Grand Teton National Park Federal Fleet Tiger Team EVSE Site Assessment

Leidy Boyce, Jesse Bennett, and Ranjit Desai

National Renewable Energy Laboratory

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List of Acronyms

BEV	battery electric vehicle
EO	executive order
EV	electric vehicle
EVI-LOCATE	Electric Vehicle Infrastructure LOcalized Charging Assessment Tool and Estimator
EVSE	electric vehicle supply equipment
FAST	Federal Automotive Statistical Tool
FEMP	Federal Energy Management Program
FY	fiscal year
GRTE	Grand Teton National Park
GOV	government-owned vehicle
GSA	U.S. General Services Administration
HDV	heavy-duty vehicle
IEC	International Electrotechnical Commission
LDV	light-duty vehicle
MDV	medium-duty vehicle
NEC	National Electric Code
NREL	National Renewable Energy Laboratory
PHEV	plug-in hybrid electric vehicle
POV	privately owned vehicle
S&SW	sedans and station wagons
SAE	Society of Automotive Engineers
SIN	Special Item Number
SUV	sport utility vehicle
ZEV	zero-emission vehicle
ZPAC	Zero Emission Vehicle Planning and Charging tool

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Acknowledgments

This work was supported by the U.S. Department of Energy Federal Energy Management Program (FEMP) and the National Renewable Energy Laboratory (NREL) through a partnership with the Department of Interior, National Park Service. This report summarizes an electric vehicle supply equipment (EVSE) site assessment performed for Grand Teton National Park (GRTE) to evaluate the feasibly of EVSE installations to prepare for anticipated electric vehicle (EV) acquisitions. This work would not have been possible without David J. Reus, Facility Management Systems Specialist for GRTE, who actively and eagerly supported this effort, sharing GRTE fleet's needs and expertise to develop the EVSE plan proposed in this report. The authors would also like to thank Margaret Wilson, Planning and Environmental Compliance and Sustainability Coordinator for GRTE and Lynn Chan, Landscape Architect and Project Manager of Sustainability for Yellowstone National Park, as well as the GRTE Personnel that supported the virtual site visit for their help throughout this process.

1 Introduction

The U.S. Department of Energy Federal Energy Management Program (FEMP) helps federal agencies reduce petroleum consumption and increase alternative fuel use through its resources for sustainable federal fleets. A key element of this assistance involves supporting agencies in the transition to zero-emission vehicles (ZEVs), including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). The current administration has established a policy for the federal fleet to lead by example and accelerate the transition to electric transportation.

Fleet electrification is part of a federal policy to achieve net-zero emissions economy-wide and a carbon pollution-free electricity sector, established through two executive orders (EOs)—14008 and 14057.

EO 14008, *Tackling the Climate Crisis at Home and Abroad* (signed on January 27, 2021), establishes the policy of the Administration to "organize and deploy the full capacity of its agencies to combat the climate crisis." Specifically, the E.O. 14008 plan calls on all agencies to transition to ZEVs.

EO 14057, *Catalyzing America's Clean Energy Industries and Jobs through Federal Sustainability* (signed on December 8, 2021), further details the EO 14008 policy by requiring in Section 102(i) that each agency ensure that all light-duty vehicle acquisitions are ZEVs by the end of fiscal year (FY) 2027, and all vehicle acquisitions are ZEVs by the end of FY 2035. To support transition of the federal fleet to ZEVs, Section 201 of the E.O. requires agencies to work with the White House Council on Environmental Quality (CEQ) and the Office of Management and Budget (OMB) to propose and establish targets for the annual (FY 2022 and onwards) acquisition of ZEVs and deployment of charging infrastructure. Key to this effort is the requirement to annually update a ZEV fleet strategy that includes "optimizing fleet size and composition; deploying [ZEV] re-fueling infrastructure; and maximizing acquisition and deployment of zero-emission light-, medium-, and heavy-duty vehicles where the General Services Administration (GSA) offers one or more zero-emission vehicle options for that vehicle class."

In developing and implementing their ZEV fleet strategy, agencies should focus on evaluating electric vehicle (EV) deployment opportunities at individual fleet locations, which have unique site, vehicle operating, and utility service characteristics. This is best achieved through site assessments to evaluate opportunities for ZEV acquisitions, identify optimal ZEV candidates, and determine optimal electric vehicle supply equipment (EVSE) deployment strategies.

This site report supports the development of a ZEV deployment plan for the Grand Teton National Park (GRTE) that can ultimately be incorporated into the overall U.S. Department of the Interior ZEV fleet strategy.

1.1 EVSE Tiger Team

FEMP offers technical assistance to agencies developing fleet electrification goals, including planning for charging infrastructure through EVSE Tiger Teams. Tiger Teams include National Renewable Energy Laboratory (NREL) engineers and fleet experts who review site ZEV acquisition opportunities, EV charging needs, and develop ZEV acquisition and EVSE installation recommendations that minimize costs while accommodating long-term charging needs.

1.2 Site Overview

The Tiger Team provided 2020 fleet data to GRTE from the Federal Automotive Statistical Tool (FAST) which showed an inventory of 178 vehicles, including 18 U.S. General Services Administration (GSA)-leased vehicles and 160 vehicles that are agency-owned. Figure 1 provides a breakdown of GRTE's fleet by vehicle type. A majority of the fleet—62% or 110 vehicles—comprises light-duty vehicles, which are the focus for 2022 EV acquisitions. The remainder of the fleet primarily consists of medium-duty vehicles—26% or 46 vehicles—with the remaining 12% or 22 are heavy-duty vehicles.

