Exhibit No. 121
Issues: Pre-Construction, Construction, and
Post-Construction Process
Witness: Thomas F. Shiflett
Type: Direct Testimony
Sponsoring Party: Grain Belt Express
Clean Line LLC
Case No.: EA-2016-0358
Date Testimony Prepared: August 30, 2016

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. EA-2016-0358

DIRECT TESTIMONY OF

THOMAS F. SHIFLETT

ON BEHALF OF

GRAIN BELT EXPRESS CLEAN LINE LLC

August 30, 2016

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I. WITNESS INTRODUCTION AND PURPOSE OF TESTIMONY

Q. Please state your name, present position and business address.

A. My name is Thomas F. Shiflett. I am the Executive Vice President, Electric Power Division for Quanta Services, Inc. ("Quanta"). My business address is 4770 N. Belleview Avenue, Suite 300 Kansas City, Missouri 64116-2188.

Q. Please describe your education and professional background.

A. I attended Southwest Missouri State University (Missouri State University) where I received my Bachelor of Science in Political Science and Psychology in 1975. I then attended the University of Central Missouri where I received my Master of Science in Industrial Safety in 1980.

Upon graduation from Central Missouri, I went to work at Iowa Power and Light ("MidAmerican Energy") in the position of Safety Specialist, reporting to the Corporate Safety Director. In this position I was responsible for promoting the general safety for all field forces of Electric Generation, Transmission and Distribution as well Natural Gas Transmission and Distribution, and the general public.

In 1983, I was promoted to the Position of Corporate Safety Director.

In 1985, I entered direct field operations by taking the position of Area Operations Supervisor, Colfax District. Then in 1988 I was promoted to the Position of Des Moines Service Center Manager with responsibility for operating and maintaining the Des Moines Electric System.

In 1991, I went to work for PAR Electrical Contractors Inc. ("PAR Electric") as their Northern Division Manager, headquartered in Des Moines, Iowa. I was responsible for all business in the upper Midwest and Western portions of the U.S. I estimated all work coming into the office which entails breaking the project down into estimated labor and equipment hours, developing an associated bill of materials and preparing bidding and subcontract documents for any work not self- performed. This analysis was then used to develop our overall proposal and bid. On projects awarded I managed all work within the region, including engineering, procurement, and construction of numerous large electric transmission and distribution capital projects. Additionally, I was involved in emergency restoration work throughout the United States.

In 1997, PAR Electric expanded its operations to the West Coast, and I became the Vice President, Western Division, headquartered in San Diego, CA. Concurrent with this move was the formation of Quanta Services. With PAR Electric as its founding member, Quanta Services created an integrated, comprehensive nationwide network of infrastructure contractors to meet the evolving needs of electric utility, gas and pipeline companies. While each Company within the Quanta family retains its operating identity, it also has access to a host of resources Quanta provides including training, procurement, engineering and expanded equipment and labor resources.

During my tenure as PAR Electric's Vice President, Western Division, PAR Electric grew into the largest electrical contractor in the western states, performing many large transmission projects primarily for San Diego Gas and Electric, Southern California Edison, Pacific Gas and Electric, Nevada Power and Arizona Public Service. In 1999 I was promoted to COO of PAR Electric, and transferred to PAR Electric's corporate office in Kansas City, Missouri. During this period, through both organic growth and Quanta acquisitions, which were tucked into PAR Electric, PAR Electric become the largest electric utility infrastructure contractor in the United States. In 2003 I became President of PAR Electric. During my tenure, PAR Electric has constructed the majority of major electric transmission projects to date in the United States. In 2013, I moved from PAR Electric to Quanta Services to take the position of Executive Vice President, Electric Power Division. A copy of my CV is attached as **Schedule TFS-1**.

Q. What are your duties and responsibilities as Executive Vice President, Electric Power Division for Quanta?

A. I initially had overall responsibility for all U.S. Electric Operating Companies for Quanta Services. These Companies included Allteck Construction, Computapole, Crux Subsurface, Inc, EHV Power, IRBY Construction, J.W. Didado, Longfellow Drilling, MJ Electric, PAR Electric, Probst Electric, Service Electric Company, Dillard Smith Company, Summit Line Construction, Sumter Utilities, Inc. Utilimap Corporation and Winco Powerline Services. These Companies employ over 6,000 craft professionals and work throughout the U.S. and Canada. My responsibilities included budget preparation, proposal development, bid review, engineering review, project management development, training, business development, and overall profit and loss responsibility.

In March of 2015 I semi-retired from Quanta but retained my title and continue to assist the operating companies listed above as well as additional Quanta Companies including: BWI Powerline Excavation, Btink Constructors, Canfer, Dacon, Dashiell Corporation, Hargrave Power, JCR Construction Company, North Houston Pole Line, Northstar, Potelco Inc., Quanta Energized Services and Valard Construction. My services include bid preparation, project review, technical assistance and safety on an as-needed basis.

Q. Do you have experience in engineering, construction and project management of high voltage electric transmission line?

A. Yes. PAR Electric has constructed the majority of major electric transmission projects to date in the U.S. A small sampling of projects PAR Electric has performed and that I was directly involved in include:

- American Electric Power's Jackson Ferry to Wyoming Junction 765kV Project
- American Transmission Company's GCMW 345kV Project
- Arizona Public Services Panda and Southwest Valley 500kV Project
- Bonneville Power Administration's Schultz to Wautona 500kV Project
- Kansas City Power and Light's LaCygne to Stillwell 345kV Energized Reconductor Project
- Nevada Power's Alturas to Reno 345kV Project
- San Diego Gas and Electric's Sunrise Power Link 500kV Project
- Allegheny Energy's TrAIL 500kV Project
- Southern California Edison's 500 kV Tehachapi Renewable Transmission Project.

Q. What responsibilities do you have on behalf of Quanta with respect to the Grain Belt Express Clean Line transmission project ("Grain Belt Express Project" or "Project")?

A. I am responsible for providing guidance on design, constructability, procurement, labor and equipment resources, budget preparation, property owner relations, schedule development, project management and controls, environmental mitigation, project labor agreements, subcontractor management and resource sharing.

Q. What is the purpose of your testimony in this docket?

A. I am testifying on behalf of Grain Belt Express Clean Line LLC ("Grain Belt Express"), and the purpose of my testimony is to describe the pre-construction, construction, and post construction process for completion of the Grain Belt Express Project. I also discuss economic impacts in terms of construction personnel and the various sub-contractors and vendors involved in the Project.

Q. Have you previously testified before any regulatory commissions?

A. Yes, I gave testimony to the Missouri Public Service Commission in 2004 regarding the South Harper power plant on behalf of Utilicorp. My testimony covered the impact of associated transmission lines.

II. PAR ELECTRIC AND QUANTA RELATIONSHIP WITH GRAIN BELT EXPRESS

Q. What is PAR Electric's role in the Grain Belt Express Project?

A. PAR Electric is an affiliate of Quanta. Grain Belt Express and Quanta have signed an HVDC Transmission Development Agreement. This Agreement commits each party to work towards an Engineering, Procurement and Construction ("EPC") contract and, in the course of doing so, commits Quanta to providing support for permitting, regulatory, construction planning and procurement strategy efforts. Quanta has specified that its affiliate, PAR Electric, will lead these efforts as primary contractor.

III. PAR ELECTRIC AND QUANTA QUALIFICATIONS AND EXPERIENCE

Q. What is the business of PAR Electric?

A. Founded in 1954, PAR Electric, a Missouri Corporation, is the largest outside electrical contracting company in North America. Based in Kansas City, Missouri, PAR Electric has permanent offices across the nation as well as temporary offices near its work sites. At any given time PAR Electric has over 3,000 employees and over 10,000 pieces of equipment.

PAR Electric is affiliated with the National Electrical Contractors Association ("NECA") and all of its physical workforce are members of the International Brotherhood of Electrical Workers ("IBEW").

The installation of foundations, lattice steel, tubular steel, wood pole structures, conductor and fiber optic ground wire and cables is PAR Electric's core expertise. PAR Electric owns more than 5,000 pieces of specialized transmission line construction equipment, the largest fleet in the nation. PAR Electric also has equipment that is easily transported to remote sites for foundation installation, tower erection and wire stringing.

PAR Electric has constructed all sizes and types of transmission lines – from 765kV six bundle, guyed V steel towers to 69 kV lines. PAR Electric and its Energized Services Group specialize in performing work on energized circuits up to 765kV, including energized reconductoring.

PAR Electric has completed substations of up to 500kV from site preparation through energization. PAR Electric is skilled at control wiring, equipment testing, bus welding and other facets of substation work. They have performed design/build turnkey projects up to 500kV. PAR Electric typically completes over 50 substation projects in a year. PAR Electric has the engineers, project managers and field personnel to complete any substation project.

Since 1954, PAR Electric has applied its fully-integrated EPC skills to its distribution work. PAR Electric performs both new plant installation and Underground Residential Distribution cable replacement on a scale unmatched by any other US contractor. Our method of installation includes trenching, cable plowing and directional boring. PAR Electric has extensive experience in the installation of all "dry utilities" on new plant development. This work includes complete installation of not only electric distribution facilities, but also of natural gas, telecommunications (including fiber optic cable), and cable television facilities in a shared trench.

PAR Electric offers fully integrated planning, engineering, design, and technical services. They deliver all types of electrical solutions to the most challenging projects in the industry. PAR Electric provides the following engineering, planning and design services:

- Generation Engineering
- Transmission Systems
- Substations/Switching Stations
- Distribution Design
- Communications
- Utility Outsourcing
- Project Management
- Construction Management
- Technical Services
- Emergency Response

The following are wholly owned DBA subsidiaries of PAR Electric, operating under the following names:

- **Crux Subsurface, Inc.** – Crux is headquartered in Spokane Valley, Washington and is a foundation EPC contractor with more than 10 years of experience designing and constructing specialty foundations for transmission structures. Utilizing patented designs and custom equipment, Crux has provided solutions to some of the most logistically challenging alignments in North America.

- **Longfellow Drilling** – Longfellow Drilling is headquartered in Clearfield, Iowa and is a specialty contractor in the installation of drilled pier foundation for a diversified customer base throughout the U.S.
- **Winco Powerline Services** – Winco offers helicopter assisted services for traditional electric maintenance and construction. Projects with limited access due to terrain or environmental concerns as well as those on aggressive schedules have benefited from Winco's aerial capabilities.

Q. What experience does PAR Electric have in constructing and project managing large, high-voltage transmission projects?

A. Since its founding in 1954, PAR Electric has been engaged in the business of constructing large transmission line projects. PAR Electric has constructed transmission projects on a design build Engineer, Procure, Construct basis; Engineer, Construct; and Construct only basis. PAR Electric has worked in every state within U.S. in the most challenging weather, terrain, and environmental conditions. PAR Electric has performed complete 500kV helicopter only access projects and 765kV projects in the Appalachian Mountains.

Attached as **Schedule TFS-2** is a representative project list which illustrates the experience and capabilities PAR Electric possesses in the electric transmission space. In addition, throughout its 60-plus-year history, PAR Electric has never failed to bring a project in on schedule and has never been assessed liquidated damages.

Q. How do Quanta and PAR Electric propose to manage construction of the Grain Belt Express Project?

A. Quanta and PAR Electric will assemble a proficient management team to properly execute an EPC project of this magnitude. Key positions in the management team will include, but are not limited to, Project Managers, Superintendents, Project Controls, Safety Managers, Material Managers, Quality Managers, Environmental Managers, Right-Of-Way ("ROW") Managers, Land Liaison Managers, and Community Relations. A proposed organizational structure is attached as **Schedule TFS-3**.

The management team's responsibility is to deliver a successful project on time, within budget, at the highest quality, while upholding safety and minimizing environmental and other impacts to land. Quanta and PAR Electric also recognize that a successful project cannot be achieved without the input of the local communities and land owners. Quanta and PAR Electric will engage local communities prior to the start of any construction by, for example, holding project awareness meetings at local facilities to allow the public and the EPC contractor to meet. These meetings will serve several purposes, including: (i) communicating to the public the details of the construction activities, sequencing, and proposed schedules; and (ii) affording Quanta and PAR Electric the opportunity to learn about local suppliers and service providers in the area that may be utilized on the Project. Quanta and PAR Electric have committed to Grain Belt Express to seek to maximize the use of local contractors and suppliers where practical.

Q. Please outline the anticipated sequence of design and construction activities for the Grain Belt Express Project.

A. The design process will consist of a series of engineering activities that will result in an Issue for Bid ("IFB") type of construction package, which allows for detailed construction pricing and planning. The engineering for the IFB package is usually 90% complete.

During this design phase, it is typical for the following items, some of which have already occurred on the Grain Belt Project, to be completed:

- Develop design basis memorandum;
- Perform "Laser Illuminated Detection And Ranging" or "LiDAR," which is used to accurately measure heights, elevations, and other geographic coordinates;
- Complete geotechnical investigation;
- Perform conductor selection study;
- Perform structure type evaluation;
- Develop structure family performance drawings for loading and clearances;
- Develop hardware assembly details;
- Perform detailed structure spotting and line design;
- Develop structure framing drawings and details;
- Generate plans and profiles and staking sheets for pricing;
- Develop foundations designs;
- Develop permit matrix; and
- Develop Landowner Obligations Report, which will list all of the landowner parcels with the owner's names, contact information, and any special provisions that have been agreed to between the transmission line owner and landowners, as described further in the Direct Testimony of Company witness Deann Lanz.

The design is typically completed at the time the Issue for Construction ("IFC") package is completed, which is typically done just prior to the start of construction. The items in this package typically include:

- Final boundary survey;

- Final environmental impact studies;
- Final structure locations (subject to possible relocation to avoid conflicts with drainage tiles);
- Final alignment; and
- Overall completion of design package.

During the period between design and the start of construction activities, the following activities are anticipated to be completed:

- Final project planning;
- Complete assembly of project team members;
- Establish material yards and project segment headquarters;
- Construct material yards and segment headquarters;
- Material procurement;
- Communicate access plan with ROW team members;
- Communicate ROW specifications, environmental regulations/controls, and Landowner Obligations to the Land Liaison Manager and ROW team members;
- Develop project-specific safety and environmental orientation material;
- Establish contacts and communication with local governments, county commissioners, Missouri Department of Transportation, and other relevant governmental units;
- Begin receiving materials for construction; and
- ROW boundary surveying.

The start of construction will begin with a project kick-off meeting with all major parties involved. PAR Electric anticipates commencing construction of the line in more than one location along the route and working in sequential order from those starting points. The typical construction sequence is as follows:

- Surveying;
- ROW access / clearing;
- Installation of foundations;
- Hauling / spotting structure to structure locations;
- Assembling structures;
- Erecting structures;
- Electrically grounding structures;
- Pulling in sock line using a helicopter;
- Stringing, splicing, and sagging conductors;
- Permanently attaching conductors; and
- Restoring ROW to original condition.

More detail about construction activities, crew sizing, and equipment usage can be found in the Grain Belt Express Construction Plan, attached as **Schedule TFS-4**.

IV. GRAIN BELT EXPRESS JOBS IMPACT ON MISSOURI

Q. What presence does PAR Electric have in Missouri?

A. PAR Electric is headquartered in Kansas City, Missouri and is a Missouri Corporation. In addition to its corporate headquarters, PAR Electric's main equipment and fabrication facility is also located in Kansas City as well as additional offices in Blue Springs, Clinton and two St. Louis locations. Members of PAR Electric's management team serve on the NECA/IBEW Joint Apprenticeship Committee both nationally and locally where we work closely with IBEW Local Unions 53 in Kansas City and Local Union 2 in St. Louis.

PAR Electric has formed close alliances with fellow Missouri sub-contractors, suppliers and engineering firms. The majority of our equipment is purchased from Missouri suppliers.

The overwhelming majority of employees PAR Electric would utilize for construction of the Grain Belt Express Project are Missouri residents.

Q. Does PAR Electric have experience working with other Missouri companies participating in the Grain Belt Express Project?

A. Yes, PAR Electric has experience working with Hubbell Power Systems, ABB, and General Cable. Each are industry leaders in the electric infrastructure industry and have all delivered equipment to numerous PAR projects.

Q. What actions are Quanta and PAR Electric taking to establish the supply chain for the Grain Belt Express Project?

A. For major materials and components, Quanta and PAR Electric are currently seeking out suppliers that have operations or supporting operations in the areas of this line route or within close proximity. As Grain Belt Express witness Wayne Galli discusses, Grain Belt Express has already identified preferred suppliers for several important components, including conductor, insulators, and collector system transformers. Quanta and PAR Electric will also seek out local companies that can provide services and miscellaneous materials to support the overall construction. Prior to the start of construction, Quanta and PAR Electric will develop a utilization plan and update it monthly to document the utilization of local resources, services, and suppliers.

V. EMERGENCY RESPONSE AND RESTORATION

Q. Do Quanta and PAR Electric have experience performing emergency response and restoration work on high-voltage transmission lines?

A. Yes. For over 60 years PAR Electric has performed the majority of emergency restoration for virtually all of the Missouri electric utilities. PAR Electric can respond to any emergency anywhere within Missouri within a matter of hours. PAR Electric and Quanta have developed a proprietary emergency restoration program termed "Quanta Storms" which assess any type of emergency restoration scenario from initial assessment, material acquisition, and crew mobilization to final repairs.

At any given time, PAR Electric has more than 500 qualified personnel within the borders of Missouri to respond to any type of emergency.

Q. Does Grain Belt Express have an operations and maintenance plan in place for the Project?

A. Yes. Grain Belt Express' Restoration Plan is attached to my testimony as **Schedule TFS-5**, and it outlines the procedure that the Company will implement in response to an outage or other emergency conditions that could be encountered over the life of the Facility. This Restoration Plan was developed with input from Quanta and PAR Electric based upon their experience in dealing with past emergency restoration efforts throughout the Country. As the project continues to develop through receipt of regulatory approvals, final routing, detailed engineering, and construction, the Restoration Plan will be revised and additional detail will be added.

Q. Based upon your review of the Company's Restoration Plan, will the Restoration Plan, to be updated once Project design details and operations strategies are finalized,

adequately address public safety, new restoration structures, replacement conductor, and other special equipment?

A. Yes. As described in the Restoration Plan, the first priority is securing the line to ensure safety of the general public. To this end, the Restoration Plan requires immediate notification to local emergency response personnel in order to isolate damaged facilities. It also includes temporary road closures, assignment of wire watchers and coordination with other utilities.

Concurrent with the above, the Restoration Plan describes procedures for ensuring de-energization of the facilities following an emergency. Even if the line indicates that it has tripped out (de-energized and isolated from its source), it does not mean the conductor remains in a de-energized state. Conductors can drape across existing utility transmission or distribution circuits thus re-energizing the line. Further, other lines in close proximity can induce voltages on the line. Finally, environmental conditions such as wind or lightening can result in high static voltages imposed on an otherwise electrically isolated section of line. Therefore the installation of grounds is the first step in the restoration process.

Physically securing the line for the protection of the general public, adjacent utilities, public roadways, public and private structures and conveyances is next. This involves securing or removing damaged structures and physically removing conductors from affected areas.

Once the line has been made safe, permanent repairs can proceed. All repair work will be performed in compliance with all applicable local, state and federal codes including the National Electrical Safety Code. Further, all work would be performed in compliance with OSHA Standard 1910.269 and 1926 Subpart V.

