Exhibit G

Materials Analysis

Yellow Rosebush Energy Center
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Prepared for
Yellow Rosebush Energy Center, LLC

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Acronyms and Abbreviations

Applicant	Yellow Rosebush Energy Center, LLC
BESS	battery energy storage system
BPA	Bonneville Power Administration
EPA	U.S. Environmental Protection Agency
Facility	Yellow Rosebush Energy Center
gen-tie	generation-tie
kV	kilovolt
Li-ion	lithium-ion
LF	linear feet
OAR	Oregon Administrative Rules
O&M	operations and maintenance
SPCC	Spill Prevention, Control, and Countermeasures
yd^3	cubic yard

1.0 Introduction

Yellow Rosebush Energy Center, LLC (Applicant) seeks to develop the Yellow Rosebush Energy Center (Facility), a solar energy generation facility, battery energy storage system, and related or supporting facilities in Wasco and Sherman counties, Oregon. This Exhibit G was prepared to meet the submittal requirements in Oregon Administrative Rules (OAR) 345-021-0010(1)(g).

2.0 Materials Inventory – OAR 345-021-0010(1)(g)(A)

OAR 345-021-0010(1)(g) A materials analysis including:

OAR 345-021-0010(1)(g)(A) An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation;

The Applicant is requesting to permit a range of technology in order to preserve permitting flexibility and will stipulate the precise details of photovoltaic solar energy generation and related or supporting facilities during final design and engineering prior to construction. Therefore, this exhibit analyzes the maximum number of materials anticipated within the Facility site boundary to address the maximum anticipated disturbance.

2.1 Construction Materials Inventory

For the Facility, the Applicant will use photovoltaic solar panels composed of mono- or poly-crystalline cells supported on galvanized steel and aluminum components. The panels are inert and will not introduce hazardous materials to the Facility site. Each tracker will be supported by steel piles. Other on-site equipment will include buried conduits, inverters, combiners, and transformers.

Lithium-ion (Li-ion) will be used in the battery energy storage system (BESS). Li-ion batteries are modular systems that contain multiple smaller battery cells. The cells are the primary containment for the gel or liquid electrolyte materials. The module containing the cells is relatively small, generally about the size of a desktop computer processer, and serves as leak-proof secondary containment. Modules are placed in anchored racks within concrete containers. Although leaks from the modules are very unlikely, because a leak will require failure of the individual cells as well as the sealed module, the material that might leak from the cell into the module and then to the floor of the container will easily be contained within the container. The Li-ion batteries will be manufactured offsite and will be shipped to the site as self-enclosed prefabricated modules, which will be installed and electrically connected on-site.

The primary construction materials for the Facility are rock and gravel (aggregate), steel, water, concrete, and assorted electrical equipment. Table G-1 provides an inventory of materials that will be used during Facility construction, based on current engineering estimates. The amount of water required for construction is discussed in Exhibit O. Solid wastes generated and flowing out of the Facility during construction are discussed in greater detail in Exhibit W.

Table G-1. Inventory of Construction Materials

Material	Quantity/Units	Ultimate Disposition
Solar Array		
Solar Panels	Maximum 2,037,360 panels	Throughout each solar panel string
Steel Solar Panel Tracker Piles	346,351 piles, 18,702 tons steel (108 pounds per pile)	Throughout each solar panel string
Solar Panels Per String	5 panels (100 panels per rack, max 20 strings)	Throughout each solar panel string
Inverters/Step-up Transformers	199 (4.4 kilovolt [kV] amps) stations	Aboveground throughout solar array
Battery Energy Storage System		
Battery Components	Li-ion: 51.75 cells per module, 1.33 modules per pack (5,431,680 cells, 104,960 modules, 78,720 packs), typical	BESS
Batteries	Li-ion: 1,220 containers	BESS
Other Typical Construction Materials		
Combiner Boxes	6,800 boxes	Aboveground throughout each solar panel string
Collector Substation Generator Step-up Transformers	Up to 4 generator step-up transformers	Within the fenced collector substation
Collector Lines (34.5 kV)	267.8 miles (underground)	Buried within solar array and between solar array and collector substation
Alternate Generation-tie line (500-kV)	4.5 miles (23,584 linear feet [LF])	Interconnecting the collector substation to the Bonneville Power Administration (BPA) Buckley substation
Alternate Generation-tie line (500-kV) support structures	Up to 24 monopole structures	Aboveground structures
Fencing	50.8 miles (268,418 LF)	Encloses solar array, BESS, collector substation, and O&M building

