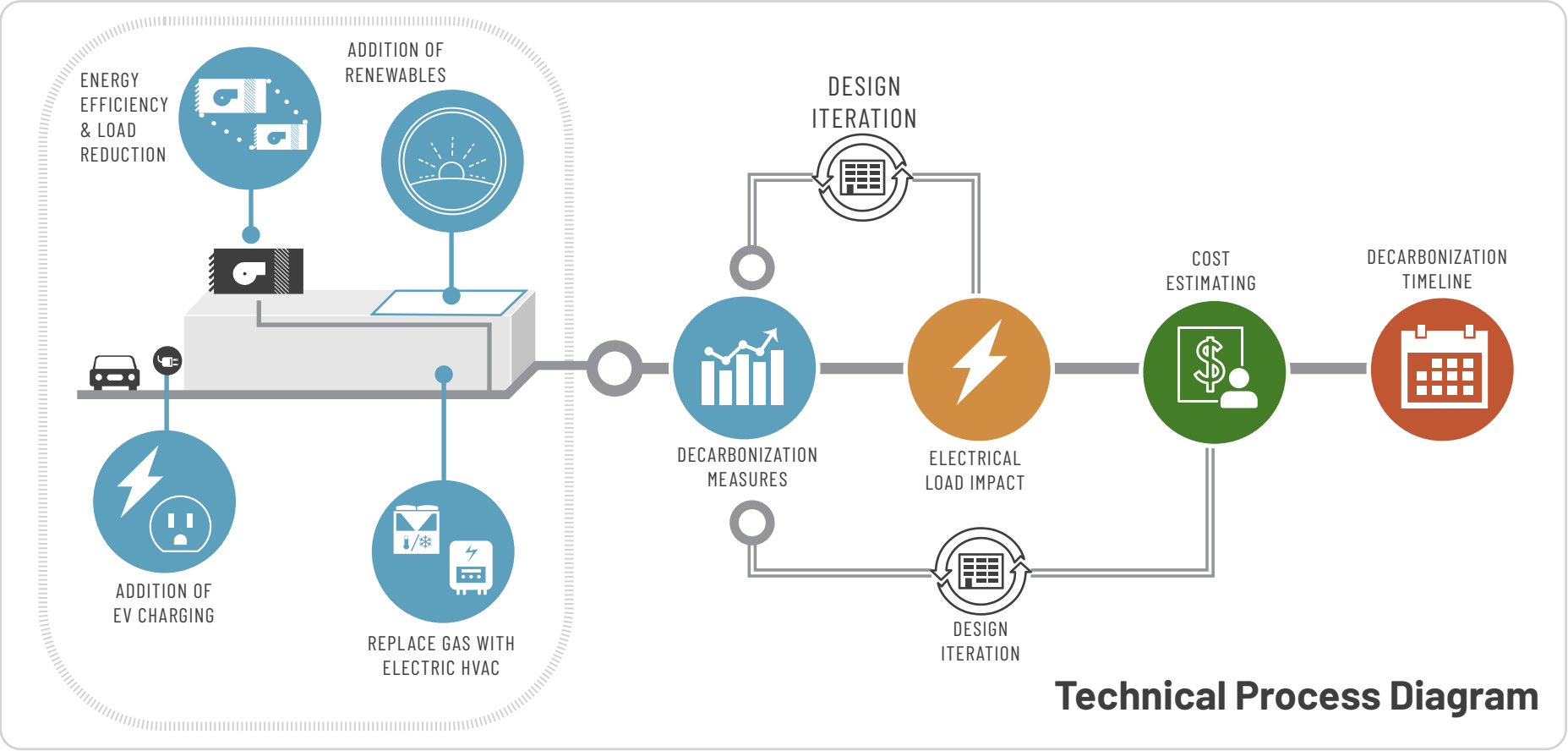
There are a host of measures to employ on the path of decarbonization, ranging from time-tested traditional energy efficiency measures to the more aggressive electrification measures. The key to decarbonization is finding the right balance between measures, as indicated by the graphic below. With this approach, Louisville will find the most cost-effective path to full decarbonization.



The decarbonization solution starts by identifying measures at the building, and continues with design iteration to arrive at the final timeline, as seen in the Technical Process Diagram.

Load & Carbon Reduction

The recent shift towards decarbonization still operates on the core foundation of reducing building's overall energy use. Measures can have two functions: reducing annual energy/carbon consumption and reducing peak building demand load. These measures are often incentivized by Xcel and may have shorter paybacks. **Note that a large portion of the electrical load at the site is associated with treatment processes, which are outside the scope of this study.**

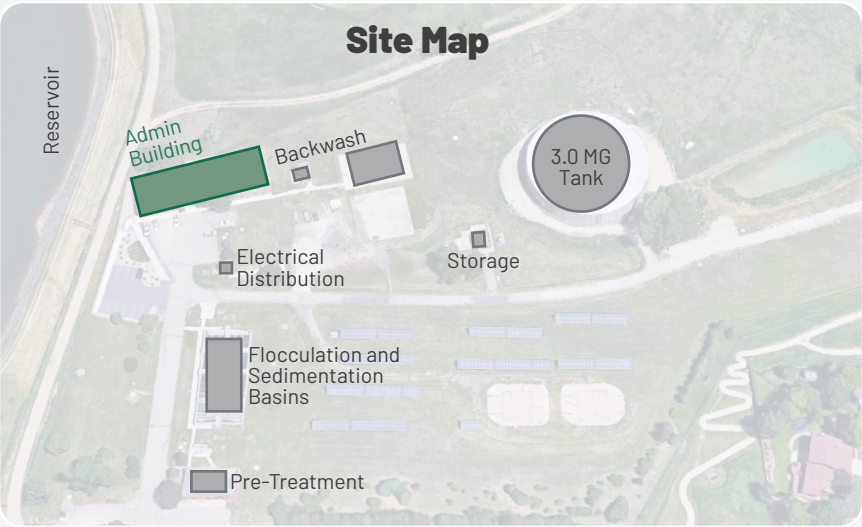


Load	Carbon	Measure	Description
■	■	ENVELOPE AIR SEALING	Buildings are often remarkably leaky – the wall/parapet junction being a frequent culprit. Ensuring a building is tight and ventilated right is an effective efficiency measure that also has durability benefits (condensation often occurs at air leakage points) and improves air quality (mold reduction and limiting outside air infiltration during wildfire events).
□	■	LIGHTING CONTROLS/VACANCY SENSORS	LED light replacements typically are the most cost effective way for saving electricity in the lighting arena, but adding lighting controls (which turn off lights with vacancy and vary based on available daylight) provide additional savings and better user experience (avoiding over-lighting).
■	■	LED LIGHTS	Complete the LED light upgrade that has already been started by the building maintenance group. Most of the building lighting has already been upgraded to LED but there is still about 5% of the light fixtures that could be upgraded. LED light replacement typically are the most cost effective way for saving electricity.

Decarbonization Measures | Mechanical Electrification

Electrification Opportunities

The Sid Copeland Water Treatment Plant facility is composed of several buildings, most of which do not contain gas-fired equipment. The Admin building, shown below in green on the site map, is the only one that contains gas-fired equipment.



AIRSIDE

Ventilation, heating, and cooling for the Sid Copeland Water Treatment Plant’s Admin building are supplied through a packaged gas/refrigeration rooftop unit (RTU), which provides cooling via packaged refrigerant and heating via gas-fired burner. The decarbonized system will replace the gas fired RTU with a heat pump based RTU that can utilize either electric resistance or gas backup heat. Backup heat is utilized to supplement the heat pump as temperatures drop and heat pump capacity is reduced or when temperatures drop below the heat pump operation limit. This is typically a small amount of time in the year and has minor energy impacts (described in results section).

FREEZE PROTECTION

Unit heaters provide freeze protection throughout the Sid Copeland Water Treatment plant buildings. The purpose of these heaters is to avoid freezing temperatures for protection to the buildings and equipment, and not to provide full space heating. Typically these units run significantly less than space conditioning units. Unit heaters are already all-electric at all buildings except for the Admin building. Seven gas unit heaters exist in the Admin Building. The proposed decarbonized system for these units are electric unit heaters.

DOMESTIC HOT WATER

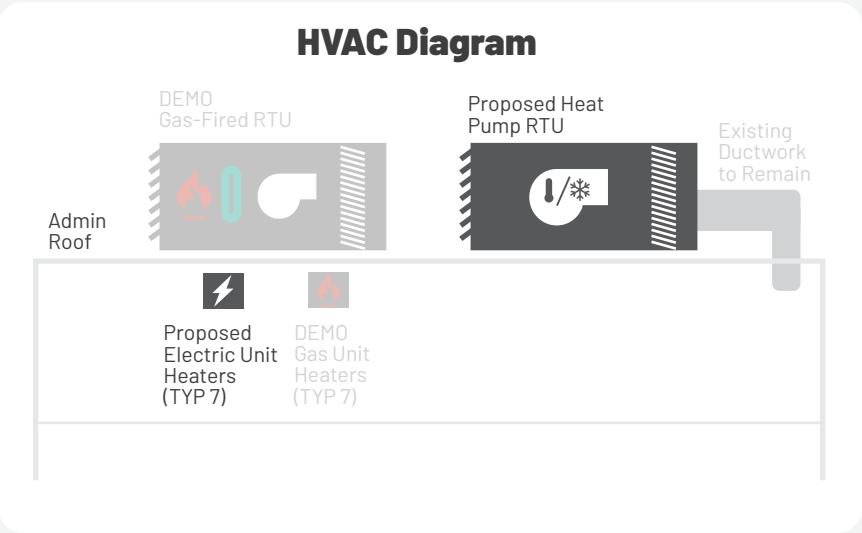
Domestic hot water (DHW) is currently served by electric resistance water heating and is to remain as is. A heat pump water heater was considered, but is not cost-effective since the domestic hot water load in this building is small.

OTHER MECHANICAL SYSTEMS FOR CONSIDERATION

A third electrification measure was considered for the mechanical systems: utilizing the reservoir as a heat source/sink, acting similar to a ground-source heat pump system. The building mechanical equipment would be served by a new condenser water loop that uses heat exchangers to transfer heat to/from the reservoir. This measure would require an electrical service upgrade and would be significantly more cost-intensive due to material costs of the new condenser water piping, as well as additional appurtenances needed for a hydronic based system, and water-sourced equipment generally being more expensive than air-sourced. This option should be considered when the facility is expanded.

Proposed Electrification

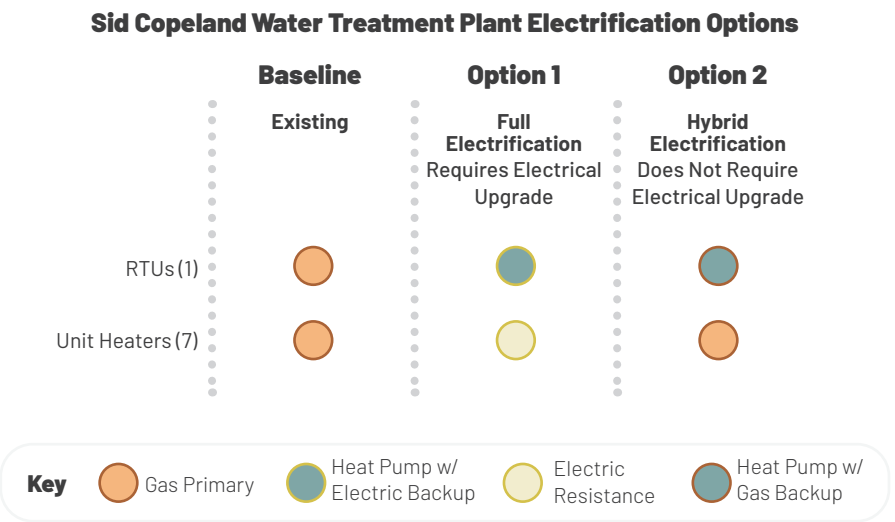
The Admin building’s HVAC system is composed of a gas/package refrigerant rooftop unit, associated ductwork, and 7 gas-fired unit heaters for additional space heating. A simple diagram of these system components and their proposed electrification measures is shown below.



All Electric vs Hybrid Systems

Hybrid systems are a useful tool for **sensible and cost-effective decarbonization**, as they strike a balance between carbon reduction, construction costs, and utility demand costs. In general, it can be expensive to electrify the “last 10%”, because the system is sized for the coldest day of the year, which rarely occurs. In many cases, using gas as the peaking fuel source on the coldest day will mitigate need for an electrical upgrade while still achieving significant carbon reductions.

Based on the sizes of the mechanical equipment and the load profile of the building, the Hybrid option for the Sid Copeland Water Treatment Plant would use gas backup for the rooftop unit, and leave the gas unit heaters as is.



Beneficial Electrification

Electrification of mechanical systems provides value beyond energy and carbon savings. This includes, but is not limited to:

- Enhanced ventilation control (outside-air supply, CO₂ Control, etc.) with a new RTU
- Improved thermal comfort with right-sized RTU and updated controls
- Improved resiliency of newer units

Decarbonization Measures | Renewables & Electric Vehicle Chargers

Renewables

At the Sid Copeland Water Treatment Plant (SCWTP), Louisville could install two solar arrays on the northeast and southwest corners of the site that would total to a ~375kW-DC fixed-tilt ground mount solar PV system.

Renewable energy plays the important role of offsetting remaining carbon emissions after building load reductions and electrification are complete. This can be handled through a variety of avenues – behind-the-meter systems, Community Solar Gardens, and utility subscriptions. Since City of Louisville already offsets its current electricity with renewable utility subscriptions, we focused on customer-owned, behind-the-meter systems that would provide more value to the City of Louisville.

When evaluating this site, the following factors were considered:

AVAILABLE SPACE & RACKING MODALITY

Solar systems benefit from economies of scale – generally, the larger the system, the cheaper it is per kW. The first constraint on system size is the available space on the property. Since ground mounts are typically the least expensive racking modality, we evaluate this first. Water Treatment Plants are constructed with many buried water lines that reduces the land available for ground mounted solar.

A floating solar array was considered at the SCWTP. However, floating arrays begin to see economies of scale between 1-2MW, and since the SCWTP has a proposed 375kW array, it is not economically viable to use floating solar for a behind the meter installation at the site.

Of the available land space, we were able to find a suitable contiguous location that could fit a 255kW-DC South facing ground mount array on the Southwest corner of the property and a 110kW SSE facing ground mount array at the Southeastern property border.

SIMPLE PAYBACK

Payback is an easy way to determine the value of a solar system. Solar PV systems last around 25-30 years. McKinstry typically only recommends systems that – including Inflation Reduction Act credits, utility incentives, and/or other funding sources – will pay back within the system lifetime. At this stage of evaluation, simple payback is used. However, if the project advances, more detailed cash flows and paybacks can be calculated.



INTERCONNECTION METHOD & INCENTIVES

Due to size and value of utility savings, the SCWTP array would interconnect behind the utility meter and would qualify for Xcel’s Solar*Rewards C&I Tier 1. These arrays were not considered for Community Solar since those gardens must typically be much larger (500kW-AC+) to make financial sense. Additionally, this solar project would be eligible for the Inflation Reduction Act incentives, giving 25-30% of the solar cost back to City of Louisville depending on the chosen financing mechanism. Further savings can be generated by transitioning from Utility Rate Secondary General (SG) to Utility Rate Secondary Photovoltaic Time of Use (SPVTOU).

ON-SITE VERSUS GRID PURCHASE

Some of the benefits of on-site solar vs renewables purchased from the grid are listed below.

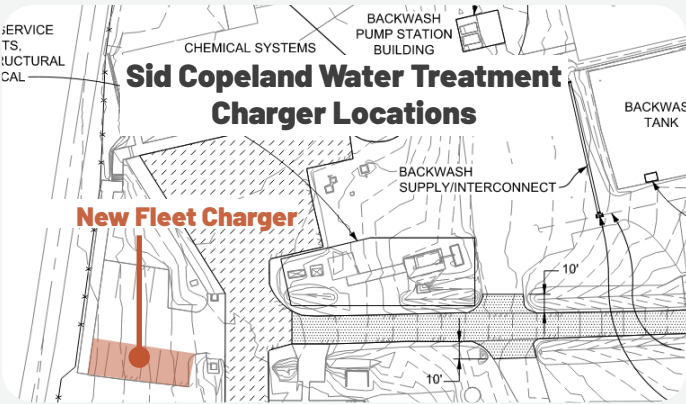
- Avoid solar sprawl at scale – avoiding offsetting of impacts to rural areas
- Avoid electrical energy loss due to transmitting power over long distances
- Dispersed approach is typically grid beneficial, especially when on-site renewables are a small percentage of the total usage of building – most solar on this building would be self used
- Enable future resiliency through addition of batteries and storage
- Demonstrate decarbonization to local Louisville community

Electric Vehicle (EV) Chargers

The Sid Copeland Water Treatment Plant has five vehicles. One is considered a medium-duty vehicle and the other four are light duty vehicles. These vehicles are primarily used around Sid Copeland, off-site at the Howard Herry water treatment plant, and to get to water pumping stations spread throughout the city.

Make	Model	Type	Qty
Chevy	Colorado	Light	1
Ford	F-150	Light	3
Ford	F-250	Medium	1

We recommend installing 3 chargers and the supporting electrical infrastructure. The table below shows the number of recommended chargers. The number of recommended fleet chargers corresponds with the number of fleet vehicles. Public chargers are not recommended for this site because there is limited public visitation at the site.