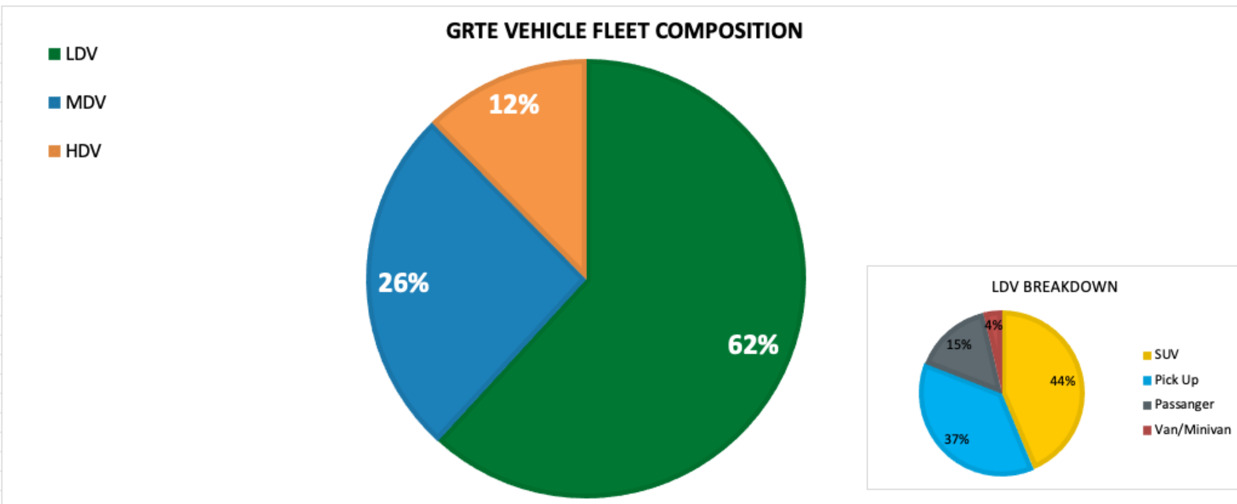

Figure 1. GRTE's vehicle fleet composition

2 Fleet Electrification Planning

GRTE's vehicle acquisition plan for FY21 included the replacement of seven vehicles, with two of those replacements being BEVs. GRTE also already has two PHEVs in its fleet. GRTE has planned for up to 76 ZEV acquisitions as funding becomes available, as shown in Figure 2. This vision for fleet electrification requires additional charging infrastructure beyond the existing 3 EVSE ports available throughout GRTE's facilities. To support the planning for this new equipment, the EVSE Tiger Team supported the evaluation of new electrical charging infrastructure at Moose General Parking Area since it is considered a central parking hub for GRTE fleet vehicles. The current EVSE and ZEVs planned at GRTE's priority sites are detailed in Table 1 below.

Table 1. GRTE's Priority Sites

	Moose General	Moose Wastewater Treatment Plant	Moose-CTDVC	CB Maint	CB-VC
Existing EVSE Ports	3	0	0	1	0
Planned ZEVs	50	3	6	3	4

The Moose General parking is a large area with 354 parking spots for use by government-owned vehicles (GOVs), privately owned vehicles (POVs), and park visitors distributed among several buildings. The GOV parking needs vary between summer and winter seasons, but typically 115 slots are needed in the summer and 76 slots in the winter. In addition to the typically designated GOV parking spots, snow storage and removal practices were considered when identifying the best areas for EVSE installations. The Tiger Team along with GRTE agreed on narrowing the hybrid site visit to the Moose headquarters building, Moose GTA Building, Moose Wastewater Treatment building, and the I.T Building, as these represent the greatest number of parking spaces, as well as the most challenging design considerations. Other areas have only a small number of future EVSE, and the information in this report can be used to inform future installation recommendations in the less complex areas.

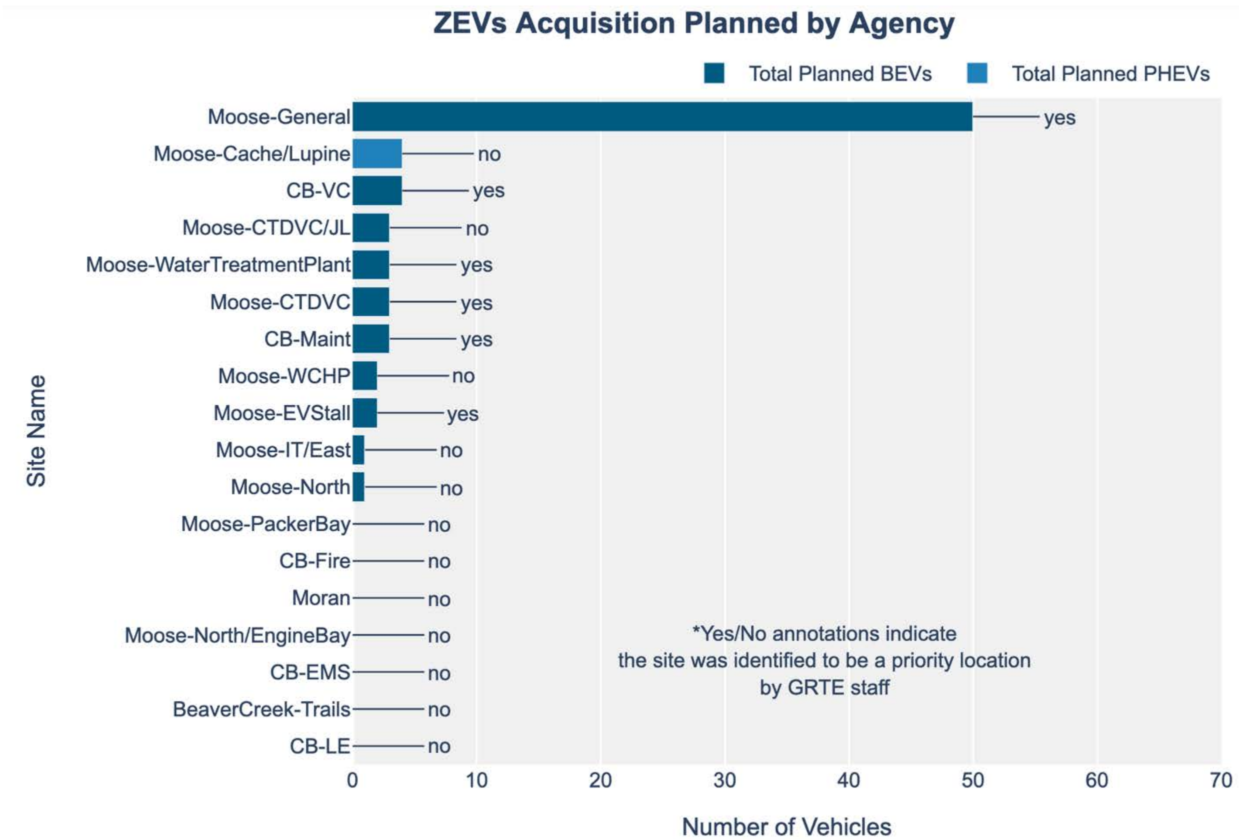

Figure 2. ZEV acquisition planned by GRTE as of Dec. 20, 2021

Note: The site names with the prefix "Moose" in Figure 2 are located in the Moose parking lot area.

2.1 Existing Infrastructure Projects

A portion of the Moose parking area is currently under a redesign phase focused on the visitor float trip parking lot and the boat shuttle parking. The EVSE installation proposed in this report are in fleet-designated parking spaces and will not interfere with the current upgrades in the Moose parking area.

2.2 ZPAC Analysis

In addition to the FAST data, the Tiger Team also shared the ZEV Planning and Charging (ZPAC) tool with GRTE. ZPAC helps federal agencies identify ZEV candidates based on vehicle mission and parking location. GRTE evaluated 177 fleet vehicles, identifying 76 potential candidate vehicles for replacement with ZEVs based on currently available BEVs and PHEVs. The time frame for acquiring ZEVs is dependent on funding availability for vehicle replacements. A summary of the ZPAC results is outlined in Figure 3, while Table 2 lists each of the potential vehicle candidates and their equivalent special item number (SIN) replacement based on the GSA Vehicle Availability Listing.[1] Most of the Agency-Owned vehicles were missing the existing SIN, but the vehicle type designation helped guide the SIN ZEV

[1] GSA Vehicle Availability Listing through Autochoice: https://autochoice.fas.gsa.gov/AutoChoice/VehicleAvailability.

counterpart. Refer to Appendix A to view the current GRTE vehicle inventory organized by existing SIN and vehicle type. It is anticipated that the Vehicle Availability Listing will be expanded in the future to include more SINs as additional ZEV models become available and therefore the number of potential ZEVs planned by the agency will also increase.