Aggregate (rock and gravel)		
BESS	28.6 tons (up to 1,220 containers, collocated with the BESS inverter/transformer stations)	On-site graveled area
Inverters/Step-up Transformers	90 tons	On-site graveled area
Access Roads	89,639 tons (24.8 miles of new service road and 2.1 miles of existing road improvements)	On-site graveled area
Collector Substation	97.5 tons	On-site graveled area
Operations & Maintenance (O&M) Building	2,000 tons (Includes graveled area outside of the foundations)	On-site graveled area
Temporary Construction Staging Area	22,000 tons	On-site graveled area
Concrete		
Steel Solar Panel Tracker Piles	10,391 cubic yards (yd^3)	Foundation
BESS	16,750 yd^3	Foundation
Alternate Generation-tie line (500-kV) support structures	2,000 yd^3	Foundation
Inverters/Step-up Transformers	7,270 yd^3	Foundation
Collector Substation	1,600 yd^3	Foundation
O&M Building	200 yd^3	Foundation

2.1.1 Rock and Gravel

Rock and gravel (aggregate) would be used for the construction of new, permanent access roads and improvements to existing roads. Rock and gravel would also be used as ground-surfacing material for the BESS area, around inverter/transformer stations in the solar array, collector substation, the O&M building and enclosure, and temporary construction staging areas. Table G-1 provides the estimated tons of aggregate for each of these purposes.

The gravel placed at the temporary construction staging area will be removed following construction by the construction contractor. The construction contractor will acquire the rock and gravel from existing or new commercial gravel pit sources in Wasco or Sherman County to the extent feasible.

2.1.2 Water and Concrete

Water will be required during construction for dust control, road compaction, concrete mixing, and drinking/sanitation.[1] The amount of water needed for construction will depend on weather conditions during the construction period, as well as the final design of Facility components. Exhibit O provides detail on water quantities, assumptions, and sources.

Concrete will be used to lay foundations for the BESS storage containers, inverter/transformer stations, collector substation, and O&M building (Table G-1). In some soils conditions, concrete backfill may be needed for pile installation. For the purposes of analysis in this ASC approximately 10 percent of piles are estimated to use concrete foundations. Concrete foundations are estimated to use approximately 0.3 cubic yards of concrete per foundation, if needed.

2.1.3 Steel

Steel containers will house each BESS battery module pack. The amount of steel will vary depending on the type and configuration of the battery system. However, this analysis assumes that 1,220 containers will be used, requiring approximately 28.6 tons of steel. The associated quantity of steel is listed in Table G-1. Large quantities of steel will be needed for the solar array, as listed in Table G-1. The estimate is based on the proposed solar array layout using 346,351 steel piles to support the solar panel trackers. Each pile is assumed to have an average length of 12 feet, requiring approximately 108 pounds of steel per pile.

2.1.4 Other Typical Construction Materials

A variety of materials other than the ones previously described will be brought on-site to construct the solar array, BESS, and related or supporting components (Table G-1). Electrical cable and combiner boxes will be used to connect the solar strings within the array and to the collector substation. The Facility will include 267.8 miles of underground 34.5-kV collector line. The solar array will be constructed from prefabricated solar panels composed of mono- or poly- crystalline cells supported on non-specular, galvanized steel racks. Depending on the battery technology selected, additional elements associated with the BESS will include fire-suppression systems, battery containers, racks, and the batteries themselves. If the alternate point of interconnect is used, the Facility will include approximately 4.5 miles of new up to 500-kV generation-tie (gen-tie) line from the proposed collector substation to the existing Bonneville Power Administration (BPA)

[1] Other dust suppressants besides water may be used as necessary during extreme drought conditions (synthetic polymer emulsions, chemical suppressants, organic glues, and wood fiber materials).

Buckley Substation. The alternate gen-tie line will be aboveground (see Exhibit B for example support structures). The solar array will include up to 199 inverter and transformer stations, which will be placed together on the same slab of concrete. Chain-link or fixed-knot (wildlife-friendly) fencing will be used to enclose the solar arrays, collector substation, BESS and O&M building (see Exhibit C, Figure C-2).

2.2 Operational Materials Inventory

Materials used during Facility operations are variable and dependent upon the maintenance or repair events that occur during the life of the Facility. Major replacement or repair events are possible during the life of the Facility; however, since the cause and extent of these types of potential events are unknown, no estimates have been provided for the number of major components that would be needed. Minor maintenance may also require the replacement and removal of smaller components, which are not expected to constitute substantial amounts of industrial materials.