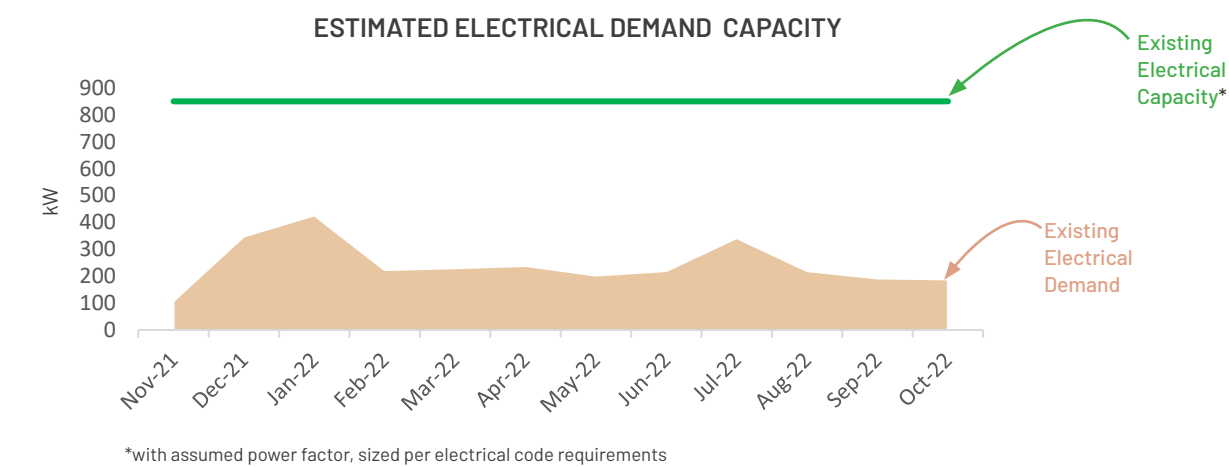


Existing Public Charging Stations	Existing Public Charger Level	Quantity of New Level 2 Public Chargers	Quantity of New Level 3 Public Chargers	Quantity of New Level 2 Fleet Chargers	Quantity of New Level 3 Fleet Chargers
0	N/A	0	0	3	0

Decarbonization Measures | Electrical and Structural Impacts

Electrical Impacts

The existing service to the Sid Copeland Water Treatment Plant is 480 Volts (V), 3 phase, 1600 Amps (A). Utility data was analyzed for the date range 11/2021 – 10/2022. This data shows the existing annual maximum demand of the Sid Copeland Water Treatment is approximately 427kW. Remaining existing capacity available for electrification projects (building HVAC or EV) is approximately 801A, equating to approximately 535kW of additional equipment.



Observed peak demand occurred in Winter. It should be noted that future changes in building occupancy or consumption patterns from the date range where data was provided may impact the service demand and available capacity for electrification.

Two key options have been considered for this electrification. Both options include the addition of the proposed Level 2 EV charging as outlined later in this document.

FULL ELECTRIFICATION

Option 1 consists of full electrification of natural gas fired heat, including substantial freeze protection heating. The size of the freeze protection heating upgrades necessitates a significant upgrade to the electrical feed to the Office/Filter/Admin building. The size of the freeze protection heating also exceeds the capacity of the backup diesel generator, necessitating an increase in the generator size. This option has been conceptually designed and costed as part of this project.

The generator upgrade drives significant costs. If the freeze protection heating capacity can be reduced, the generator upgrade may be able to be removed. From an electrical perspective, the 270kW of freeze protection heating provided within the chlorine, chemical and filter rooms appears high.

HYBRID ELECTRIFICATION

Option 2 electrifies the existing natural gas rooftop unit with an electric heat pump. It is understood that the existing natural gas furnace is the only equipment that operates to provide a conditioned environment, rather than just freeze protection heat. As such, this is considered high value electrification as it operates for a larger proportion of the year. Only minor electrical modifications are required to support this upgrade.

BACKUP POWER

The Sid Copeland Water Treatment Plant has a backup diesel generator, shown in the drawings as rated at 800kW. This generator supplies the entire facility via an automatic throw-over scheme built into MDS 1A exterior switchboard.

Structural Impacts

Options 1 and 2 associated with the rooftop RTU replacements are not anticipated to trigger a structural upgrade to underlying truss framing below the roof level. In order to distribute the load and engage more underlying truss members, structural steel sleepers to be configured and installed between the mechanical equipment curb or base rail and underlying framing. If new roof framing openings are required, structural steel angle to be configured to trim-out openings and support the existing metal deck. Structural costs are included in the electrification project costs.

Decarbonization Measures | Proposed Electrification

Electrification Options



FULL ELECTRIFICATION – Full electrification at the Sid Copeland Water Treatment Plant, including all-electric RTUs and electric resistance unit heaters. EV charging costs are not included in this option. **This option requires significant electrical and generator upgrades.**

	Load & Carbon Reduction	Grid Friendly Electrification	Renewables
	Envelope Air Sealing Lighting Controls LED Upgrades	Electrification Hybrid Electrification Full	On-Site Ground Mount PV
Total Cost	\$15k	\$1.7M*	\$1.3M**
Base Cost	N/A	\$140k	N/A
Net Cost of Electrification	N/A	\$1.5M*	N/A



HYBRID ELECTRIFICATION – Hybrid electrification at the Sid Copeland Water Treatment Plant, including all-electric RTUs. Gas unit heaters remain in this option. EV charging costs are not included in this option. **This option does not require significant electrical and generator upgrades.**

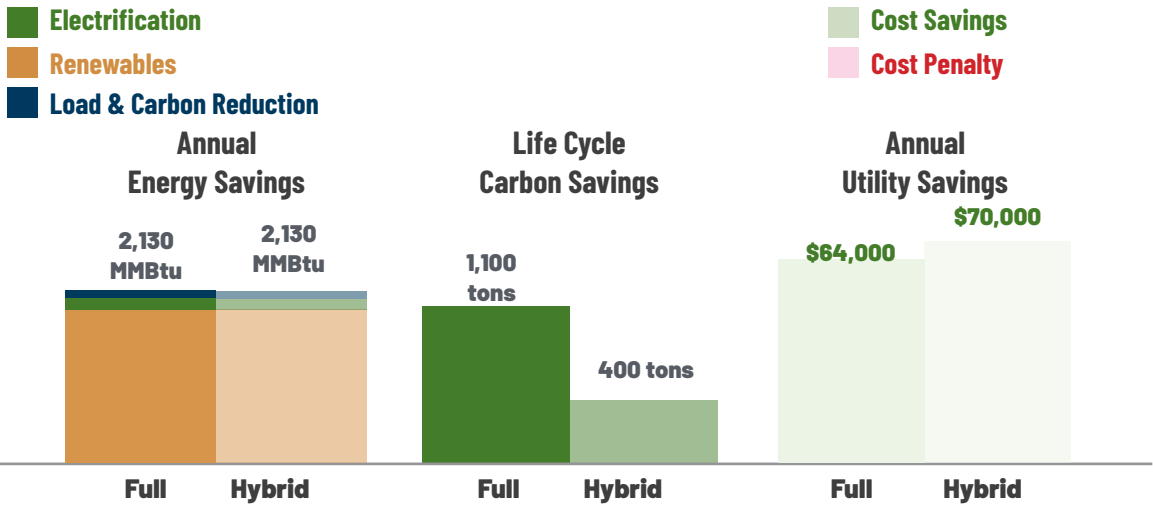
	Load & Carbon Reduction	Grid Friendly Electrification	Renewables
	Envelope Air Sealing Lighting Controls LED Upgrades	Electrification Hybrid Electrification Full	On-Site Ground Mount PV
Total Cost	\$15k	\$150k	\$1.3M**
Base Cost	N/A	\$140k	N/A
Net Cost of Electrification	N/A	\$20k	N/A

*Full electrification assumes like-like capacity replacements for unit heaters. Costs subject to further evaluation of required freeze protection and generator requirements.

**Renewable costs do not account for funding from the Inflation Reduction Act (IRA).

Proposed Annual Measure Savings

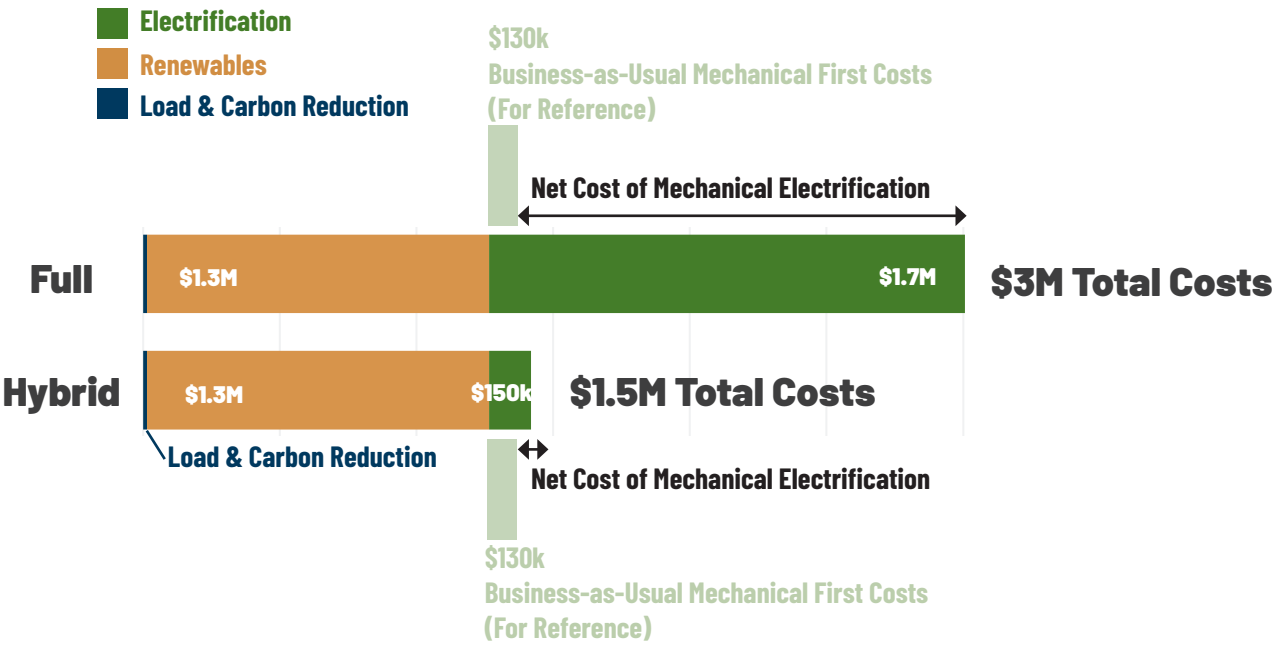
Energy, carbon, and utility cost savings of the proposed options are shown here. The full electrification option is roughly equivalent in energy savings. Conversion from gas to electricity does provide additional carbon savings. There is a larger utility penalty when you electrify the unit heaters, largely driven by increased demand (kW) charges.



Proposed Total Measure Costs

Proposed measure costs are shown below, including any structural and electrical upgrades needed for each option. They are also Rough Order of Magnitude (ROM) numbers, with a +/-20% range.

The total cost is the total amount that will need to be allocated for budgetary purposes. The net cost represents the total cost minus the replacement cost that would've been spent to replace the existing units with like-for-like fossil fuel units. Note that there is a significant net cost premium for full electrification due to electrical upgrades.



Decarbonization Measures | Construction Pricing Context & Constructibility

Construction Pricing Context

The MEP scope narratives described in previous sections and included in the appendices were used by McKinstry’s construction division to provide Rough Order of Magnitude (ROM) pricing. This early ROM budgeting process sought to be reasonable but conservative wherever possible. **Typically for ROM-level pricing a range of +/- 20% is applied to the total construction and start up costs.** This range can be reduced, and the pricing further refined, via a deeper understanding of existing building conditions and detailed design. Note this does not account for escalation, which is addressed separately. This pricing represents the total construction and startup cost to Louisville, including:

- General contractor markup
- Design fees
- Engineering energy analysis
- Controls
- Equipment startup, commissioning, testing, and balancing
- Placeholders for miscellaneous trades (e.g. carpentry).
- Allowances specific to each building for construction conditions (e.g. crane time)

All construction costs are in 2023 dollars unless noted otherwise.

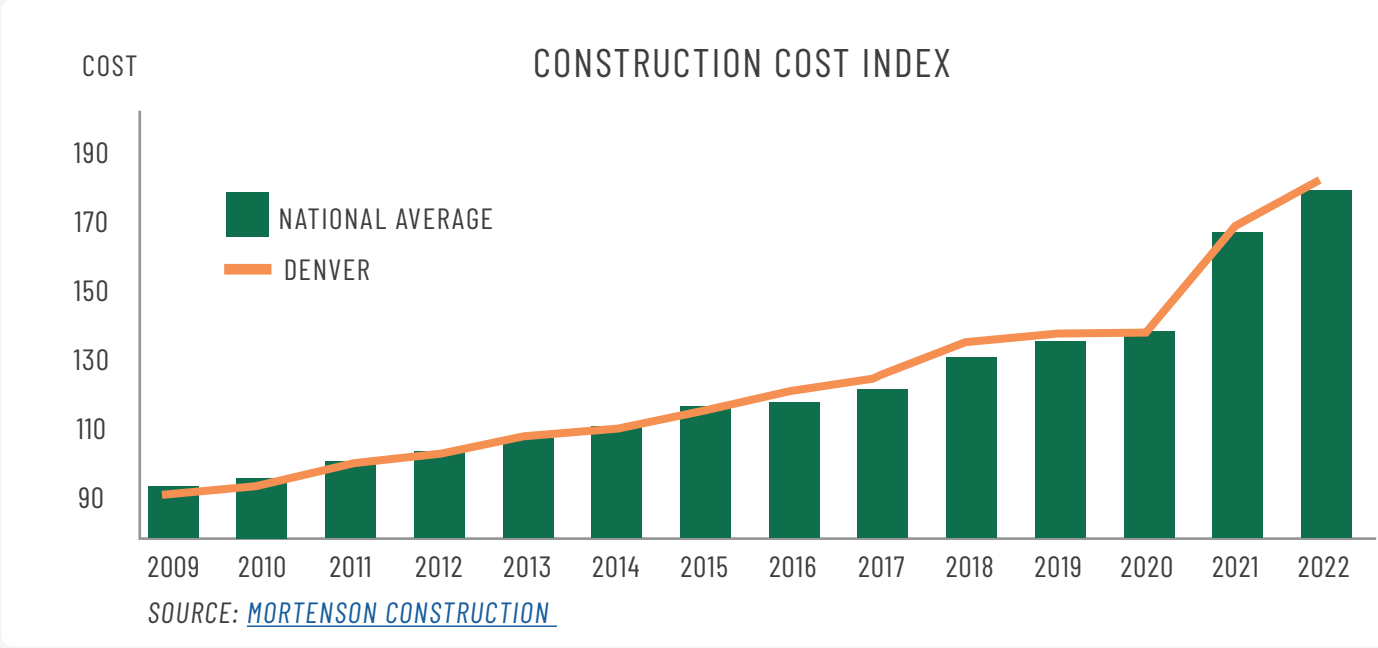
Using These Construction Costs

Throughout this report, differentiation is made between “total construction costs” and “net cost over business-as-usual fossil fuel systems”The distinction between the two is:

- Total costs: these are the total construction costs. This is the total amount of money that will need to be allocated for budgetary purposes.
- Net Cost: these are the total construction costs minus the replacement costs that would’ve been spent to replace the existing units with like-for-like fossil fuel units. These numbers represent the true cost of this decarbonization effort.

Note the numbers in the 2023 City Budget are budget numbers, and do not represent all costs for replacing the existing units. As such, they should not be used when determining the costs of decarbonization. In addition, the cost estimates in this report assume miscellaneous equipment (e.g. expansion tanks, domestic hot water storage tanks) need to be replaced. This assumption should be validated in detailed design, and could result in the total construction cost being lower if equipment can be reused.

As shown in the graph by the Mortenson, construction costs have been steadily rising since 2009. However, costs rose drastically from 2020 to 2022 (approximately 35%) due to global supply chain issues and unforeseen consequences of the COVID-19 pandemic.



Constructibility

Recent upheavals in the global supply chain and labor workforce have caused uncertainty in the construction market. Our construction teams are seeing the following trends as of March, 2023:

ELECTRICAL LEAD TIMES:

- Most commodity items, such as conduit, wire, fittings, etc. are readily available.
- Lead times for Switchboards are being quoted 50-80 weeks. Panel-boards can be 20-40 weeks depending on complexity.

MECHANICAL LEAD TIMES:

- Equipment needs to be ordered earlier in detailed design process to accommodate long lead times. Requires additional coordination earlier in design.

In order to combat these lead time challenges, design teams may need to be flexible with their specifications and the products/manufacturers they are selecting.

LABOR MARKET:

While we are seeing a general relaxing of labor shortages in other markets around the country, the contractor and labor shortages continue to persist in the Denver market.

Next Steps | Implementation

Implementation

A preliminary implementation timeline is shown below, based on the 2023 Capital Improvement Plan (CIP). Given the CIP replacement schedule, the Sid Copeland Water Treatment Plant fits well within the 2030 timeline, meaning it is on schedule to implement decarbonized measures. The summary below is the implementation recommendation based on age of equipment as well as additional thoughts on emerging technologies and sequence of upgrades.

AIRSIDE

- As RTUs reach end of life, replace with heat pump alternatives. This replacements can be made over time as they will not trigger electrical upgrades. However, consider structural implications of new RTUs.

UNIT HEATERS

- As unit heaters reach end of life, replace with electric resistance options. Like-like capacity replacements will trigger significant electrical and generator upgrades.
- If upgrades are made over time there may be opportunity to downsize heaters and reduce load which can reduce chances of triggering electrical impacts.