VI MAINTAINING LANDOWNER RELATIONSHIPS

Q. How do Quanta and PAR Electric plan to share information with landowners before, during and after construction?

A. The Land Liaison Manager will be assigned to the Project to work closely with the Grain Belt Express Land Team and the Agricultural Inspector (as described in the Direct Testimony of Deann Lanz) and in conjunction with such parties will communicate with landowners prior to entry on their properties, during construction operations, and after construction activities are completed, to address any concerns and maintain consistent communications. The ROW will be clearly delineated and affected property owners will be informed specifically what activities will occur on their land and when it will occur prior to commencement of any work. The Land Liaison Manager will be an employee who has experience in both the construction industry, and in this case, working knowledge of agriculture practices. This dual knowledge base will aid in conducting successful construction operations across agriculture lands.

The Land Liaison Manager will also work with Grain Belt Express and the Agricultural Inspector to ensure that all Landowner Obligations are honored by the contractor(s).

Q. How will Quanta and PAR Electric work with landowners during clearing and access road construction?

A. Prior to commencement of any work, the ROW will be clearly delineated utilizing stakes, flags etc. Trees which are to be cleared will be clearly marked and all property owners will have the ability to review our ROW development plan for questions and input.

Q. How will Quanta and PAR Electric restore and remediate affected areas during and after construction?

A. PAR will comply with all requirements outlined in the Project's Agricultural Impact Mitigation Policy, Missouri Agricultural Impact Mitigation Protocol, and Stormwater Pollution and Prevention Plan. See the Direct Testimony of witness Dr. James L. Arndt, Ph.D., for additional details.

Q. Does this conclude your Direct Testimony?

A. Yes.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Grain Belt Express Clean Line LLC for a Certificate of Convenience and Necessity Authorizing it to Construct, Own, Control, Manage, Operate and Maintain a High Voltage, Direct Current Transmission Line and an Associated Converter Station Providing an Interconnection on the Maywood-Montgomery 345 kV Transmission Line	)	Case No. EA-2016-0358

AFFIDAVIT OF THOMAS F. SHIFLETT

STATE OF Missouri)
) ss
COUNTY OF Jackson)

Thomas F. Shiflett, being first duly sworn on his oath, states:

1. My name is Thomas F. Shiflett. I am the Executive Vice President, Electric Power Division for the Quanta Services, Inc.

2. Attached hereto and made a part hereof for all purposes is my Direct Testimony on behalf of Grain Belt Express Clean Line LLC consisting of 19 pages, having been prepared in written form for introduction into evidence in the above-captioned docket.

3. I have knowledge of the matters set forth therein. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded, including any attachments thereto, are true and accurate to the best of my knowledge, information and belief.

Thomas F. Shiflett

Subscribed and sworn before me this 25th day of August, 2016.

Notary Public

My commission expires: 4/18/2020

Dena A. Crossman
Notary Public - Notary Seal
STATE OF MISSOURI
Jackson County
My Commission Expires: April 18, 2020
Commission #16802981

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QUANTA SERVICES

RESUME

Thomas F. Shiflett

Position Executive Vice President, Electric Power Division, Quanta Services, Inc.

Summary Mr. Shiflett was responsible for the successful management and leadership of Quanta's Electric Operations in the United States. During Mr. Shiflett's tenure, Quanta's Electric Operating Companies achieved record growth and surpassed established goals and objectives.

On March 1, 2015, Mr. Shiflett entered into semi-retirement after more than 35 years in the electric utility/outside electrical construction industries.

Specialized skills

- Business Management
- Project Management
- Project Estimating and Development
- Business Development
- Safety Program Development and Management

Work history

Quanta Services, Inc.
Houston, Texas
2011 - Present

Executive Vice President
Electric Power Division
Responsible for managing Quanta's Electric Operating Companies in North America. Under Mr. Shiflett's management, Quanta was successfully awarded and completed the majority of major transmission projects throughout North America.

PAR Electrical Contractors, Inc.
Kansas City, Missouri
1998 - 2011

President
Chief Operating Officer
Responsible for managing PAR's 18 divisional offices and more than 2,500 employees. Under Mr. Shiflett's leadership, PAR increased annual revenue from $64 million to $800 million. In addition to becoming the largest outside electrical contractor in North America, PAR also completed the majority of large transmission projects built in the U.S. during this period. Included among these projects are the following:

- AEP's Jackson Ferry-Wyoming Junction 765kV
- American Electric Power GCMW 345kV
- Arizona Public Service Panda and Southwest Valley 500kV
- BPA's Schultz-Wautoma 500kV
- Eversource's Middletown-Norwalk 345kV
- KCP&L's LaCygne-Stillwell 345kV Energized
- Nevada Power Alturas to Reno 345kV

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www.quantaservices.com

- Salt River Project Palo Verde to Kyreen 500KV
- SDG&E's Sunrise Powerlink 500kV
- Allegheny Energy's TrAIL 500kV
- SCE's Tehachapi Renewable Transmission Project 500kV

President - Western Division
Escondido, California
1996 - 1998
Overall P&L responsibility for division's work. Duties included development of new business opportunities, staffing area offices, budgeting, equipment procurement, and development of customer base, estimating, project management and administration.

Northern Division Manager
Des Moines, Iowa
1992 - 1996
Overall P&L responsibility for division's work. Duties included development of customer base, estimating, project management and administration.

MidAmerican Energy (Formerly Midwest Power Systems, Inc.)
Des Moines, Iowa
1980 – 1992

Des Moines Service Center Manager
Responsible for all functions related to safe, efficient and reliable operation of Des Moines Electric System south of the Des Moines and Raccoon rivers and coordination of all concerned departments.

Colfax Area Supervisor
Directed all activities involved in the operation of Electrical System for Eastern Polk and Western Jasper Counties in Iowa.

Safety Director
Established and promoted the general safety and accident prevention policies and measures followed by the company. Developed and implemented measures to reduce or eliminate industrial accidents and health hazards. Developed procedures and conducted training:

- Maintenance and construction of Electrical Network Systems
- Maintenance and construction of Electrical Substations
- Live line rubber gloving procedures
- Live line hot stick procedures up to 161 kV
- Work area protection
- URD Maintenance and Construction procedures

Safety Specialist (Des Moines, Iowa)

Promoted general safety policies and measures to be followed by the company. Assisted Safety Supervisor in administration of Corporate Safety Program.

Inland Steel Company, Inc.
Black River Falls, Wisconsin
1979 - 1980

Engineering Intern

Engineering intern for taconite mine and pelletizing plant. Developed training programs for mine and plant personnel including:

- Equipment Operator
- Blaster
- Driller
- Haul Truck Driver

Education and training

M.S. Degree Industrial Safety — 1980
University Central Missouri

B.S. Degree Political Science/Psychology — 1975
Missouri State University

Affiliations

- Professional Organizations
- National Electrical Contractors Association
- Served on numerous apprenticeship and labor management committees as NECA representative throughout West and Midwest
- Past Chairman Electrical Subcommittee Iowa Governor's Occupational Safety and Health Advisory Council
- American Society of Safety Engineers
- Phi Kappa Phi National Scholastic Honor Society
- American Red Cross

PAR

ELECTRICAL CONTRACTORS, INC.

A QUANTA SERVICES COMPANY

Experience with 345kV and 500kV Lines

Sample Projects

PAR has constructed all sizes and types of transmission lines – from 765 kV, six-bundle, guyed V steel towers to 69 kV lines. PAR has the expertise and the equipment to get the job done safely. PAR — through Quanta Services — is the only electrical contractor qualified and certified to perform all aspects of transmission construction and maintenance while the system remains energized.

Allegheny Energy Service	Allegheny TrAIL project: Constructed approximately 150 miles of 500kV transmission line as well as two 500kV Switchyards; one in PA and one in VA	2010
	Masontown Re-route 500kV Transmission line: 2 bundle 2036 ACSR	2010
	Hatfield 500kV Power Station: Removed four lattice towers and installed six steel mono poles and related hardware; relocate three 500kV lines, 2 bundle 2032 ASCR	2006
Alliant Energy	Peetz Interconnect 345kV transmission line: Pulled nine miles of 795 bundle conductor	2007
American Electric Power	Sporn-Muskingum: 345kV change out, the 50 mile line traverses West Virginia and Ohio	2014
	West 345kV Bixby-Conesville - Installed structures, foundations, and conductor weights	2014
	Conesville-Bixby – Constructed 345kV and 138kV lines	2013
	Rockport-Jefferson 765kV Transposition - Provided supervision, personnel and equipment to install three 6-pole transposition structures and all associated conductor work	2012
	Single circuit 138kV wood H-frame line between Poston and Ross Substations, Ohio; approximate 43 mile line of rebuild, separated into six sections for construction; also removed existing wood poles and conductor and installed new steel (WPE) and reconductor	2011
	Wyoming-Jackson Ferry 765kV line - Constructed 90 miles, 6 bundle, 795 conductor, 111 lattice steel four-legged structures, 222 lattice steel guyed-V structures; experienced extreme terrain conditions, extensive use of helicopters for wire string and steel transport, more than 350 personnel at peak loading, completed on time	2004
	Rolling Hills - 1 mile, 765kV, 4 bundle 1351 ACSR, lattice towers	2002
American Transmission Company	Twenty Mile project: Reconstructed existing single circuit 345kV overhead transmission facilities, replaced wood k-frame structures with steel H-frame structures	2009
	Paddock-Rockdale Project: Approximately 34.3 mile reconstruction project of overhead transmission facilities to add an additional 345kV circuit to an existing double circuit 345kV/138kV corridor; conductor sizes are T-2 556.5 ACSR Dove, T-2 113.2 ACSR Blue Jay, and 2156 ACSR Bluebird; also included installation of a 12-Fiber and a 24-Fiber DNO OPGW circuit along the project route; the project involved work within environmentally sensitive areas including waterways and wetlands and was constructed under a compressed timeframe due to outage constraints.	2009

	Arpin-Rocky Run 345kV Project: Approximately 20 mile project that required the reconstruction of existing single circuit 345kV overhead transmission facilities to replace the wood k-frame structures with steel H-frame structures. Re-sagged the existing 2 bundle 795 ACSR Drake conductor to meet new circuit loading requirements as well as installed one 12 fiber DNO OPGW along the entire route; involved extensive amount of work within heavy wetlands and environmentally sensitive areas.	2009
	GCMW HWY 22: Provided labor, equipment, tools, material and supervision to perform construction services for the Highway 22 - White Clay project (installed poles, grounding and installed 345kV-static-OPGW)	2008
	GCMW-Caroline-Highway 22 below grade: Provided labor, equipment, tools, material and supervision to remove existing 345kV line	2008
	WHB-CAE 138/345kV T-Line: Provided labor, equipment, tools, material and supervision to perform removal, grounding and t-line construction (115kV, 345kV, static, OPGW) for the Whitcomb Substation to Caroline Substation project; Phase 1 Installed poles (16.1 miles) & 345kV/Static/OPGW	2008
	GCMW-CTV SS to WW SS 138/345kV: Installed 137 138/345kV steel mono poles and approximately 18.1 miles of T-2 1113 ACSR T-2 556 ACSR, shield wire and OPGW 12 fiber	2008
	GCMW-WW SS to RRN/WL: Temporary line construction, installed and removed 1.45 miles of temporary 138kV transmission line, also installed 1.95 miles 138/345kV mono steel structures	2007
	White Clay to Morgan GCMW demo 138kV H-frames – removed approximately 9.5 miles of 138kV line, consisting of 145 H-frames, hardware and conductor, 345kV, 138kV permanent lines, line removal/below grade	2007
Associated Electric Coop	Lutesville-New Madrid 345kV line ice storm restoration	2009
Arizona Public Service Co.	Panda: Constructed 40 miles of 500kV, 3 bundle 1780 ACSR transmission line on steel lattice towers	2002
	Southwest Valley: 38 miles 500kV steel pole/lattice tower on 500kV transmission line	2002
Bonneville Power Administration	Midway-Benton #1 and Benton-Othello #1 Rebuild Project: Scope included approximately 40 Miles of 115kV Rebuild from Midway substation to Benton substation including a 14-mile reroute, rebuild used H-frame wood pole construction with Toutle conductor	2013

	Benton-Othello #1, 115kV Rebuild: Rebuild line from Benton substation to structure 11/7 Scooteney Tap to Midway-Benton #1, 115kV Extension: Extended the line from its existing location to the Midway-Benton #1 reroute, extension used H-frame wood pole construction with Toutle conductor	
	Hot Springs 500kV spare transformer installation	2011
	Alvey 500kV spare transformer installation	2011
	McNary 500kV spare transformer installation	2011
	Schultz to Wautoma: Constructed 65 miles of 500kV, 3 bundle 1300 ACST/TW on lattice towers	2005
	Yakima River Crossing: Re-routed existing 230kV/500kV circuits	2003
	Hanford-John Day 500kV: Reconductor included a 4,100 foot river crossing	2004
Colorado Public Service	Installed 100 miles of 345kV 2 bundle 795 ACSR on wood poles with helicopter	2001
Con Ed/O&R	Ramapo-Sugarloaf 345kV: Reinforced approximately 11 miles of existing lattice steel towers and strung 11 miles of new 345kV bundle conductor on a previously vacant position	2011
	Constructed the 345kV Beaver-Greenfield Line Project	2003
Constellation Energy Group	Nine Mile Point Nuclear station: Constructed 345kV line	2005
	Repaired one 345kV switch connection *energized* at Nine Mile Point Nuclear Power Plant	2005
Elk River Wind Farm, LLC	Construction of Elk River 345kV transmission line	2005
Eversource (NU)	The Interstate Reliability Project consists of 38 miles of new 345kV overhead transmission line. Work performed in east CT. • Installed 79 drilled shaft foundations • Installed 613 direct embedded foundations • Installed 337 steel pole structures • Installed 38 circuit miles of 345kV conductor • Cut-overs to three new structures on two adjacent circuits (345kV and 69kV) • 31 guy relocations on the adjacent 345-kV line	2015
	Replaced 20 345 kV structures on the 307 Line. Drilling included on this project.	2015

	Replaced 37 345kV structures on the 354 line and five 345kV structures on the 393 line. Replacement of structures will be energized. Drilling to be included on this job.	2015
	345 kV storm hardening, lines 3424, 398	2015
	345 kV structure change outs, line 3041	2015
	The Greater Springfield Reliability Project: Required the construction or re-build of 27 circuits on the Northeast Utilities System; MA work was under the Western Mass Electric operating company (WMECO) and CT work was under their Connecticut Light & Power operating company (CL&P). • Installed 540 drilled shaft foundations (largest is 11'diam x 71' deep – 300 CY) • Installed173 Direct Embedded Foundations • Installed 714 steel pole structures (tallest is 195') • Installed 98.7 circuit miles of conductor (63.4 mi of 115kV and 35.3 mi of 345kV)	2013
	Worked within urban area challenges with approximately 22 major interstate crossings of the MA. Turnpike, I-91 and I-391	
	345kV structure replacement: 4 phases	2010
	Middletown-Norwalk 345kV transmission line: Approximately 90 miles of 345kV overhead lines and various 115kV circuit rebuilds, structure heights ranged between 30 ft. and 195 ft., approximately 760 miles of wire strung and nearly 3,000 truckloads of concrete poured; helicopter use was critical to completing much of the project's overhead line, it reduced construction time and mitigated environmental impacts and helped complete the project ahead of schedule and under budget	2007
	345kV live sleeve replacement: provided services for 2,156 slice and dead-end replacement for several lines in Meriden, CT; work performed *energized*	2007
	345kV polymer insulator replacement for various lines while *energized*	2007
	345kV live line sleeve replacement - purchased materials only for splice and dead-end replacement project	2007
	Bethel-Norwalk 345kV/115kV double circuit, approximately 31 miles	2007
First Energy	Handsome Lake-Homer City 345kV Loop: The new 345kV loop will be approximately 1.5 miles of double circuit steel monopole construction, there are nine single poles and one six pole tap structure	2014
	Avon Beaver #1 and #2 - Removed two 345kV lattice towers and installed four steel poles including transfer of existing conductors	2014

	Davis Besse-Hayes 29 mile, 345kV transmission line: Added 345kV circuit to existing towers	2013
	Doubs-Mt. Storm 500kV - Project consisted of rebuilding 2.9 miles of existing 500kV transmission line from Potomac Edison's Doubs Substation to the Potomac River. Work included removal/salvage of existing structures, insulator and hardware assemblies, overhead ground wire, conductor and the installation of new foundations, structures, conductor and optical ground wire. Wire will be strung from the Doubs Substation deadend structure to deadend structure number 551/457 located on the West side of the Potomac River; this structure and its foundation will be installed by Dominion. Also included in the work will be the receiving of owner furnished materials as well as sorting, loading, transporting and off-loading material from owner's storage yard at 502 Junction Substation located near Mt. Morris, PA. All existing OHGW, conductor, insulator and hardware assemblies, vibration dampers, spacers and sixteen lattice tower structures comprising the 2.9 mile portion of line to be reconstructed will be removed and salvaged, includes disposal of conductor reels.	2013
	Beaver Carlisle 345kV Relocate: Relocated existing 345kV single bundle transmission line, erected anchor-bolted steel poles, installed new conductor and removed and salvaged existing poles	2005
	Beaver-Greenfield 345kV Project: Constructed transmission line	2003
Georgia Power	McGrau Ford-Mostellar Springs: 35 miles of 500kV, 3 bundle 113 ACSR, lattice towers	2006
Kansas City Power & Light	The Iatan-Nashua Project required the construction of a new 345kV transmission line in northwest Missouri, the transmission line will extend approximately 31 miles from an existing substation at the Iatan power plant near Weston, Missouri (Iatan Substation), to the Nashua 161kV substation near Smithville, Missouri (Nashua Substation); the 161kV Nashua Substation will be expanded and upgraded by others to accommodate both the new 345kV Iatan-Nashua line, and the connection with the existing St. Joseph-Hawthorn 345kV transmission line by installing a new 345/161kV autotransformer between the existing 161kV substation and the 345kV facilities at the Nashua Substation	2014
	U-KCP and LaCygne 345kV Line: Nine drilled piers for transmission line	2013

	LaCygne Generating Plant 345kV transmission line: Provided labor, tools, equipment, supervision and certain materials to build .33 miles of 345kV, single pole, double circuit, vertical I-String transmission line this includes eight structures with two 48 fiber OPGW and 3 bundled 795 ACSR "Drake" phase conductors; the new transmission line was constructed from the existing switchyard to a new transformer within the LaCygne plant	2013
	Re-conductor 40.9 miles of 345kV 2 bundled line from LaCygne to W. Gardner; installed 954MCM Cardinal ACSS/TW conductors and removed 954MCM Rail ACSR conductors	2005
	Reconductored 40.9 miles of 345kV 2 bundle, de-energized transmission line from La Cygne to West Garden, wood H-frame	2003
	Reconductored *energized* line, 30 circuit miles of 345kV, 954 rail, 2 bundle conductor on wood H-frame	2003
MidAmerican Energy	345kV Containment Structure A11, A23	2012
	Crawford County and Atchison 345kV Rebuild	2011
	Storm rebuild of 15 miles of 345kV, H-frame construction	1998
	North loop and Bondurant: Constructed 20 miles of 345kV/161kV in Des Moines; used steel poles and drilled pier foundations 60 ft. deep	1995
Minnkota Power	30 miles, 500kV, 3 bundle ACSR, lattice towers	1976
NPPD	Grand Island to McCool Junction - 345kV storm restoration	2008
Nevada Power Co.	Alturas, CO and Reno, NV: Alturas 345kV Intertie - 171 miles of 345kV steel pole transmission line with two 345kV substations, bundled 954 ACSR on steel tubular H-frames and single pole structures including foundations	2008
	Lenzie 500kV - Interconnection at Lenzie generating plant 3 bundle, 1590 ACSR, steel poles; all involved installation and/or removal of steel poles and triple bundle conductor, only 2 to 4 spans in and out of the Lenzie Generating Plant Switchyard; included OPGW work	2005
NV Energy	Moapa 500kV Interconnect: Excavation and foundations, installed reinforced concrete foundation with anchor bolts, installed two steel foundation poles, installed additional ground rod, Installed one overhead ground wire complete, installed one circuit of 6-1590 MCM lapwing ACSR bundled conductors complete, installed all NVE supplied fiber optic cable, Installed NVE supplied pole mounted splice box.	2014