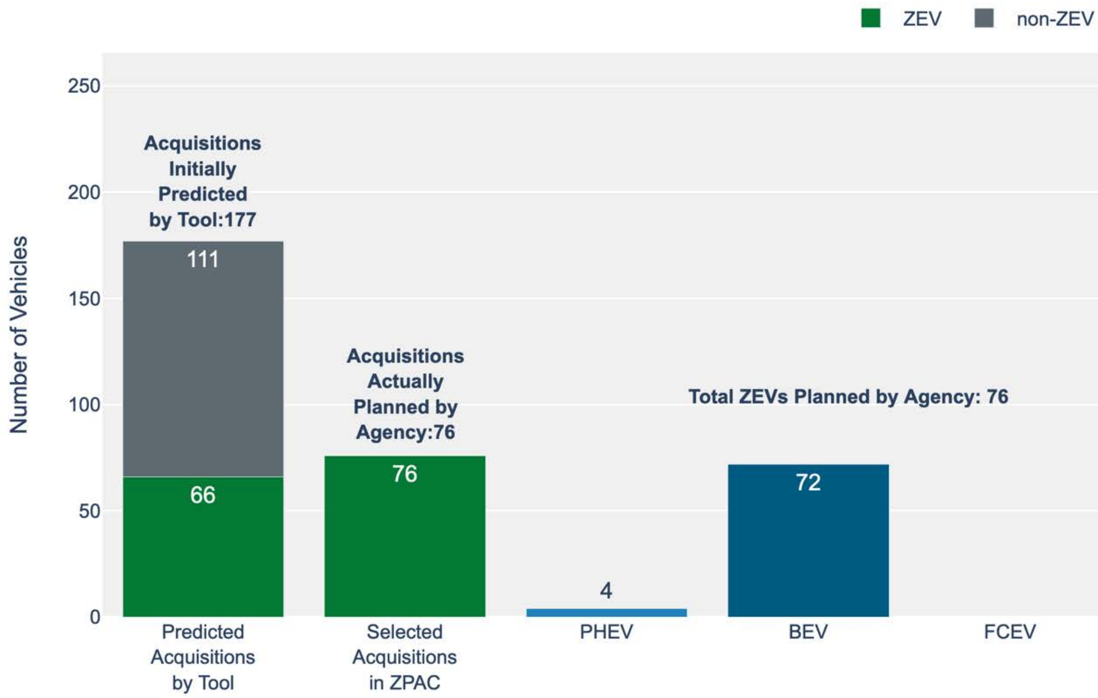

Figure 3. ZPAC summary results Feb. 22, 2022

Table 2. Potential EV Candidates Based on ZPAC Tools Results

Vehicle Ownership	Vehicle SIN	Vehicle Type	Vehicle Count	BEV SIN	PHEV SIN
Agency-owned	99	LD SUV 4x4	5	105E	
Agency-owned	NA	Sedan/St Wgn Midsize	1	10E	98P
Agency-owned	NA	LD Pickup 4x4	22	55E	
Agency-owned	NA	LD SUV 4x4	3	55E	
Agency-owned	NA	LD Minivan 4x2 (Passenger)	1	55E	
Agency-owned	NA	LD Van 4x2 (Passenger)	1	55E	
Agency-owned	NA	LD Pickup 4x2	1	55E	
Agency-owned	NA	LD Van 4x2 (Cargo)	1	55E	
Agency-owned	NA	MD Van (Cargo)	1	55E	
Agency-owned	NA	LD SUV 4x4	3	55E	96P
Agency-owned	NA	Sedan/St Wgn Compact	10	8E	8P
Agency-owned	NA	Sedan/St Wgn Subcompact	3	8E	8P
Agency-owned	NA	Sedan/St Wgn Compact	2	8E	8P
Agency-owned	NA	LD SUV 4x4	2	8E	96P
Agency-owned	NA	LD SUV 4x4	3	96E	96P
Agency-owned	NA	LD SUV 4x2	2	98E	98P
Agency-owned	NA	Sedan/St Wgn Compact	1	9E	8P
GSA Leased	99	LD SUV 4x4	2	96E	96P
GSA Leased	46	LD Pickup 4x4	2	55E	

2.3 EVSE Deployment Needs

A critical element to fleet electrification, in addition to ZEV acquisition planning, is the deployment of EVSE to provide the energy these new vehicles will require to fulfill their daily mission needs. As mentioned in Section 2, only three EVSE ports are currently available for fleet vehicles across Moose General Parking Area, as detailed in Table 3. The current EVSE installed at these locations will not be able to support the future charging needs of the 76 ZEVs planned at Moose General parking area. Additional EVSE must be installed throughout GRTE to support these vehicles with an ideal EV to EVSE ratio of 1:1 to ensure each vehicle has its own dedicated EVSE. This will ensure vehicles are always charged and capable of supporting their mission, although in some instances, additional EVSE may be suggested to plan for fleet electrification beyond the currently planned replacements.

Table 3. Existing EVSE Units at Moose Parking Area

Building	Type	Rating (A)	Port Count	Label on Figure 4
Moose Headquarter	Clipper Creek HCS-40	32	1	E1
GTA	Clipper Creek HCS-40	32	2	E2

2.3.1 Parking Layout at Moose General Parking Area

Moose General Parking Area has a series of GOV and POV parking around the Headquarters, GTA, Wastewater Treatment, and IT buildings, as displayed in Figure 4. Although there is a significant amount of GOV and POV parking around these buildings, only a portion of these spots can support EVSE and EV charging. Throughout the winter months, snow removal operations require significant space to ensure parking is consistently available. The red polygons indicate fleet parking spaces adjacent to aforementioned buildings, for a total of 47 parking slots, while the yellow polygon covers spaces that cannot be considered for EVSE installations since this area is required for snow removal operations. Throughout these 47 parking spots, there is one existing EVSE port wall-mounted on the headquarter building, and two that are pedestal-mounted at the southeast end of the GTA building, which are used for GOVs. Throughout these 47 parking spots, there is one existing wall-mounted EVSE port on the headquarter building, and two pedestal-mounted ports at the southeast end of the GTA building, which are used for GOVs. The top priority at Moose General Parking area was to install EVSE to accommodate fleet vehicles in the same areas as the vehicles are used for their ordinary park operations.