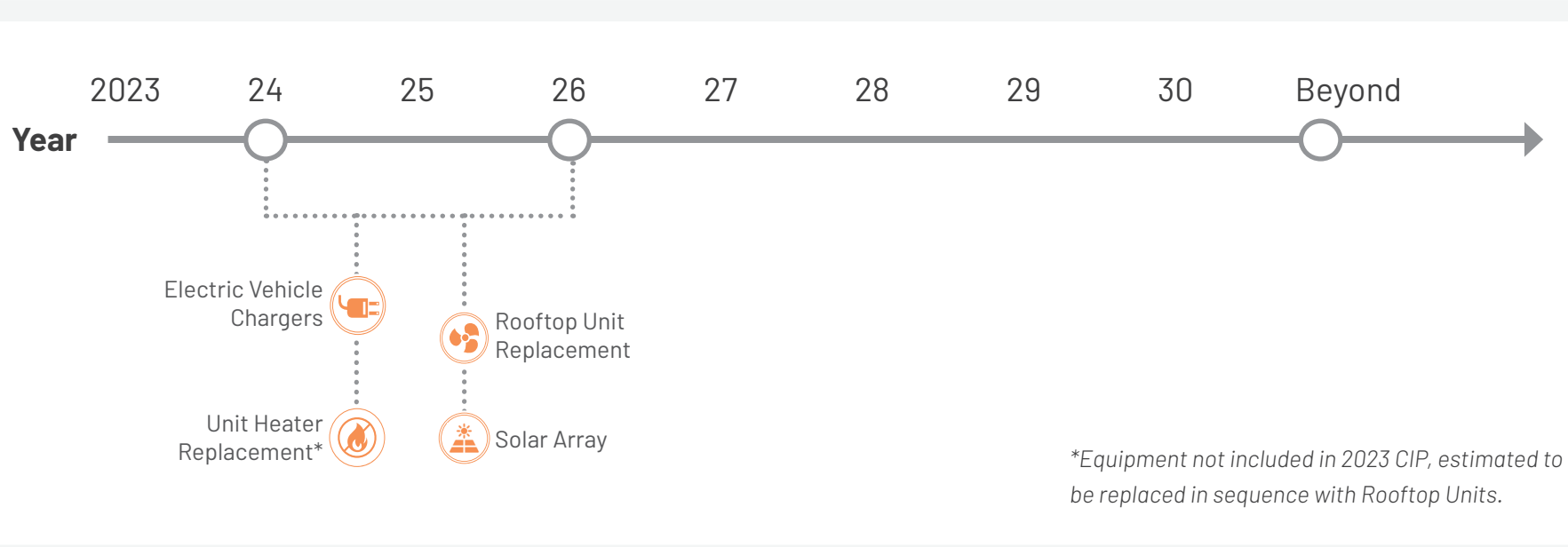
RENEWABLES

- Install 375 kW ground-mounted PV system (SW Array - 255 kWdc) (NE Array - 120 kWdc)

ELECTRIC VEHICLE CHARGER

- Provide EV chargers for fleet.

Preliminary Implementation Timeline





Appendix

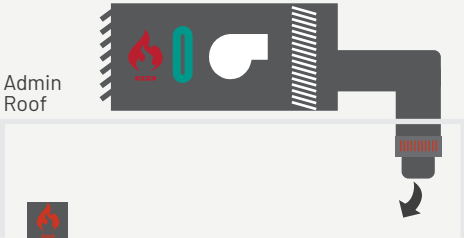
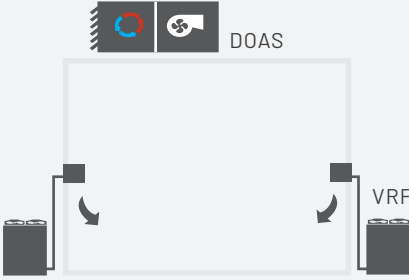
1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

HVAC System Options Matrix: Sid Copeland Water Treatment Plant

	Existing System	Recommendation	Imporoved Performance Retrofit Alternate	High Performance Alternate
General	Gas Rooftop Unit & Gas Unit Heaters	Rooftop Heat Pump & Electric Unit Heaters	DOAS with ACVRF throughout - full system replacement	Ground-Source Condenser Water Loop Utilizing Reservoir, with Rooftop Water-Source Heat Pump
Plant Equipment				
Extent of Retrofit	-	Minimal Reuse all ductwork, piping, and downstream equipment.	Extensive Reuse existing medium pressure ductwork for ventilation air. Provide new zone-level units.	Extensive Provide new condenser water loop. Reuse existing medium pressure ductwork for ventilation air.
Electrical Impacts	-	Upgrade Potentially Needed. Can be a component of system mix and match to avoid electrical upgrade. Unit heaters will drive electrical upgrade.	Upgrade Potentially Needed. Can be a component of system mix and match to avoid electrical upgrade.	Upgrade Potentially Needed. Can be a component of system mix and match to avoid electrical upgrade.
Limiting Factor	-	None	Cost Prohibitive Building is too small.	High First Cost More viable as part of expansion.
Verdict	-	Proceed w/ Detailed Scoping	Fast Fail	High-Level Consideration Evaluate further if site expansion.



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

SCWTP – Mechanical Scope Narratives

Option 1 – Full Electrification

Demo Scope of Work:

- Includes removal and disposal of (1) 3-ton RTUs and (7) gas-fired unit heaters.
 - Assumes cut, cap and make safe gas piping for each RTU and GUH
 - Includes demo of existing GUH flue ducts and patch/seal roof

New Scope of Work:

- Includes (1) new 3-ton rooftop heat pump.
 - Includes new curb.
 - Assumes existing ductwork and any sound attenuation to remain and be reused.
 - Assumes RTUs condensate can drain directly onto roof.
- Includes (7) new electric unit heaters.

Option 2 – Hybrid Electrification

Demo Scope of Work:

- Includes removal and disposal of (1) 3-ton RTUs
 - Assumes cut, cap and make safe gas piping for each RTU

New Scope of Work:

- Includes (1) new 3-ton rooftop heat pump.
 - Includes new curb.
 - Assumes existing ductwork and any sound attenuation to remain and be reused.
 - Assumes RTUs condensate can drain directly onto roof.

Mechanical General Inclusions, Clarifications, & Exclusions

- Includes allowance for crane/rigging
- Includes allowance for permits
- Includes allowance for carpentry
- Carrying Seattle labor rates
- Pricing in today's dollars
- Excludes temp HVAC and plumbing
- Excludes overtime work
- Excludes parking
- Excludes any new sound attenuation scope. Assumes ductwork and existing sound attenuation to remain.
- Excludes duct smoke detectors and wiring
- Excludes any heat tracing



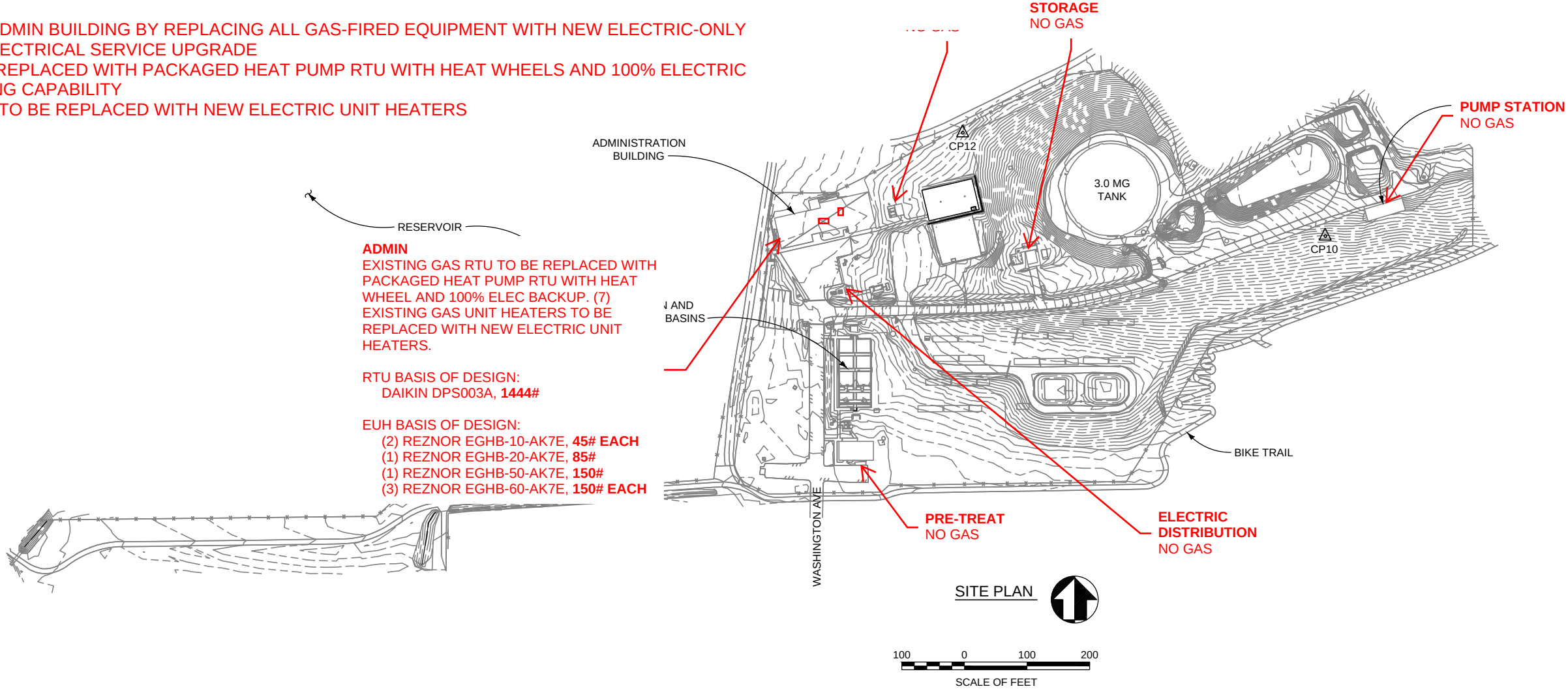
- Excludes good faith survey
- Excludes demolishing gas distribution lines/piping back to meter
- Excludes condensate drain piping to roof drains. Assumes piping directly down onto roof.

LOUISVILLE SID COPELAND WATER TREATMENT PLANT - MECHANICAL PRICING DOCUMENT

OPTION 1 - FULL ELECTRIFICATION

NARRATIVE:

- FULL ELECTRIFICATION OF THE ADMIN BUILDING BY REPLACING ALL GAS-FIRED EQUIPMENT WITH NEW ELECTRIC-ONLY EQUIPMENT; WILL REQUIRE AN ELECTRICAL SERVICE UPGRADE
- EXISTING 3-TON GAS RTU TO BE REPLACED WITH PACKAGED HEAT PUMP RTU WITH HEAT WHEELS AND 100% ELECTRIC RESISTANCE EMERGENCY HEATING CAPABILITY
- (7) EXISTING GAS UNIT HEATERS TO BE REPLACED WITH NEW ELECTRIC UNIT HEATERS



SURVEY CONTROL

1. SURVEY PROVIDED BY FLATIRONS, INC. BOULDER, COLORADO, DATED JANUARY, 2017.
2. ELEVATIONS BASED ON CONTROL POINTS (NAD 83).
SEE CONTROL POINT LOCATION AND INFORMATION THIS SHEET.

SITE CONTROL POINTS:

DESCRIPTION	NORTHING	EASTING	ELEVATION
CP 10 - #4 REBAR	N=1786040.552	E=3097724.213	ELEV=5539.34
CP 12 - #4 REBAR	N=1786205.523	E=3097145.212	ELEV=5579.83

LEGEND

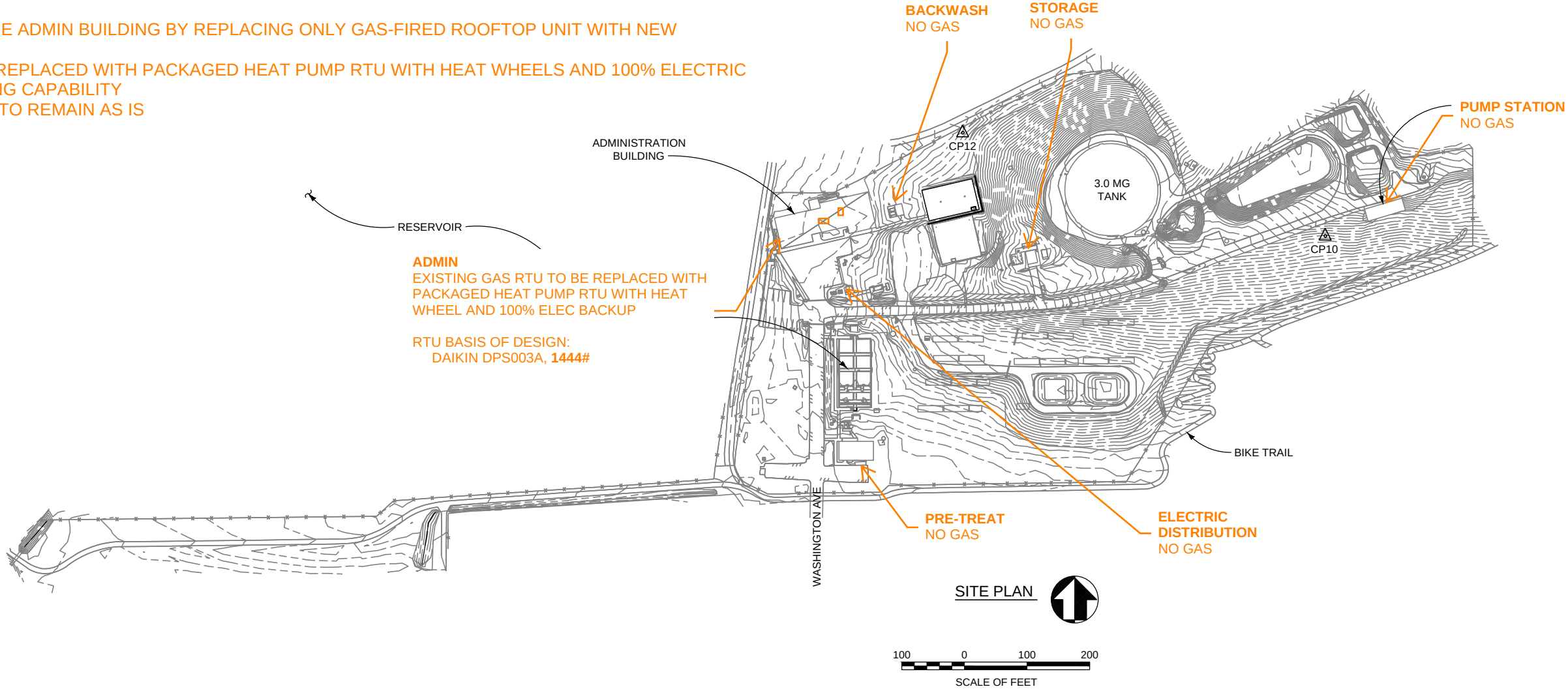
 CONTROL POINT

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LOUISVILLE SID COPELAND WATER TREATMENT PLANT - MECHANICAL PRICING DOCUMENT
OPTION 2 - PARTIAL ELECTRIFICATION

NARRATIVE:
-PARTIAL ELECTRIFICATION OF THE ADMIN BUILDING BY REPLACING ONLY GAS-FIRED ROOFTOP UNIT WITH NEW ELECTRIC-ONLY EQUIPMENT
-EXISTING 3-TON GAS RTU TO BE REPLACED WITH PACKAGED HEAT PUMP RTU WITH HEAT WHEELS AND 100% ELECTRIC RESISTANCE EMERGENCY HEATING CAPABILITY
-(7) EXISTING GAS UNIT HEATERS TO REMAIN AS IS



SURVEY CONTROL

- 1. SURVEY PROVIDED BY FLATIRONS, INC. BOULDER, COLORADO, DATED JANUARY, 2017.
- 2. ELEVATIONS BASED ON CONTROL POINTS (NAD 83).
SEE CONTROL POINT LOCATION AND INFORMATION THIS SHEET.

SITE CONTROL POINTS:

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CP 10 - #4 REBAR	N=1786040.552	E=3097724.213	ELEV=5539.34
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LEGEND

△CP CONTROL POINT

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VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING. 0" 1"
IF NOT ONE INCH ON THIS DRAWING, ADJUST SCALES ACCORDINGLY.