	Harry Allen to Mead: 500kV, 3 bundle 1590 ACSR, intersect one lattice tower	2006
OG&E	Muskogee to Pittsburg 345kV: Installed 20 miles of bundled 7995 Single Circuit with 2 statics	2012
	Hugo-Calliant 345kV Transmission Line, 20 anchor bolt foundations for transmission line near Hugo, OK	2011
ONCOR	Central Bluff-Bluff Creek 345kV project is a 345kV transmission line constructed on lattice steel V towers	2012
	Texas Utilities transmission project: Constructed 80 circuit miles of 345kV 1590 ACSR 2 bundle conductor on approximately 55 lattice steel towers, used helicopter to set towers; weather delays made this an especially challenging project, which was completed before deadline	2001
PacifiCorp	Malin Re-route of 500kV double circuit, 2 bundle 2500 AAC, 3 Lattice Towers	2009
	Oquirrh 345kV-138kV substation: moved existing 345kV transmission line for new substation	2008
	Relocated 138kV/345kV line	1996
Pacific Power & Light Company	Alvey to Dixonville 500kV: Installed 58 miles of 500kV line on lattice steel towers: clearing, roads, foundations; towers set by helicopter; triple bundle 1272 ACSR conductor; removed 58 miles of 230kV wood pole line	1993
PPL	The Susquehanna (Berwick, PA) to Roseland (NJ) project consists of 101 miles of new 500kV overhead transmission line. The existing right-of-way required expansion from a single 230kV electric transmission line to replacing the existing towers with new, taller tower structures, updating the 230kV to one that will carry 500kV and add an additional 500kV transmission line. In addition to the 101 miles of 500kV overhead transmission line, the project also includes: • One new Greenfield 500-Kv Substation • Seven substation upgrades • One 500-kV substation • Six 230-kV substations The expansion also required constructing new access roads	2015

	Northeast Pocono Reliability Project required the installation of approximately 68 miles of new 230kV and 138kV overhead transmission line, erection of steel transmission structures, installation of concrete foundations and the construction and maintenance of access roads	2015
	Susquehanna-Roseland Project B2-B4 Overhead Transmission: Installed new structures and foundation for B2 and B4 line segments in the Susquehanna Nuclear PP and T10 SS, string 230kV and 500kV conductor and replace static wire with OPGW	2012
Public Service Electric & Gas	SRP Segment 4: The Project consisted of approximately three miles of the 46 mile New Jersey portion of the S-R Project, designated as Segment 4. In addition, there are approximately seven miles of OPGW to be installed on the KI-HA transmission line over circuit K-1019 and one span over circuit T-2298	2013
Public Service Co. of Colorado	345kV intertie line: Installed 100 miles of wire on 345kV line using a helicopter	2001
Rocky Mountain Power	90th S to Camp Williams: Double circuit 345kV transmission line on steel poles	2009
Salt River Project	Springerville 4 Project: Construction 345kV switchyard and transmission line	2007
	Palo Verde to Kyreen (SRP): Constructed 50 miles of 500kV, 3 bundle 2312 ACSR, lattice towers	1986
	Constructed 50 miles of 500kV Lattice Tower Line	1982
San Diego Gas & Electric	The Sunrise Powerlink Project: New and modified electric transmission lines, a substation and related facilities, project consisted of approximately 120 miles of both overhead and underground transmission lines and 72 count OPGW, 90 miles of 500kV and 28 miles of 230kV and the Sun Crest Substation; the segment from the Sycamore Canyon Substitution through Alpine to the Sun Crest Substation is 28 miles; 6.2 miles of the 235kV line is underground and called "Alpine Underground Segment."	2010
	Copper Mountain for Hampton Tedder on a Sempra Project in Nevada: Scope included a substation with approximately 1000' of 138kV line at 1.5 miles of 34.5kV distribution and a small substation	2010
	Transmission lines 13813, 13814, 13815: Removed 18 bridge towers and lattice towers including Epic 2	2009

	Firestorm 2007: Designed/Rebuilt various transmission lines	2008
	Replaced wood poles with steel poles at various locations	2008
	Removed transmission line 13815 at 30th Street; Phase II 20SD Overhead	2008
Sho-Me Power	Thayer-Gobbler Knob: Constructed approximately 58 miles of 345kV transmission line, steel H-frames	2007
	Constructed 67 miles of 345kV transmission line, wood H-frame	1970
Sierra Pacific Power Company (NV Energy)	Alturas 345kV Intertie: Constructed 171 miles of 345kV steel pole transmission lines with two 345kV substations; bundle 954 ACSR on steel tubular H-frames and single pole structures including foundations	2005
	Built 179 miles of 345kV line, combination of direct buried and anchor bolt foundation structures; steel monopole and H-Frame structures installed, 954 ACSR bundle conductor	1998
Southern California Edison	Devers–Palo Verde 500kV No. 2 (DPV2) Transmission Line Project consists of a new 500kV transmission line including 111 miles of 96 count OPGW communication line, upgrades to the Valley and Devers substations, and the new Colorado River Substation. The DPV2 transmission line is located within SCE's right-of-way (ROW) parallel to the existing 500kV Devers-Palo Verde No. 1 (DPV1) Transmission Line. Because the ROW traverses multiple jurisdictions including private, Riverside County, California State Lands Commission (CSLC), and federal lands, PAR will use its years of experience to work with each landowner to ensure the project is completed on time, safely. The Project consists of the following: • Colorado River to Devers transmission line including the new series capacitor bank adjacent to the existing DPV1 series capacitor bank • Devers to Valley transmission line • New Colorado River Substation including dead-end structures, circuit breakers, and disconnect switches • Devers Substation expansion, including installation of a 500kV line shunt reactor bank, dead-end structures, circuit breakers, and disconnect switches • Valley Substation upgrade, including installation of a 500kV dead-end structure, circuit breakers, and disconnect switches • Distribution line extension for Colorado River Substation Worked with Bureau of Land Management (BLM), United States Forest Service (USFS), and United States Fish and Wildlife Service	2013

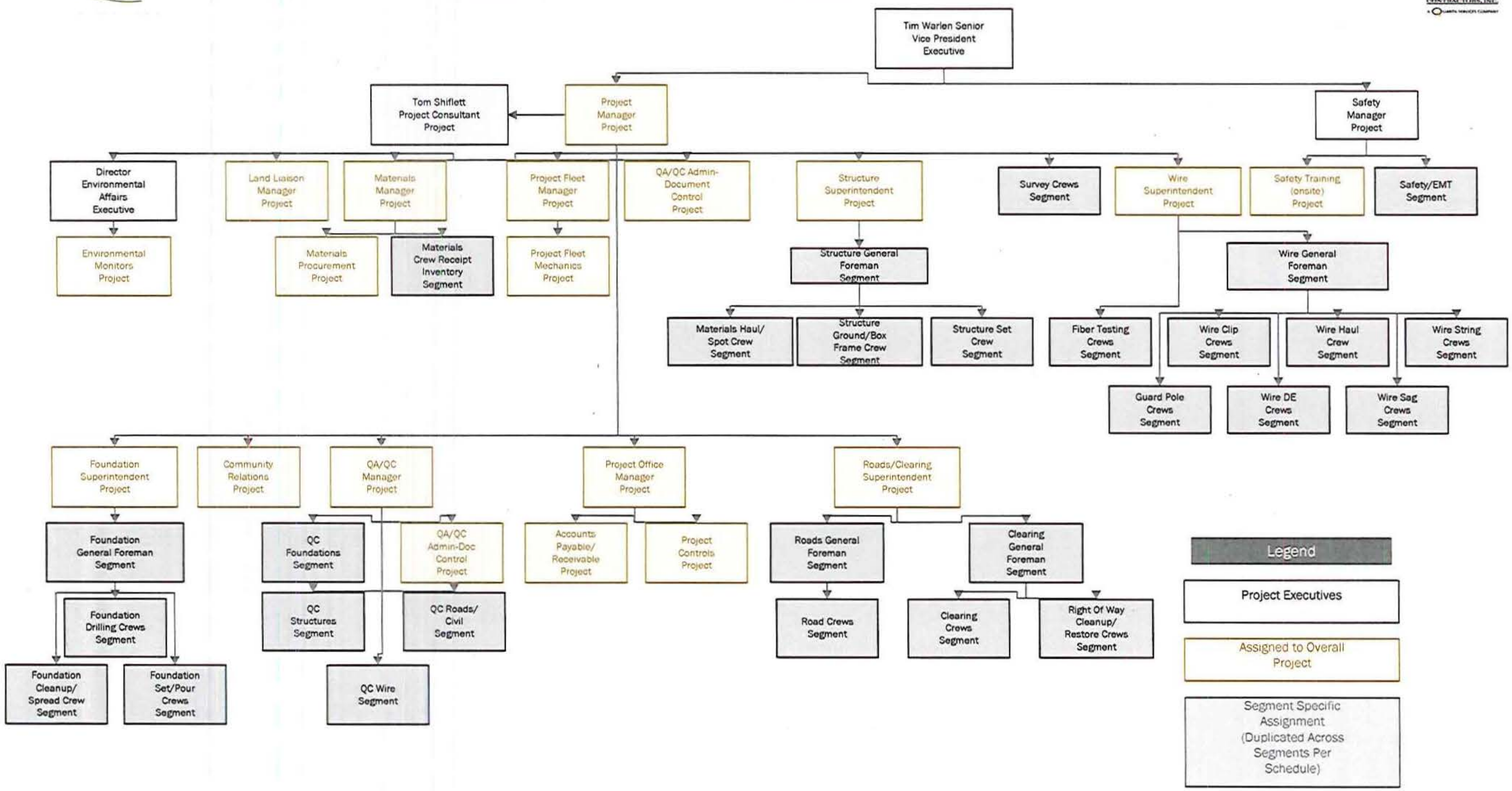
The Tehachapi Renewable Transmission Project (Segments 6 – 11): Segment 6 consisted of removing 32 miles of 220kV lattice steel towers (LSTs), conductor and associated hardware, and installing 32 miles of both new 500kV transmission line and 96 count OPGW on LSTs and tubular steel poles (TSPs). Segment 11 consists of removing approximately 19 miles of 220kV transmission line on LSTs, construction of 19 miles of 500kV transmission line on LSTs and TSPs, installation of 16 miles 220kV transmission line conductors on existing double circuit LSTs and rearrangement of 220kV lines and 220kV line-bus connections. Segments 6 and 11 of the Tehachapi project are located predominately in the Angeles National Forest and present significant environmental, biological and ANF constraints for construction.	2013
West of Devers Interim (WODI): Installed six towers 1590 2-bundle conductor, removed existing for new 230kV reactor site.	2013
WODUP Potholing – potholed underground facilities for 48 miles of transmission line	2013
Windhub Markers: Installed mile/tower identification signs removed existing, installed aerial crossing signs, installed marker balls on Antelope-Vincent #1 and #2 circuits	2013
Path 42 Civil Work: Installed foundations for three towers, using composite matts	2013
Distribution deteriorating pole evaluation and planning: Performed distribution deteriorated pole replacement design services	2013
TRTP Segments 7&8p4, Segment 7: Constructed 27 lattice 500kV and 230kV structures, 14 miles 2156 bundle Bluebird, with OPGW; Segment 8p4: constructed 16 lattice 500kV & 220kV structures, 15 miles 2156 bundle Bluebird, with OPGW	2013
CRS - Devers 500kV transmission line work	2011
Devers-Valley 500kV transmission line work	2011
Installed 34 miles of 500kV lattice and steel pole transmission line	2010
Relocated three 500kV structures and installed six, 500kV steel poles for new capacitor bank	2010
Tehachapi Renewable Transmission Project: Constructed 26 miles of both 500kV line and 48 count OPGW from Antelope Substation to Pardee Substation (Segment 1); 22 miles of both 500kV line and 48 count OPGW from Antelope Substation to Vincent Substation (Segment 2); and 25 miles of both 500kV line and 48 count OPGW from New Windhub Substation to Antelope Substation (Segments 3A); 2400 feet of 220kV line re-located outside of the Antelope Substation,	2010

	10 miles 220kV line from Windhub Substation to New Tehachapi Substation	
Texas Utilities	Installed 40 miles of 345kV 2/c bundle line and approximately 55 lattice steel towers; helicopters used to complete work, which began first week in February 2001 and completed all work 3 days before deadline	2001
TransElectric	PATH 15: Installed 84 miles of 500kV transmission line, 3 bundle 1590 ACSR on steel poles	2004
Transource	AEP & KCP&L: 676 direct embedded foundations and 186 anchor bolt foundations for 345kV transmission line	2015
Utah Power & Light	Constructed 116 miles of 345kV, used lattice H-frames	1980
Western Area Power Administration (WAPA)	Installed 82 miles of 500kV line on lattice steel towers: triple bundle 1565 ACSR conductor, new towers, existing tower modification; all materials provided by the contractor; removed 82 miles of conductor, foundations installed by the contractor, COPT Olinda to Tracy 500kV	1991
Westar Energy	Summit to Elm Creek: Installed 29 miles of 345kV transmission line	2015
	Built 57 miles of 345kV/115kV double circuit transmission line	2009
	Wichita to Reno County: Constructed 345kV line	2008
	Installed 82 miles of 500kV line on lattice steel towers: triple bundle 1565 ACSR conductor, new towers, existing tower modification; all materials provided by the contractor; removed 82 miles of conductor, foundations installed by the contractor, COPT Olinda to Tracy 500kV	1991
Xcel	Replaced 345kV structures	2006
	345kV structure replacement: Replaced existing 345kV wood H-frame structures with 345kV steel H-frame structures; line was *energized*	2005
	Green Valley to Spruce - Constructed 345kV transmission line	2004

Proposed Organization for:
Grain Belt Express Clean Line Transmission Project Construction

CLEAN LINE ENERGY PARTNERS

PAR ELECTRICAL CONTRACTORS, INC.



Construction Plan

for the

GRAIN BELT EXPRESS
CLEAN LINE

Revision 1.0
June 2016

CLEAN LINE
ENERGY PARTNERS

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ppendices

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ppendix A, "Figures," contains all of the figures.

Acronyms and Abbreviations

C	alternating current
TV	all-terrain vehicle
lean Line	Clean Line Energy Partners LLC of Houston, Texas, (parent company of Grain Belt Express Clean Line LLC referred to herein as "Clean Line")
·C	direct current
VDC	high-voltage direct current
O	Independent System Operator
√	kilovolt(s)
IISO	Midcontinent Independent System Operator
IW	megawatt(s)
IERC	North American Electric Reliability Corporation
IESC	National Electrical Safety Code
›PGW	optical ground wire
·oject, the	Grain Belt Express Clean Line transmission project
OW	right-of-way
TO	Regional Transmission Organization
·HA	Special Flood Hazard Area
›P	Southwest Power Pool, Inc.
·VPPP	Stormwater Pollution Prevention Plan

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Please note: The following construction plan contains forward-looking statements and anticipated typical designs based on current knowledge. These descriptions are subject to change as further transmission planning, environmental permits, and engineering studies progress.

1.0 Project Overview

Clean Line Energy Partners LLC of Houston, Texas, (parent company of Grain Belt Express Clean Line LLC referred to herein as "Clean Line"), with the assistance of PAR Electrical Contractors of Kansas City, MO, (referred to herein as "PAR"), prepared this document to describe proposed project facilities and land needs, as well as construction, operation and decommissioning activities for the proposed Grain Belt Express Clean Line transmission project (the Project).

The proposed Project is an overhead ± 600 kilovolt (kV) high-voltage direct current (HVDC) electric transmission system and associated facilities with the capacity to deliver approximately 4,000 megawatts (MW) from renewable energy generation facilities in western Kansas to load serving entities in the Midwest and Mid-Atlantic via an interconnection with PJM Interconnection (PJM) in Indiana and to the Midcontinent Independent System Operator (MISO) in Missouri.

A summary of the Project's major facilities and improvements is as follows:

- **Converter Stations:** Three alternating current (AC)/direct current (DC) converter stations, one at each end of the transmission line and one at an intermediate point. Clean Line proposes to locate the converter stations in Ford County, Kansas, Clark County, Illinois and Ralls County, Missouri. Transmission facilities will be required between each converter station and the point of interconnection to the existing AC grid, as follows:
  - Two 345kV AC tie lines connecting to a future ITC Great Plains substation in Kansas.
  - One double circuit 345kV AC transmission line connecting to the existing AEP Sullivan substation in Indiana.
  - One single circuit 345kV AC tie line connecting to a point along an existing 345kV transmission line in Missouri.

  Supply of converter station equipment and construction of the converter stations is anticipated to be the responsibility of a single Original Equipment Manufacturer (OEM). This OEM has not yet been selected.

- **HVDC Transmission Facilities:** A ± 600kV HVDC overhead electric transmission line with the capacity to deliver approximately 3,500MW to PJM and 500MW to an intermediate substation in Missouri. Components of the HVDC transmission facilities include:
  - Tubular and lattice steel structures used to support the transmission line.
  - Communications/Control and protection facilities (optical ground wire [OPGW] and fiber optic regeneration sites).
  - Right-of-way (ROW) easements for the transmission line, with a typical width of approximately 150 to 200 feet.

  Clean Line and PAR's parent company Quanta Services have entered into an agreement to work towards an Engineering, Procurement and Construction (EPC) contract for the HVDC Transmission Facilities. As part of this agreement, PAR has incorporated information about their proposed construction activities into this Plan.

- **AC Collection Facilities:** To facilitate efficient interconnection of wind generation, there will be four to six AC collection lines at 345kV from the Kansas converter station to points in the western Kansas region. Components of the AC facilities include:
    - Tubular or lattice steel structures used to support the transmission line;
    - Communications facilities;
    - Control and protection facilities;
    - ROW easements for the transmission line with a typical width of approximately 150 to 200 feet

  AC Collection Facilities may be built by Clean Line or by individual wind generators.
- **Access Roads:** To access the Project facilities and temporary construction areas during the construction and operation phases, Clean Line will use existing public and private roads and construct new roads to certain permanent features.
- **Temporary Construction Areas:** To facilitate project construction, Clean Line will use temporary construction areas such as multi-use construction yards, fly yards, tensioning and pulling sites, and wire splicing sites.

Section 2 describes the Project components in detail, Section 3 discusses construction, Section 4 discusses operations and maintenance, and Section 5 describes decommissioning. Table 1-1, "Location of Project Facilities by County," lists the counties within which the Project facilities could be located. Figure 1-1, "Project Overview" (see Appendix A, "Figures") provides an overview of the Project components.