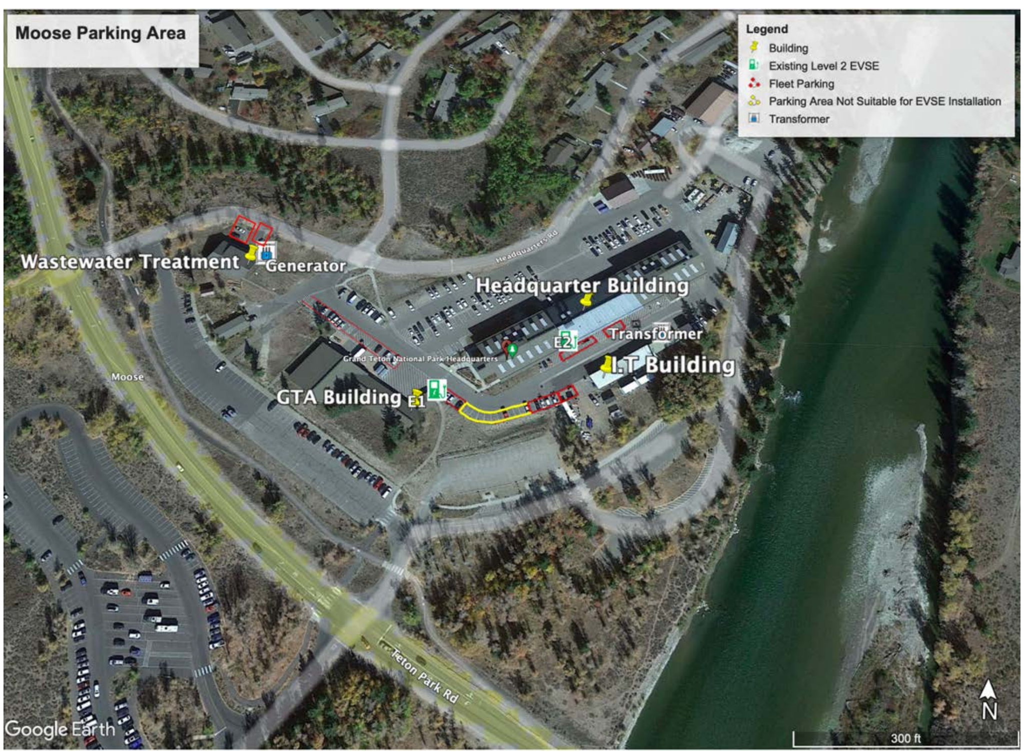

Figure 4. Moose General Parking Lot layout

2.4 EVSE Installation Design Guidelines

EVSE must be installed to provide the charging power that ZEVs require. Due to the large energy demand from fleet mobility needs, the power ratings of these devices are much higher than most other electrical devices. This requires specific installation considerations that are outlined in the National Fire Protection Association's Standard 70—the National Electrical Code (NEC)—and as outlined in the FEMP EV Champion Training Series.[2]

Most ZEVs available in the United States are capable of charging from the Society of Automotive Engineers (SAE) Standard J1772 EVSE charge coupler. This standard provides two common charging levels—Level 1 and 2—which provide AC power directly to the vehicle, which is then converted to DC power for the battery through the vehicle's onboard charger. Level 1 charging provides a maximum 1.9 kW of power and is typically plugged into a standard 120-V receptacle, which is best served through a dedicated 20-A circuit breaker to provide a maximum 16 A of current to the vehicle, per the 125% overcurrent protection required in NEC Section 625. These chargers are best suited for PHEVs or BEVs with a low number of daily vehicle miles traveled. However, for most BEVs, the higher-power Level 2 charging option will be preferable to ensure the vehicle is always able to receive a full charge after each day of driving. These chargers are typically hard-wired dual-port pedestal units and are capable of supplying either 208 V or 240 V to the vehicle, depending on whether the building is receiving a three-phase (3Φ) or single-phase (1Φ) electric service from the utility. They also require a double-pole breaker that is typically rated at 40 A. The power capabilities for these chargers are dependent on the service voltage and 32 A of charging current, with 208 V and 240 V providing 6.7 kW and 7.7 kW, respectively. These options and requirements are outlined in Table 4.

Table 4. SAE J1772 AC Charging Options

EVSE	Typical Charging Power	Typical Service Type	Typical Installation Requirements
AC Level 1	1.9 kW (16 A @ 120 V)	120/240 V 1Φ or 208Y/120V 3Φ	Portable EVSE, 120-V receptacle, 20-A single-pole circuit breaker
AC Level 2	6.7 kW (32 A @ 208 V) 7.7 kW (32 A @ 240 V)	208Y/120V 3Φ 120/240 V 1Φ	Hard-wired EVSE, 40-A double-pole circuit breaker

[2] FEMP Fleet EV web page: https://www.energy.gov/eere/femp/electric-vehicles-federal-fleets.

EVSE deployment electrical and facility considerations:

1. The installation of EVSE has the potential to significantly increase the facility power demand, with the potential to impact demand charges and utility interconnections. As a result, it is important to review utility rate options and how a higher peak demand or larger interconnection could impact the cost of electricity.
2. The EVSE deployment plans presented in this report do not consider existing building loads and are designed based on existing electrical capacity, as indicated in the EVSE Questionnaire and on the assumption that all EVSE may charge simultaneously.
3. Managing charging times can reduce electricity costs and improve life cycle economics for EVs. The Tiger Team recommends charging vehicles at times that do not coincide with peak demands to the extent possible. In addition, it is advised to consider EV battery capacity, EVSE power, and battery/outdoor temperature to estimate charging speed profiles.
4. The branch circuit overcurrent protection is based upon 125 % of the equipment rating. The overload protection may be provided by a circuit breaker.
5. Twenty-five feet is the longest output cable length that can be provided on an EVSE based on NEC (Section 625) requirements. A longer cord length gives users operational flexibility at the station but could require the installation of a cable management system to maintain a safe environment free of tripping hazards and to reduce the likelihood of cable damage.
6. An EVSE port provides power to charge only one vehicle at a time even though it may have multiple connectors. The unit that houses EVSE ports is sometimes called a charging post, which can have one or more EVSE ports.
7. EVSE units can feature single or multiple ports. The Tiger Team recommends installing multiple (typically two) port units as far as practicable. The advantage of having dual ports is that the user can potentially charge two EVs at the same time. In which case, the charging station can either share its total power between each of the outputs or it can have dedicated full power for each output, independently of the other outputs.
8. Charging station can be installed indoors or outdoors. In practice, EVSE can usually operate within a range of -25°C to +50°C and within a relative humidity range of 5% to 95%. Nevertheless, different values could be declared by the manufactures.[3]
9. The costs of owning and operating a charging station include equipment, installation, maintenance, and electricity costs. Fueling cost comparisons can be estimated using the eGallon price.[4] The eGallon represents the cost of fueling a vehicle with electricity compared to a similar vehicle that runs on gasoline. The cost estimates in this report are only concerned with the equipment and installation cost.

[3] IEC 61851-1:2017 states the minimum operating conditions for EVSE.
[4] https://www.energy.gov/articles/egallon-what-it-and-why-it-s-important

2.5 Parking Ordinances

Parking ordinances are important tools to manage public enforcement of both public and private property that offer access to EVSE. To manage access to fleet EVSE, GRTE might install official signage, such as those displayed in Figure 5 and Figure 6 that identify a parking space as dedicated for EV charging only. GRTE may also want to consider enforcement action if combustion-engine POVs park in "EV-Only" spots. Reserving parking spaces near EVSE may be of interest to ensure EVs always have access to their primary energy source.