NO.	DATE	REVISION	BY	CHK.
1	3/19	RECORD DRAWINGS		

DESIGNED BY:	RJA
DRAWN BY:	JFA
CHECKED BY:	RAF
DATE:	AUGUST 2017



CITY OF LOUISVILLE, COLORADO
SID COPELAND
WATER TREATMENT PLANT
HIGH ZONE / MID ZONE PUMP STATION

SURVEY CONTROL PLAN

PROJECT NO.	369618
SHEET NO.	G4
DWG.	4 OF 70

LOUISVILLE SID COPELAND WATER TREATMENT PLANT - MECHANICAL PRICING DOCUMENT

OPTION 3 - GEOTHERMAL HEAT PUMP SYSTEM

NARRATIVE:

- FULL ELECTRIFICATION OF THE ADMIN BUILDING BY REPLACING ALL GAS-FIRED EQUIPMENT WITH AN UGRADED GEOTHERMAL HEAT PUMP SYSTEM USING THE RESERVOIR AS A HEAT SOURCE/SINK; WILL REQUIRE AN ELECTRICAL SERVICE UPGRADE
- ESTIMATED APPROX. 16 TONS CAPACITY TOTAL FOR BOTH EXISTING AND NEW BUILD
- ASSUME 30% GLYCOL IN CW LOOP, AS WELL AS A GLYCOL FEEDER, AIR SEPARATOR, AND ALL OTHER TYPICAL APPURTENANCES
- EXISTING 3-TON GAS RTU TO BE REPLACED WITH PACKAGED HEAT PUMP RTU WITH HEAT WHEELS AND 100% ELECTRIC RESISTANCE EMERGENCY HEATING CAPABILITY
- (7) EXISTING GAS UNIT HEATERS TO BE REPLACED WITH NEW ELECTRIC UNIT HEATERS

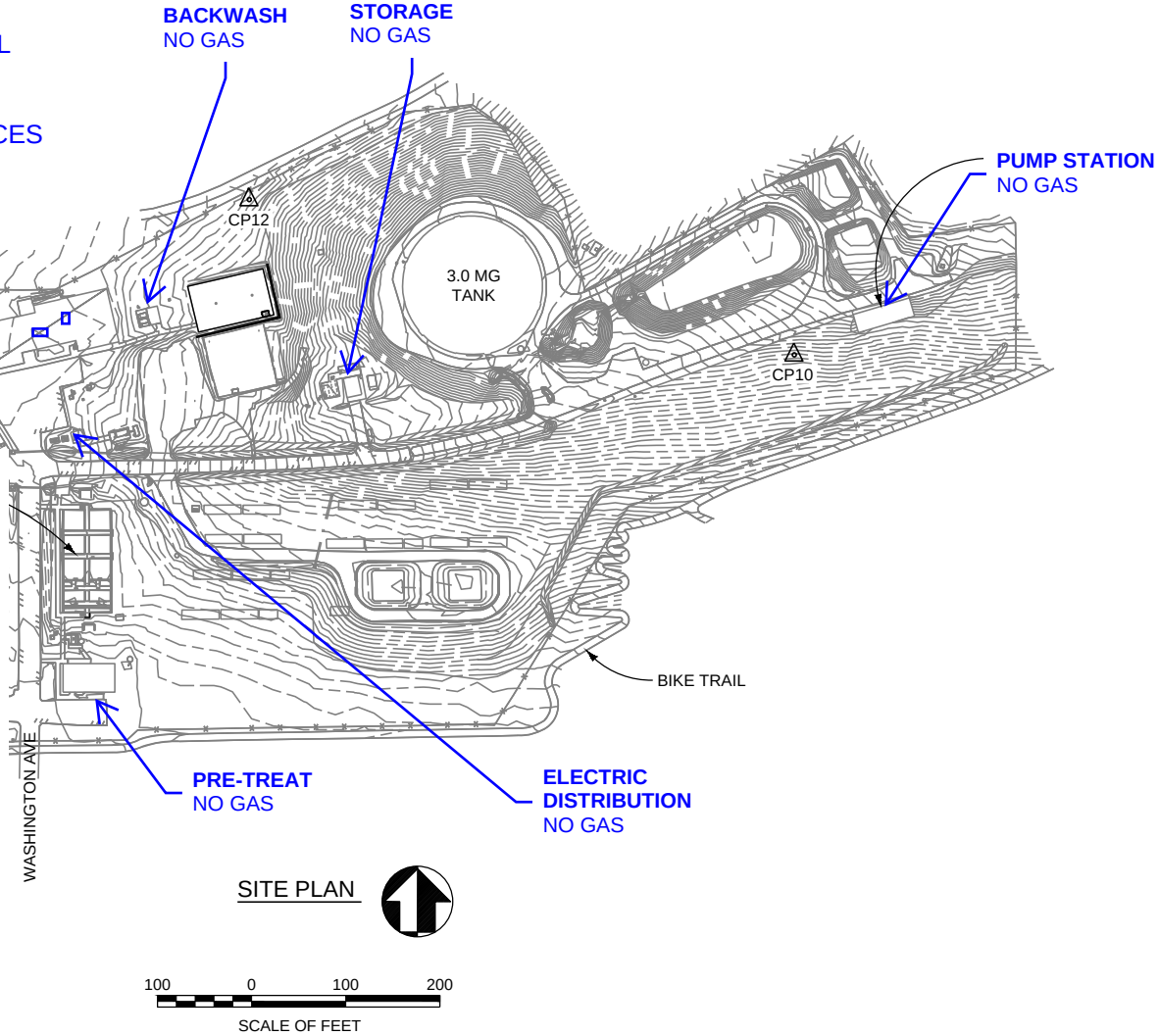
GEOTHERMAL EQUIPMENT BASIS OF DESIGN:
ENVIROPLATE 5-PLATE BANK WITH 3" MANIFOLD OR SIMILAR
(2) BASE-MOUNTED PUMPS WITH VFDS, APPROXIMATELY 50 GPM AND 50 FT HD, 1.5 HP MOTOR
(4) 4-TON WATER-SOURCED HEAT PUMP RTUS, CLIMATEMASTER TRT-048 OR SIMILAR

APPROXIMATE LOCATION OF RESERVOIR PLATE HEAT EXCHANGERS. ROUTE 3" CDWS/R TO ADMIN BUILDING

ADMIN
EXISTING GAS RTU TO BE REPLACED WITH PACKAGED HEAT PUMP RTU WITH HEAT WHEEL AND 100% ELEC BACKUP. (7) EXISTING GAS UNIT HEATERS TO BE REPLACED WITH NEW ELECTRIC UNIT HEATERS.

RTU BASIS OF DESIGN:
DAIKIN DPS003A, 1444#

EUH BASIS OF DESIGN:
(2) REZNOR EGHB-10-AK7E, 45# EACH
(1) REZNOR EGHB-20-AK7E, 85#
(1) REZNOR EGHB-50-AK7E, 150#
(3) REZNOR EGHB-60-AK7E, 150# EACH



SURVEY CONTROL

1. SURVEY PROVIDED BY FLATIRONS, INC. BOULDER, COLORADO, DATED JANUARY, 2017.
2. ELEVATIONS BASED ON CONTROL POINTS (NAD 83). SEE CONTROL POINT LOCATION AND INFORMATION THIS SHEET.

SITE CONTROL POINTS:

DESCRIPTION	NORTHING	EASTING	ELEVATION
CP 10 - #4 REBAR	N=1786040.552	E=3097724.213	ELEV=5539.34
CP 12 - #4 REBAR	N=1786205.523	E=3097145.212	ELEV=5579.83

LEGEND

△CP CONTROL POINT

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VERIFY SCALES
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0" 1"
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NO.	DATE	REVISION	BY	CHK.
1	3/19	RECORD DRAWINGS		

DESIGNED BY:	RJA
DRAWN BY:	JFA
CHECKED BY:	RAF
DATE:	AUGUST 2017

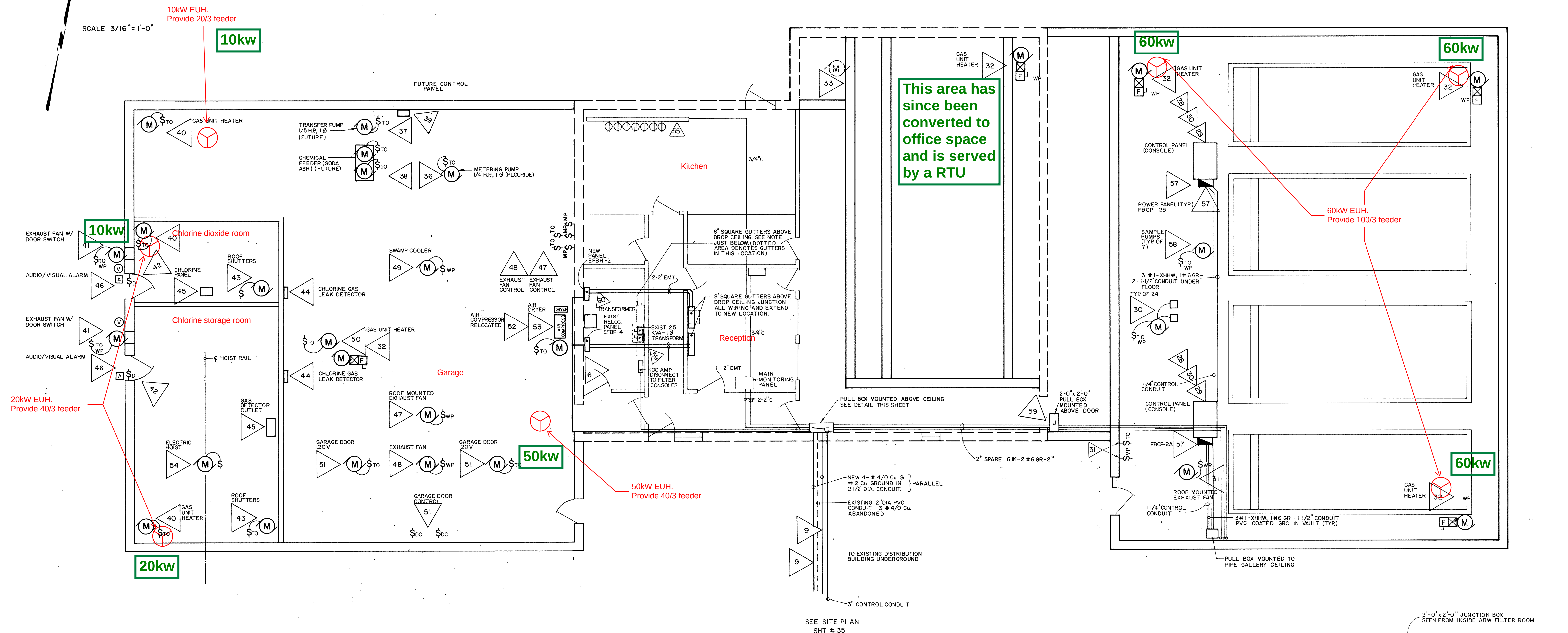
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MACDONALD

CITY OF LOUISVILLE, COLORADO
SID COPELAND
WATER TREATMENT PLANT
HIGH ZONE / MID ZONE PUMP STATION

SURVEY CONTROL PLAN

PROJECT NO.	369618
SHEET NO.	G4
DWG.	4 OF 70

DRAWING INSERTED FROM 1985-SCWTP EXPANSION PHASE 2 DRAWING SET
FOR HEATER LOCATION REFERENCE ONLY

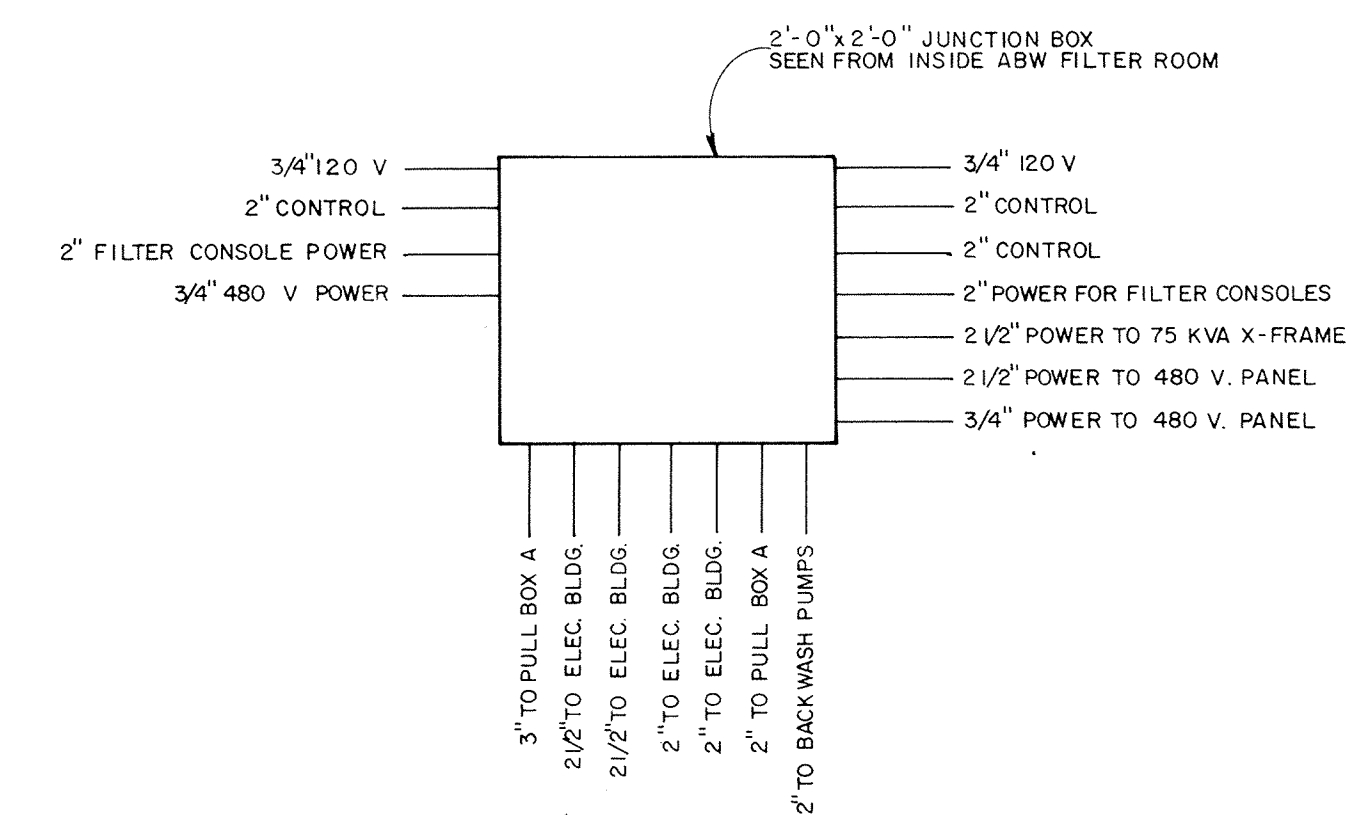


NOTES

- 6 PROVIDE CORE DRILLED OPENINGS THROUGH EXISTING BRICK
- 9 INSTALL 4-#4/O XHHW CU 1-2#-2 1/2" C TO FILTER BUILDING ADDITION AT NEW FILTER PLANT.
- 28 TERMINATE 2" CONDUIT (PVC COATED GRC) FOR CONTROL OF BACKWASH PUMPS AT CONTROL CONSOLES IN FILTER BUILDING. CONSOLES ARE FLOOR MOUNTED. SUB 2" INTO CONTROLS FROM FLOOR. PROVIDE CONTROLS WIRING PER MANUFACTURER'S RECOMMENDATIONS. PROVIDE A 24 POLE 120/240V PANEL AT EACH CONSOLE WITH 14-15 AMP, 1 POLE, 6-20 AMP, 1 POLE. BREAKERS AT EACH IN NEMA 4 GASKETED ENCLOSURE NIPPLED TO CONSOLE. PANEL DESIGNATIONS FBGP2A AND FBGP2B. PANELS HAVE 125 AMP 1 Ø 3 WIRE BUS WITH 50 AMP 2 POLE MAIN BREAKER.
- 29 PROVIDE RECTANGULAR BLOCK OUT IN FLOOR BELOW CONSOLE FOR ROUTING RACEWAYS INTO PIPE GALLERY BELOW FOR VALVE AND CONTROL WIRING, VAPORSEAL OPENINGS.
- 30 WIRE TO AND CONNECT 24 VALVE CONTROLS FROM CONTROL CONSOLE (12 AT EACH). ALL WIRING AND CONDUIT PVC COATED GRC. SEALTIGHT FLEX TO VALVE NOT TO EXCEED 12" IN LENGTH. CONNECT 2 LIMIT SWITCHES AT EACH VALVE VIA SEALTIGHT. TERMINATE ALL CONDUITS IN GUAX D BOX BY VALVE UNIT. SPRAY 2 COATS OF CARLON BRAN 1B PVC COATING ON ALL FITTINGS AND HARDWARE. ALL EQUIPMENT 120V 1Ø. PULL 10 #14 FROM EACH VALVE J BOX TO CONSOLE AND CONNECT PER MANUFACTURER RECOMMENDATIONS. CONNECT EACH VALVE FROM A 15A1P BREAKER ON PANEL FBGP2A OR FBGP2B.
- 31 CONNECT 120 VOLT 1Ø 1/2 HP EXHAUST FAN ON ROOF. PROVIDE WIRING AND CONDUIT AND INSTALL CONTROL SWITCH AS REQUIRED. EFHB-2-18.
- 32 3/4 HP 480V 3Ø UNIT HEATER WITH STARTER (WP) AND 30A3P F. HP (WP) FUSED DISC. SWITCH CONTROL WIRING UNDER MECHANICAL DIVISION. PROVIDE FRSR-6 FUSES. REMOVE ON CTECFBP-4 CTT 2/4/6, 20/3P.
- 33 REMOVE WIRING AND DISCONNECT EXISTING ELECTRIC UNIT HEATER. REMOVE UNIT HEATER.

- 30 ➤ 1/4 HP 120V 1 ϕ METERING PUMP. CONNECT ON EFBH-2-36.
- 31 ➤ 1/5 HP 120V 1 ϕ TRANSFER PUMP. CONNECT ON EFBH-2-36. FOR FUTURE USE
- 32 ➤ 120V 1 ϕ CHEMICAL FEEDER WITH MIXER AND AUGER CONNECT ON EFBH-2-38. FOR FUTURE USE
- 33 ➤ 120V 1 ϕ CONTROL PANEL WIRE PER MANUFACTURER'S RECOMMENDATIONS TO CONTROL ON CCT EFBH-2-38.
- 40 ➤ 1/2 HP 120V 1 ϕ UNIT HEATER WITH THERMAL OVERLOAD SWITCH. CONTROL WIRING UNDER MECHANICAL DIVISION. EFBH-2-30/32.
- 41 ➤ THRU WALL EXHAUST FAN. FRACTIONAL HP 120V 1 ϕ CONTROLLED BY DOOR SWITCH. EFBH-2-34.
- 42 ➤ DOOR SWITCH FOR EXHAUST FAN. BRASS FLUSH MULLION TYPE 15A 120V RATED WIRED THROUGH DOOR FRAME. P & S MFG.
- 43 ➤ ROOF SHUTTERS AND MOTOR 120V 1 ϕ FRACTIONAL HP INTERLOCK WITH WALL EXHAUST FAN SHUTTERS OPEN WHEN FAN IS ON. EFBH-2-34.
- 44 ➤ LEAK DETECTOR PANEL FOR CHLORINE ROOM. MOUNT UP 48" CCT #EFBH-2-42.
- 45 ➤ OUTLET FOR SNIFFER SEAL OFF CONDUIT TO CONTROL PANEL 1/2" PVC CONDUIT. WITH GROUND WIRE - CCT EFBH-2-42.
- 46 ➤ LEAK ALARM LIGHT AND BELL OVER DOOR. WIRE TO CONTROL PANEL WITH 1/2" PVC CONDUIT WITH GROUNDWIRE. SEAL OFF CONDUIT. CCT EFBH-2-42.
- 47 ➤ EXHAUST FAN ON ROOF. 1/2 HP 120V 1 ϕ CONTROL SWITCH AND PILOT LT. BY DOOR. CCT EFBH-2-20.
- 48 ➤ EXHAUST FAN ON ROOF 1/6 HP 120V 1 ϕ CONTROL SWITCH AND PILOT LT. BY DOOR. CCT EFBH-2-22.
- 49 ➤ ROOFTOP EVAP. COOLER 1/2 HP 120V 1 ϕ CONTROL SWITCH AND PILOT LIGHT BY DOOR. CCT EFBH-2-24.