Table 1-1
Location of Proposed Route and Project Facilities by State and County

	Approximate Length (Miles)	State(s)	County(ies)
CONVERTER STATIONS AND AC INTERCONNECTIONS			
Kansas Converter Station	N/A	Kansas	Ford
Kansas AC Interconnection	<1	Kansas	Ford
Illinois Converter Station	N/A	Illinois	Clark
Illinois and Indiana AC Interconnection	6	Illinois, Indiana	Clark (IL), Sullivan (IN)
Missouri Converter Station	N/A	Missouri	Ralls
Missouri AC Interconnection	<1	Missouri	Ralls
HVDC ROUTE			
Segment 1			
Total PR in Region 1	185	Kansas	Ford, Hodgeman, Edwards, Pawnee, Barton, Russell, Osborne
Segment 2			
Total PR in Region 2	185	Kansas	Mitchell, Cloud, Washington, Marshall, Nemaha, Brown, Doniphan
Segment 3			
Total PR in Region 3	205	Missouri	Buchanan, Clinton, Caldwell, Carroll, Chariton, Randolph, Monroe, Ralls
Segment 4			
Total PR in Region 4	205	Illinois	Pike, Scott, Greene, Macoupin, Montgomery, Christian, Shelby, Cumberland, Clark
Total Length of the Proposed Route	**780**		

Key:

PR = Proposed Route

2.0 Project Description

2.1 Converter Stations and Other Terminal Facilities

The Project includes three AC/DC converter stations, one at each end of the transmission line and one at an intermediate point. Clean Line proposes to locate the western converter station in Ford County, Kansas and the eastern converter station in Clark County, Illinois. The intermediate converter station would be located in Ralls County, Missouri. At each converter station, AC transmission lines would connect to the existing grid. The following sections provide a description of these facilities.

2.1.1 Elements Common to the Converter Stations

Note: To avoid repetition, this section describes the elements common to the converter stations. Sections 2.1.2, "Kansas Converter Station and Other Terminal Facilities," 2.1.3, "Illinois Converter Station and Other Terminal Facilities," and 2.1.4, "Missouri Converter Station and Other Terminal Facilities," discuss differences between converter stations and associated AC interconnections.

Converter stations are similar to a typical AC substation, with additional equipment to convert between AC and DC. Ancillary facilities (e.g., communications equipment and cooling equipment) will be required at each converter station. In addition, AC transmission lines will connect each converter station to the existing grid.

Each converter station will include:

- DC switchyard;
- DC smoothing reactors;
- DC filters;
- Valve hall(s) (which contain the power electronics for converting AC to DC and vice versa);
- Ancillary building(s) (which house, e.g., control and protection equipment, cooling);
- AC switchyard;
- AC filter banks;
- AC circuit breakers and disconnect switches; and
- Transformers.

A typical converter station may require an area encompassing approximately 45 to 60 acres, most of which is occupied by the AC switchyard. The AC switchyard will be the largest portion of the electrical facility within the converter station footprint. There could be up to two buildings (valve halls) to house the power electronic equipment used in AC/DC conversion, each approximately 275 feet long by 80 feet wide. Valve halls protect the converter equipment from ambient conditions and impede the audible noise generated by the thyristors and other equipment. The valve halls could reach heights of 60 to 85 feet. Additionally, smaller building(s) will house the control room, control and protection equipment, auxiliaries, and cooling equipment. Other electrical equipment such as synchronous condensers, static compensators, or static var compensators may be required within the AC portion of the switchyard dependent on system studies. Transformers will be located adjacent to the valve hall(s) and surrounded on two sides with concrete fire walls. In addition to preventing a fire in one transformer from spreading to adjacent ones, the walls will also impede audible noise generated by the transformers. Clean Line will typically utilize 10- to 20-acre lay down areas during construction and post construction as parking and for locating warehousing facilities within the fenced converter station, if needed. Figure 2-1, "Clean Line Converter Station General Layout," shows a typical converter station layout.

Tables 2-1, "Kansas Converter Station and Associated Facility Dimensions and Land Requirements," 2-2, "Illinois Converter Station and Associated Facility Dimensions and Land Requirements," and 2-3, "Missouri Converter Station and Associated Facility Dimensions and Land Requirements," provide the typical facility dimensions and anticipated land requirements during construction and operation.

Figure 1-1, "Project Overview," depicts potential siting areas under consideration for the Converter Stations and interconnection facilities. Figures 2-2a, "Kansas Converter Station Siting Area Property Location," 2-2b, "Kansas Converter Station Siting Area Property Aerial," 2-3a, "Illinois Converter Station Siting Area Property Location," and 2-3b, "Illinois Converter Station Siting Area Property Aerial," depict converter stations. Figure 2-4a, "Missouri Converter Station Siting Area Property Location," and Figure 2-4b, "Missouri Converter Station Siting Area Property Aerial" depict the siting area for the Missouri converter station.

AC for Interconnection, Kansas, Illinois, and Missouri

Typical structures include lattice structures and tubular pole structures and the dimensions are summarized in Tables 2-1, "Kansas Converter Station and Associated Facility Dimensions and Land Requirements," 2-2, "Illinois Converter Station and Associated Facility Dimensions and Land Requirements," and 2-3, "Missouri Converter Station and Associated Facility Dimensions and Land Requirements." They are depicted on Figures 2-20a, "345kV Lattice Deadend," 2-20b, "345kV Lattice V-String," 2-23a, "345kV 3-Pole Running Angle," 2-23b, "345kV 3-Pole Deadend," 2-24a, "345kV 3-Pole Guyed Running Angle," 2-24b, "345kV 3-Pole Guyed Deadend," 2-25a, "345kV Double Circuit Pole Deadend," 2-25b, "345kV Double Circuit Pole V-String," 2-26a, "345kV Single Circuit Pole Deadend," 2-26b, "345kV Pole Braced Post," 2-26c, "345kV Single Circuit Pole V-String," 2-28a "345kV Braced H-Frame," 2-28b "345kV H-Frame Tangent," and 2-28c "345kV H-Frame V-String."

2.1.2 Kansas Converter Station and Other Terminal Facilities

The Kansas converter station will be the same as described in Section 2.1.1, "Elements Common to the Converter Stations."

AC Interconnection Process and Facilities, Kansas

The following explains the processes applicable to Clean Line's requests for interconnections between the Project and the existing electrical grid, including the study and assessment of the upgrades and improvements needed for such interconnections.

Clean Line requested a Point of Interconnection (POI) in Kansas at a tap of the existing Clark County-Spearville and Clark County-Ironwood 345 kV transmission lines. These lines are owned by ITC Great Plains, a member of the SPP regional transmission organization. This interconnection is necessary to enable the AC to DC conversion process by HVDC line-commutated converters within the Kansas converter station. The interconnection between the proposed Kansas converter station and the ITC system would be controlled to a nominal value of zero (0) MW.

For Clean Line to interconnect to the ITC system, a series of studies are performed to review the potential interconnection and identify any upgrades to existing facilities or additions of new facilities to allow a reliable interconnection. ITC has completed a facilities study of the requested interconnection to the ITC 345 kV system. Based on the ITC analysis, a new substation would be necessary to tap the existing 345 kV circuits. The interconnection of the Kansas Converter Station to the new substation would be facilitated by 345 kV tie lines. Since the converter site is directly adjacent to the proposed substation site, these tie lines will be very short and are likely to be contained entirely within the footprint of the converter station and the new substation. Clean Line's selected HVDC vendor will incorporate the results of the ITC facilities study into its study work on the final converter station design. This final study work will identify specific technology solutions such as reactive power requirements and filter design that will be included in the final converter station design. Following completion of these studies, Clean Line anticipates that it will enter into an Interconnection Agreement (IA) with ITC and SPP for the Project.

2.1.3 Illinois Converter Station and Other Terminal Facilities

The Illinois converter station will be the same as described in Section 2.1.1, "Elements Common to the Converter Stations."

AC Interconnection Process and Facilities, Illinois and Indiana

Clean Line requested interconnection service in Indiana at the AEP Breed 345 kV substation for delivery of up to 3,500 MW of power. Clean Line originally requested interconnection in the fall of 2011, at which time PJM performed a feasibility study pursuant to the request. Subsequent to the feasibility study, PJM and AEP performed a System Impact Study and issued a report in October 2014. A facilities study of the attachment facilities and new system reinforcements is ongoing. Following completion of these studies, Clean Line anticipates that it will enter into an Interconnection Agreement (IA) with PJM and AEP for the Project.

The double-circuit 345kV AC interconnection line between the Illinois converter station and the new substation will consist of an arrangement of three electrical phases per circuit, each with a two-conductor bundle (i.e., two subconductors) in a vertical configuration of about 18 to 24 inches separation. Each conductor will be an approximately 1- to 1.5-inch diameter aluminum conductor with a steel reinforced core, or a very similar configuration. Clean Line will design minimum conductor height above the terrain, assuming no clearance buffers, per Rule 232D of the NESC, Edition 2012, requiring 25 feet of clearance above general areas and areas with vehicular traffic. The NESC provides for minimum distances between the conductors and the ground, crossing points of other lines, the transmission support structure, and other conductors on the same structure. The NESC also provides minimum working clearances for personnel during energized operation and maintenance activities (NESC 2012). The exact height of each tower and required vertical clearances is governed by topography and safety requirements.

2.1.4 Missouri Converter Station and Other Terminal Facilities

The Missouri converter station will be the same as described in Section 2.1.1, "Elements Common to the Converter Stations."

AC Interconnection Process and Facilities, Missouri

An AC interconnection is required to deliver power from the intermediate converter station to the existing transmission system owned by Ameren Missouri, a subsidiary of Ameren Corp. Ameren Missouri is part of the MISO system. Clean Line submitted the interconnection request to MISO in September 2012. Under MISO rules, interconnection requests and interconnection agreements involve three parties: the system operator (MISO), the transmission owner (Ameren Missouri) and the interconnecting customer (Clean Line).

The AC interconnection for the Missouri Converter Station would involve looping an existing 345 kV AC line into the converter station AC yard or into a new, adjacent AC substation. An additional 5 acres will be required during construction of the converter station and 345kV AC interconnection for materials staging and equipment storage. The design and layout of the interconnection facilities are dependent on the results of ongoing interconnection and engineering studies.

Table 2-1 Kansas Converter Station and Associated Facilities Dimensions and Land Requirements		
Facility	**Construction Dimensions**	**Operation Dimensions**
Kansas Converter Station		
Kansas Converter Station (Figures 2-2a, "Kansas Converter Station Siting Area Property Location," and 2-2b, "Kansas Converter Station Siting Area Property Aerial")	45 to 60 acres of land will be required for the station, plus an additional 5 to 10 acres for construction.	45 to 60 acres of land will be required for the station; approximately 45 acres will be fenced.
Kansas Converter Station Access Road	All weather access roads 20 feet wide by less than 1 mile long will be required. Construction of the access roads may disturb an area up to 35 feet wide.	20 feet wide, paved roadways.
Kansas AC Interconnection Facility Dimensions and Land Requirements [1]		
ROW (Figure 2-19, "AC R.O.W. Limits")	Kansas AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.	Kansas AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.
345kV **Lattice Structures**	Kansas AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.	Kansas AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.
AC Interconnection Point	(Inside the Kansas Converter Station AC yard or inside a new, adjacent substation)	(Inside the Kansas Converter Station AC yard or inside a new, adjacent substation)

(1) The ultimate design of the interconnections will be dependent on interconnection studies and engineering studies.

Table 2-2
Illinois and Indiana
Converter Station and Associated Facilities
Dimensions and Land Requirements

Facility	Construction Dimensions	Operation Dimensions
Illinois Converter Station		
Illinois Converter Station (Figures 2-3a, "Illinois Converter Station Siting Area Property Location," and 2-3b, "Illinois Converter Station Siting Area Property Aerial")	Forty-five to 60 acres of land will be required, plus an additional 5 to 10 acres for construction.	Forty-five to 60 acres of land will be required for the station; approximately 45 acres will be fenced.
Illinois Converter Station Access Road	All weather access roads 20 feet wide by less than 1 mile long will be required. Construction of the access roads may disturb an area up to 35 feet wide.	20 feet wide, paved roadways.
Illinois and Indiana AC Interconnection Facility Dimensions and Land Requirements [1]		
ROW (Figure 2-19, "AC R.O.W. Limits")	One 345kV ROW 150–200 feet wide x 7 miles long	One 345kV ROW 150–200 feet wide x 7 miles long
345kV **Lattice Structures** (Figures 2-20a, "345kV Lattice Deadend," and 2-20b, "345kV Lattice V-String") (Figures 2-21, "345kV Lattice Work Area," and 2-22, "345kV Lattice Plan View")	Structure assembly area 150 feet wide (ROW width) x 150 feet long (within ROW) 5 to 7 structures per mile	Structural footprint 28 feet x 28 feet (typical for lattice structures) 75 to 180 feet tall 5 to 7 structures per mile
345kV **Tubular Pole Structures** (Figures 2-23a, "345kV 3-Pole Running Angle," 2-23b, "345kV 3-Pole Deadend," 2-24a, "345kV 3-Pole Guyed Running Angle," 2-24b, "345kV 3-Pole Guyed Deadend," 2-25a, "345kV Double Circuit Pole Deadend," 2-25b, "345kV Double Circuit Pole V-String," 2-26a, "345kV Single Circuit Pole Deadend," 2-26b, "345kV Pole Braced Post," 2-26c, "345kV Single Circuit Pole V-String,") (Figure 2-27, "345kV Monopole Work Area")	Structure assembly area 150 feet wide (ROW width) x 150 feet long (within ROW) 5 to 7 structures per mile	Structural footprint 7 feet x 7 feet (typical for tubular pole structures) 75 to 180 feet tall 5 to 7 structures per mile
AC Interconnection Point	(Inside the existing Breed substation)	(Inside the existing Breed substation)

(1) The ultimate design of the interconnections will be dependent on interconnection studies and engineering studies.

Table 2-3
Missouri
Converter Station and Associated Facilities
Dimensions and Land Requirements

Facility	Construction Dimensions	Operation Dimensions
Missouri Converter Station		
Missouri Converter Station (Figure 2-4a, "Missouri Converter Station Siting Area Property Location," and 2-4b, "Missouri Converter Station Siting Area Property Aerial")	Forty-five to 60 acres of land will be required, plus an additional 5 to 10 acres for construction.	Forty-five to 60 acres of land will be required for the station; approximately 45 acres will be fenced.
Missouri Converter Station Access Road	All weather access roads 20 feet wide by less than 1 mile long will be required. Construction of the access roads may disturb an area up to 35 feet wide.	20 feet wide, paved roadways.
Missouri AC Interconnection Facility Dimensions and Land Requirements [1]		
ROW (Figure 2-19, "AC R.O.W. Limits")	Missouri AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.	Missouri AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.
345kV **Lattice Structures**	Missouri AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.	Missouri AC interconnection ties are expected to be contained entirely within the converter station footprint and/or the footprint of a new, adjacent substation. No additional ROW is required.
AC Interconnection Point	(Inside the Missouri Converter Station AC yard or inside a new, adjacent substation)	(Inside the Missouri Converter Station AC yard or inside a new, adjacent substation)

(1) The ultimate design of the interconnections may change, based interconnection studies and engineering studies.

2.2 HVDC Transmission Line

The Project will transmit energy via a ± 600kV HVDC transmission line. The final location of the ROW for the HVDC transmission line will be determined following engineering design and ROW acquisition activities.

Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," provides the typical facility dimensions and anticipated typical land requirements during construction and operation of the HVDC transmission line.

Table 2-4
HVDC Transmission Line Facility Dimensions and Land Requirements

Facility	Construction Dimensions	Operation Dimensions
ROW (Figure 2-6, "DC R.O.W. Limits")	200 feet wide x approximately 780 miles long	200 feet wide x approximately 780 miles long
Lattice Structures (Figures 2-6, "DC R.O.W. Limits," 2-7a, "600kV Lattice Deadend," 2-7b, "600kV Lattice Running Angle," 2-7c, "600kV Lattice Tangent," 2-8, "600kV DC Lattice Work Area," and 2-9, "600kV DC Lattice Foundation and Structure Construction Activities-Plan View")	Structure assembly area 200 feet wide (ROW width) x 200 feet long (within ROW) 4 to 6 areas per mile (one for each structure)	Structural footprint 28 feet x 28 feet (typical) 120 to 200 feet tall (typical) 4 to 6 structures per mile
Monopole Structures (Figures 2-6, "DC R.O.W. Limits," 2-10a, "600kV Monopole Deadend," 2-10b, "600kV Monopole Running Angle," 2-10c, "600kV Monopole Tangent," 2-11, "600kV DC Monopole Work Area," and 2-12 "600kV DC Monopole Foundation and Structure Construction Activities-Plan View")	Structure assembly area 200 feet wide (ROW width) x 200 feet long (within ROW) 5 to 7 areas per mile (one for each structure)	Structural footprint 7 feet x 7 feet (typical) 120 to 160 feet tall (typical) 5 to 7 structures per mile
Guyed Structures (Figures 2-13, "600kV Guyed Mast Lattice Tangent," and 2-14, "600kV Guyed V-Lattice Tangent")	Structure assembly area 200 feet wide x 300 feet long	Structural footprint 7 feet x 7 feet typical (does not include guy wire[s]) 120 to 200 feet tall
Lattice Crossing Structures (Figure 2-15, "600kV Lattice Crossing Structure")	Structure assembly area 200 to 550 feet wide x 300 feet long As necessary in limited situations (e.g., Mississippi River and Missouri River crossings)	Structural footprint 64 feet x 64 feet (for a 350-foot-tall version) 200 to 350 feet tall As necessary in limited situations

Table 2-4 HVDC Transmission Line Facility Dimensions and Land Requirements		
Facility	**Construction Dimensions**	**Operation Dimensions**
Fiber Optic Regeneration Sites (Figure 2-17, "Regeneration Station Plan")	100 feet wide x 100 feet long (outside the ROW) one site every 50 to 70 miles (780 miles/1 site every 60 miles = approximately 13 sites) Typically within, but potentially outside the ROW and near the ROW (within 500 feet) but not necessarily abutting the ROW	100 feet wide x 100 feet wide 75 feet wide x 75-ft-long fenced area Control building 12 x 32 feet and 9 feet tall, within the fenced area. Permanent access road to the fenced area. Power supply to control building. Backup power generator and fuel supply.

2.2.1 Right-of-Way

ROW easements for the transmission line, with a typical width of approximately 150 to 200 feet, will be required. Figure 2-6, "DC R.O.W. Limits," depicts the ROW requirements for the HVDC transmission line. Section 4.2, "Permitted Uses within the Right-of-Way," provides restrictions on use within the ROW during operation.

2.2.2 Structures

The structures used to support the transmission line will be constructed of either tubular or lattice steel and will typically range in height from 120 to 200 feet. Preliminary engineering indicates that, when using lattice, most structures would be less than 160 feet and when using monopole structures tend to be less than 140 feet. Structure heights, span lengths, and vertical clearance will be determined in accordance with the National Electrical Safety Code (NESC), Clean Line design criteria, terrain and land use, and all applicable standards and laws. Clean Line may use taller structures in circumstances where additional clearances and/or longer spans are required. Typical structures include lattice structures and monopole structures (e.g., tubular steel structures and masts), as summarized in Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," and depicted on Figures 2-7a, "600kV Lattice Deadend," 2-7b, "600kV Lattice Running Angle," 2-10a, "600kV Monopole Deadend," 2-10b, "600kV Monopole Running Angle," and 2-10c, "600kV Monopole Tangent." In addition to typical structures, there will be limited use of lattice crossing structures (presently planned for the crossing of the Mississippi River and the crossing of the Missouri River) composed of lattice steel, which could approach 350 feet in height in order to maintain necessary clearance over the navigable channels. There could also be limited use of guyed structures, either tubular or lattice steel.

Clean Line will select structure types at locations along the Project ROW based on, but not limited to, land use, engineering efficiency, ROW restrictions, and existing facilities. Clean Line anticipates using guyed structures only in open grass or shrub terrain.

Clean Line will use either galvanized or weathering steel structures. Pier foundations, screw piles, caissons, concrete footings, guying, or other foundations will support the structures based on engineering considerations, cost, and land use. Direct embedment of structures may be possible if loadings and soil conditions at a specific site allow for direct burial. The structural footprint will vary by structure type; Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," describes these requirements.