Figure 5. EV parking sign[5]

Figure 6. EV space marker

2.6 Americans With Disabilities Act Considerations

Publicly available EVSE installations require considerations under the Americans with Disabilities Act (ADA) (DOE 2014). The authors could not locate specific Wyoming DC ADA EVSE regulations. However, the state of California (which significantly leads the country in EV adoption) has promulgated regulations with specific requirements for ADA compliance. (California Building Code 11B-812). These requirements include minimum numbers of EVSE (number of ports) required to be ADA accessible based on the total number of EVSE ports in a particular location. The ratios in Table 5 apply to the number of existing publicly available EVSE ports plus new public ports. The California regulations do not apply to fleet EVSE (Clair 2017).

Table 5. Minimum Number of Accessible Charging Ports

Total Number of EVSE at a Facility	Minimum Number (by type of EVSE Required to Comply with Section 11B-812:1 Van Accessible)	Minimum Number (by type of EVSE Required to Comply with Section 11B-812:1 Standard Accessible)	Minimum Number (by type of EVSE Required to Comply with Section 11B-812:1 Ambulatory)
1 to 4	1	0	0
5 to 25	1	1	0
26 to 50	1	1	1
51 to 75	1	2	2
76 to 100	1	3	3
101 and over	1, plus 1 for each 200, or fraction thereof, over 100	3, plus 1 for each 60, or fraction thereof, over 100	3, plus 1 for each 50, or fraction thereof, over 100

[5] Clair, Ida. 2017. https://slidetodoc.com/access-california-new-accessibility-regulations-for-electric-vehicle/.

The California Building Code has specific requirements for the size of the parking spaces designed to serve van accessible, standard accessible, and ambulatory parking spots, as well as signage, access aisles, and accessible routes with clear floor space. The Code does not appear to contemplate ceiling-mounted EVSE, but the authors recommend considering an alternative mounting solution for the ADA-accessible parking spaces such as wall-mounted or pedestal-mounted EVSE.

2.7 Step-Down Transformers

In some circumstances, a building may receive a 480 V 3Φ that is unable to support AC Level 1 or Level 2 EVSE. To provide the voltage needed to charge a vehicle using this service, a step-down transformer must be installed. This will step the voltage down to a voltage more suitable to AC charging; to maximize the power capabilities of a Level 2 EVSE, 240 V is best to supply 7.7 kW off a 40 A circuit. Therefore, in the event a building has a 480-V service, a step-down transformer and service panel must be installed, as displayed in Figure 7.

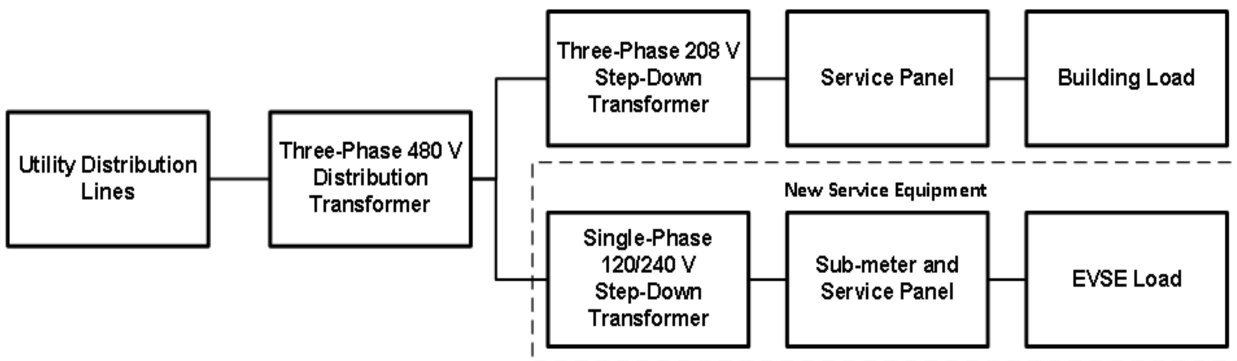

Figure 7. Overview of typical step-down transformer application

2.8 Winter Storage of EVs

Lithium-ion batteries in EVs will suffer degradation over time from the day-to-day operations, but the degradation rate depends on their service life and how they are used. Environmental and functional conditions, such as deep depth of discharge (below 20%) and exposure to cold and hot temperatures for extended periods of time, can accelerate the degradation rate to the point of failure. A study on battery life cycles has found that temperature has a strong influence on the cycle aging rate of lithium-ion batteries. The vulnerability to low temperature decreases battery cycle life due to intensified lithium plating, and high temperatures reduce battery life due to Arrhenius-driven aging reactions[6] (Qian et al. 2010).

While there is no specific information or unique standard practice available from the different vehicle manufactures on how to store a BEV or PHEV for a long period of time, general storage advice is to never allow the battery to fully discharge; therefore, performing partial or full charges on the EV battery will help with premature battery degradation. Vehicle manufacture warranties do not often cover battery replacements as a result of "improper vehicle storage" and will require a battery evaluation to assess its condition if the energy is depleted after sitting idle

[6] Qian et al. 2010. https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5736181&tag=1.

for an extended amount of time without access to EVSE. To optimize the service life of both BEVs and PHEVs, it is best to maintain a battery state of charge between 20% and 80%. This will be particularly important for vehicles that are stored idle for long winter months, as the battery will likely become depleted over this period without regular access to EVSE.

Depending on the vehicle manufacturer, occasional charging sessions can ensure a vehicle maintains a proper battery state of charge and may occur as often as every 2 weeks or as infrequently as every 3 months. Managed charging solutions can be employed with low-power Level 1 EVSE to maintain a consistent battery state of charge without the need for employee interaction. When considering these general guidelines, the Tiger Team recommends building vehicle shelters with Level 1 receptacles in the areas where vehicles are stored for the winter to prevent snow from accumulating around the charge port and support regularly scheduled charging sessions. In addition, before storing the EVs, it is good practice to always ensure that all doors and tailgate are closed fully, interior lights are switched off, and the car is locked.

3 EVSE Installation Planning at Moose Parking Area

The Tiger Team evaluated four different buildings at the Moose General Parking Area, as shown in Table 6.The 12 parking spaces adjacent to the Headquarters building are not adequate to be used for ZEV charging infrastructure due to the existing exterior features of this building (three large garage doors right in front of the parking area). Nevertheless, because there is an existing single port wall-mounted unit at this facility, the Tiger Team recommends upgrading the existing unit to a dual port wall-mounted unit with power sharing features to better utilize the parking available at this building. This will allow the fleet to simultaneously charge two vehicles at this location without the need to upgrade the Headquarters building electrical infrastructure.