- ▶ MOTORIZED F.A. DAMPER 120V 1Ø INTERLOCK WITH 48 CCT #EFBH 2-22.
- ▶ GARAGE DOOR OPERATOR 1/2 HP 120V 1Ø WIRE TO AND CONNECT CONTROL STATION PER MANUFACTURER'S RECOMMENDATIONS. CCT EFBH 2-26/28.
- ▶ 240V 1Ø 2HP AIR COMPRESSOR. CCT EFBH 2-29/31 20/2P.
- ▶ 1500 WATT AIR DRYER 120V 1Ø CCT EFBH 2-33.
- ▶ CHLORINE STORAGE ROOM HOIST 3 HP, 460V, 3Ø WITH CONTROLS. CONNECT ON CCT EFBH-4 1/3/5 15/3P.
- ▶ PROVIDE WIREMOLD 3000 WITH DUPLEX RECEPTACLES CENTERED ABOVE TURBIDIMETERS CONNECTED ON CIRCUIT #EFBH-2-16. PROVIDE STAINLESS STEEL PLATES #G3014E CONNECTOR, G-3010 AE END, #G3007C DEVICE BRACKET. COAT RACEWAY WITH CARLON PVC PAINT.
- ▶ FILTER CONSOLE PANEL, TYPICAL OF 2, PER 2B
FBCP2 PANEL A AND PANEL B. 3" NIPPLE TO CONSOLE. MOUNT AS DIRECTED
- ▶ CONNECT AND WIRE TO 7 120V 1Ø PLASTIC PUMPS WITH WP THERMAL OVERLOAD SWITCHES. SEALTIGHT NOT OVER 10' LONG AND SAMPLE COATED GRP CONDUIT FROM CONTROL CONSOLE PANELS FBCP2A OR 2B PER CONTROL DRAWINGS - 3 #12-1/2" C. 20AIP BKR @ EA.
- ▶ PROVIDE 2-60A 2P/5N FUSIBLE DISCONNECT SWITCHES WITH FRN-R 60 FUSES ON 6" X6" X36" WIREMAY AND CONNECT FROM EXISTING 25KVA 1Ø TRANSFORMER WITH 3 #1XHHW IN SEALTIGHT FLEX WITH #6 GROUND. 1" C AND 3/4" X10' GROUND ROD. FEED FROM 60 AMP DISCONNECTS TO PANELS AT FILTER CONSOLES FBCP 2A AND 2B. PROVIDE 24"x24"x6" U NEMA 4 J-BOX FOR CONTROL AND POWER CONDUITS IN FILTER BUILDING ADDITION. RUN CONDUITS VIA VAULT CEILING IN PVC COATED GRC.
- ▶ 75 KVA TRANSFORMER AT FLOOR ON 3" HIGH HOUSEKEEPING PAD. CONNECT VIA SEALTIGHT WITH 4 #4/OXHHW 1 #2 GR. GROUND TRANSFORMER 3/4X10 CW GND. ROD AND #10 DOMESTIC COLD WATER SERVICE WITH #2W-3/4" C. CADDLED ALL GND. CONNECTIONS.



JUNCTION BOX DETAIL
N.T.S.

AS BUILT

				LOUISVILLE WATER TREATMENT PLANT				
				EXPANSION PHASE II				
				FILTER PLANT & MAINTENANCE BUILDING				
				ELECTRICAL PLAN				
								
				ROCKY MOUNTAIN CONSULTANTS 4260 E EVANS AVE DENVER, COLORADO 80222 (303) 758-4532				
I	MISC REVISIONS	I-85	TB	DESIGNED BY	G.A.P.	JOB NO.	SHEET	SHEETS
NO	DESCRIPTION	DATE	BY	DRAWN BY	CGZ.	7-4420	32	35
REVISIONS				CHECKED BY	G.A.P.	DATE 11-84		



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

SCWTP – Electrical Scope Narratives

Option 1 – Full Electrification

- General: Replacement of Gas unit heaters with electric unit heaters + heat pump. Requires major electrical upgrades, including:
 - New 800A feeder and panel to admin building and new 800A distribution panelboard.
 - Upsizing of existing 800kW generator to 1000kW.
 - Installing feeders to new electric unit heaters and equipment as scheduled
- 30 Day Metering: None required. Will use utility data and as-built calculations for existing loads.
- Electrical Demo:
 - Demolish circuit powering existing RTU. Believed served from panel EFBH-2. Evaluate existing conduit for reuse.
 - Demolish existing Cummins 800kW generator. Retain conduit / wire / branch circuits for reuse.
 - Demolish 225A/4 feeder from MDS 1B to GEN 1.
 - Demolish 100A/3 480V feeder from MDS 1B to 75kVA transformer serving EFBH-2.
- Electrical New Work:
 - Distribution upgrade:
 - Install new 800A circuit breaker in existing switchboard MDS-1A. Refer drawing E3.
 - Install new 800A MCB distribution panelboard 4DPB1. Refer drawing E2 for location and E3 for one-line diagram. Panel shall contain:
 - (1) 225A/3P
 - (4) 100A/3P
 - (1) 80A/3P
 - (1) 40A/3P
 - (1) 35A/3P
 - (2) 20A/3P
 - (5) spare 3P breakers, assorted sizes.
 - Install 800/4 feeder from MDS-1A to new 800A MCB distribution panelboard 4DPB1. Allow for the installation of new concrete encased duct bank for this feeder.
 - Install new 225/4 feeder from new 4DPB1 to re-feed existing panel GEN1 in same room.
 - Install new 100/3 feeder from new 4DPB1 to re-feed 75kVA transformer and subpanel EFBH-2 in same room.
 - Electric Unit Heater & ASHP Feeders
 - Install circuits to heaters and air source heat pump as shown on plan (PDF sheet 7 of 9. This sheet has been inserted from 1985 drawing set, please use as reference for mechanical equipment locations only).

Option 2 – Hybrid Electrification

- General: Replacement of a gas furnace with an electric heat pump



- 30 Day Metering: Required for 225A MLO Panel “GEN” (also known as “GEN 1”) located in Admin building. Refer drawing E1 & E2 for location.
- Electrical Demo:
 - Demolish circuit powering existing RTU & 30A/240V (single phase) wiring. Believed served from panel EFBH-2. Evaluate existing conduit for reuse.
- Electrical New Work
 - Within panel GEN (also known as GEN 1) replace existing Square D spare circuit breaker with new 35AT/3P circuit breaker. Refer panel schedule on drawing E4.
 - Install new 4#8, 1#10G branch circuit to location of new RTU - Daikin DPS003A air source heat pump located on roof (replacement for demolished RTU). Reuse existing conduit if in acceptable condition (both panels EFBH-2 and GEN 1 are in the same room).

PV Array Electrical Infrastructure (Costs are included in Renewables report)

- General: 500A PV interconnect for ground mount solar:
- Evaluation: Evaluate MDS 1A (1600A paralleling SWBD) to determine if supply side interconnect is possible.
- Electrical Demo: None required.
- Electrical New Work:
 - Supply & install new 600A AMP CT enclosure and utility meter base.
 - Perform supply side interconnect to MDS 1A, install (2) sets of 3#350, 1#1/0, 1#1/0 between MDS 1A and new CT enclosure, mounted adjacent.
 - 50kWAC PV ARRAY (SOUTH)
 - Install 100A/3P NEMA 3R fuse switch and service conductors from CT enclosure.
 - Install 3#1, 1#6G AL to South Array. Total feeder length 280', mostly in existing spare conduit. Allow for 50' of excavation and installation of new duct bank (concrete encasement not required).
 - 250KWAC PV ARRAY (NORTH)
 - Install 400A/3P NEMA 3R fuse switch and service conductors from CT enclosure.
 - Install 3"-6#300MCM, 1#2/0G AL to North Array. Total feeder length 300', in new trench. Allow for 140' of concrete encasement and 160' of standard duct bank (concrete encasement not required).

Level 2 EV Chargers and Supporting Infrastructure

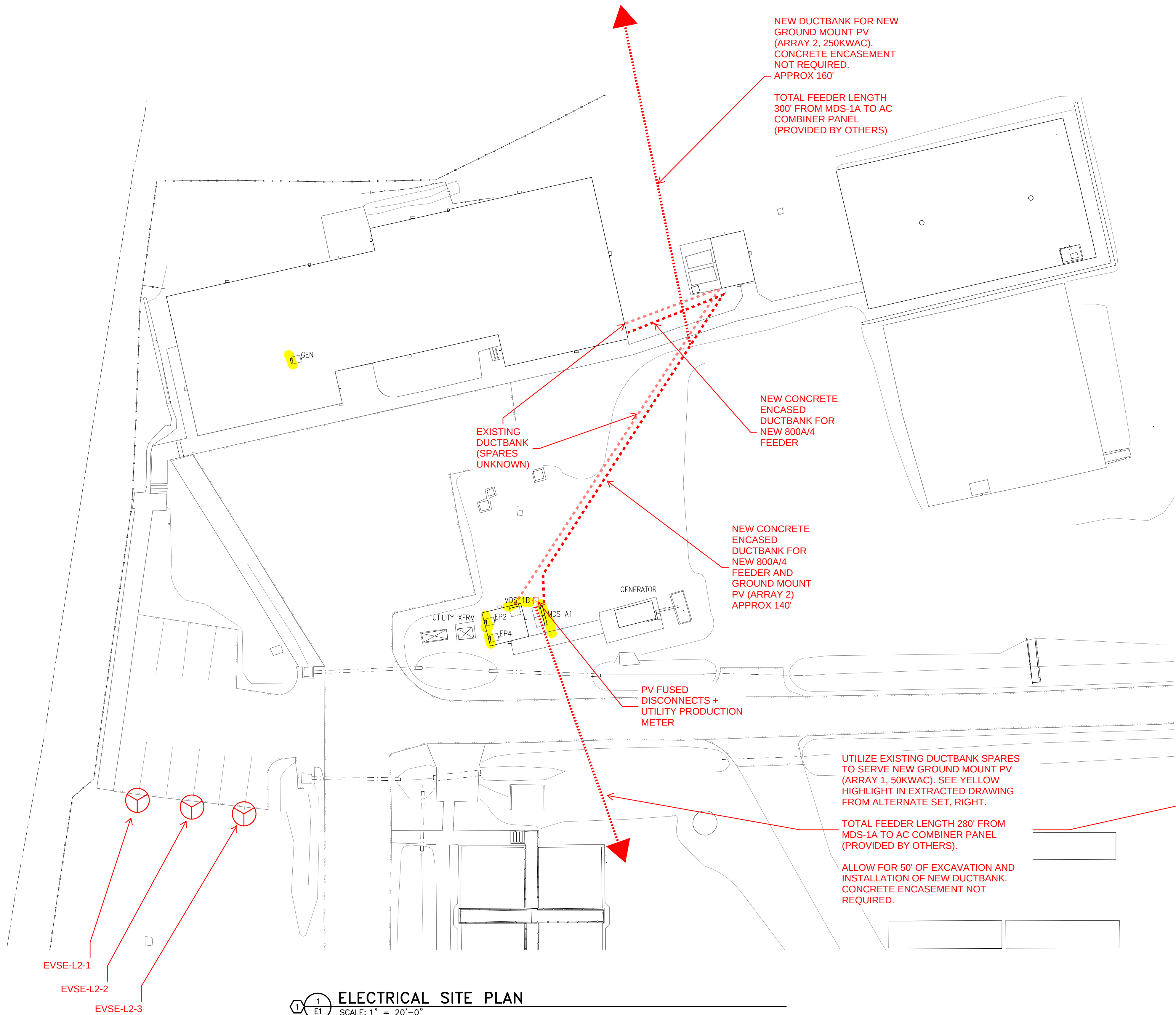
- General: Installation of (3) dual port pedestal type EVSE's.
- 30 Day metering: Required for Panel EP-2 located in Elec building. Refer drawing E1 for location and E3 for one-line diagram.
- Electrical Demo: None required.
- Electrical New Work:
 - Install (3) 60A 208V dual port pedestal type EVSE's. Zefnet-60-CPD or approved equivalent
 - Install (3) 60A/2P circuit breakers in existing panel EP-2. Move existing circuit breakers as needed to ensure the new EV load is balanced.



- Install 1 1/4" – 6#6, 1#10G from EP-2 to location of EVSE's as shown on plan. Provide pull-box / junction box to split the (3) 208V circuits to each EVSE.

Electrical Exclusions

- Applicable sales, use and B&O tax
- Performance and Payment Bonds
- Utility company charges.
- Refurbishing existing lighting (cleaning, re-lamping, re-trimming, repair, restoration).
- Roof and building envelope penetrations, waterproofing.
- Moving, placing and (re)-calibrating owner equipment.
- Mechanical and plumbing control devices, including wiring, conduit, and components.
- Correcting existing code violations
- Hidden conditions.
- Removing, re-installing and replacing ceiling tiles.
- Opening and repairing walls and ceilings for electrical work.
- Patching and painting.
- Access panels.
- Temporary power and lighting
- Handling hazardous material including but not limited to asbestos, lead and PCB's.
- Overtime and shift premiums.
- Work stoppages, hindrances, multiple trim passes and out-of-sequence installation.
- Electrical engineering, calculations, drawings, peer review services.
- Structural and Seismic Engineering
- Material cost escalation.
- Plywood and specialty backing.
- Low voltage systems (telecom, CCTV, access control, audio visual, etc.).
- Any work not specifically included in this proposal.
- No thermostat relocations are included



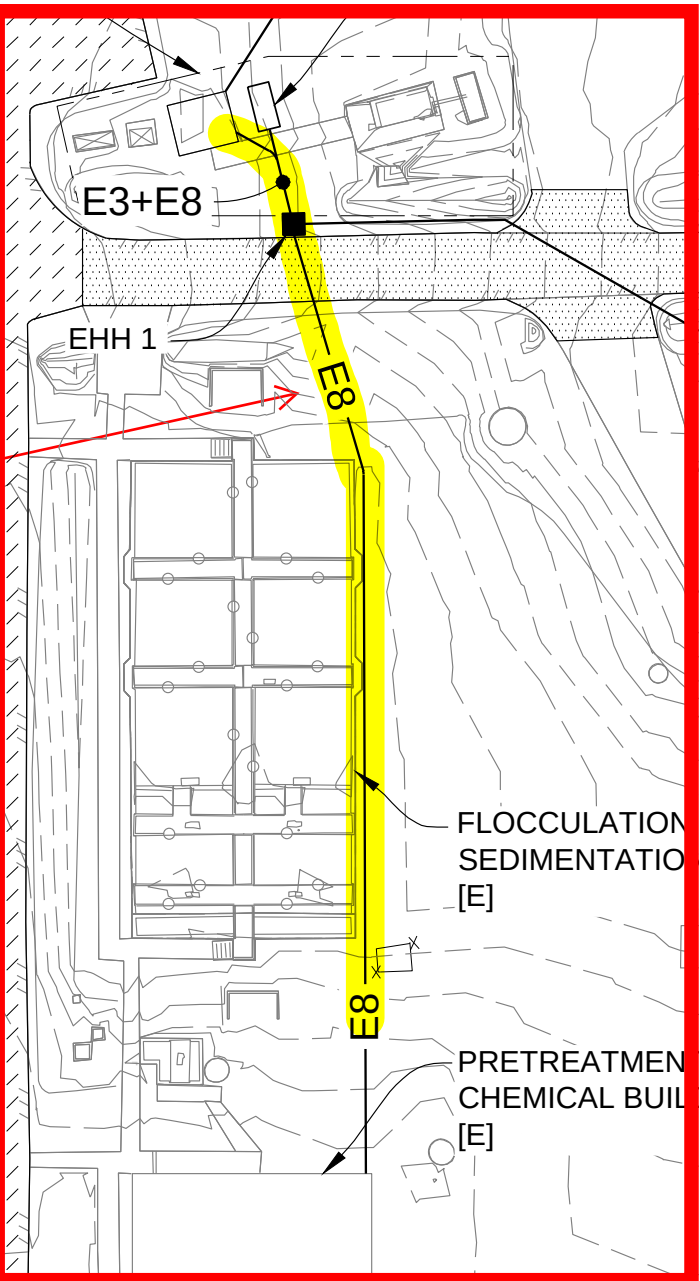
ELECTRICAL SITE PLAN
SCALE: 1" = 20'-0"

SHEET NOTES

1. REFER TO THE ONE-LINE DIAGRAM FOR FEEDER SIZES.

KEY NOTES

1. DRAWING SHOWN FOR REFERENCE ONLY.



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VERIFY SCALES	NO.	DATE	REVISION	BY	CHK.	DESIGNED BY:
BAR IS ONE INCH ON ORIGINAL DRAWING. 0" 1"	1	04-30-19	100% REVIEW	RMH	RMH	J. WHITLEY
IF NOT ONE INCH ON THIS DRAWING, ADJUST SCALES ACCORDINGLY.						DRAWN BY: J. WHITLEY
						CHECKED BY: M. BILLINGTON
						DATE: APRIL 26, 2019