Table G-2 provides an inventory of industrial materials that will be used in substantial quantity during operation of proposed Facility elements.

Table G-2. Materials Inventory for Operations

Material	Quantity/Units	Ultimate Disposition
Spare solar panels	200 solar panels	Stored at the O&M building or within conex containers to be dispersed throughout the fenced solar array.
Batteries	3 Li-ion battery modules	Disposed of at approved facility.
Transformer oil	Generation step-up transformers. Inverter step-up transformers. (Oil quantity for each transformer type will be determined prior to Facility operations once final equipment is selected.)	Within transformer boxes for cooling. (No extra oil will be stored outside of transformers. Additional oil only required due to failure and provided on an as-needed basis.)
Herbicide (such as Round-up and 2,4-D)	5 gallons for spot weed control; total used for weed control per year will be determined prior to operations by a weed control contractor.	Up to 5 gallons stored in the O&M building.

2.2.1 Solar Array and Collector Substation

Aside from small quantities of spare solar panels, no substantial quantities of industrial materials will be brought onto, stored, or removed from the Facility site during operations. The materials that will be brought onto or removed from the site will relate to maintenance or replacement of damaged equipment (e.g., spare solar panels and related components, electrical equipment). Besides spare solar panels, the materials replaced and removed will not constitute significant amounts. It is estimated that a total of approximately 10,000 spare solar panels will be replaced during operations and ultimately recycled with applicable recycling and removal methods dispersed throughout the site boundary; this assumes a 0.01 percent breakage of panels per year (200 panels per year) during the 40-year Facility lifespan. Table G-2 includes materials and amounts of transformer oil that will be used during operation of the transformers for the solar array and collector substation.

Although the need to conduct solar panel washing is not anticipated, analysis in Exhibit O incorporates water use in Facility operations for periodic solar panel washing, if needed. The potential for solar panel washing will be dependent on weather conditions. For example, during drought conditions when there is more dust, the panels may need washing. However, the panels will not all be cleaned at the same time, but rather in segments, or targeted to underperforming panels to minimize the need for large quantities of water at one time. Analysis in Exhibit O conservatively assumed that the solar array panels will be washed once a year. At an estimated 0.26 gallon (1 liter) per panel for a total of 2,037,360 panels, washing will use approximately 521,000 gallons (gal) per year. Water will be applied either via robotic panel cleaners or watering hose and will not contain cleaning solvents. Washwater will be discharged by evaporation and seepage into the ground. See Exhibit O for further information.

2.2.2 Battery Energy Storage System

The types and quantities of industrial materials used during operation of the BESS are listed in Table G-2. A Li-ion system will require periodic replacement of the batteries as they degrade over time and will be replenished at a rate depending on usage. For example, a battery that is cycled more often will degrade faster than one that is used less often. For this analysis, it is assumed that the battery will be fully discharged each day and it is assumed that 4.2 battery racks per MW will be replaced every 40 years over the life of the Facility (40 years). This assumption likely overestimates the number of batteries that will be replaced at the Facility, because not all batteries will be replaced during each replenishment cycle (e.g., fewer batteries will need replacing early in the Facility lifecycle). A group of Li-ion battery cells will comprise a "rack." Because approximately 9,760 battery racks will be needed for the proposed 800-MW storage system, 13,120 battery racks will be used over operation term of the battery energy storage system.

Li-ion battery systems typically are air cooled, and do not have a liquid component. However, some Li-ion battery systems are liquid cooled, such as the Tesla Powerpack, which uses coolant similar to automotive antifreeze. The coolant, if used, is recirculated through a closed system to cool the batteries.

3.0 Hazardous Materials Handling and Management – OAR 345-021-0010(1)(g)(B)

OAR 345-021-0010(1)(g)(B) The applicant's plans to manage hazardous substances during construction and operation, including measures to prevent and contain spills; and

Potentially hazardous substances used during Facility construction and operations will be used in a manner that is protective of human health, protective of the environment, and that complies with applicable local, state, and federal environmental laws and regulations. If a potentially hazardous substance is necessary for use during Facility construction or operations, Safety Data Sheets will be made available and located at the construction staging area or the relevant Facility component. Extremely hazardous substances in excess of threshold planning quantities, highly toxic substances, or explosive materials will not be necessary to support Facility construction or operations. Materials used during Facility construction and operations will be selected so that they minimize the potential for producing "hazardous waste," as defined by the Resource Conservation and Recovery Act. Accidental releases of hazardous materials will be prevented or minimized through proper containment of these substances during use and transportation to the Facility site in accordance with the Spill Prevention, Control, and Countermeasures (SPCC) Plan.