The potential to expand the parking area contiguous to the IT building along with the current spare capacity at this building, make this area a great contender for future EVSE installations. The Tiger Team proposes to expand on the double port unit available at the southeast end of the GTA building by planning for the installation of four additional charging ports (two dual-port pedestals) adjacent to the existing EVSE and eight charging ports (four dual-port pedestals) to the south of the I.T building where the former fueling station was located. At the Wastewater Treatment building, the snow plowing practices at this location are driving the type and amount of EVSE installations, thus the Tiger Team recommends the installation of five charging ports (two dual-port pedestals and one wall-mounted unit). Finally, also feeding off the Wastewater Treatment building, an additional eight ports (four dual-port pedestals) would be installed to the northwest of the GTA Building. All these designs are outlined in detail throughout Table 6 with a brief overview of the advantages and drawbacks of each.

The EVSE installations designs depicted in Table 6 will provide enough EVSE to support a majority of GRTE's ZEV acquisition plans throughout the foreseeable future.

Table 6. EVSE Deployment Options at Moose General Parking Area

Design	Description	Advantages	Disadvantages
Headquarter Building	Replace the Level 2 single-port wall-mount unit with a dual port wall-mount unit.	Power sharing features avoid electrical upgrades.	Power sharing features reduce charging power if two vehicles are present.
GTA Building	Four Ports, two Level 2 pedestal units	Proximity to I.T building will minimize extensive trenching cost through concrete	No electrical capacity at main service panel in this building
IT Building	Eight ports, four Level 2 pedestal units	Sufficient electrical capacity at this building	Counting with additional three parking spaces closer the building as part of the parking lot redesign
Wastewater Treatment Plant-Option A	Five Ports, two Level 2 pedestal units, and one wall-mounted unit	Electrical service panel capacity available	Step-down transformer needed
Wastewater Treatment Plant-Option B	Eight Ports, two Level 2 pedestal units	Electrical service panel capacity available	Step-down transformer needed

The electrical considerations for the additional 21 or 26 EVSE units depending on the Wastewater Treatment building option selection are summarized in Table 7 and briefly explained below.

The current main service panel at the GTA building is 600 A 208 Y/120 V but does not have the spare capacity needed to support the addition of four new ports. The IT building existing main service panel (1,200 A 208 Y/120 V) appears to have the electrical capacity needed to support the eight new ports proposed at this facility and the four ports at the GTA building, but it lacks the physical panel space; therefore, a service panel upgrade is recommended at the IT building. Lastly, the Wastewater Treatment building main service panel (800 A 480 Y/277 V) will need a step-down transformer to support the installation of five ports at adjacent parking lot or eight ports at the west of the GTA building, which will also require the installation of a new service panel.

Table 7. Physical and Electrical Capacity for Each Building at Moose General Parking Area

Building	Existing EVSE Ports	Planned New EVSE Ports	Service Panel Main Braker Rating (Amp)	Service Panel Spare Breaker Positions	Considerations
Headquarters	1	1	5,000	10	Existing electrical and physical capacity
GTA	2	4	600	22	Tap into the propose IT building service panel
IT	0	8	1,200	0	Install a new subpanel fed from the IT service panel
Wastewater Treatment-Option A	0	5	800	15*	75-kVA step-down transformer needed
Wastewater Treatment-Option B	0	8	800	15*	75-kVA step-down transformer needed
Total	**3**	**26**			

*PP-1 Panel at Wastewater Treatment Plant

3.1 GTA and IT Building Design

At southeast GTA parking lot install four new Level 2 dual-port pedestal EVSE units (P1 to P2), as shown in Figure 8 and outlined in Table 8. This option also includes the installation of eight additional Level 2 dual-port pedestal EVSE units (P3 to P6) in the adjacent parking lot to the south of the IT building. These additional six EVSE dual port units will be ideally located at the extremities of the 23 curved parking slots connecting these two facilities to accommodate snow removal and storage. P1 to P6 EVSE units should be supported by the 1,200 A 208 Y/120 V service panel at the IT Building, but it will require a service panel upgrade. However, in the event electrical capacity restrictions, each new dual-port EVSE may employ a power sharing feature, which would reduce service panel requirements by sharing one double-pole breaker between two EVSE ports, effectively halving the service panel capacity requirements.

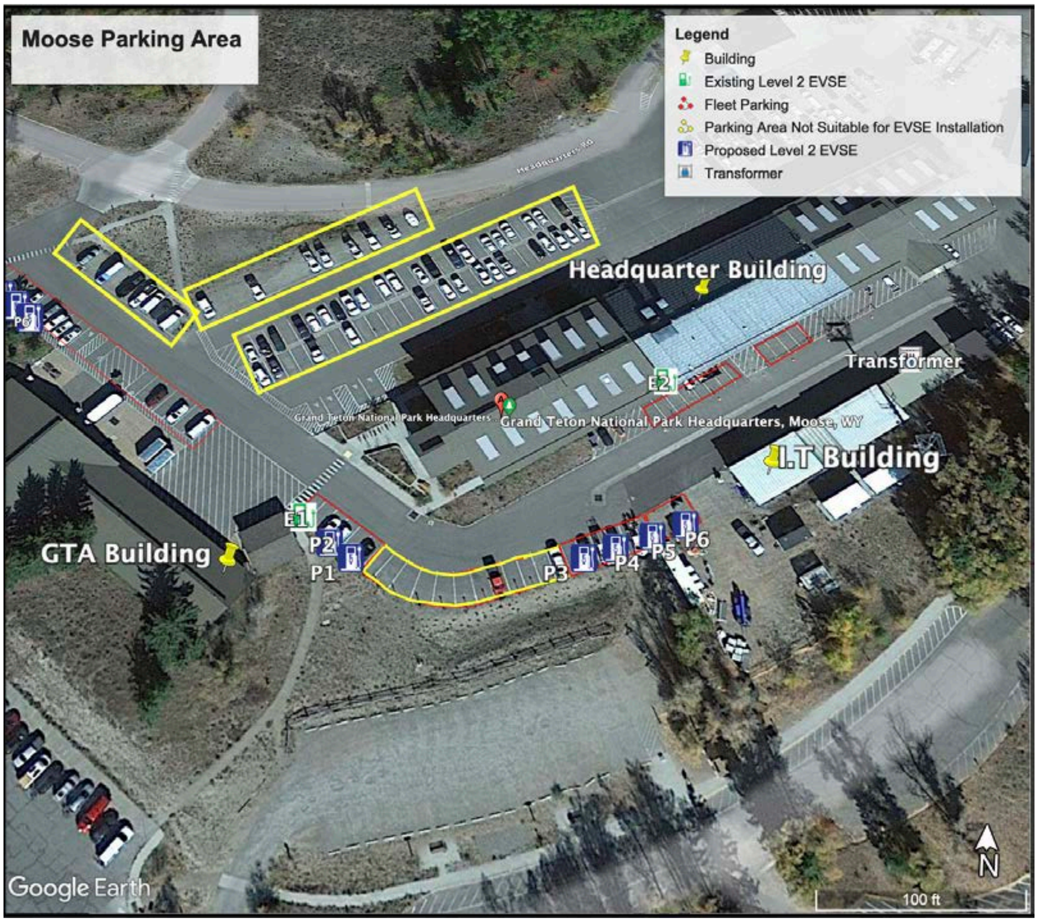

Figure 8. GTA and IT Building EVSE deployment outline

Table 8. GTA and IT Building EVSE Installations

Building	Existing EVSE Ports	Planned New EVSE Ports	Recommendations	Considerations
GTA	2	4	Install four ports Level 2 dual-port pedestal EVSE units	Tap into IT Building Main Service panel
IT	0	8	Install eight port Level 2 dual-port pedestal EVSE units	Install a new subpanel fed from the IT service panel
Total	**2**	**12**	**Upgrade the physical capacity of Main Service Panel in the IT Building, utilizing the power provided by the 208-Y/120-V three-phase transformer.**	