M M
MOTT MACDONALD

CITY OF LOUISVILLE, COLORADO
SID COPELAND
WATER TREATMENT PLANT
ON-SITE CHLORINE GENERATION

ELECTRICAL
SITE POWER PLAN

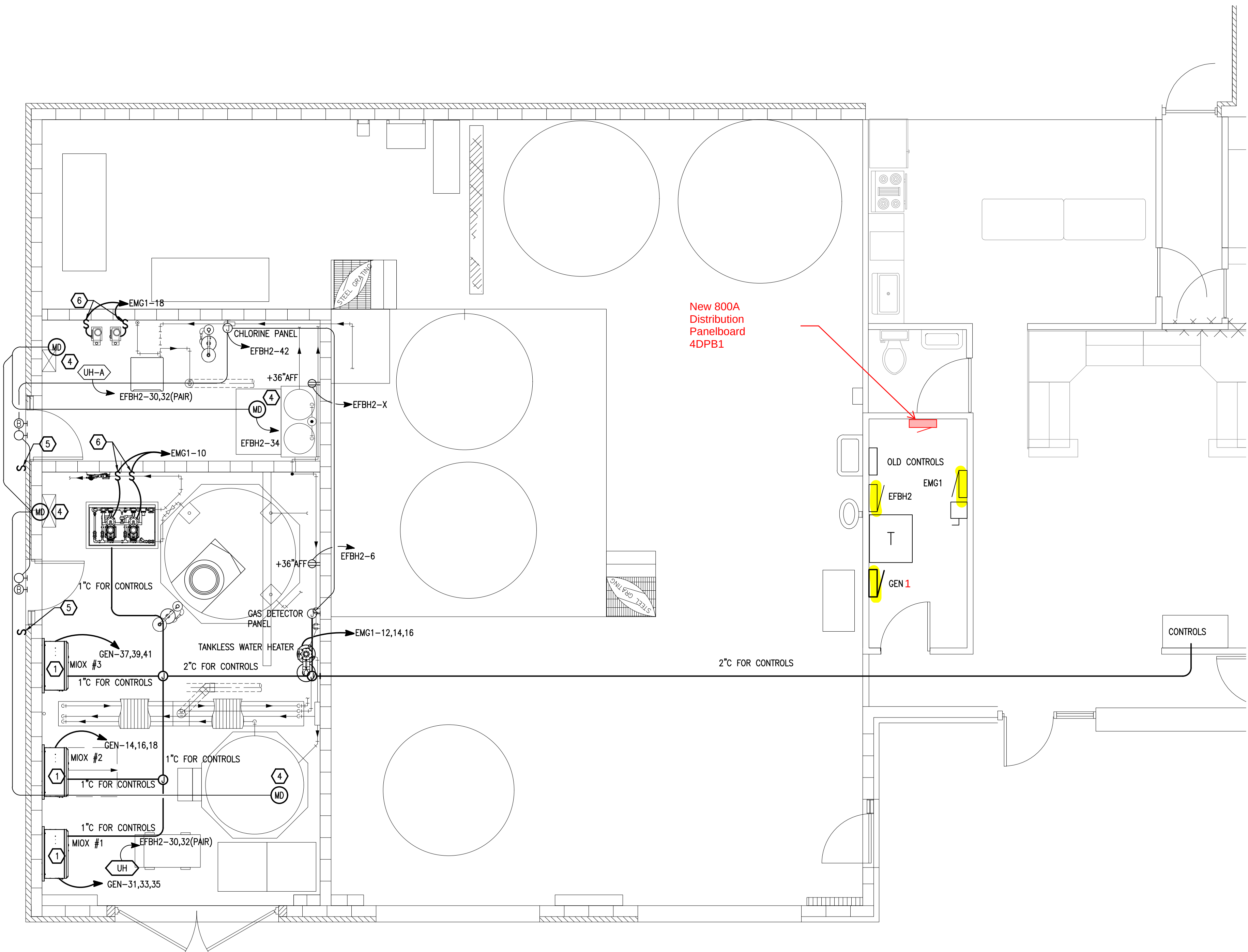
PROJECT NO.	402821
SHEET NO.	E1
XX DWG.	XX OF

SHEET NOTES

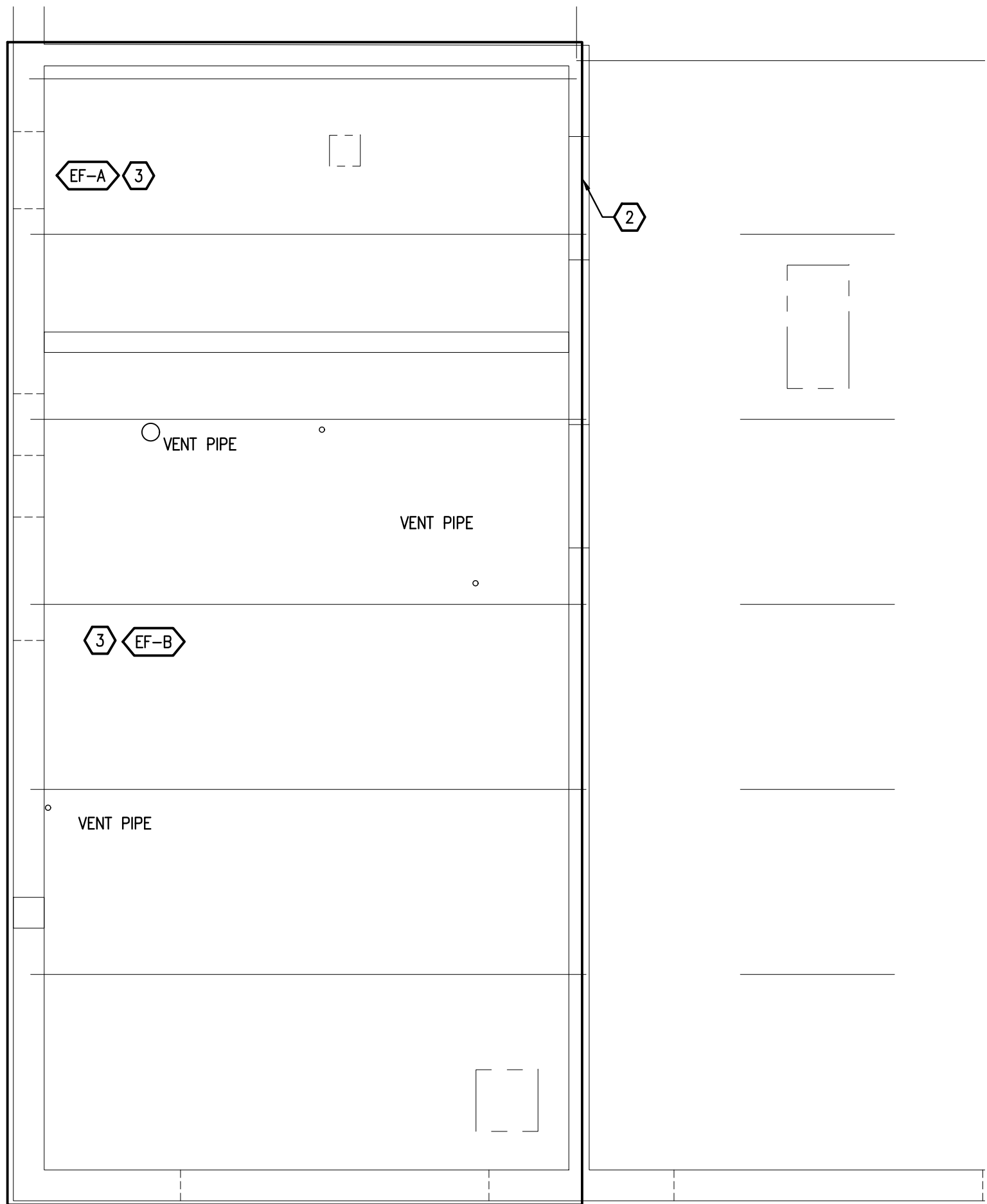
- ALL CONDUIT SHALL BE PVC OR PVC COATED RIDGE IN ROOMS WITH CHLORINE.
- LIGHT LINEWEIGHT INDICATES EXISTING. BOLD LINEWEIGHT INDICATES NEW WORK.
- CONTRACTOR SHALL PATCH AND PAINT ANY DAMAGED SURFACES DUE TO DEMOLITION OR CONSTRUCTION TO MATCH EXISTING CONDITIONS.

KEY NOTES

- PROVIDE 1" C (3#6,1#10G) FOR MIOX POWER.
- PROVIDE A COMPLETE LIGHTNING PROTECTION SYSTEM FOR THIS SECTION OF THE ROOF. FIX ANY BROKEN PARTS OF THE SYSTEM AND ENSURE THE SYSTEM IS CONNECTED TO GROUND. AND PROVIDE NEW LIGHTENING PROTECTION FOR NEW EQUIPMENT ADDED.
- RECONNECT NEW EQUIPMENT TO EXISTING CIRCUIT IN NEW LOCATION SHOWN ON THE MECHANICAL DRAWINGS.
- INTERLOCK MOTORIZED DAMPER WITH EXHAUST FAN IN THIS ROOM.
- PROVIDE A FIRE FIGHTERS SWITCH TO DISABLE EXHAUST FAN IN THIS ROOM.
- PROVIDE POWER TO BOOSTER PUMPS. THE TWO PUMPS ARE REDUNDANT WITH ONLY ONE RUNNING AT A TIME. PROVIDE A 20A1P DISCONNECT SWITCH FOR EACH ONE. CONNECT TO THE SAME CIRCUIT. CONFIRM EXACT REQUIREMENTS PRIOR TO ROUGH-IN.



1
E2 ELECTRICAL INSTALLATION POWER PLAN
SCALE: 1/4" = 1'-0"



2
E2 ELECTRICAL INSTALLATION ROOF PLAN
SCALE: 1/4" = 1'-0"

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VERIFY SCALES	NO.	DATE	REVISION	BY	CHK.	DESIGNED BY:
BAR IS ONE INCH ON ORIGINAL DRAWING. 0" 1"	1	04-30-19	100% REVIEW	RMH	RMH	J. WHITLEY
IF NOT ONE INCH ON THIS DRAWING, ADJUST SCALES ACCORDINGLY.						DRAWN BY: J. WHITLEY
						CHECKED BY: M. BILLINGTON
						DATE: APRIL 26, 2019

M
MOTT
MACDONALD

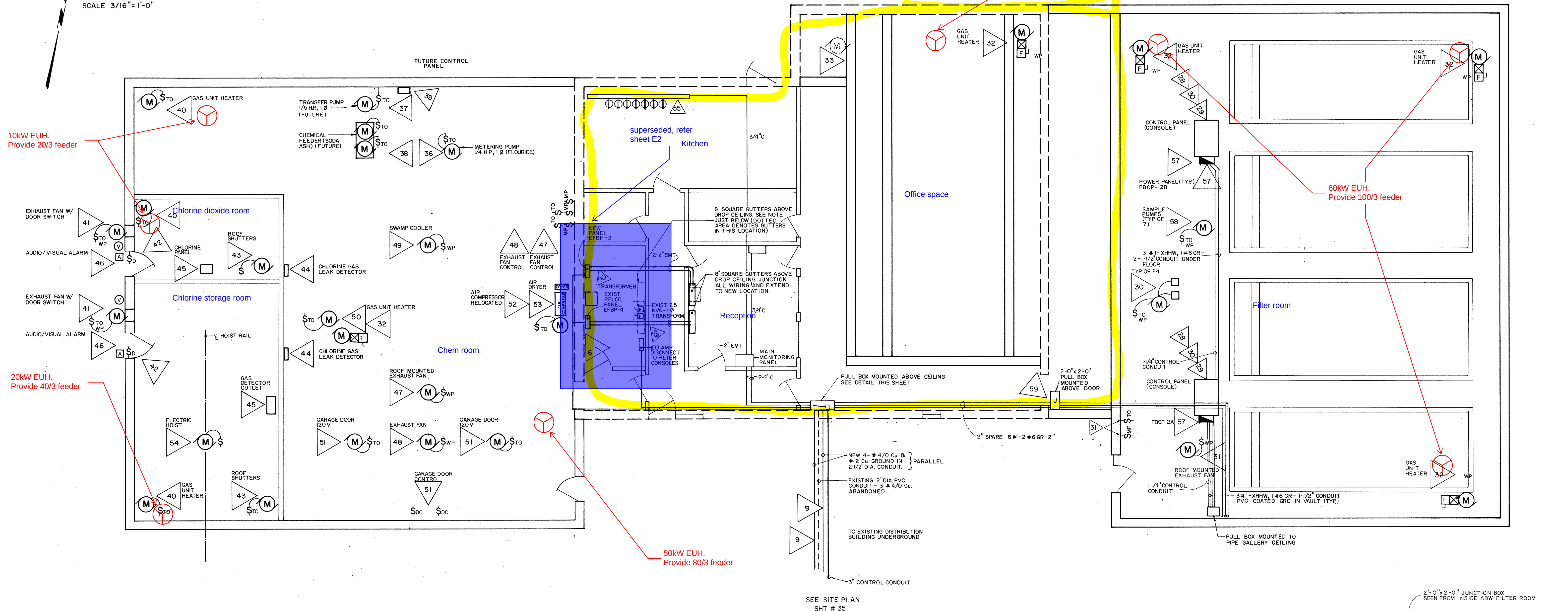
CITY OF LOUISVILLE, COLORADO
SID COPELAND
WATER TREATMENT PLANT
ON-SITE CHLORINE GENERATION

ELECTRICAL
POWER PLAN

PROJECT NO. 402821
SHEET NO. E2
XX OF DWG.

DRAWING INSERTED FROM 1985-SCWTP EXPANSION PHASE 2 DRAWING SET FOR HEATER LOCATION REFERENCE ONLY

SCALE 3/16" = 1'-0"

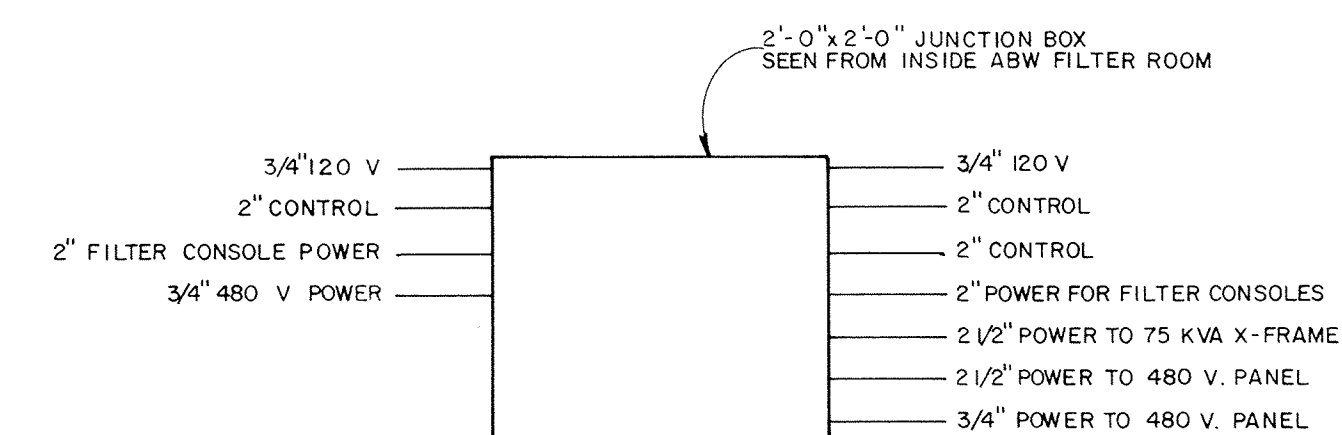


NOTES

- 6 PROVIDE CORE DRILLED OPENINGS THROUGH EXISTING BRICK
- 9 INSTALL 4-#4/0 XHHW CU 1-#2-2 1/2" C TO FILTER BUILDING ADDITION AT NEW FILTER PLANT.
TERMINATE 2" CONDUIT (PVC COATED GRC) FOR CONTROL OF BACKWASH PUMPS AT CONTROL CONSOLES IN FILTER BUILDING. CONSOLES ARE FLOOR MOUNTED. STUB 2" INTO CONTROLS FROM FLOOR. PROVIDE CONTROLS WIRING PER MANUFACTURER'S RECOMMENDATIONS. PROVIDE A 24 POLE 120/240V PANEL AT EACH CONSOLE WITH 14-15 AMP, 1 POLE, 6-20 AMP, 1 POLE. BREAKERS AT EACH IN NEMA 4 GASKETED ENCLOSURE NIPPLED TO CONSOLE. PANEL DESIGNATIONS FBPC2A AND FBPC2B. PANELS HAVE 125 AMP 1Ø 3 WIRE BUS WITH 50 AMP 2 POLE MAIN BREAKER.
- 28 PROVIDE RECTANGULAR BLOCK OUT IN FLOOR BELOW CONSOLE FOR ROUTING RACEWAYS INTO PIPE GALLERY BELOW FOR VALVE AND CONTROL WIRING, VAPORSEAL OPENING.
WIRE TO AND CONNECT 24 VALVE CONTROLS FROM CONTROL CONSOLE (12 AT EACH). ALL WIRING AND CONDUIT PVC COATED GRC. SEALTIGHT FLEX TO VALVE NOT TO EXCEED 12" IN LENGTH. CONNECT 2 LIMIT SWITCHES AT EACH VALVE VIA SEALTIGHT. TERMINATE ALL CONDUITS IN GUAX D BOX BY VALVE UNIT. SPRAY 2 COATS OF CARLON BRAND PVC COATING ON ALL FITTINGS AND HARDWARE. ALL EQUIPMENT 120V 1Ø. PULL 10 #14 FROM EACH VALVE J BOX TO CONSOLE AND CONNECT PER MANUFACTURER RECOMMENDATIONS. CONNECT EACH VALVE FROM A 15AIP BREAKER AT PANELS FBPC2A OR 2B.
- 29 CONNECT 120 VOLT 1Ø 1/2 HP EXHAUST FAN ON ROOF. PROVIDE WIRING AND CONDUIT AND INSTALL CONTROL SWITCH AS REQUIRED. EFBH-2-18.
- 30 3/4 HP 480V 3Ø UNIT HEATER WITH STARTER (WP) AND 30A3P F. HD (WP) FUSED DISC. SWITCH CONTROL WIRING UNDER MECHANICAL DIVISION. PROVIDE FRSR-6 FUSES. CONNECT ON CTEFBP-4 CCT 2/4/6. 20/3P.
- 31 REMOVE WIRING AND DISCONNECT EXISTING ELECTRIC UNIT HEATER. REMOVE UNIT HEATER.