3.1 Construction Materials

Potentially hazardous materials used for construction include paint, unused solvents, and spent vehicle and equipment fluids and components (e.g., used oil, used hydraulic fluids, spent fluids, oily rags, and spent lead-acid or nickel-cadmium batteries). During construction, on-site fuel storage may be placed in designated areas within the temporary construction staging areas. Secondary containment and refueling procedures for on-site fuel storage will follow the contractor's SPCC Plan.

Applicable local, state, and federal environmental laws and regulations will be followed for managing hazardous materials in a manner that is protective of human health and the environment. As will be described in the SPCC Plan, accidental releases of hazardous materials will be prevented or minimized through proper containment of these substances during use and transportation to the Facility site. Potentially hazardous substances will not be permanently present within the construction areas in quantities that exceed Oregon State Fire Marshal Reportable Quantities.[2]

Fuels will be the only hazardous material that may be stored in substantial quantities on-site during construction. The Applicant anticipates that diesel fuel and gasoline may be kept on-site for fueling of construction equipment and will be stored in temporary aboveground tanks in the construction

[2] "Reportable quantity" refers to the amount of hazardous substance that has to be released into the environment before the U.S. Environmental Protection Agency requires notification of the release to the National Response Center pursuant to the Comprehensive Environmental Release, Compensation, and Liability Act, also known as Superfund. These numerical designations are listed under 49 Code of Federal Regulations 172.101 Appendix A, Table 1 and Table 2.

staging areas, within an area that provides for secondary containment. Secondary containment and refueling procedures for on-site fuel storage will follow the contractor's SPCC Plan. Secondary containment will be compliant with requirements in 40 Code of Federal Regulations §112.7(c), which requires secondary containment for aboveground, buried, and partially buried containers. It is anticipated that the majority of fuel containers will have self-contained secondary containment (e.g., double-walled containers) that provide capacity for the entire container plus precipitation, but in some cases smaller containers (e.g., drums) will be placed in a constructed secondary containment area that is impervious and is diked or otherwise contained to provide the required fuel and precipitation capacity. Fuel for construction equipment will be delivered to the site via a specialized mobile vehicle by a licensed service contractor on an as-needed basis. Following the completion of fueling activities, these vehicles will not remain on-site longer than necessary to complete their fueling tasks. Construction-based equipment will be regularly inspected to detect potential leaks or other issues that may require maintenance. Potentially hazardous substances related to the maintenance of the construction equipment will only be brought to the construction site by a maintenance technician on an as-needed basis, and unused or waste substances will be removed during the same service call. Refueling will take place a substantial distance from waterways or wetlands to prevent water quality impacts in the event of an accidental release.

In the unlikely event of an accidental hazardous materials release, the spill or release will be cleaned up and the contaminated soil or other materials impacted by the spill will be disposed of and treated according to applicable regulations as described in the SPCC Plan. Spill kits with absorbents, absorbent pads, spill socks, and disposable bags will be maintained in close proximity to construction activities, as specified in the contractor's SPCC Plan. The Oregon Emergency Management Division's Oregon Emergency Response System will be immediately notified of reportable spills per OAR Chapter 340 Division 142. See Exhibit CC for a list of applicable regulations.

3.2 Operational Materials

Internal battery components within the BESS may include hazardous substances; however, batteries are considered non-hazardous equipment when used according to the recommendations of the manufacturer and as long as their integrity is maintained (i.e., not damaged and internal seal is intact). Li-ion batteries present a flammability hazard and require cooling systems to prevent overheating. The BESS will have integrated safety systems that monitor battery performance to detect malfunctions and implement response measures. These monitoring systems include notifying operators of failures, depowering the system, or deploying fire suppression devices. O&M staff will also conduct inspections of the battery cells for damage on a regular basis. Batteries will be housed in leak-proof containers to prevent inadvertent releases of hazardous materials. The U.S. Environmental Protection Agency (EPA) does not consider Li-ion batteries hazardous waste. The EPA provides optional guidelines (EPA's Universal Waste Regulations) that address the responsible disposal and recycling of these batteries.

The O&M building will store small quantities of lubricants, degreasers, herbicides, and other chemicals in a manner consistent with the label instructions. No underground storage tanks will be installed within the O&M enclosure or within the Facility site boundary. No extremely hazardous materials (as defined by 40 Code of Federal Regulations 355) are anticipated to be produced, used, stored, transported, or disposed of at this Facility during operation.