3.1.1 GTA and I.T Building Design Cost Estimate

The NREL EVI-LOCATE tool was used to estimate the cost of each option proposed by the Tiger Team. The total estimated cost for GTA and I.T Building Design includes six dual-port pedestal EVSE units with an installation cost ranging from $146,000 (without contingency) to

$186,000 (with 20% additional as a contingency), including EVSE units, materials, and labor. EVSE units and installation cost make up 73% of the total cost of the project, 27% and 46%, respectively, while 27% is associated with project costs such as permitting and overhead charges. The trenching distances and EVSE unit counts summarized in Table 9.

Table 9. GTA and IT Building Raceway/Trenching Distances

Reference EVSE for Distance	From Electrical Source	Distance (Ft)
P1 (Level 2 Dual Port)	IT Building Main Panel	270
P2 (Level 2 Dual Port)	IT Building Main Panel	290
P3 (Level 2 Dual Port)	IT Building Main Panel	90
P4 (Level 2 Dual Port)	IT Building Main Panel	108
P5 (Level 2 Dual Port)	IT Building Main Panel	90
P6 (Level 2 Dual Port)	IT Building Main Panel	68

3.2 Wastewater Treatment Building Design

The Wastewater Treatment Building is equipped with an 800-A service panel with power provided by the 480-Y/277-V 3Φ transformer; this setup is unable to support AC Level 1 or Level 2 EVSE. To provide the voltage needed to charge a vehicle using this service, a step-down transformer must be installed, as outlined in Section 2.7. This will step the voltage down to a more suitable level for AC charging. To maximize the power capabilities of a Level 2 EVSE, 240 V is best to supply 7.7 kW off a 40-A circuit (32 A delivered to the vehicle). Therefore, a step-down transformer and service panel must be installed. Two different designs were developed for this location, as described in the following sections.

3.2.1 Wastewater Treatment Building Design Cost Estimate: Option A

The need for a step-down transformer, in addition to the snow removal practices at the five parking slots available at the Wastewater Treatment Building impose a greater challenge for EVSE installations at this facility. If GRTE considers the step-down transformer as recommended in Table 10, the Tiger Team recommends to reconsider and most likely redesign the snow removal and storage practice at this location to equip each available parking slot with a charging port, as shown in Figure 9.

The total estimated cost for the Wastewater Treatment Building Design A includes two dual-port pedestal EVSE units and one single-port wall-mounted unit with installation costs ranging from ~$107,000 (without contingency) to $137,000 (with 20% additional as a contingency), including EVSE units, materials, and labor. EVSE units and installation cost make up 73% of the total cost of the project, 14% and 59%, respectively, while 27% is associated with project costs such as permitting and overhead charges. The installation component costs (~$68,000) for this design are higher than the cost of the EVSE units (~$16,000) due to the step-down transformer cost and trenching distance from the main service panel. The trenching distances and EVSE unit counts summarized in Table 11.

Figure 9. Wastewater Treatment Building EVSE deployment outline: Option A

Table 10. Wastewater Treatment EVSE Installations: Option A

Building	Existing EVSE Ports	Planned New EVSE Ports	Recommendations	Considerations
Wastewater Treatment	0	5	Install four ports Level 2 Dual-Port Pedestal EVSE units and one single-port Level 2 wall-mounted unit	Tap into Wastewater Treatment plant main service panel
Total	**0**	**5**	**Install a 75-kVA step-down transformer.**	

Table 11. Wastewater Treatment Raceway/Trenching Distances: Option A

Reference EVSE for Distance	From Electrical Source	Distance (Ft)
W1 (Level 2 Single Port Wall-mounted)	Wastewater Building Main Panel	80
P1 (Level 2 Dual Port)	Wastewater Building Main Panel	145
P2 (Level 2 Dual Port)	Wastewater Building Main Panel	104

3.2.2 Wastewater Treatment Building Design Cost Estimate: Option B

The Tiger Team also proposes to plan on adding four dual-port pedestal EVSE units (P3 to P6), as shown in Figure 10 and depicted in Table 12. These units will be locating to the northwest of the GTA building, but the electric capacity will be provided by the main service panel in the Wastewater Treatment Building. The cost estimate for this option ranges from 133,000 (without contingency) to $157,000 (with 20% additional as a contingency), including EVSE units, materials, and labor. EVSE units and installation costs make up 53% of the total cost of the project, 21% and 52%, respectively, with 27% associated with project costs, such as permitting and overhead charges. The trenching distances and EVSE unit counts are summarized in Table 13.