Clean Line will not complete final design for the HVDC transmission line until a final route is chosen and subsequent detailed engineering studies and ROW acquisition activities are complete. Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," summarizes typical dimensions for structures. Drawings of the structures are included as Figures 2-8a, "600kV Lattice Deadend," 2-8b, "600kV Lattice Running Angle," 2-11a, "600kV Monopole Deadend," 2-11b, "600kV Monopole Running Angle," 2-11c, "600kV Monopole Tangent," 2-14a, "600kV Guyed Mast Tubular Tangent," 2-14b, "600kV Guyed V-Tube Tangent," 2-14c, "600kV Guyed Monopole Tangent," 2-14d, "600kV Guyed Chainette Tangent," 2-14e, "600kV Guyed Mast Lattice Tangent," 2-14f, "600kV Guyed V-Lattice Tangent," and 2-15, "600kV Lattice Crossing Structure."

2.2.3 Conductor

The ±600kV HVDC line will consist of an arrangement of two electrical poles,[1] each with a three-conductor bundle (i.e., three subconductors) arranged in a triangle of 18 to 24 inches on each side. Each subconductor will be an approximately 1- to 2-inch diameter aluminum/steel conductor with a steel reinforced core, or a very similar configuration. The aluminum/steel conductor is composed of three layers of aluminum strands wrapped around a core of steel strands. The aluminum provides the current carrying capacity and the steel provides additional mechanical strength. Alternatively, Clean Line may use a four-conductor bundle per pole (i.e., four subconductors) based on future economic or engineering analysis. In that case, Clean Line will arrange each bundle in a square configuration 18 to 24 inches on each side or similar. Clean Line will design minimum conductor height above the terrain, assuming no clearance buffers, per Rule 232D of the NESC, Edition 2012, which requires a minimum of 31 feet for general areas and areas with vehicular traffic. The NESC provides for minimum distances between the conductors and the ground, crossing points of other lines, the transmission support structure, and other conductors on the same structure. The NESC also provides minimum working clearances for personnel during energized operation and maintenance activities (NESC 2012). Topography and safety requirements govern the exact height of each structure and required vertical clearances. Figure 2-6, "DC R.O.W. Limits," depicts the ROW requirements for the HVDC transmission line and the conductor clearance. The conductor is placed on the transmission structure. The typical structure placement of the conductor in relation to other facilities is depicted on the typical structure drawings (Figures 2-7a, "600kV Lattice Deadend," 2-7b, "600kV Lattice Running Angle," 2-10a, "600kV Monopole Deadend," 2-10b, "600kV Monopole Running Angle," 2-10c, "600kV Monopole Tangent," 2-13, "600kV Guyed Mast Lattice Tangent," 2-14, "600kV Guyed V-Lattice Tangent," and 2-15, "600kV Lattice Crossing Structure").

2.2.4 Metallic Return

The Project includes a dedicated metallic conductor return configuration in lieu of a ground electrode or earth return system. An HVDC system requires a complete return path for the current. In bi-pole operation, this is accomplished by the current flowing down one pole and returning via the opposite pole in balanced normal operation. However, when one set of pole conductors are not available due to the

[1] HVDC schemes, like those Clean Line is proposing, are typically arranged in a bi-pole configuration; meaning there are two electrical poles with one at an electrical potential that is positive with respect to ground potential and one that is negative with respect to ground potential. In the case of HVDC transmission lines, a pole is akin to a phase in AC technology.

electrical failure of that pole or maintenance, the current must have a return path for the line to remain in service. This is accomplished through a smaller set of conductors identified as the dedicated metallic return conductors. These conductors will be of sufficient size to carry full load current during any outage of one set of pole conductors and will also accommodate any imbalance in current during normal operation. Clean Line will place the metallic return on the transmission structure. The typical structure drawings (Figures 2-7a, "600kV Lattice Deadend," 2-7b, "600kV Lattice Running Angle," 2-10a, "600kV Monopole Deadend," 2-10b, "600kV Monopole Running Angle," and 2-10c, "600kV Monopole Tangent") depict the typical structure placement of the metallic return in relation to other facilities.

2.2.5 Optical Ground Wire and Static Wire

The Project includes one OPGW and one static wire to protect the transmission line from direct lightning strikes. Clean line will install these overhead ground wires, approximately 0.75 to 1 inch in diameter, on the top of the transmission structures. The ground wires and structures will transfer current from lightning strikes through the ground wires and structures into the ground. The typical structure drawings (Figures 2-7a, "600kV Lattice Deadend," 2-7b, "600kV Lattice Running Angle," 2-10a, "600kV Monopole Deadend," 2-10b, "600kV Monopole Running Angle," and 2-10c, "600kV Monopole Tangent") depict the typical structure placement of the OPGW (shield wire/OPGW) and static wire in relation to other facilities.

2.2.6 Communication Facilities

Fiber optic cable is embedded within the OPGW to allow direct communication between converter stations. Fiber optic cables typically have 24 to 48 fibers each. Based on typical practice, Clean Line will use four to six fibers for communications between the converters. The remaining fibers can be utilized as spares or for other communication purposes subject to applicable regulatory requirements.

2.2.7 Fiber Optic Regeneration Sites

As a data signal passes through fiber optic cable, the data signal degrades with distance. This data signal must be regenerated or amplified every 50 to 70 miles at fiber optic regeneration sites. Typical dimensions for fiber optic regeneration sites are summarized in Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," along with the approximate number of sites required for the HVDC transmission line.

A typical fiber optic regeneration site will be approximately 100 feet by 100 feet, with a fenced area of approximately 75 feet by 75 feet. Regeneration sites are typically adjacent to the ROW. A small control building made of either metal or concrete, approximately 12 feet by 32 feet by 9 feet tall, will enclose the regeneration equipment. An access road and power supply to the site will be required. An existing electric distribution line near the fiber optic regeneration site typically supplies power. If required, the local service provider will extend power lines to serve the regeneration site; these distribution lines will likely be placed on single wood poles, or they may be buried. The voltage of the power supply line is typically 34.5kV or lower. The location and routing of the existing distribution lines to the new sites will be determined during the final design process. Clean Line will install an emergency generator with fuel storage at the site, inside the fenced area. Two cable routes (aerial and/or buried) between the transmission ROW and the equipment shelter will be required.

There are two basic methods of direct burial installation for the cables: trenching and plowing. Trenching involves digging a trench, placing the cable in the trench, and backfilling with native soils. Trenches are often dug with backhoes using narrow buckets (18 inches wide or less) to a depth of approximately 42 inches and are visually inspected for rocks or debris that could potentially damage the cable. In some instances, conduit is laid in the trench and the cable pulled through the conduit. Plowing involves a cable-laying plow designed to simultaneously excavate a ditch and lay the cable. Native soil is used to backfill the ditch.

A permanent access road to each fiber optic regeneration site will be required. Clean Line may also use these access roads for permanent access to the transmission lines. Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," summarizes typical construction and operation dimensions for fiber optic regeneration sites. Figure 2-17, "Regeneration Station Plan," depicts a typical fiber optic regeneration site.

2.3 AC Collection System

In addition to the HVDC transmission line, the Project will also include AC collection transmission lines to collect energy from generation resources in the Western Kansas Region.

The Project will include the construction and operation of an AC collection system in Western Kansas. The collection system will consist of four to six AC transmission lines up to 345kV from the Kansas converter station to points in the Western Kansas region to facilitate efficient interconnection of wind energy generation. Clean Line expects that the point of interconnection from generation facilities will be located within approximately 40 miles of the Kansas converter station. Wind energy generation facilities (wind farms) would connect to the AC Collection System by way of a number of possible configurations. These configurations could range in size from a direct tap, a bus ring, or even a small substation (up to 2 to 5 acres in size) with transformer and switching equipment. The type and size of these AC connections is unknown at this time; the final design of these facilities is dependent on a number of factors including their location, the number of connections, and the nameplate capacity and voltage of generation facilities.

Figure 1-1, "Project Overview," depicts the siting area for the AC collection system in the Western Kansas Region. Table 2-5, "AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements," provides the typical facility dimensions and anticipated typical land requirements during construction and operation of the AC collection facilities.

Table 2-5
AC Collection System Western Kansas Region
Transmission Lines Facility Dimensions and Land Requirements

Facility	Construction Dimensions[1]	Operation Dimensions
ROW (Figure 2-19, "AC R.O.W. Limits")	Four to six 345kV ROWs each: 150–200 feet wide x extending up to 40 miles from the converter station	Four to six 345kV ROWs each: 150–200 feet wide x extending up to 40 miles from the converter station
345kV **Lattice Structures** (Figures 2-20a, "345kV Lattice Deadend," and 2-20b, "345kV Lattice V-String") (Figures 2-21, "345kV Lattice Work Area," and 2-22, "345kV Lattice Foundation and Structure Construction Activities - Plan View")	Structure assembly area 150 feet wide (ROW width) x 150 feet long (within ROW) 5 to 7 structures per mile	Structural footprint 28 feet x 28 feet (typical for lattice structures) 75 to 180 feet tall 5 to 7 structures per mile
345kV **Tubular Pole Structures** (Figures 2-23a, "345kV 3-Pole Running Angle," 2-23b, "345kV 3-Pole Deadend," 2-24a, "345kV 3-Pole Guyed Running Angle," 2-24b, "345kV 3-Pole Guyed Deadend," 2-25a, "345kV Double Circuit Pole Deadend," 2-25b, "345kV Double Circuit Pole V-String," 2-26a, "345kV Single Circuit Pole Deadend," 2-26b, "345kV Pole Braced Post," 2-26c, "345kV Single Circuit Pole V-String,") (Figure 2-27, "345kV Monopole Work Area")	Structure assembly area 150 feet wide (ROW width) x 150 feet long (within ROW) 5 to 7 structures per mile	Structural footprint 7 feet x 7 feet (typical for tubular pole structures) 75 to 180 feet tall 5 to 7 structures per mile
345kV H-Frame Structures (Figures 2-28a, "345kV Braced H-Frame," 2-28b, "345kV H-Frame Tangent," and 2-28c, "345kV H-Frame V-String")	Structure assembly area 150 feet wide (ROW width) x 150 feet long (within ROW) 5 to 7 structures per mile	Structural footprint Two poles spaced 25 feet apart each with a 7 feet x 7 feet footprint (typical for H-frame structures) 75 to 180 feet tall 5 to 7 structures per mile

Table 2-5 AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements		
Facility	**Construction Dimensions**[1]	**Operation Dimensions**
Fiber Optic Regeneration Site (Figure 2-17, "Regeneration Station Plan")	100 feet wide x 100 feet long (outside the ROW) (Approximately 6 sites required for the 4 to 6 AC collection system lines) Outside the ROW and near the ROW (within 750 feet) but not necessarily abutting the ROW	100 feet wide x 100 feet wide 75 feet wide x 75-foot-long fenced area Control building 12 x 32 feet and 9 feet tall, within the fenced area. Permanent access road to the fenced area. Power supply to control building. Backup power generator and fuel supply.

(1) The ultimate design of the interconnections will be dependent on interconnection studies and engineering studies.

2.3.1 Right-of-Way

Right-of-way easements for the AC collection transmission lines, with a typical width of approximately 150 to 200 feet, will be required. The ROW requirements for the AC collection transmission line are depicted on Figure 2-19, "AC R.O.W. Limits." Restrictions on use within the ROW during operation are provided in Section 4.2, "Permitted Uses within the Right-of-Way."

2.3.2 Structures

The structures used to support the AC collection transmission lines will be constructed of either tubular or lattice steel and will generally range in height from 75 to 180 feet. Clean Line will determine structure heights, span lengths and vertical clearance in accordance with the NESC, Clean Line design criteria, and all applicable standards and laws. Clean Line may use taller structures in circumstances where additional clearances and/or longer spans are required based on engineering review.

Clean Line will construct the structures of either galvanized or weathering steel. Pier foundations, screw piles, caissons, concrete footings, guying, or other appropriate foundations will support the structures. Direct embedment of structures may be possible if loadings and soil conditions at a specific site allow for direct burial. The structural footprint will vary by structure type and these are described in Tables 2-1, "Kansas Converter Station and Associated Facility Dimensions and Land Requirements," 2-2, "Illinois Converter Station and Associated Facility Dimensions and Land Requirements," 2-3, "Missouri Converter Station and Associated Facility Dimensions and Land Requirements," and 2-5, "AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements."

Clean Line will complete final design for the AC collection transmission lines after a final route is chosen and subsequent detailed engineering studies and ROW acquisition activities are complete.

Typical structures include lattice structures and tubular pole structures and the dimensions are summarized in Tables 2-1, "Kansas Converter Station and Associated Facility Dimensions and Land Requirements," 2-2, "Illinois Converter Station and Associated Facility Dimensions and Land

Requirements," 2-3, "Missouri Converter Station and Associated Facility Dimensions and Land Requirements," and 2-5, "AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements." They are depicted on Figures 2-20a, "345kV Lattice Deadend," 2-20b, "345kV Lattice V-String," 2-23a, "345kV 3-Pole Running Angle," 2-23b, "345kV 3-Pole Deadend," 2-24a, "345kV 3-Pole Guyed Running Angle," 2-24b, "345kV 3-Pole Guyed Deadend," 2-25a, "345kV Double Circuit Pole Deadend," 2-25b, "345kV Double Circuit Pole V-String," 2-26a, "345kV Single Circuit Pole Deadend," 2-26b, "345kV Pole Braced Post," and 2-26c, "345kV Single Circuit Pole V-String."

In addition to typical structures, Clean Line may employ use of H-frame structures, typically tubular steel.

2.3.3 Conductor

The ROW requirements for the AC transmission line are depicted on Figure 2-19, "AC R.O.W. Limits," and conductor clearance is illustrated. Typical structure drawings depict the typical placement of the conductor in relation to other facilities on the structure.

2.3.4 Optical Ground Wire and Static Wire

Clean Line will install one OPGW and one static wire to protect the transmission lines from direct lightning strikes. Clean Line will install these overhead ground wires, approximately 0.75 to 1 inch in diameter, on the top of the transmission structures. The ground wires and structures will transfer current from lightning strikes through the ground wires and structures into the ground. The typical structure placement of the OPGW and static wire in relation to other facilities is depicted on the typical structure drawings.

2.3.5 Communication Facilities

Fiber optic cable is embedded within the OPGW to support communications between substations. Fiber optic cables will typically have 24 to 48 fibers each. Based on typical practice, four to six fibers will be used for communications between the converters. The remaining fibers can be utilized as spares or for other communication purposes.

2.3.6 Fiber Optic Regeneration Sites

Clean Line will install and operate fiber optic regeneration sites along the AC transmission lines associated with the AC collection system in the Western Kansas Region. As a data signal passes through fiber optic cable, the data signal degrades with distance. This data signal must be regenerated or amplified every 50 to 70 miles. A typical fiber optic regeneration site is described in Section 2.2.7, "Fiber Optic Regeneration Sites." Typical dimensions for fiber optic regeneration sites are summarized in Table 2-5, "AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements," along with the approximate number of sites required for the AC collection system.

2.4 Access Roads

Clean Line intends to maximize the use of existing public and private roads to the extent practicable, improve some roads on private land where they are insufficient, and build some new access roads. Clean Line will use access roads during both construction and operation of the project. During construction, new and existing roads are required to access transmission ROWs (for clearing and for moving equipment to structure locations), structure locations, fiber optic regeneration sites and temporary construction areas. During operation of the project, new and existing roads are required to access transmission ROWs (for vegetation management and movement of maintenance equipment) and to access structure locations and fiber optic regeneration sites for maintenance (see Section 4, "Operations and Maintenance"). A new, permanent access road along the entire length of the ROW is not required.

Clean Line will locate access between structures in active agricultural areas along fence lines or field lines where practicable to minimize impacts. Site conditions, engineering design, construction requirements, adopted environmental protection measures and relevant permits will govern the specific locations of proposed new and existing access roads. Clean Line's road construction standards will be in accordance with appropriate jurisdictions' requirements. There are no plans for improvements[2] to public roads (e.g., highways, state roads, or county roads). Clean Line plans to repair existing private roads before and after construction. Any paving will be limited to approach aprons at intersections with existing paved roads and all-weather access roads to converter stations, unless otherwise required by jurisdictional authorities.

2.4.1 Existing Access Roads

Clean Line will use existing roads for access during construction and operation of the project wherever practicable. Some existing roads may require improvement prior to use. Clean Line divided existing roads into three categories for the purposes of this description, as follows:

- Existing (Public or Private) Roads with No Improvements,
- Existing (Private) Roads that May Need Repairs, and
- Existing (Private) Roads that Need Improvements.

Any improvements to existing roads will be left in place for access during Project operation, where practicable. Table 2-6, "Access Roads Facility Dimensions and Land Requirements" includes more detailed descriptions of each category of existing roads.

2.4.2 New Access Roads

New access for construction equipment will be required where the use of existing roads is not practicable or where existing roads do not provide adequate access. Access types can range from direct overland travel to mat-covered or aggregate temporary roads, and new graded roads that may be shaped with drainage. Clean Line will site new access roads to avoid steep side slopes where practicable. In areas of moderate to steep terrain, Clean Line will site roads to fit the terrain by following the natural contours. In some instances, vertical slopes from 15 percent to 20 percent are acceptable, but roads will not typically exceed straight-line lengths of 1,000 feet in areas with steep terrain. Clean Line will avoid areas with steep terrain and slopes greater than 20 percent to the extent practicable.

Clean Line divided new roads into four categories for the purposes of description as follows:

- New Overland Travel Roads (no improvements needed),
- New Overland Travel Roads with Clearing,
- New Bladed Roads, and

[2] Improvements are upgrades or expansions to allow passage of equipment or vehicles that would include, for example, alignment modifications or structural replacement (e.g. bridge or culvert). Repairs, as defined in the table, include minor activities such as pothole repair.

- New Temporary Matted or Aggregate Roads.

New roads may be temporary (removed after construction) or left in place to provide access during operation and maintenance of the project. Table 2-6, "Access Roads Facility Dimensions and Land Requirements" includes more detailed descriptions of each category of new roads and whether that road will be removed after construction or preserved for access during Project operation.

Typical facility dimensions and anticipated typical land requirements during construction and operation for access roads associated with converter stations are included in Tables 2-1, "Kansas Converter Station and Associated Facility Dimensions and Land Requirements," 2-2, "Illinois Converter Station and Associated Facility Dimensions and Land Requirements," and 2-3, "Missouri Converter Station and Associated Facility Dimensions and Land Requirements." Table 2-6, "Access Roads Facility Dimensions and Land Requirements," provides the typical facility dimensions and anticipated typical land requirements during construction and operation for access roads associated with HVDC and AC transmission lines. Typical access roads are depicted on Figure 2-29, "Typical Access Roads."

Estimated access road miles for converter stations are included in Tables 2-1, "Kansas Converter Station and Associated Facility Dimensions and Land Requirements," 2-2, "Illinois Converter Station and Associated Facility Dimensions and Land Requirements," 2-3, "Missouri Converter Station and Associated Facility Dimensions and Land Requirements."

Table 2-6, "Access Roads Facility Dimensions and Land Requirements," includes a description of existing roads with no improvements; however, Clean Line will use existing public roads during construction and operation of the Project to the extent practicable.