- 32 1/4 HP 120V 1Ø METERING PUMP. CONNECT ON EFBH-2-36.
- 33 1/5 HP 120V 1Ø TRANSFER PUMP. CONNECT ON EFBH 2-36. FOR FUTURE USE
- 34 120V 1Ø CHEMICAL FEEDER WITH MIXER AND AUGER CONNECT ON EFBH 2-38. FOR FUTURE USE
- 35 120V 1Ø CONTROL PANEL WIRE PER MANUFACTURER'S RECOMMENDATIONS TO CONTROL ON CCT EFBH 2-38.
- 36 1/2 HP 120V 1Ø UNIT HEATER WITH THERMAL OVERLOAD SWITCH. CONTROL WIRING UNDER MECHANICAL DIVISION. EFBH-2-30/32.
- 37 THRU WALL EXHAUST FAN. FRACTIONAL HP 120V 1Ø CONTROLLED BY DOOR SWITCH. EFBH-2-34.
- 38 DOOR SWITCH FOR EXHAUST FAN. BRASS FLUSH MULLION TYPE 15A 120V RATED WIRED THROUGH DOOR FRAME. P & S MFG.
- 39 ROOF SHUTTERS AND MOTOR 120V 1Ø FRACTIONAL HP INTERLOCK WITH WALL EXHAUST FAN SHUTTERS OPEN WHEN FAN IS ON. EFBH-2-34.
- 40 LEAK DETECTOR PANEL FOR CHLORINE ROOM. MOUNT UP 48" CCT #EFBH-2-42.
- 41 OUTLET FOR SNIFFER SEAL OFF CONDUIT TO CONTROL PANEL 1/2" PVC CONDUIT. WITH GROUND WIRE - CCT EFBH 2-42.
- 42 LEAK ALARM LIGHT AND BELL OVER DOOR. WIRE TO CONTROL PANEL WITH 1/2" PVC CONDUIT WITH GROUNDWIRE. SEAL OFF CONDUIT CCT EFBH 2-42.
- 43 EXHAUST FAN ON ROOF. 1/2 HP 120V 1Ø CONTROL SWITCH AND PILOT LT. BY DOOR. CCT EFBH 2-20.
- 44 EXHAUST FAN ON ROOF 1/6 HP 120V 1Ø CONTROL SWITCH AND PILOT LT. BY DOOR. CCT EFBH 2-22.
- 45 ROOFTOP EVAP. COOLER 1/2 HP 120V 1Ø CONTROL SWITCH AND PILOT LIGHT BY DOOR. CCT EFBH 2-24.

- 46 MOTORIZED F.A. DAMPER 120V 1Ø INTERLOCK WITH 48 CCT #EFBH 2-22.
- 47 GARAGE DOOR OPERATOR 1/2 HP 120V 1Ø WIRE TO AND CONNECT CONTROL STATION PER MANUFACTURER'S RECOMMENDATIONS. CCT EFBH 2-26/28.
- 48 240V 1Ø 2HP AIR COMPRESSOR. CCT EFBH 2-29/31 20/2P.
- 49 1500 WATT AIR DRYER 120V 1Ø CCT EFBH 2-33.
- 50 CHLORINE STORAGE ROOM HOIST 3 HP, 460V, 3Ø WITH CONTROLS. CONNECT ON CCT EFBP-4 1/3/5 15/3P.
- 51 PROVIDE WIREMOLD 3000 WITH DUPLEX RECEPTACLES CENTERED ABOVE TURBIDIMETERS CONNECTED ON CIRCUIT #EFBH-2-16. PROVIDE STAINLESS STEEL PLATES #3014E CONNECTOR, G-3010 AE END, #G3007C DEVICE BRACKET. COAT RACEWAY WITH CARLON PVC PAINT.
- 52 FILTER CONSOLE PANEL, TYPICAL OF 2, PER 28 FBPC2 PANEL A AND PANEL B. 3" NIPPLE TO CONSOLE. MOUNT AS DIRECTED
- 53 CONNECT AND WIRE TO 7 120V 1Ø SAMPLE PUMPS WITH WP THERMAL OVERLOAD SWITCHES. SEALTIGHT NOT OVER 10" LONG AND PLASTIC COATED GRC CONDUIT FROM CONTROL CONSOLE PANELS FBPC2A OR 2B PER CONTROL DRAWINGS - 3 #12-1/2"C. 20A1P BKR @ EA.
- 54 PROVIDE 2-60A 2P+SN FUSIBLE DISCONNECT SWITCHES WITH FRN-R 60 FUSES ON 6"x6"x36" WIREWAY AND CONNECT FROM EXISTING 25KVA 1 TRANSFORMER WITH 3 #1XHHW IN SEALTIGHT FLEX WITH #6 GROUND. 1 1/2"C AND 3/4"x10" GROUND ROD. FEED FROM 60 AMP DISCONNECTS TO PANELS AT FILTER CONSOLES FBPC 2A AND 2B. PROVIDE 24"x24"x6"U NEMA 4 J-BOX FOR CONTROL AND POWER CONDUITS IN FILTER BUILDING ADDITION. RUN CONDUITS VIA VAULT CEILING IN PVC COATED GRC.
- 55 75 KVA TRANSFORMER AT FLOOR ON 3 1/2" HIGH HOUSEKEEPING PAD. CONNECT VIA SEALTIGHT WITH 4 #4/OXHHW 1 #2 GR. GROUND TRANSFORMER TO 3/4"x10 CW GND ROD AND #10 DOMESTIC COLD WATER SERVICE WITH #2W-3/4"C. CADWELD ALL GND. CONNECTIONS.

JUNCTION BOX DETAIL
N.T.S.

AS BUILT

LOUISVILLE WATER TREATMENT PLANT			
EXPANSION PHASE II			
FILTER PLANT & MAINTENANCE BUILDING ELECTRICAL PLAN			
ROCKY MOUNTAIN CONSULTANTS			
4260 E EVANS AVE. DENVER, COLORADO 80222			
(303) 758-4532			
DESIGNED BY G.A.P.	JOB NO.	SHEET	SHEETS
DRAWN BY CGZ.	7-4420	32	35
CHECKED BY G.A.P.	DATE 11-84		
REVISIONS			
NO.	DESCRIPTION	DATE	BY
1	MISC REVISIONS	1-85	TB

Note. Some additional load has been added since this project. Assume metered data would show ~100-120kVA; 120-145A load.
45-60A of available capacity assumed on this panel, sufficient for RTU addition.

PANEL AND CIRCUIT
SERVING DEVICE

NOTES:

1. NO CHANGE TO EXISTING CIRCUIT BREAKER.
2. PROVIDE NEW CIRCUIT BREAKER AND MATCH EXISTING PANEL TYPE AND AIC RATING

NOTES:
1. NO CHANGE TO EXISTING CIRCUIT BREAKER

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SCALE: NONE
NOTE: LABEL WITH BROTHER "P-TOUCH" SYSTEM. PROVIDE CLEAR OR WHITE TAPE WITH BLACK LETTERING.

M

**MOTT
MACDONALD**

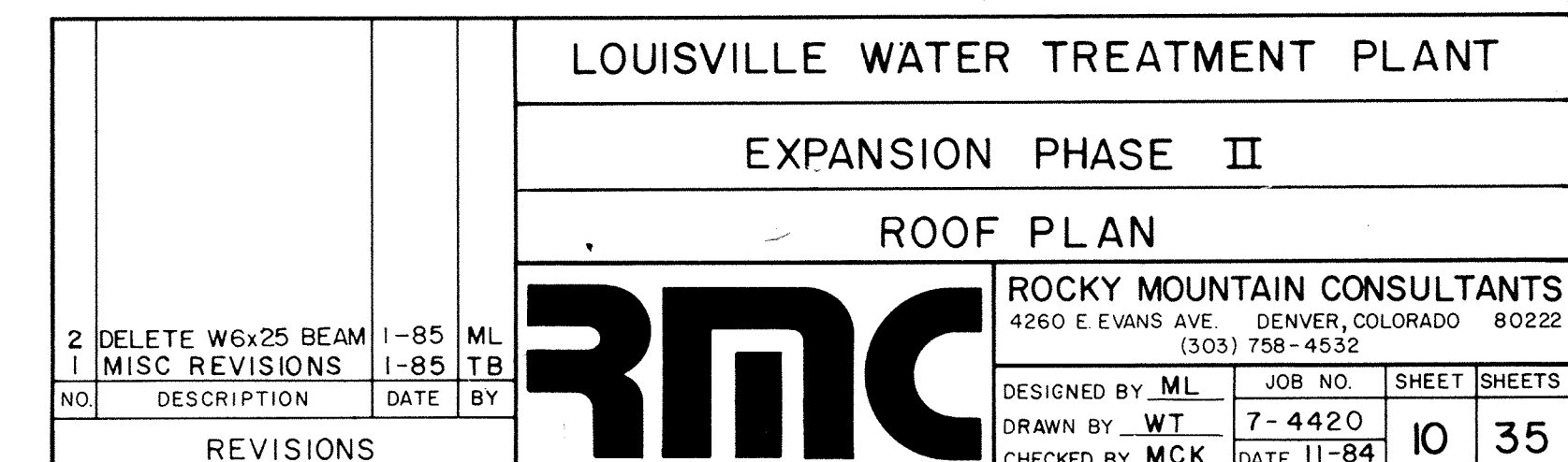
ELECTRICAL SCHEDULES

PROJECT NO.	
402821	
SHEET NO.	
E4	
XX	XX
DWG.	OF



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating





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City of Louisville

Sid Copeland Water Treatment Plant

Electric Vehicle Charging Narrative

Electric Vehicle Charging Narrative

Electric Vehicle Charging Narrative

Fleet & Electric Vehicle Charging

As part of the decarbonization study, the fleet vehicles were analyzed for replacement with electric vehicle (EV) equivalents. In addition, building electrical capacities were reviewed to determine if they have enough capacity to charge the fleet vehicles and if any electrical upgrades may be needed to the buildings.

EV Fleet Conversion

Based on current technology, transitioning from internal combustion engine (ICE) vehicles to EVs can substantially lower overall carbon emissions. A caveat to consider in assessing the environmental impact of EVs is the variation of electricity generation sources in each area. The state of Colorado relies mainly on coal and natural gas. However, the share of these fuel sources as a percentage of total generation is decreasing. Alternative energy sources such as wind and solar are increasing rapidly. By using additional onsite renewable energy sources and phasing in vehicle replacement it will be possible for Louisville's fleet to be entirely carbon free.

In the current vehicle market mainly light duty vehicles are being produced. The battery technology is still being developed for heavy-duty vehicles. The market is rapidly changing so over the course of the next 5 years, new innovation should allow heavy duty vehicles to be carbon free through either advanced battery technology or other yet to be determined technology.

EVs typically have a higher initial capital cost to purchase or lease when compared to ICE vehicles, EVs can cost less in the long-term due to lower fuel costs, different maintenance requirements, and longer vehicle lives. Therefore, it is important to consider the entire lifespan of a vehicle when investing in fleet vehicles. There are also limiting factors of EVs to consider, such as range and power needs of certain fleet vehicles, as well as the near-constant changes in the electric vehicle and infrastructure technology.

Charging Infrastructure

When planning for EV charging infrastructure, it is recommended to proactively plan for the number of charging stations needed by installing more electrical equipment (e.g. transformers and conduits) than is needed for the initial purchase of EVs. It is more cost effective to install excess electrical equipment during the initial installation than having to add electrical wires each time additional stations are required. This electrical equipment installation does not include purchasing all the charging stations that can fit with that equipment, but instead having the electrical capacity to purchase charging stations to meet future capacity needs without additional construction. The city has already thought about this and this report is the result of that forward thinking.

While there are three levels of EV charging infrastructure currently available, Level 2 charging is currently the most prevalent among them and requires electrical infrastructure upgrades to extend 240 volt AC service to locations where the EVs would charge. It charges at over twice the rate of level 1, adding 12 to 80 miles of range per hour charging. Level 3 charges are also becoming more common and can add from 80 to 500 miles of range per hour. Level 3 charging typically requires a 480 volt AC service. The level 2 and 3 chargers with the increased rate of charging can justify the costs to serve the needs of fleet management in a timely manner. Costs per unit can vary within these ranges depending on the installation and labor costs, warranties for equipment, and operation and maintenance costs for the equipment. Level 2 chargers provide good value for infrastructure investment when factoring in cost and time required to charge when compared to Level 3 chargers. Level 3 chargers can make sense when high use vehicles need quick recharging, though these chargers will cost more to install and incur a higher charging cost than level 2 chargers.

Electric Vehicle Charging Narrative

For the public chargers the City may want to consider charging a some type of fee for usage. Many charging stations charge a usage fee at some dollar per kWh of charging. This can help offset the peak demand that may be incurred by the city. Another option is to charge an idle fee. This type of fee encourages people not to leave their vehicle plugged in for long period of times once the vehicle has reached full charge.

Another consideration for charging infrastructure is the daily charging schedule. Most of the buildings reviewed for this study are on a secondary general rate schedule. This rate schedule does not have time of use rates for electrical consumption or peak demand. This means depending on when and how many vehicles charge relative to the buildings peak demand, it may increase the demand charges the city pays. Xcel Energy does offer a EV charging rate plan that incentivize the intentional reduction of electricity use during peak energy demand periods, such as during hot summer days. This rate plane does require a separate service for just the charging stations. Planning for fleet recharging during off-peak periods can add up to thousands of dollars in savings.

Battery capacity

Battery technology is changing rapidly, resulting in increased charge capacity and lower operating cost per mile. Many manufactures now offer eight year/100,000 mile warranties on their EV batteries (generally covering defects and workmanship), and some offers an eight year/100,000 mile warranty on battery capacity. Auto manufacturer warranties and charge capacity have generally reduced consumer concern about battery life and range. As a result, the analysis of total ownership cost does not account for the cost of EV battery replacement, assuming that municipal vehicles will be retired at the warranty expiration.

Sid Copeland Water Treatment Plant Site

The Sid Copeland Water Treatment Plant has five vehicles. One is considered a medium-duty vehicle and the other four are light duty vehicles. These vehicles are primarily used around the Sid Copeland water treatment plant and offsite at the Howard Berry water treatment plant and to get to water pumping stations spread throughout the city. The heavy duty vehicle is used for plowing operations in the winter at both the Sid Copeland and Howard Berry water treatment plants. See the table below.

Site	Make	Model	Quantity
Sid Copeland Water Treatment Plant	Chevy	Colorado	1
	Ford	F-150	3
	Ford	F-250	1

We recommend installing 3 chargers and upgrading the electrical infrastructure to support them. Currently there is no direct replacement for the heavy duty truck (used to plow the parking lot). It is anticipated those types of vehicles will be available in the next 10 years. The table below shows the number of recommended chargers.

Existing Public charging stations	Existing Public Charger Level	Quantity of New Level 2 Public Charger	Quantity of New Level 3 Public Charger	Quantity of New Level 2 Fleet Charger	Quantity of New Level 3 fleet Charger
0	N/A	0	0	3	0

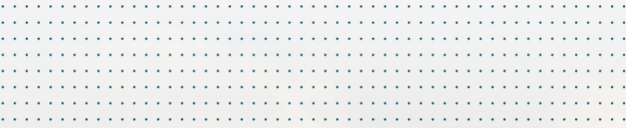
At this site the number of fleet chargers selected to be installed here were based on the number of vehicles stored onsite.

The quantity of public chargers selected for this site was zero because there is limited public visitation at the site.



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City of Louisville Decarbonization Study

Louisville Sid Copeland Water
Treatment Plant

RENEWABLES SUPPORTING ANALYSIS

LOUISVILLE, CO

AUGUST 18, 2023

Together Building a Thriving Planet



Louisville Sid Copeland Water Treatment Plant

The Louisville Sid Copeland Water Treatment Plant is a great candidate for a fixed-tilt ground mount solar PV system. The corners of the property to the SE and SW of the property are open, allowing for cohesive arrays. This site has enough open space to offset 99% to 100% of the property’s consumption.

1. Proposed Solar PV System Overview

Below is a high-level summary of the proposed system specifications. Please note, specific equipment manufacturers and models may change depending on availability and market conditions at the time of construction.

SITE NAME	SITE ADDRESS	OPTION	SIZE (KW-DC)	SIZE (KW-AC)	SYSTEM TYPE	YEAR 1 PRODUCTION (kWh)
Louisville Sid Copeland Water Treatment Plant	1955 Washington Ave, Louisville, CO 80027	1	376.4	300	Fixed-tilt ground mount	620,685



Louisville Sid Copeland Water Treatment Plant

LOUISVILLE SID COPELAND WATER TREATMENT PLANT EQUIPMENT AND QUANTITY SUMMARY

QUANTITY	EQUIPMENT DESCRIPTION
Ground Mount	
697	JA Solar, JAM72D30-540 (540W) – Bifacial Mono PERC Half Cell Double Glass Modules
6	CPS SCA60KTL-DO/US-480 - Inverters
1	30° Fixed-Tilt Ground Mount Racking System
1	AlsoEnergy Data Acquisition System (DAS) Package – PLCS400
1	Electrical Balance of Systems Package

AlsoEnergy Data Acquisition System (DAS) includes the equipment/functionality listed below.