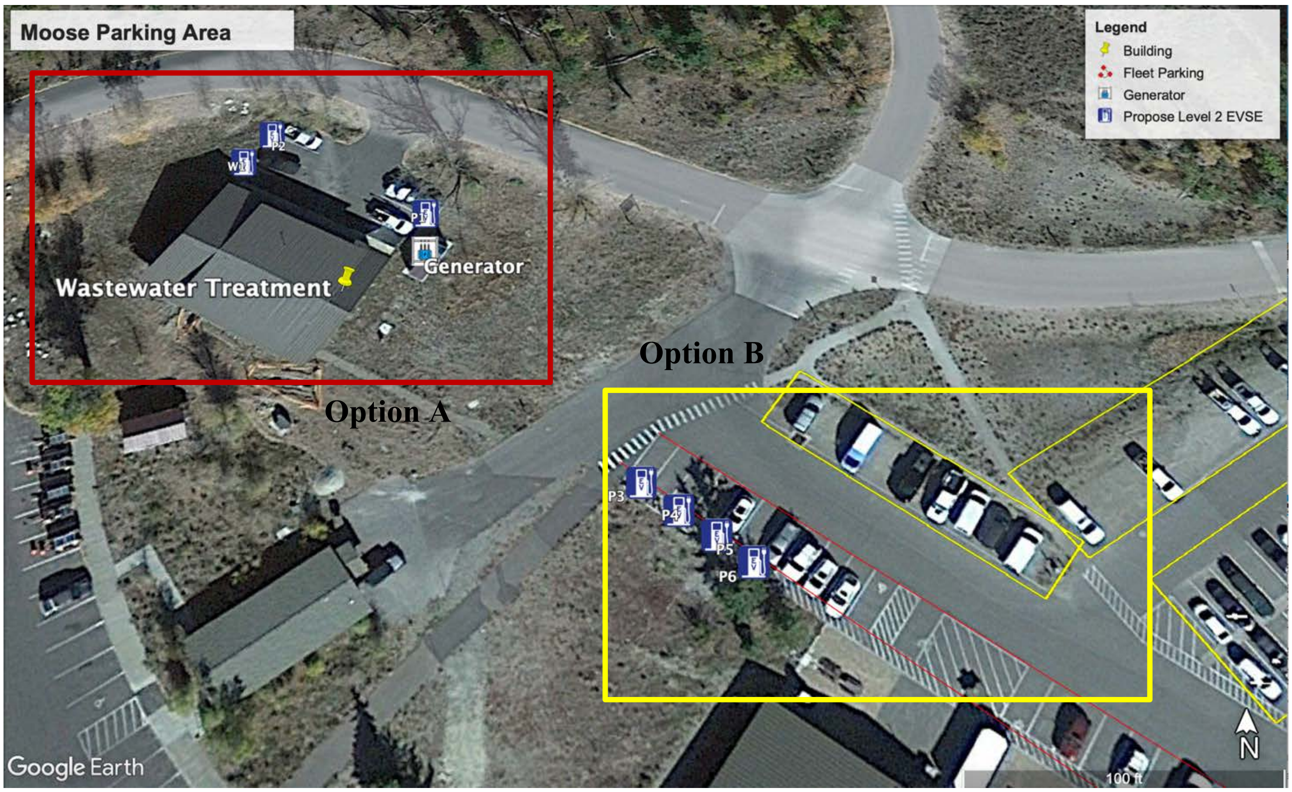

Figure 10. Wastewater Treatment Building EVSE deployment outline: GTA northwest

Table 12. Wastewater Treatment EVSE Installations: Option B

Building	Existing EVSE Ports	Planned New EVSE Ports	Recommendations	Considerations
Wastewater Treatment	0	8	Install four Level 2 dual-port pedestal EVSE units	Tap into Wastewater Treatment Plant main service panel of Wastewater Treatment Plant
Total	**0**	**8**	**Install a 75-kVA step-down transformer**	

Table 13. Wastewater Treatment Raceway/Trenching Distances: Option B

Reference EVSE for Distance	From Electrical Source	Distance (Ft)
P3(Level 2 Dual Port)	Wastewater Building Main Panel	182
P4 (Level 2 Dual Port)	Wastewater Building Main Panel	200
P5 (Level 2 Dual Port)	Wastewater Building Main Panel	215
P6 (Level 2 Dual Port)	Wastewater Building Main Panel	235

4 Tiger Team Recommendations

In conclusion, the Tiger Team sees great opportunity for EVSE deployment at Moose General Parking Area to support GRTE's fleet electrification plans. The minimum EVSE Deployment Plan recommendation is shown in Table 14 with 21 additional EVSE ports. However, GRTE could also consider the installation of the Wastewater Treatment Options A and B combined. The latter option would be adding a total of 26 EVSE ports to the Moose General parking area, as shown in Table 15 for a total of 29 EVSE ports to support the changing needs of 76 planned ZEV acquisitions over the next 5 years and thus maximize the value of planned transformer upgrades.

Table 14. Moose Parking Area Minimum EVSE Deployment Plan Recommended

Site	Existing EVSE Ports	Planned New EVSE Ports	Estimated Cost (Without Contingency)	Estimated Cost (With Contingency)
Headquarters	1	1	$ 1,500*	$ 1,500*
IT and GTA	2	12	$146,000	$ 186,000
Wastewater Treatment: Option B	0	8	$133,000	$ 158,000
Total	3	21	$ 280,000	$ 350,000

*Clipper Creek dual-port Wall Mount HCS-D40 cost from GSA EVSE schedule Spring-2022[7].

Table 15. Moose Parking Area EVSE Deployment Plan Recommended

Site	Existing EVSE Ports	Planned New EVSE Ports	Estimated Cost (Without Contingency)	Estimated Cost (With Contingency)
Headquarters	1	1	$ 1,500*	$ 1,500*
IT and GTA	2	12	$146,000	$ 186,000
Wastewater** Treatment	0	13	$233,000	$ 277,000
Total	3	26	$380,000	$ 465,000

** 112.5 kVA Step-down transformer is needed for a Wastewater Treatment plant Option A and B combined.

4.1 Next Steps

To fully support an electrified fleet, agency locations will require EVSE to support the energy needs of these new vehicles. The plans outlined in this report provide a framework for where and how EVSE could effectively be installed at Moose General Parking Area. Once funding is secured and required environmental compliance is completed, the next steps in this process are for GRTE to reach out to EVSE installers to request quotes for the installations described in

[7] https://www.gsa.gov/buying-selling/products-services/transportation-logistics-services/fleet-management/vehicle-leasing/alternative-fuel-vehicles/electric-vehicle-charging-stations.

Section 3.1. During this time, GRTE should also coordinate these installations with their local utility, facility managers, and building electrification project managers. The FEMP Tiger Team is also available to provide any guidance or technical support throughout this process. Ensuring each of these stakeholders is appropriately engaged throughout the EVSE installation process will ensure the fleet will have robust and reliable EVSE available throughout the fleet electrification process.

Appendix A. GRTE's Full Vehicle Inventory as of February 2022

Table A-1. Grand Teton National Park Vehicle Inventory

Vehicle Ownership	Existing SIN	Existing Vehicle Type	Vehicle Count
Agency-owned	57	LD SUV 4x4	1
Agency-owned	57A	HD	1
Agency-owned	645	HD	1
Agency-owned	99	LD SUV 4x4	5
Agency-owned	NA	HD	20
Agency-owned	NA	LD Minivan 4x2 (Passenger)	1
Agency-owned	NA	LD Minivan 4x4 (Cargo)	1
Agency-owned	NA	LD Pickup 4x2	3
Agency-owned	NA	LD Pickup 4x4	29
Agency-owned	NA	LD SUV 4x2	2
Agency-owned	NA	LD SUV 4x4	36
Agency-owned	NA	LD Van 4x2 (Cargo)	1
Agency-owned	NA	LD Van 4x2 (Passenger)	1
Agency-owned	NA	MD Ambulance	3
Agency-owned	NA	MD Other	1
Agency-owned	NA	MD Pickup	34
Agency-owned	NA	MD Van (Cargo)	1
Agency-owned	NA	MD Van (Passenger)	2
Agency-owned	NA	Sedan/St Wgn Compact	13
Agency-owned	NA	Sedan/St Wgn Midsize	1
Agency-owned	NA	Sedan/St Wgn Subcompact	3
GSA	100	LD SUV 4x2	1
GSA	147	MD Other	1
GSA	46	LD Pickup 4x4	4
GSA	55	LD Pickup 4x4	4
GSA	57	MD PICKUP	3
GSA	67	LD Pickup 4x4	1
GSA	78	MD Other	1
GSA	99	LD SUV 4x4	3