In the unlikely event of an accidental hazardous materials release, the spill or release will be cleaned up and the contaminated soil or other materials disposed of and treated according to applicable regulations. See Exhibit CC for a list of applicable regulations. The Applicant will have an operations SPCC Plan to detail appropriate response measures. The Applicant will report spills or releases of hazardous materials during operation as noted above to the Oregon Emergency Management Division's Oregon Emergency Response System per reporting requirements detailed in OAR Chapter 340 Division 142.

For the replacement of batteries during operation, the Applicant will follow the handling guidelines of 49 Code of Federal Regulations 173.185 – Department of Transportation Pipeline and Hazardous Material Administration related to the shipment of lithium-ion batteries. The regulations include requirements for prevention of a dangerous evolution of heat, prevention of short circuits, and prevention of damage to the terminals. They also require that no battery will come into contact with other batteries or conductive materials. Licensed third-party battery suppliers will be responsible for transporting batteries to and from the Facility in accordance with applicable regulations. Spent batteries will be disposed of at a facility permitted to handle them in compliance with applicable Resource Conservation and Recovery Act and Toxic Substances Control Act regulations administered by the EPA or Oregon Department of Environmental Quality.

Adherence to the requirements and regulations (including personnel training, safe interim storage, and segregation from other potential waste streams) will minimize safety hazards related to transport, use, or disposal of batteries.

4.0 Non-Hazardous Waste Management – OAR 345-021-0010(1)(g)(C)

> *OAR 345-021-0010(1)(g)(C) The applicant's plans to manage non-hazardous waste materials during construction and operation.*

4.1 Construction Materials

Non-hazardous waste materials generated during Facility construction are described in Exhibit W and may include items such as scrap steel, wood, concrete, excavated soil, and packaging material waste. Construction will not require the use of specialized structures, systems, or equipment for waste management or disposal. Standard 30-cubic-yard roll-off dumpsters for construction waste will be kept on-site to keep construction debris until it is hauled off-site by a licensed waste hauler (see Exhibit U for waste service provider information). Excess excavated soil material will be used to restore ground contours after construction, and to provide fill on-site or be transported off-site for disposal.

Packaging waste (such as paper and cardboard) and refuse will be separated, accumulated in dumpsters, and periodically removed for recycling or disposal at the Wasco County Landfill (see Exhibit U). Portable toilets will be provided for on-site sewage handling during construction and will be pumped and cleaned regularly by the construction contractor. Construction stormwater will be generated at the location of the solar array and BESS construction sites. Such stormwater will be covered under the Facility's National Pollutant Discharge Elimination System 1200-C construction permit and its associated Erosion and Sediment Control Plan.

The only material that has the potential to be disposed of on-site is waste concrete generated during construction. Waste concrete will consist of concrete solids contained in the concrete chute washout water. Washdown methods will be determined by the contractor and may occur at contractor-owned batch plants or a designated concrete washout. Excess concrete will be incorporated into the foundation, rather than disposal of the material. There will be no disposal of hardened waste concrete on-site other than as described here. Portable toilets will be provided for on-site sewage handling during construction and will be pumped and cleaned regularly by the construction contractor.

4.2 Operational Materials

During Facility operations solid waste generation will be minimal. Operations staff maintaining the solar array and BESS will rely on the O&M building for sanitation. Administrative activities related to the solar array and battery storage system will be conducted at the O&M building. Damaged equipment and other solid waste will be collected by the maintenance crews, removed, and transported off-site to facilities such as the Wasco County Landfill that handle the disposal or recycling of these items. Operations waste will be handled according to the Wasco County Solid Waste Collection and Disposal Ordinances. Sewage from the O&M building will be disposed of on-site with a septic system.

If solar panel washing occurs, the limited quantity of washwater will evaporate or will infiltrate into the ground near the point of use (see Exhibit W). No additional industrial wastewater streams will be generated at the solar array.

5.0 Submittal Requirements and Approval Standards

5.1 Submittal Requirements

Table G-3. Submittal Requirements Matrix

Requirement	Location
OAR 345-021-0010(1)(f) A materials analysis including:	-
(A) An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation;	Section 2.0
(B) The applicant's plans to manage hazardous substances during construction and operation, including measures to prevent and contain spills; and	Section 3.0
(C) The applicant's plans to manage non-hazardous waste materials during construction and operation.	Section 4.0

5.2 Approval Standards

OAR 345 Division 22 does not provide an approval standard specific to Exhibit G.

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