- NEMA 4 Enclosure and Data Logger
- Cellular modem
- CT Based Revenue Grade Meter
- Inverter Direct Monitoring
- 5-year service plan
- A Meteorological Station consisting of the following:
 - Cell Temp Sensor
 - Pyranometer
- Publicly accessible web-based dashboard functionality

The Electrical Balance of Systems Package includes all components to create an electrically complete ground mount solar PV installation. This includes grounding materials, wiring, conduit, MCT, panelboards/combiners, switchgear, fuses, and disconnects. For the purposes of this decarbonization study, this scope may be split between the electrical and solar PV pricing. More details provided in Section 4.

2. Production Modeling

Array layouts and system production are modeled in Helioscope, an industry-standard design and energy modeling software package with 3-dimensional modeling capabilities. Through Helioscope, we can incorporate site-specific characteristics of buildings and shade producing obstructions to determine their impacts upon system layout and production. McKinstry further applies our knowledge of codes and regulations, industry best practices, and professional judgment to ensure that designs are code-compliant and strike a balance across customer preferences, production, constructability, and price concerns.

Helioscope provides robust PV system output modeling capabilities. We use these in conjunction with Typical Meteorological Year (TMY) weather datasets, real-world equipment specifications, proprietary 3rd-party-engineered dust and snow soiling models, and professional judgment to determine a system's annual kWh production. For City of Louisville, we are using the TMY, DENVER INTL AP, NSRDB (tmy3,l) weather data set and soiling conditions from the DNV-GL NOAA Lafayette station. Full Helioscope report below.

Louisville Sid Copeland Water Treatment Plant



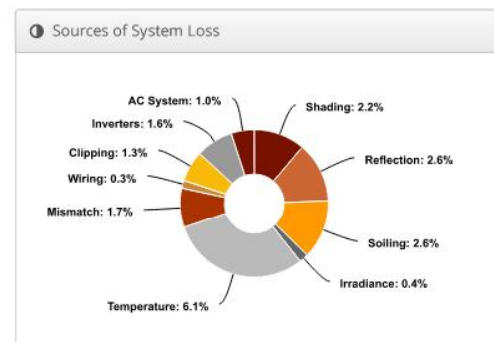
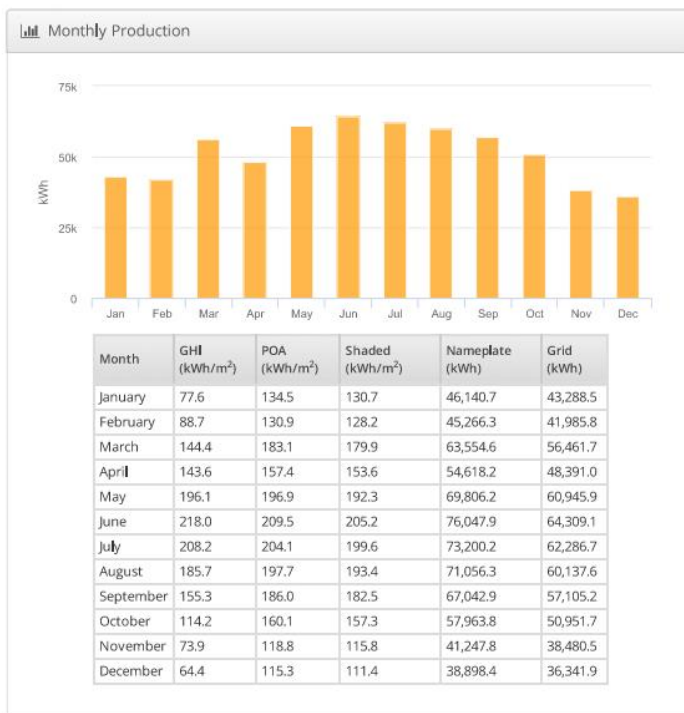
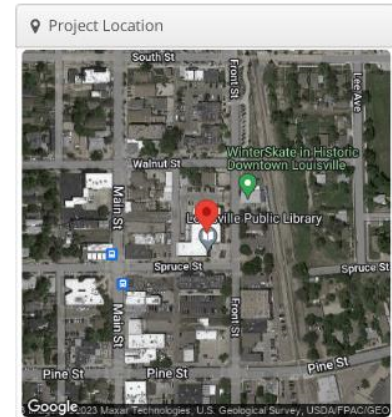
Annual Production Report produced by Mountain Bryan H

Cohort 2 - NWTP_site max City of Louisville, 951 Spruce St, Louisville, CO 80027

Report

Project Name	City of Louisville
Project Address	951 Spruce St, Louisville, CO 80027
Prepared By	Mountain Bryan H bryanh@mckinstry.com

System Metrics	
Design	Cohort 2 - NWTP_site max
Module DC Nameplate	376.4 kW
Inverter AC Nameplate	300.0 kW Load Ratio: 1.25
Annual Production	620.7 MWh
Performance Ratio	82.7%
kWh/kWp	1,649.1
Weather Dataset	TMY, DENVER INTL AP, NSRDB (tmy3, I)
Simulator Version	0b20365465-f9de7709be-37a695226a-28e7c7d839



Louisville Sid Copeland Water Treatment Plant



Annual Production Report produced by Mountain Bryan H

⚡ Annual Production			
	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,670.2	
	POA Irradiance	1,994.3	19.4%
	Shaded Irradiance	1,949.8	-2.2%
	Irradiance after Reflection	1,898.6	-2.6%
	Irradiance after Soiling	1,849.4	-2.6%
	Total Collector Irradiance	1,849.3	0.0%
Energy (kWh)	Nameplate	704,843.3	
	Output at Irradiance Levels	702,044.1	-0.4%
	Output at Cell Temperature Derate	659,540.7	-6.1%
	Output After Mismatch	648,160.5	-1.7%
	Optimal DC Output	645,927.1	-0.3%
	Constrained DC Output	637,289.7	-1.3%
	Inverter Output	626,955.2	-1.6%
	Energy to Grid	620,685.6	-1.0%
Temperature Metrics			
	Avg. Operating Ambient Temp	15.0 °C	
	Avg. Operating Cell Temp	29.6 °C	
Simulation Metrics			
	Operating Hours	4513	
	Solved Hours	4513	

☁ Condition Set												
Description	Ground 30 deg											
Weather Dataset	TMY, DENVER INTL AP, NSRDB (tmy3, I)											
Solar Angle Location	Project Lat/Lng											
Transposition Model	Perez Model											
Temperature Model	Diffusion Model											
Temperature Model Parameters	Rack Type					U _{const}			U _{wind}			
	Fixed Tilt					20			0			
	Flush Mount					15			0			
	East-West					29			0			
	Carport					29			0			
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D
	5	5	5	4	2	0	1	1	1	1	4	6
Irradiation Variance	3.5%											
Cell Temperature Spread	3° C											
Module Binning Range	0% to 2.5%											
AC System Derate	1.00%											
Trackers	Maximum Angle						Backtracking					
	30°						Disabled					
Module Characterizations	Module					Uploaded By		Characterization				
	JAM72D30-540/MB (JA Solar)					HelioScope		Spec Sheet Characterization, PAN				
Component Characterizations	Device						Uploaded By		Characterization			
	CPS SCA50KTL-DO/480 (Chint)						HelioScope		Spec Sheet			

📦 Components		
Component	Name	Count
Inverters	CPS SCA50KTL-DO/480 (Chint)	6 (300.0 kW)
Strings	10 AWG (Copper)	41 (5,933.6 ft)
Module	JA Solar, JAM72D30-540/MB (540W)	697 (376.4 kW)

🔌 Wiring Zones			
Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	17-17	Along Racking
Wiring Zone 2	-	17-17	Along Racking
Wiring Zone 3	-	17-17	Along Racking

🏠 Field Segments									
Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Portrait (Vertical)	30°	180°	21.0 ft	2x17	8	272	146.9 kW
Field Segment 2	Fixed Tilt	Portrait (Vertical)	30°	169.73064°	25.0 ft	2x51	1	102	55.1 kW
Field Segment 3	Fixed Tilt	Portrait (Vertical)	30°	180°	0.0 ft	2x17	6	204	110.2 kW
Field Segment 4	Fixed Tilt	Portrait (Vertical)	30°	169.73064°	0.0 ft	2x1	60	119	64.3 kW

Louisville Sid Copeland Water Treatment Plant

3. Annual Utility Savings and Value of Solar Energy

To analyze utility bill savings, we utilize Energy Toolbase, an industry-standard bill modeling software package. Energy Toolbase estimates bill savings based upon a site's electric load characteristics, PV system production (imported from Helioscope or other sources), and local utility tariffs and net metering policies. Xcel Energy tariffs and Net Metering tariff adjustments used in this analysis are:

- Secondary General (SG)
- Secondary Photovoltaic Time-of-Use (SPVTOU)
- Net Metering Service (Schedule NM)

To properly calculate the annual utility savings associated with the solar PV, we need to analyze the building load after all electrification and carbon reduction measures are implemented. As noted in the Summary Report, there are two bundles of measures – Bundle 1 (Full Electrification) and Bundle 2 (Hybrid Electrification). Each create a slightly different building load baseline. Therefore, both scenarios are listed below. Baseline utility data year is 2019 and a modeled usage profile was created from the Wastewater Treatment Plant interval data. There is a single proposed solar array for these two consumption models. Bundle 1 is projected to have 99% offset of consumption while Bundle 2 is projected to have 100% offset.

OPTION 1 - GROUND MOUNT ONLY ESTIMATE WITH SPVTOU RATE SWITCH

SCENARIO	ANNUAL SAVINGS	ENERGY SAVINGS	DEMAND SAVINGS
Bundle 1	\$69,935	\$35,602	\$34,333
Bundle 2	\$68,174	\$35,099	\$33,075

To qualify for a rate switch to SPVTOU, the facilities meter must have a minimum 30% load factor for the trailing 12 months and a maximum service load rating of 500kW. This site's service load is under 500kW. 2019 Average Load factor was 30% not including the correction factor the existing solar array decreases the load factor of the site.. Bundle 1 and 2 are projected to have an increased load factor of 34% and 36% respectively prior to PV installation. We have projected that this site will qualify for the SPVTOU rate class.

4. System Price and Financial Results

There are two main avenues City of Louisville can choose to finance these projects – cash purchase or tax-exempt lease purchase (TELP). As a tax-exempt entity, City of Louisville is eligible for direct pay in Year 1 at Energy Investment Tax Credit (ITC) rates. These rates are 30% for cash purchase and 25.5% for TELP.

At this early feasibility study stage of a portfolio, we focus on simple payback to get a high-level look at the project economics. Our simple payback calculation is based on Year 1 solar production, Year 1 annual utility savings, and the Solar*Rewards C&I incentive program. Should any of these projects move into the next stage of development, McKinstry would develop more detailed proformas and cash flows to include items like solar degradation, Operations & Maintenance, discount rates, and more.

McKinstry aims to recommend solar systems that will pay back within the system lifetime, 30 years for a ground mount system. In all funding scenarios, this system would pay back well within the solar lifetime and under 15 years.

Louisville Sid Copeland Water Treatment Plant

BUNDLE 1 - GROUND MOUNT ONLY

SCENARIO	SYSTEM PRICE	ANNUAL SAVINGS	UTILITY INCENTIVE	SIMPLE PAYBACK (YRS)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$1,275,000	\$69,935	\$21,763	14
TELP with IRA	\$949,875			10.44
Cash Purchase with IRA	\$892,500			9.81

BUNDLE 2 - GROUND MOUNT ONLY

SCENARIO	SYSTEM PRICE	ANNUAL SAVINGS	UTILITY INCENTIVE	SIMPLE PAYBACK (YRS)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$1,275,000	\$68,174	\$21,763	14.2
TELP with IRA	\$949,875			10.65
Cash Purchase with IRA	\$892,500			10

Please note that there is no proposed service upgrade for this site. The full PV scope from the Point of Interconnection, to the Solar Disconnect, Solar Meter, AC Combiner, Inverters to Modules is included in the pricing below. Additionally, pricing below assumes Louisville moves forward with a system at the Howard Berry Water Treatment Plant and the Wastewater Treatment Plant; there are cost efficiencies in material, installation, and construction management scopes using a portfolio approach.

Another metric that may be useful as the City of Louisville considers the best way to decarbonize is levelized cost of electricity (LCOE). This is defined as capital cost divided by the estimated system lifetime production with units of \$/kWh. It can help the City of Louisville compare the value of owning onsite solar versus subscribing to renewable utility programs like Renewable Connect and Windsource. The table below shows LCOE with and without the Solar*Rewards C&I incentive.

SCENARIO BUNDLE 1	LCOE - NO UTILITY INCENTIVES (\$/KWH)	LCOE - W/ UTILITY INCENTIVES (\$/KWH)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$0.068	\$0.043
TELP with IRA	\$0.051	\$0.026
Cash Purchase with IRA	\$0.048	\$0.023

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SCENARIO BUNDLE 2	LCOE –	LCOE –
	NO UTILITY INCENTIVES (\$/KWH)	W/ UTILITY INCENTIVES (\$/KWH)
Cash Purchase or Tax-Exempt Lease Purchase (TELP)	\$0.068	\$0.043
TELP with IRA	\$0.051	\$0.026
Cash Purchase with IRA	\$0.048	\$0.023

5. Future Considerations and Next Steps

Should Louisville decide to move forward with the Sid Copeland Water Treatment Plant ground mount system, next steps would involve a geotechnical study, utility locates, land survey, racking and electrical bid sets, an interconnection application to Xcel, a subcontractor RFP to get final pricing, and any other due diligence items necessary to de-risk the project and ready it for implementation.

6. Assumptions, Inclusions, and Exclusions

- Codes and Utility Standards:
 - NEC 2020
 - IBC 2018
 - IFC 2018
 - Xcel Energy Blue Book (7/31/2022 Version)
 - Xcel Energy DG Tech Manual (10/28/2021 Version)
- Tax-exempt
- Prevailing wage
- The provided financial model projects that this site will qualify for SPVTOU rate class as its existing Load factor is 30% (the minimum required amount) and site demand is below 500kW.
- Pricing assumes a portfolio approach; Louisville will move forward with a solar PV system at both the Howard Berry Water Treatment Plant and Wastewater Treatment Plant
- Pricing includes payment & performance bond
- Terms & Conditions listed in the Xcel Energy Interconnection Agreement
- Current labor rates
- Modeling:
 - TMY, DENVER INTL AP, NSRDB (tmy3,l) weather file
 - 1.5% production gain for ground mounts with bifacial modules
 - Soiling data from DNV-GL
- Design Loads
 - Wind speed:
 - Risk Category II: 145mph
 - Exposure: C
 - Ground snow load: 30 psf
 - Risk Category II: 1.0 importance factor
- No interconnection upgrade costs
- No grounding transformers

Louisville Sid Copeland Water Treatment Plant

- Major equipment warranties
 - Modules – 12 year Product
 - Modules – 30 year Power Output
 - Inverters – 10 years
 - DAS – 5 years
 - AC Combiners – 5 years
- No extended warranties
- No ongoing DAS Costs
 - Any ongoing fees beyond year 5 are excluded (both Cell Service and Data Subscription Monitoring fees).
- No backup generation
- Favorable soil conditions. No hard drilling or special footers/foundations required.
- No hazardous soils or materials (asbestos, PFAS, etc.). Should monitoring, mitigation, abatement, and/or disposal be required, Louisville would be responsible for this additional scope.
- Xcel Energy Solar*Rewards C&I Incentives:
 - Tier 2: 250kWac-500kWac = \$0.0375/kWh for 20 years



Appendix

1. Mechanical System Matrix Options
2. Mechanical Decarbonization Scoping
3. Electrical Decarbonization Scoping
4. Structural Scoping
5. Electric Vehicle Charging Narrative
6. Renewables Scoping
7. Cost Estimating

SCWTP Cost Estimates

Three sets of numbers are listed below:

1. Cost Delta of Decarbonization – These are the total construction costs minus the replacement costs that would've been spent to replace the existing units with like-for-like fossil fuel units. These numbers represent the true cost of this decarbonization effort.
2. Total Decarbonization Construction Costs – These are the total amounts of money that will need to be allocated for budgetary purposes. The delta between the above numbers and the below numbers represents the cost of decarbonization.
3. Baseline Costs - These are the costs that would be spent to replace the existing gas-based systems with like-for-like gas units.

All numbers are “all-in costs”, including all GC markups, permitting, etc. They are also Rough Order of Magnitude (ROM) numbers, with a +/-20% range. See the “Construction Pricing Context” section in the report body for more detail. All costs associated with the solar PV systems (including the electrical infrastructure to support these systems) are included in the Renewables costs as outlined in a separate section of the Appendix.

Cost Delta of Decarbonization

DECARBONIZATION DELTA COSTS: NWTP

	Total Cost
Option 1 (Full Electrification)	\$ 1,487,000
Option 2 (Hybrid Electrification)	\$ 18,000

Total Decarbonization Construction Costs

OPTION 1 (Full Electrification): NWTP

Scope	Total Cost
HVAC Rooftop Units and Ductwork	\$ 155,000
HVAC Piping	\$ 110,000
Domestic Water Heating and Piping	\$ -
Electrical	\$ 354,000
Generator	\$ 1,075,000
Structural	\$ 49,000
GC all-in Total (design, CM, bonds, etc.)	\$ 1,741,000

OPTION 2 (Hybrid Electrification): NWTP

Scope	Total Cost
HVAC Rooftop Units and Ductwork	\$ 38,000
HVAC Piping	\$ 48,000
Domestic Water Heating and Piping	\$ -
Electrical	\$ 21,000
Structural	\$ 49,000
GC all-in Total (design, CM, bonds, etc.)	\$ 154,000

EV Charging L2	\$ 154,000
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Baseline Costs
GAS LIKE-FOR-LIKE REPLACEMENT COSTS: NWTP

	Total Cost
Option 1 (All Mechanical Units)	\$ 255,000
Option 2 (Freeze Protection Heaters Remain)	\$ 137,000