Table 2-6
Access Roads Facility Dimensions and Land Requirements

Road Type	Definition	Construction Dimensions	Operation Dimensions
Existing Roads			
Existing Roads with No Improvements or Repairs (Public or Private Roads)	Existing roads with no improvements or repairs include public roads maintained by local or state jurisdictions. Private roads that can support construction traffic with no improvements or repairs are also included in this category.	Anticipate existing roads with no improvements or repairs are suitable for construction as is. No construction or ground disturbance expected.	Existing roads with no improvements or repairs are suitable for operation as is.
Existing Roads that May Need Repairs (Private Roads)	Existing roads that may need repairs include most dirt and unimproved two-track roads on private land (not publically maintained roads), which are generally in a condition that supports construction traffic with repairs in some spots. No improvements to public roads are planned for construction. Examples of repairs would include grading to remove potholes or surface ruts over short distances. In many cases, grading would include reshaping the surface to	Typically, 14 feet wide travel surface at straight sections and 16 to 20 feet wide at corners. In areas with steep side slopes (greater than 15%), the construction disturbance corridor may be up to 50 feet wide. It is assumed that construction would typically use a total corridor up to 35 feet wide for these roads in limited areas where repairs are needed. However, it is assumed that the new disturbance width would be reduced by the width of the	Repairs to existing roads will be left in place to facilitate access during Project operation.

Table 2-6
Access Roads Facility Dimensions and Land Requirements

Road Type	Definition	Construction Dimensions	Operation Dimensions
	promote drainage from the travel surface. In some cases, it may be necessary to replenish and re-grade gravel-surfacing material.	existing road (e.g., 35-foot-wide construction corridor – 16-foot-wide existing road = 19-foot-wide new disturbance). Further, for disturbance estimates, it is assumed that repairs will be needed on 10% of the road surface of those roads identified as being in this category. New disturbance footprint is estimated to be 19*5280*0.1/43560 = 0.23 acres/mile.	
Existing Roads that Need Improvements (Private Roads)	Existing roads that need improvements include private roads along which modifications to alignment, structural improvements, or drainage improvements are required before they could be used for construction and/or operation of the Project. These are roads that could not support construction traffic without significant upgrades. Some examples include private roads that traverse numerous drainages, exhibit severe rutting, or have sharp switchbacks. Structural improvements typically involve excavation and replacement of unstable roadbed with structural embankment fill over geotextile and gravel surfacing.	Typically, 14 feet wide travel surface at straight sections and 16 to 20 feet wide at corners. In areas with steep side slopes (greater than 15%), the construction disturbance corridor may be up to 50 feet wide. It is assumed that construction would typically use a total corridor up to 35 feet wide for these roads. However, it is assumed that the new disturbance width would be reduced by the width of the existing road (e.g., 35-foot-wide construction corridor – 16-foot-wide existing road = 19-foot-wide new disturbance). New disturbance footprint for improvements is assumed to be 19'*5280/43560 = 2.3 acres/mile	Improvements to existing roads will be left in place to facilitate access during Project operation.
New Roads			
New Overland Travel Roads (no improvements needed) (Private Roads)	Overland travel roads include routes that are created by direct vehicle travel over low-growth vegetation and do not require clearing or grading. Existing low-growth vegetation will be maintained where practicable. These roads require no preparation prior to use by vehicles and equipment.	Typically, 14 feet wide travel surface at straight sections and 16 to 20 feet wide at corners. It is assumed that there will be no clearing or grading for these roads. Construction traffic would occur over an area 14 -20 feet wide. New disturbance footprint is assumed to be 20*5280/43560 = 2.4 acres/mile	Clean Line estimates that 75% of construction roads will be re-used for operation and maintenance access.

Table 2-6
Access Roads Facility Dimensions and Land Requirements

Road Type	Definition	Construction Dimensions	Operation Dimensions
New Overland Travel Roads with Clearing (Private Roads)	New overland travel roads with clearing include overland travel routes that require clearing and minor grading using heavy machinery to remove larger vegetation or other obstructions in some locations to ensure safe vehicle operation and access.	Typically, 14 feet wide travel surface at straight sections and 16 to 20 feet wide at corners. In areas with steep side slopes (greater than 15%), the construction disturbance corridor may be up to 50 feet wide. It is assumed that construction disturbance would typically include an average corridor up to 35 feet wide for these roads. New disturbance footprint is assumed to be 35'*5280/43560 = 4.2 acres/mile.	Clean Line estimates that 90% of construction roads will be re-used for operation and maintenance access.
New Bladed Roads (Private Roads)	New bladed roads may be constructed to access structure locations or temporary work areas in steep or uneven terrain. Bladed roads are generally used on side slopes greater than 8% and are shaped to provide drainage. New bladed roads are typically un-surfaced unless required by the applicable jurisdiction where soil and moisture conditions contribute to surface erosion or rutting.	It is assumed that construction disturbance for these roads will be 35 feet wide for 90% of the new bladed roads used for the Project. Assumed new disturbance footprint for slopes < 15% is 35'*5280*1/43560 = 4.2 acres/mile In areas with steep side slopes (greater than 15%), construction disturbance may be up to 50 feet wide. Such areas are assumed to represent 10% of new bladed roads for the Project. Assumed new disturbance footprint for slopes > 15% is 50'*5280/43560 = 6.1 acres/mile.	Clean Line estimates that 90% of construction roads will be re-used for operation and maintenance access.
New Temporary Matted or Aggregate Roads (Private Roads)	New matted or aggregate roads are temporary driving surfaces used to access structures or temporary work areas in soft, wet conditions. These would include a timber or composite temporary mat or aggregate underlain by geotextile fabric.	It is assumed that the temporary construction disturbance for these roads will typically be 35 feet wide. Assumed temporary disturbance footprint is 35*5280/43560	No roads of this type will be retained for operations and maintenance.

Notes:

Disturbance Footprints

Disturbance footprints for new bladed roads are related to side slope. Using AutoCAD Civil 3D a surface model was used to establish the disturbance footprint impacted by construction of a 14-foot wide bladed road traversing a hillside with variable slopes. Existing ground and proposed finish road surface profiles were created of the roadway alignment. Design parameters were selected for low volume service roads for this analysis and the finish grade profile was established to closely follow the existing ground surface to minimize cuts and fills. A crowned road section with variable daylight treatments was assumed. Sample cross sections were established at major engineering stations along the corridor alignment and the disturbance width between daylight catch points were recorded along with existing side slope at each cross section. Slope and disturbance width data was tabulated for each station, sorted by side slope and average disturbance widths were established for select slope ranges. Disturbance footprints in acres per mile were established for each access road type consistent with construction dimensions.

3.0 Typical Construction

This section describes general construction practices for the converter stations (Section 3.1), the HVDC and AC transmission lines (Section 3.2), and access roads (Section 3.3). Section 3.4 provides information on construction of the interconnections. Section 3.5 discusses how Clean Line will handle hazardous materials during construction of all Clean Line facilities. Section 3.6 discusses gravel sources. Appendix B, "Workforce and Crews" provides estimates of the construction workforce (by crew type and over time), crew types (based on construction activities), and crew numbers. Clean Line will complete access road layout and geologic/geotechnical investigations during engineering design. All of such practices are subject to final contracting, engineering and design.

Pre-construction activities for transmission lines and converter station facilities include:

- Land surveys for structure and boundary location staking;
- Access road survey and staking;
- Training; and
- Pre-construction surveys for biological and cultural resources, as required by federal or state permits.

Clean Line will mark and survey the boundaries of all construction workspaces. Clean Line will keep construction sites, material storage yards, and access roads in an orderly condition throughout the construction period. Clean line will train construction personnel on safety and on the protection of sensitive resources, such as biological, cultural, and paleontological issues.

3.1 HVDC Converter Station Construction

The construction of a converter station includes:

- Land surveying and staking;
- Pre-construction surveys for biological and cultural resources;
- Clearing and grubbing, grading, and construction of all-weather access roads;
- Fencing;
- Compaction and foundation installation;
- Installation of underground electrical raceways and grounds;
- Steel-structure erection and area lighting;
- Installation of insulators, bus bar, and high-voltage equipment;
- Installation of Control and protection equipment;
- Placement of final crushed-rock surface; and
- Testing and electrical energization.

Clean Line will begin the construction of a typical converter station with survey work, geotechnical sample drillings, and soil resistivity measurements that Clean Line will use in the final design phases of the station. Once the near-final design of the station has been completed, a civil contractor will mobilize to perform site-development work, including grubbing and reshaping the general grade to form a relatively flat working surface. This effort also will include the construction of all-weather access roads. Clean Line will erect an 8-foot-tall chain-link fence around the perimeter of the station to prevent unauthorized personnel from accessing the construction and staging areas. The perimeter fence will be a permanent safety feature to prevent the public from accessing the station. Clean Line will compact the excavated and fill areas to the required densities to allow structural foundation installations. Following the foundation installation, underground electrical raceways and copper ground-grid installation will take place, followed by steel-structure erection and area lighting. The steel-structure erection will overlap the installation of the insulators and bus bar, as well as the installation of the various high voltage apparatus (typical of an electrical substation). The installation of the high voltage transformers will require special, high-capacity cranes and crews (as recommended by the manufacturer) to be mobilized for the unloading, setting-into-place, and final assembly of the transformers.

While the above-mentioned activities are taking place, Clean Line will construct, equip, and wire the enclosure that contains the control and protection equipment for the station. Clean Line will place a final crushed-rock surfacing on the subgrade to make a stable driving and access platform for the maintenance of the equipment. After Clean Line has installed the equipment, testing of the various systems will take place, followed by electrical energization of the facility. Clean Line will generally time the energization of the facility to take place with the completion of the transmission line work and other required facilities.

Construction of a single converter station is estimated to take 32 months. The construction personnel peak is estimated to be 242 workers, and the average over the construction duration is estimated to be 138 workers. An estimate of HVDC converter station construction workforce over time is included in Appendix B, "Workforce and Crews."

Table 3-1, "Typical HVDC Substation/Converter Station Construction and Equipment," provides the typical types of equipment Clean Line expects to use to construct a converter station.

Table 3-1
Typical HVDC Converter Station,
Estimated Equipment

Activity	Quantity of Equipment	Type of Equipment
Site Management	2	Office Trailer
	5	Pick-up Truck
	6	All-Terrain Vehicle (ATV)
	1	Loader Backhoe
	2	Truck (1-ton)
	2	Generator
Surveyors	5	Pick-up Truck
Site Development	1	Office Trailer
	8	Pick-up Truck
	8	Scraper
	1	Bulldozer (D-8 Cat or Equivalent)
	1	Bulldozer (D-4 Cat or Equivalent)
	4	Excavator 300 Series
	2	Excavator 100 Series
	4	Loader Backhoe
	2	Water Truck
	1	Road Sweeper
	4	Vibratory Compactor
	4	Motor Grader
	4	Wheel Loader (5 CY)
	2	Articulated Dump Truck
	10	Dump Truck
	2	Fuel Truck
	2	Mechanics' Truck
	14	Plate Compactor

Table 3-1
Typical HVDC Converter Station, Estimated Equipment

Activity	Quantity of Equipment	Type of Equipment
	4	Lowboy Truck
Fence Installation	5	Pick-up Truck
	4	Truck (1-ton)
	4	Forklift (Telescopic)
	3	Concrete Truck
	1	Concrete Line Pump
	4	Loader Backhoe
Equipment Footings	1	Office Trailer
	5	Pick-up Truck
	4	Truck (1-ton)
	4	100 Series Excavator
	4	Loader Backhoe
	2	Vibratory Compactor
	2	Wheel Loader (5 CY)
	4	Bobcat\Skid Loader
	2	Forklift (Telescopic)
	5	Dump Truck
	4	Concrete Truck
	2	Concrete Pump Truck
	2	Concrete Line Pump
	2	Air Compressor
	2	Generator
	2	Mechanics' Truck
	1	Fuel Truck
Cable Trench, Conduits, Grounding	5	Pick-up Truck
	4	Truck (1-ton)
	4	Trencher
	8	Excavator Mini
	4	100 Series Excavator
	4	Loader Backhoe
	2	Vibratory Compactor
	4	Bobcat\Skid Loader
Steel Structures, Electrical	1	Office Trailer

Table 3-1
Typical HVDC Converter Station, Estimated Equipment

Activity	Quantity of Equipment	Type of Equipment
Equipment Installation	5	Pick-up Truck
	6	Truck (2-ton)
	2	Truck (1-ton)
	4	Forklift (Telescopic)
	4	Boom Lift
	2	Crane (15-ton Boom Truck)
	2	Crane (30-ton)
	4	Welder Truck
	2	Generator
Control Building and Wiring Installation	3	Air Compressor
	5	Pick-up Truck
	4	Crane (120- to 300-ton)
	2	Truck (2-ton)
	4	Utility Van
	2	Trencher
Construction Inspection	1	Splicing Truck
Materials Testing/ Inspection	2	Pick-up Truck

3.2 HVDC and AC Transmission Line Construction

Construction activities for the HVDC and AC transmission lines will include the following activities:

- Preparation of multi-use construction yards;
- Pre-construction surveys for biological and cultural resources;
- Preparation of the ROW;
- Clearing and grading;
- Foundation excavation and installation;
- Structure assembly and erection;
- Conductor stringing;
- Grounding; and
- Cleanup and site restoration.

Figure 2-30, "HVDC Transmission Line Construction Sequence," illustrates these activities and the typical transmission construction sequence. For a more detailed example of construction activities and durations during and between those activities, as they would occur on one tract of agricultural land, see "Typical Construction Activities and Durations on Single Parcel" in Appendix B, "Workforce and Crews."

The duration of construction is expected to be approximately 36 to 42 months for the entire Project, including the time from initiation of clearing and grading through clean up and restoration. Clean Line expects the duration of construction for the HVDC transmission line to be 30 months from mobilization to restoration. The actual construction duration will be dependent on a number of factors such as weather and availability of labor. Clean Line will divide the Project into several segments with multiple construction groups working concurrently on different portions of the route to accomplish this schedule and to maintain effective management of construction operations and allocation of resources. For the purposes of estimating resource needs, Clean Line assumes that the HVDC line will be constructed in 4 segments of between 185 and 205 miles in length. Construction would be active on several HVDC segments and/or the AC collection system simultaneously.

Clean Line expects the duration of construction for an individual HVDC segment to be approximately 24 months from mobilization of equipment to site restoration. Disturbance at any one location along a segment would be less, with the length of disturbance affected by the land use, and progress of the individual work crews. The construction personnel peak in any segment of the HVDC route would be approximately 240 workers, and the average over the construction duration of one HVDC segment would be approximately 125 workers. An estimate of construction workforce over time for the HVDC transmission line is included in Appendix B, "Workforce and Crews."

Clean Line will stage construction on each HVDC segment and on the AC collection system from multi-use construction yards located at regular intervals (approximately every 30-50 miles) along the route. Construction access will occur at several locations along the transmission line route, resulting in dispersed construction activity and associated traffic.

For the entire HVDC line, the workforce will reach a peak of approximately 592 workers. The average workforce across the HVDC line during an assumed 30 month construction duration will be approximately 392 people. Appendix B, "Workforce and Crews," provides an estimate of Project-wide workforce over time.

Table 3-2, "Typical HVDC Segment Construction Equipment," provides the number and type of equipment Clean Line expects to use to construct the HVDC transmission line in a typical segment.

The equipment types and quantities required is similar for the AC collection system on a per-mile basis.

Table 3-2
Typical HVDC Segment Construction Equipment

Activity	Quantity of Equipment	Type of Equipment
ROW Clearing	3	Bulldozer (Caterpillar D8 or equivalent)
	2	Chipper
	3	Excavator
	2	Feller buncher
	2	Flail mower or bush hog
	2	Hydra-Ax or mulcher

Table 3-2
Typical HVDC Segment Construction Equipment

Activity	Quantity of Equipment	Type of Equipment
	3	Loader
	14	Pick-up truck
	2	Skidder
Access Roads & Pads	5	Backhoe
	4	Bobcat
	3	Bulldozer (Caterpillar D8 or equivalent)
	9	Dump truck
	5	Excavator
	3	Loader
	2	Motor grader
	10	Pick-up truck
	2	Roller compactor
	2	Scraper
	2	Water truck
Foundation Construction	5	Bobcat
	3	Bulldozer (Caterpillar D8 or equivalent)
	15	Concrete truck
	7	Crane (20-ton)
	5	Drill rig
	4	Dump truck
	3	Excavator
	5	Generator
	3	Loader
	10	Pick-up truck
	5	Plate compactor
	5	Truck (1-ton)
	5	Wagon drill
Structure assembly crews	4	Air compressor
	20	Crane (rubber-tired)
	5	Generator
	14	Pick-up truck
	15	Truck (2-ton)

Table 3-2
Typical HVDC Segment Construction Equipment

Activity	Quantity of Equipment	Type of Equipment
Structure Erection	10	Cranes (120- to 300-ton)
	5	Generator
	1	Helicopter (large) as necessary
	14	Pick-up truck
	5	Truck (1-ton)
	5	Truck (2-ton)
Wire installation crew (Stringing, Tensioning, & Pulling)	4	3-drum puller (heavy)
	4	3-drum puller (medium)
	4	Bulldozer (Caterpillar D8 or equivalent)
	7	Crane (20-ton)
	4	Crane (30-ton)
	2	Double bull-wheel tensioner (heavy)
	2	Double bull-wheel tensioner (light)
	1	Helicopter (small)
	14	Pick-up truck
	2	Single-drum puller (large)
	4	Splicing truck
	8	Truck (5-ton)
	12	Wire reel trailer
Restoration crew	2	Loader
	2	Motor grader
	7	Pick-up truck
Supervision	2	Office trailer
	4	Pick-up truck
Materials management & delivery, steel hauling	5	Boom truck
	4	Dump truck
	15	Forklift
	7	Pick-up truck
	10	Steel haul truck
Mechanic & Equipment Management	3	Air compressor
	2	Mechanic's truck
Refueling	2	Fuel truck
Watering & Dust Control	2	Water truck
Construction Inspection	4	Pick-up truck

Table 3-2
Typical HVDC Segment Construction Equipment

Activity	Quantity of Equipment	Type of Equipment
Materials Testing	4	Pick-up truck
Environmental Compliance	4	Pick-up truck
Survey crew	3	All-terrain vehicle (ATV)
	4	Pick-up truck
Clean-up crew (Cleanup/Sanitation)	4	Backhoe
	4	Dump truck
	4	Pick-up truck
	5	Road sweeper

3.2.1 Temporary Construction Areas

Clean Line will use temporary construction areas to support construction. Examples of temporary construction areas include multi-use construction yards, fly yards, tensioning or pulling sites, wire-splicing sites and concrete batch plants.

The approximate number and typical dimensions for temporary construction areas are summarized in Table 3-3, "Temporary Construction Areas."

Table 3-3
Temporary Construction Areas

Facility	Construction Dimensions
AC Interconnection	
Tensioning or Pulling Sites (Figure 2-16, "Conductor and Ground-Wire Stringing Activities")	150 feet wide (ROW width) x 600 feet long (Typical) No greater than 18,000 linear feet apart. [1] **Kansas AC Interconnection** Tensioning and pulling for ties between the new substation and the Kansas Converter Station (if necessary) will be contained within the footprint of both stations. No temporary construction area will be necessary. **Illinois and Indiana AC Interconnection** 345kV AC: 7 miles/1 pulling site and 1 tensioning site for every 2 miles = approximately 8 sites for the 345kV line.) **Missouri AC Interconnection** Tensioning and pulling for ties between the new substation and the Missouri Converter Station (if necessary) will be contained within the footprint of both stations. No temporary construction area will be necessary.

Table 3-3 Temporary Construction Areas	
Facility	**Construction Dimensions**
Wire-splicing Site (Figure 2-16, "Conductor and Ground-Wire Stringing Activities")	100 feet x 100 feet (within the ROW) Spaced 1 to 3 miles apart. **Kansas AC Interconnection** Any wire splicing site for the Kansas AC interconnection will be contained within the footprint of the Kansas Converter Station and/or the new substation. **Illinois and Indiana AC Interconnection** 345kV AC: 7 miles/1 site per 2 miles = approximately 3 sites for the 345kV line **Missouri AC Interconnection** Any wire splicing site for the Missouri AC interconnection will be contained within the footprint of the Missouri Converter Station and/or the new substation.
Multi-use Construction Yards (Figure 2-18, "Multi-Use Construction Yard")	25 acres +/- **Kansas AC Interconnection** Multi-use construction yard space for the Kansas AC interconnection will be shared with that of the HVDC line. No separate MUCY is necessary for the Kansas AC interconnection. **Illinois and Indiana AC Interconnection** The Illinois and Indiana AC Interconnection will share construction yard space with the Illinois Converter Station, and will be contained within the footprint of the converter station. **Missouri AC Interconnection** Multi-use construction yard space for the Missouri AC interconnection will be shared with that of the HVDC line. No separate MUCY is necessary for the Missouri AC interconnection.
Fly Yards (Figure 2-18, "Multi-Use Construction Yard")	No fly yards outside MUCYs will be required for the AC Interconnections
HVDC Transmission Line	
Tensioning or Pulling Sites (Figure 2-16, "Conductor and Ground-Wire Stringing Activities")	200 feet wide (ROW width) x 650 feet long (Typical) No greater than 15,000 linear feet apart.[2]

Table 3-3 Temporary Construction Areas	
Facility	**Construction Dimensions**
Wire-splicing Site (Figure 2-16, "Conductor and Ground-Wire Stringing Activities")	100 feet x 100 feet (within the ROW) Spaced 1 to 3 miles apart (780 miles/average of 1 site every 2 miles = 390 sites)
Multi-use Construction Yards (Figure 2-18, "Multi-Use Construction Yard")	25 acres +/- Located at regular intervals of approximately 30-50 miles apart and typically within 10 miles of the ROW. (780 miles/average of 1 every 40 miles = approximately 20 yards)
Fly Yards (Figure 2-18, "Multi-Use Construction Yard")	10 to 15 acres Preferably located within Multi-Use Construction Yards or at local airports
Concrete Batch Plants	Access to concrete is required at approximately 60-mile intervals along the ROW. Clean Line will use local concrete plants where practicable. Temporary batch plants may be required where the haul time for a commercial ready-mix concrete producer exceeds 45 minutes (where the haul distance may exceed 25 to 30 miles). Temporary portable concrete batch plants will require approximately 1 to 2 acres within multi-use construction yards.
AC Collection System	
Tensioning and Pulling Sites (Figure 2-16, "Conductor and Ground-Wire Stringing Activities")	150 feet wide (ROW width) x 600 feet long No greater than 18,000 linear feet apart.[1] (Total 345kV AC: 206.4 miles/1 pulling site and 1 tensioning site for every 2 miles = approximately 200 sites for 345kV)
Wire-splicing Site (Figure 2-16, "Conductor and Ground-Wire Stringing Activities")	100 feet x 100 feet (within the ROW) Spaced 1 to 3 miles apart (345kV AC: 206.4 miles/1 site per 2 miles = 104 sites for 345kV)
Multi-use Construction Yards (Figure 2-18, "Multi-Use Construction Yard")	25 acres +/- Located at regular intervals approximately 30-50 miles apart.

Table 3-3 Temporary Construction Areas	
Facility	**Construction Dimensions**
Fly Yards (Figure 2-18, "Multi-Use Construction Yard")	10 to 15 acres Preferably located within Multi-Use Construction Yards or at local airports
Concrete Batch Plants	Access to concrete is required at approximately 60-mile intervals along the ROW. Clean Line will use local concrete plants where practicable. Temporary batch plants may be required where the haul time for a commercial ready-mix concrete producer exceeds 45 minutes (where the haul distance may exceed 25 to 30 miles). Temporary portable concrete batch plants will require approximately 1to 2 acres within multi-use construction yards.

(1) Assumes AC reel lengths are 9,000 feet on 96-inch reels. Two reels per setup limits the separation between T&P to about 18,000 feet maximum. Clean Line will also utilize shorter distances.

(2) HVDC Reel lengths are 7,500 feet on 96-inch reels. Two reels per setup limits the separation between tensioning and pulling to about 15,000 feet maximum. Clean Line will also utilize shorter distances.

3.2.1.1 Tensioning or Pulling Sites

Tensioning or pulling sites will typically be 2 to 3 miles apart. Land requirements for typical tensioning or pulling sites are listed in Table 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," and Table 2-5, "AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements," and would be either entirely within the ROW or partially outside the ROW, depending on the structure's turning angle and type. Where the transmission line turns, the tensioning or pulling site may extend outside of the ROW to maintain a straight line with the ground wire and conductor being pulled (see Figure 2-16, "Conductor and Ground-Wire Stringing Activities").

3.2.1.2 Multi-use Construction Yards

Multi-use construction yards are one type of temporary construction area that Clean Line will use. Multi-use construction yards are primarily for staging of construction personnel and equipment, and for material storage to support construction activities (Figure 2-18, "Multi-use Construction Yard"). Clean Line will locate temporary concrete batch plants (discussed in Section 3.2.1.5, "Concrete Batch Plants") within a multi-use construction yard where needed. Clean Line will locate multi-use construction yards outside the ROW and typically at intervals of approximately 30-50 miles. Additionally, they will be located within approximately 10 miles of the ROW or Project facility. Typical multi-use construction yards will be approximately 25 acres in size, fenced and access-controlled.

Flat ground is preferred for multi-use construction yards, although moderate slopes (maximum slope 6 percent) are acceptable for some activities. Approximately 20 percent of each multi-use construction yard (approximately 5 acres each) must be reasonably flat (maximum 4 percent slope) and will be surfaced with a 6-inch gravel base.

To the extent practicable, Clean Line will employ site-selection criteria to determine preferred locations, with exceptions noted below. The site-selection criteria for both temporary multi-use construction yards and fly yards are as follows:

- Preferred sites will be on previously disturbed, privately owned parcels (e.g., vacant industrial yards, commercial lots) or on other such suitable parcels.
- Sites will be located in a manner to minimize conflict with nearby and adjacent land uses.

- Sites will have good access to public roads.
- Sites will be relatively flat.
- Sites will be selected for their relative ease of restoration; preferred sites are those that can be restored more easily to their original condition.

Clean Line may arrange individual multi-use construction yards differently, but typical sites will include areas designated for a field office, crew parking, sanitation, waste management, fueling, equipment wash, material storage, and equipment storage. Clean Line will base fuel trucks, maintenance trucks and construction crews in multi-use construction yards. Clean Line will store any fuel, lubricants, antifreeze, detergents, paints, solvents, and/or other chemicals used during construction at the multi-use construction yards consistent with standard practices and relevant permits.

3.2.1.3 Fly Yards

Clean Line will use helicopters for conductor stringing operations and/or for transport and erection of structure sections during construction. Clean Line will locate landing areas for the helicopters (fly yards) within Multi-Use Construction Yards or at local airports. Typical fly yards will be approximately 5 acres or less in size.

Clean Line may arrange individual fly yards differently, but typical sites will include areas designated for helicopter landing, crew parking, sanitation, waste management, refueling, and temporary material staging. Fly yards would be operated and maintained consistent with standard practices and relevant permits.

To the extent practicable, Clean Line will employ site-selection criteria for fly yards similar to those used for multi-use construction yards.

3.2.1.4 Wire Splicing Sites

Typically, wire-splicing sites are within the ROW. Conductors and shield wires (wires) are strung into their supporting structures over a length of two reels. The wire from the two reels is mechanically joined at the wire ends with a temporary steel wire-gripping sleeve (stringing sock) which passes through the stringing blocks. After the wire is strung and secured, the stringing sock is replaced with a compression splice connector. The location of the splice connector installation is the wire splicing site. Typical wire splicing sites include a wire splicing truck and a line truck to facilitate installation.

3.2.1.5 Concrete Batch Plants

Portable concrete batch plants will be located within multi-use construction yards.

Concrete will be required for construction of foundations for transmission structures, foundations for transformers and electrical equipment at converter stations, and foundations at fiber optic regeneration sites. Concrete will be delivered to structure sites and ancillary facilities in concrete trucks with a capacity of up to 10 cubic yards. Clean Line will obtain concrete from commercial ready-mix concrete producers, to the extent practicable. In locations where haul times exceed 45 minutes (approximately 25 to 30 miles haul distance), concrete will be dispensed from portable concrete batch plants located within a multi-use construction yard.

Temporary concrete batch plant facilities typically consist of silos containing fly ash or blast furnace slag and cement; sand and gravel material storage bins; mixing equipment; aboveground storage tanks containing concrete additives and water; designated areas for sand and gravel truck unloading, concrete truck loading, and concrete truck washout. The batching unit, aggregate conveying unit, water supplying and additive agent supplying system, scaling system, mixing system, electrical control system, and pneumatic system are centralized on one or two trailer chassis.

3.2.2 Preparation of the Transmission Line Right-of-Way

Prior to the start of construction, Clean Line will prepare the ROW for construction by delineating all approved access, work, and environmentally sensitive areas (e.g., wetlands, streams, etc.) and conducting any required surveys or inspections of such areas. Clean Line will develop specific flagging, staking, and signage procedures for the Project to identify these areas. Some limited vegetation trimming may be required for land surveying activities. The ROW will be 150 to 200 feet in width.

3.2.3 Clearing and Grading Activities

Clean Line will begin construction of the transmission lines with clearing and grading of access roads to allow entry to individual structure locations. After the access roads are cleared and/or graded, individual structure sites, wire splicing sites, and tensioning and pulling sites will be cleared and/or graded, as necessary, to install the transmission line support structures and facilitate access for future transmission line and structure maintenance and grading.

Clearing of natural vegetation and grading will be required for safe construction purposes and for long-term electrical safety clearances, maintenance, and reliability of the transmission line. Hand and/or mechanized clearing methods may be used. Clearing of tensioning and pulling sites will be limited to removal of larger woody vegetation or dense brush that might otherwise interfere with tensioning equipment or damage conductors. Similarly, ground disturbance activities will be limited to minor grading to provide temporary access for tensioning equipment.

Within or adjacent to the ROW, Clean Line may selectively remove vegetation for access during construction and to provide adequate electrical safety clearance. Present vegetation reliability rules issued by North American Electric Reliability Corporation (NERC) require the removal of all tall-growing species that could grow into the conductors (wire zone) and adjacent tall-growing species that could fall into the conductors (Figures 2-6, "DC R.O.W. Limits" and 2-19 "AC R.O.W Limits"). Clean Line will also remove vegetation outside the wire zone, including beyond the limits of the ROW, which could fall into the conductors, as described in the Transmission Vegetation Management Plan that will be developed and filed with NERC for the Project. Section 4 "Operations and Maintenance," describes the Transmission Vegetation Management Plan for maintenance.

Clean Line may selectively apply herbicides during clearing and grading for construction to minimize regrowth of certain trees and woody species. Only persons who are certified and licensed to apply herbicides perform this work. During clearing and grading for construction, Clean Line may remove dead, dying, diseased, or unstable trees or branches outside of the easement, which are encroaching on the ROW and will later threaten the safe and reliable operation of the transmission system.

Clean Line will clear individual structure sites to provide a safe working space for placing equipment, vehicles, and materials for tower assembly and erection. Equipment used in clearing could range from a brush hog flail-type mower to a bulldozer to blade the area required. The grade of the temporary disturbance area should be no greater than 8 percent. If grading structure sites will require a bulldozer or other earth moving equipment, the minimum amount of grading will occur to provide a safe working space for placing equipment, vehicles, and materials for tower assembly and erection.

Additional equipment or construction practices may be required if solid rock is encountered at a structure location and cannot be removed with conventional excavation equipment. Hydraulic rock hammers or blasting may be required to remove the rock. Excess rock that is too large in size or volume to be spread at the site or rock that the landowner requests not be spread at the site will be hauled away and disposed of at approved landfills.

In addition, Clean Line will develop a Stormwater Pollution Prevention Plan (SWPPP) during preliminary and final engineering and will implement the SWPPP during construction.

3.2.4 Foundation Excavation and Installation

Excavations for foundations will typically be made with power equipment (Table 3-2, "Typical HVDC Transmission Line Construction, Estimated Personnel, and Equipment," provides a list of equipment used for foundation construction). The excavation and installation of a foundation will require access to the site by a power auger or drill rig, a crane, material trucks, and concrete trucks using designated access roads. In areas where disturbance is limited (i.e., by permit conditions or adopted environmental protection measures) or areas of steep terrain, excavation and installation of the foundation may require a power auger or drill brought in by all-terrain vehicle (ATV), track unit, or similar device.

Within the work areas, the disturbance associated with the tower footings (structure footprint) will depend on the type of structure and foundation. Tables 2-4, "HVDC Transmission Line Facility Dimensions and Land Requirements," and 2-5, "AC Collection System Western Kansas Region Transmission Lines Facility Dimensions and Land Requirements provide information on approximate structure footprints. Clean Line will clear the work area of vegetation to the extent necessary for installation of foundations and erection of transmission structures and for safe operation of the transmission facilities. After transmission line construction, all work areas outside of structure footprint and not otherwise occupied by permanent access roads or ancillary facilities needed for operations and maintenance of the transmission facilities, will be restored (see Section 3.2.8, "Cleanup and Restoration").

Clean Line will excavate the foundation holes by drilling, blasting, or installing special rock anchors. Blasting may be used in isolated locations where required to break up rock. When blasting techniques are used, all safeguards associated with using explosives (e.g., blasting mats) will be implemented.

In sandy soils and areas with a high water table, Clean Line may use approved synthetic drilling fluids to suspend drill cuttings and stabilize excavations for drilled shaft foundations.

Clean Line will procure the required water to prepare drilling fluids from municipal sources and/or from landowners. While Clean Line currently anticipates obtaining water from municipal sources, if other sources are used written landowner approval and any applicable state or local authorizations will be obtained prior to extracting water from any non- municipal source and the approval will include a description of the location of the water source and the volume approved for use.

Clean Line will temporarily fence, when practicable, or cover foundation holes temporarily left open or unguarded to protect the public and wildlife.

After excavations are complete, Clean Line will typically install foundations through:

- Installation of a rebar cage in the excavation, backfill of the excavation with concrete, and installation of an anchoring assembly while the concrete is still wet; or
- Installation of the structure within the excavation, and backfill with engineered fill (compacted gravel, controlled density fill, or concrete); or
- Installation of a steel grill pad connected with the reinforced steel legs of the structure, which is in turn connected to a driven steel shaft or concrete pile.

Clean Line will contain unused concrete and liquids generated when cleaning concrete placement equipment and dispose of them in accordance with federal, state and local permit requirements. Clean Line will transport excess concrete off site for disposal or return it to the ready-mix plant to be recycled. Dried concrete may be broken up and blended with native spoils for use as clean fill or as a substitute for conventional aggregate on the Project.

Stockpiled soils will be used to backfill the foundation holes. During backfilling, soil will be replaced subsoil first and topsoil at the surface, thereby salvaging the highest concentration of organic matter, nutrients, and residual seed bank. Clean Line will spread remaining topsoil on the access road. This will ensure that Clean Line does not cover the best topsoil for reseeding with subsoil during the restoration of the site. Clean Line may leave some large rocks onsite, if appropriate, to help blend the area in with the surrounding landscape.

3.2.5 Structure Assembly and Erection

For lattice structures, Clean Line will transport bundles of steel and associated hardware (e.g., insulators, hardware, and stringing sheaves) to each structure site by truck for on-site assembly. Clean Line will haul wood blocking to each location and lay it out to support bundled materials aboveground. Then, Clean Line will open and lay out the steel-structure bundles for assembly by sections and assembly into subsections. Typically, the leg extensions for the structures are assembled and erected by separate crews with smaller cranes, to make ready for the setting of the main structure assembly. In other cases, one crew may assemble the entire structure. The assembled subsections will then be hoisted into place by means of a large crane and fastened together to form a complete structure. A follow-up crew will then tighten all the bolts in the required joints. Where lattice structures are used, four to six structures will be required per mile.

For tubular monopole structures, sections will be delivered near each structure site. Each section or the entire structure will be hoisted into place by a crane onto the foundation. Where monopole structures are used, five to seven structures will be required per mile.

3.2.6 Conductor Stringing

Clean Line will deliver insulators, hardware, and stringing sheaves to each structure site. The structures will be rigged with insulator strings and stringing sheaves at each ground-wire and conductor position.

For protection of the public during wire installation, Clean Line will erect guard structures over highways, railroads, power lines, foreign structures, and other barriers. Guard structures will consist of either an H-frame wood pole structure placed on each side of the barriers or a guard cross-beam raised by boom trucks. These structures will prevent ground wires, conductors, or equipment from falling across obstacles. Equipment for erecting guard structures includes augers, backhoes, line trucks, boom trucks, pole trailers, and cranes. Guard structures may not be required for small roads. In such cases, Clean Line will use other safety measures such as barriers, flaggers, or other traffic control. Following stringing and tensioning of all conductors, Clean Line will remove the guard structures and restore the area (see Section 3.2.8, "Cleanup and Restoration").

Clean Line will pull (string) pilot lines from structure to structure by either a helicopter or land-operated equipment and thread them through the stringing sheaves at each structure. Following pilot lines, Clean Line will attach a stronger, larger diameter line to conductors, which will then be used to pull the conductors through the sheaves onto structures. Clean Line will repeat this process, using pulling equipment at one end and braking or tensioning equipment at the other end, until the ground wire or conductor is pulled through all the sheaves.

Clean Line will string ground wires, fiber optic cable, and conductors using powered pulling equipment at one end and powered braking or tensioning equipment at the other end of a conductor segment.

Tensioners, pullers, line trucks, wire trailers, dozers, pick-ups, and tractors needed for stringing and anchoring the ground wire or conductor will be located at these sites. The tensioner, in concert with the puller, will maintain tension on the ground wire or conductor while they are fastened to the structures.

In areas with soft unstable soils, Clean Line may use matting or rock to support tensioning equipment. Clean Line will reclaim gravel used for temporary access for use elsewhere on the Project and restore surface contours as described in the Restoration Plan.

3.2.7 Grounding

Grounding will be required for each structure. The need for counterpoise,[3] a trenched-in ground wire and rod, will depend on local soil resistance characteristics. Part of standard construction practices prior to conductor installation involves measuring the resistance of the ground to electrical current near the structures. If the measurements indicate high resistance, counterpoise will be installed, which will consist of trenching in-ground wire to a depth of 12 inches in non-cultivated land and 18 to 30 inches in cultivated land, with a ground rod driven at the end. Clean Line will contain the counterpoise within the limits of the ROW and may alter it or double it back and forth to meet the requirements of the Project. Clean Line will install the ground rod at the time of structure installation. Typical equipment used for installing ground rods includes line trucks, backhoes, and trenchers.

3.2.8 Cleanup and Restoration

Clean Line will keep construction sites, material storage yards, and access roads in an orderly condition throughout the construction period. Clean Line will remove refuse and trash from the sites and dispose of it in a timely and approved manner (e.g., in an approved landfill). In remote areas, trash and refuse could be removed to a construction staging area and contained temporarily until it could be hauled to an approved site. Clean Line will not burn construction trash. Clean Line will restore the ROW and work areas when construction is complete according to the Restoration Plan (to be developed).

The Restoration Plan will identify and describe restoration actions for construction- and operation-related disturbance. Restoration actions will be specific to the setting and vegetation communities affected during construction and operation activities, disturbance type, and duration. In particular, additional information is required to develop appropriate seed mixes that will incorporate the dominant plant species of the existing vegetation communities, where applicable.

3.3 Access Road Construction

Clean Line will use existing highways, local public roads, and existing local private roads to the extent practicable. Clean Line will also repair or improve certain private roads to improve access for heavy equipment. Where existing roads do not provide sufficient or safe access and as local conditions allow, Clean Line will use a range of access road options, such as overland travel or building new roads. For more detail regarding the types of access roads anticipated for the Project, please see Section 2.4, "Access Roads," and Table 2-6, "Access Roads Facility Dimensions and Land Requirements."

During construction, the size and weight of the heavy equipment typically dictates the minimum road dimensions. For example, heavy equipment during construction will typically include a lowboy equipment hauling truck, flatbed steel hauling truck, or truck-mounted aerial lift crane. Commercial concrete mixing trucks will typically generate the heaviest axle loads and often dictate certain structural requirements. Partial concrete loads may reduce weight where weight restrictions exist. To accommodate this

[3] **Counterpoise** is a type of electrical ground that enhances electrical connection to the Earth. It is used when a normal earth ground is compromised because of high soil resistance. It consists of a network of wires buried in the native soil to develop a low resistance connection to earth ground.

construction equipment, project specifications for roads require a 14-foot-wide travel surface on straight sections and 16- to 20-foot-wide travel surface for horizontal curves.

Existing farm roads and unimproved two-track roads often suffice for both construction and operational access needs without significant upgrades, provided there is adequate horizontal clearance, level terrain, and firm native soil to support overland travel. Some grading may be required to ensure safe vehicle passage or during restoration.

Different types of construction activities are required with different terrain. In areas of gentle terrain, and where soil conditions permit, direct vehicle travel over low growth vegetation is generally preferred. In this case, Clean Line will retain existing low-growth vegetation to the extent practicable and will only remove any larger woody vegetation to allow safe vehicle passage. In areas of moderate to steep terrain, new roads will follow the natural contours of the terrain to avoid cuts on steep side slopes. In areas of rolling to hilly terrain, a wider disturbance area will be required to account for cuts and fills and surface drainage. In steep or mountainous terrain, the disturbance width may exceed 50 feet depending on soil conditions.

3.3.1 Specialized Road Construction Techniques

In limited circumstances (e.g., flood hazard areas, waterbodies, steep slopes, shallow bedrock), special road construction techniques may be required.

Special construction techniques addressed below include:

- Temporary Crossings;
- Road construction within special flood hazard areas;
- Road construction at waterbody crossings;
- Broad Based Dips;
- Construction on steep slopes; and
- Blasting.

Temporary Crossings

Clean Line may use temporary matting or temporary channel spanning structures during construction where soil conditions will not support heavy construction vehicles or where gravel or fill is prohibited or would otherwise interfere with the current land use. Bottom land soils and wetlands typically have engineering properties that make them poorly suited for roads. Where fill in floodplains is prohibited or where gravel surfacing would interfere with agricultural land uses, temporary matting or other similar solutions may be necessary. The size and placement of temporary matting or temporary channel spanning structures will be location specific.

Road Construction within Special Flood Hazard Areas

Conventional roadway construction within Special Flood Hazard Areas (SFHAs) will typically involve excavation of native soils, placement of separation geotextile fabric, and replacement of native soils with coarse rock sub-base topped with smaller crushed gravel base. Permanent roads are compacted and shaped to promote drainage and will be designed with roadside drainage ditches to convey stormwater. In many cases, cuts and fills will need to balance in order to satisfy floodplain development criteria and obtain a no-rise certification, if applicable. The SFHA is that portion of the floodplain subject to inundation by the base flood (1 percent annual chance or 100-year floodplain) SFHAs are shown on FEMA Digital Flood Insurance Rate Maps as A Zones.

Road Construction at Waterbody Crossings

In some instances, avoiding construction of access roads across waterbodies will not be practicable. Clean Line has identified four typical stream crossing methods, based on stream characteristics and permitting requirements. All Project-related activities in waterbodies will be conducted in compliance with applicable federal and state permit requirements.

- *Type 1 – Drive-Through with Minimal Grading and/or Fill*: Type 1 crossings may be used for crossings of seasonally dry, non-fish-bearing drainages (ephemeral and intermittent streams) requiring minimal grading and/or fill to repair surface ruts or re-contour minor surface erosion. Where required, stabilization to support vehicular travel will generally involve minor grading and, in some cases, placement of geotextile fabric and surface application of commercially available aggregate base material on approaches and the drainage bottom below the ordinary high water mark. Clean Line will limit the use of fill material to the amount needed for safe vehicular travel. A Type 1 drive-through crossing results in an average disturbance profile of approximately 25 feet wide (along the waterbody).
- *Type 2 – Drive-Through/Ford*: Type 2 crossings may be used for defined stream channel (ephemeral, intermittent, or perennial) that require grading and stabilization. Use of ford crossings on perennial streams would largely be limited to shallow water streams. Clean Line would typically grade stream banks and approaches to allow vehicle passage. In some cases, the channel bed may require stabilization. Ford crossings will have equal slope to the natural channel. Clean Line will armor approaches with surface application of commercially available aggregate base rock extending at least 75 feet on each side of the stream channel. Rock armoring will be placed so as not to impede natural water flow. If necessary to ensure flow, Clean Line will typically excavate the streambed and replace native materials with large angular rock (pit run) over geotextile fabric, while maintaining the dimensions of the natural streambed. Armoring of the approaches will provide a suitable running surface, protect the stream banks and floodplain, keep soil from sticking to tracks or tires, and prevent soil from washing off in streams. If the soil type for the approaches is fine-grained, Clean Line may use a woven geotextile fabric between the subgrade and the gravel surfacing to add strength and separation. A Type 2 drive-through crossing results in an average disturbance profile of approximately 25 feet wide (along the waterbody).
- *Type 3 – Culvert: Type 3 crossings may be used for more incised stream channels and channels with more consistent flow regimes sufficient to maintain native fishery populations. Clean Line will design and install culverts under the guidance of a qualified engineer who, in consultation with a hydrologist and aquatic biologist, will recommend culvert locations, specifications, and construction techniques, including culvert gradient, height, and sizing. Culvert design will consider drainage basin characteristics, hydrology, bed load, and debris. Culvert slope will not exceed stream gradient. Typically, Clean Line will partially bury culverts in the streambed to maintain streambed material in the culvert. Clean Line will place sandbags or other non-erosive material around the culverts to prevent scour or water flow around the culvert. A stable travel surface will be installed across the culverts by backfilling with clean gravel or rock. Adjacent sediment control structures such as silt fences, check dams, rock armoring, or riprap may be necessary to prevent erosion or sedimentation. Clean Line may stabilize stream banks and approaches with rock or other erosion control devices. The disturbance footprint for culvert installation is estimated to be 30 feet to 60 feet wide (along the waterbody) depending on the channel profile.*

- *Type 4 – Channel-Spanning Structures*: Type 4 crossings may be used for higher quality defined perennial stream channels that do not exceed 30 feet in width. Clean Line will use channel-spanning structures to span the channel from bank to bank. The type of structure used will be largely determined by the width of the active channel and will potentially include a submerged arch culvert, low-profile multi-plate arch, or short-span bridge structure. Clean Line will design and install channel-spanning structures under the guidance of a qualified engineer who, in consultation with a hydrologist and aquatic biologist, will recommend structure locations, specifications, and construction techniques, including structure gradient, height, and sizing. Clean Line estimates that the disturbance footprint for channel-spanning structure installation is 30 feet to 60 feet wide.

Broad-Based Dips

Sometimes referred to as water bars, a broad-based dip is a gradual depression in the roadway that is hardened to allow water to cross over the roadway in a controlled manner so that it drains into stable, vegetated areas at the side of the road. Dips are preferred to culverts for cross-drainage of seeps where no defined channels are present. Broad-based dips can serve two functions: 1) to divert surface flow off a traffic surface, and 2) to permit water to drain across a traffic surface. They are best suited for grades of less than 10 percent.

The dip would be approximately 20 feet long. The bottom of the dip would be aligned at a slight angle across the road and out-sloped where the terrain permits to ensure drainage. The bottom of the dip is typically armored with 3-inch diameter (or larger) crushed aggregate applied to a depth of 10 inches over a geotextile separation fabric and topped with crushed gravel.

A broad-based dip results in an average disturbance profile of 25 feet wide. Clean Line would conduct minor excavation to remove material from the dip and replace with geotextile fabric and rock.

Construction on Steep Slopes

Clean Line will site new access roads and transmission structures to avoid steep side slopes, to the extent practicable. Where access to structures along steep slopes is required, special construction techniques are required to ensure the structure foundation and access roads are stable and persist for future access if needed. If required for access to individual transmission structures, roads will generally be located to traverse ridgelines to avoid extensive cuts, which would otherwise be required for bladed roads traversing steep side slopes. Clean Line will construct transmission structures and new roads on steep side slopes, if required, on an excavated bench rather than on compacted embankment fills. Where Clean Line encounters hard rock, blasting may be required to enable excavation of the bench. Access roads on steep side slopes will be insloped (shed to the inside) and Clean Line will construct them with frequent cross-drainage structures to convey water across the road. Clean Line will typically surface access roads on steep side slopes with crushed rock to minimize erosion. Specialized techniques may be required to stabilize cut slopes, promote vegetative cover, and minimize rill erosion. Embankment fills on side slopes over 25 percent may require benched cut and fill slopes depending on soil characteristics and site-specific geologic conditions. Clean Line will avoid sidecasting of excavated spoils onto slopes greater than 30 percent.

Blasting

Blasting may be used in isolated locations, where required, to break up rock, enabling excavation using traditional techniques. This technique is used most frequently in steep mountainous terrain where roads or structure benches must be excavated in hard rock. Rock is not a homogeneous material; Clean Line must consider fracture planes, seams, and overburden issues. There are four main categories of commercial high explosives: dynamite; slurries; ammonia nitrate and fuel oil; and two-component explosives. Ammonia nitrate and fuel oil is the most common general purpose explosive in use today.

Every blast must be designed to meet existing conditions of the rock formation and overburden and to produce the desired result. A trial blast is typically performed in the field to validate theoretical blast designs or to provide additional information for final blast designs. There are federal and state regulations concerning the transportation and handling of explosives. All safeguards associated with using explosives (e.g., blasting mats) would be implemented. Alternatively, Clean Line may install special rock anchors.

3.4 Construction of AC Interconnections and Related Upgrades

The AC interconnections and related upgrades would involve construction of transmission lines and upgrades to existing equipment to facilitate injection of additional power transmitted by the Project.

Section 2.1, "Converter Stations and Other Terminal Facilities," describes the transmission lines between each converter station and their respective interconnection point. Section 3.2, "HVDC and AC Transmission Line Construction," describes construction of AC transmission lines; all construction methods described for AC transmission lines are the same as those expected for AC interconnection lines.

- Construction of upgrades are anticipated as follows: Based on the Facility Study completed by ITC, a new 9-breaker 345 kV interconnection switching station at the POI on the Spearville – Clark County and Ironwood – Clark County 345 kV lines would be necessary to accommodate Grain Belt Express's interconnection to ITC-GP system. This new switching station is anticipated to utilize a breaker-and-a-half configuration that will loop the existing Spearville – Clark County and Ironwood – Clark County 345 kV lines into this station as well as connect the two new 345 kV lines from the Project's converter station 345 kV bus. This new switching station is also expected to include 345 kV relaying panels with microprocessor based relays, 345 kV disconnect switches, 345 kV 3-winding capacitance coupled voltage transformers (CCVTs), insulators, surge arresters, meters, control cables and other standard switching station equipment (steel structures, yard lighting, grounding system, lightning shielding, etc.)
- Based on the System Impact Study completed by PJM, a new 765 kV transmission line from AEP's Sullivan substation to NIPSCO's new Reynolds substation would be necessary to accommodate Grain Belt Express's interconnection to AEP's system. In addition to this new 765 kV line, the installation of a wavetrap on AEP's Dumont 765 kV substation as well as the installation of 3 new 345 kV circuit breakers will be required along with associated microprocessor relays and revenue meters at the Sullivan 345 kV substation will be required to accommodate interconnection. Finally, there is also the possibility of re-arranging the breaker configuration at the Reynolds 345 kV substation.
- Based on the analysis completed to date, Clean Line expects that a new 4-breaker 345 kV interconnection switching station at the POI along the Maywood – Montgomery 345 kV line in Ralls County, Missouri would be necessary to accommodate the interconnection. This new switching station is anticipated to utilize a ring-bus configuration, expandable to a breaker-and-a-half configuration, that will loop the existing Maywood – Montgomery 345 kV line into this station as well as connect the new single 345 kV line from the Project's converter station 345 kV bus. This new switching station is also expected to include 345 kV relaying panels with microprocessor based relays, 345 kV disconnect switches, 345 kV 3-winding capacitance coupled voltage transformers (CCVTs), insulators, surge arresters, meters, control cables and other standard switching station equipment (steel structures, yard lighting, grounding system, lightning shielding, etc.)

3.5 Hazardous Materials Handling and Disposal

Construction will involve the transport of limited quantities of hazardous materials to the Project site and will pose minor hazards associated with their use. Small oil spills may occur during onsite refueling of equipment. If a fuel spill occurs on soil, Clean Line will place the contaminated soil into barrels or trucks for offsite disposal as a hazardous waste. In addition, Clean Line will perform equipment refueling away from water bodies to prevent contamination of water in the event of a fuel spill. The worst-case scenario for a chemical release from fueling operations would be an accident involving a service or refueling truck.

The quantities of hazardous materials that Clean Line will handle during construction are relatively small and Clean Line will implement applicable construction practices.

The health and safety program will comply with all federal, state, and local health standards that pertain to worker health and safety. Clean Line will handle and dispose of all hazardous materials according to applicable regulations. Clean Line will develop pollution prevention control measures during preliminary and final engineering design. Clean Line will remediate accidental leakage of fuel or lubricants from construction, operation, and maintenance equipment in accordance with applicable regulatory standards.

3.6 Gravel Sources

Crushed stone and gravel resources used for concrete and road construction are widely distributed across the Project area and Clean Line will obtain these resources from commercial suppliers. Crushed stone and gravel resources include limestone, dolomite, granite, and rhyolite and extensive sand and gravel deposits along existing and historic river courses. Due to the high cost of transportation, mineral aggregate (e.g., sand, rock and gravel) would typically be procured from local producers. These producers may distribute bulk aggregate or construction contractors may elect to utilize their own trucking resources. Contractors may solicit bids from local and/or regional producers to support the project and would consider availability, quality, cost, and distribution capabilities in their selection.

4.0 Operations and Maintenance

This section describes the activities performed to operate and maintain the Project. The maintenance activities will consist of a Transmission Line Maintenance Program, a Vegetation Management Plan, and a ROW Management Program.

4.1 Operational Characteristics

The nominal voltage of the DC line will be ±600kV DC. There may be minor variations of the nominal level depending on load flow. The nominal voltage of the AC facilities will be 345kV as described previously. There may be minor variations of the nominal level depending on load flow and operating conditions. The typical ROW for both AC and DC lines will be 150 to 200 feet in width. The final ROW width will be determined during engineering design.

4.2 Permitted Uses within the Right-of-Way

Land uses compatible with reliability and safety requirements for HVDC and AC facilities will be permitted in and adjacent to the ROW. Existing land uses such as agriculture and grazing, vehicle and pedestrian access, recreational use, and pre-existing compatible uses are generally permitted. Incompatible land uses within the ROW include construction and maintenance of inhabited dwellings, and any use requiring changes in surface elevation that affect electrical clearances of existing or planned facilities.

Good Utility Practice, NERC rules, and the planned design, maintenance, and operation of the line govern height restrictions of activities within the right-of-way in order to maintain minimum clearance requirements as determined from the NESC. Once a route is established, Clean Line will review the route for non-standard activities that may require adjustments to minimum clearances.

After the transmission line has been energized, agricultural and non-agricultural land uses that are compatible with reliability and safety requirements will be permitted in the ROW, subject to limitations. Limitations on land uses will be described in the easement agreements; these limitations may be modified based on site-specific conditions and coordination with landowners. For example, limitations on uses within the ROW include the following:

- A prohibition on placing a building or structure within the ROW.
- Restrictions on timber or the height of orchard trees within the ROW.
- Restrictions on grading and land re-contouring within the ROW that would change the ground surface elevation within the ROW such that required electrical clearances are no longer maintained.
- Restrictions and/or required coordination for the construction of future facilities such as fences and/or irrigation lines within the ROW.
- Restricted access for safety considerations where maintenance activities are being performed.

Clean Line anticipates that any restrictions on land use within the ROW would be determined based on site-specific conditions and/or in coordination with landowners. These are not blanket limitations or restrictions that would apply to every parcel associated with the Project. For example, Clean Line recognizes that agricultural areas are graded, contoured, and ditched as part of routine agricultural practices. These types of routine practices are compatible with the reliability of the HVDC and AC facilities and would not be restricted. Similarly, Clean Line has no intent to displace or prohibit livestock grazing in pastures overlapped by the ROW during construction, operation or maintenance, unless otherwise desired by the landowner. Clean Line anticipates that livestock would continue grazing during construction, operation, and maintenance.

To illustrate the typical activities, restrictions, and temporal nature of construction, Clean Line has developed the *Example of Typical Construction Activities on Agricultural Property* (included in Appendix B), which describes a typical construction sequence that could occur on a single parcel.

Clean Line anticipates that construction practices would be implemented and carried forward into operations and maintenance phases. For example, Clean Line will work with landowners to develop compensation for lost crop value caused by operations and maintenance activities. To avoid the potential of operations and maintenance activities resulting in loss of or injuries to livestock, Clean Line will continue to coordinate with landowners regarding access controls (e.g., cattle guards, fences, gates).

4.3 Transmission Line Maintenance Program

Clean Line will establish a Transmission Line Maintenance (TLM) program to maintain physical facilities. Through this program, Clean Line will identify, prioritize, and schedule maintenance activities for resolution depending on their potential severity. This section describes the categories and types of maintenance activities, potential staffing, and general safety practices. Maintenance activities can be classified into preventative and corrective activities. Preventative activities are more regular and scheduled in nature. Corrective activities are those that are discovered following an inspection or caused by a discrete event.

The TLM Program will include Program Level Guidelines (PLGs) to address the goals, activities, frequency and duration, and required resources for all maintenance activities. For example, Clean Line PLGs would include, but may not be limited to, the following:

- All transmission structures will be inspected from the ground every 24 months.
- All transmission lattice structures will be climbed and inspected every 10 years (climbing inspection).
- All transmission structures and spans will be patrolled by helicopter every 6 months (aerial inspection).

Corrective Activities

Depending on the severity of the issue, corrective activities would be either immediate or scheduled. Activities considered immediate are those that require a response in the case of an event, or imminent threat of an event, that could result in a sustained outage. Immediate corrective maintenance activities tend to be intermittent and random in nature. Scheduled corrective activities can be delayed, reprioritized and scheduled without risking damage or outages. Scheduled corrective activities tend to be planned and scheduled and/or performed after the event is found.

To minimize the frequency and duration of corrective activities, Clean Line has designed robust structures that incorporate the appropriate National Electric Safety Code requirements. The Project's design criteria contemplate a loading scenario, on a structure without wires, of wind speeds equivalent to an F-2/EF3 tornado. While these loading scenarios don't eliminate the potential for damage to the line, they do decrease the likelihood of structure damage or a major outage. Current engineering plans call for stop-structures (deadends) every 5-10 miles to prevent cascading events.

Clean Line plans to utilize weather monitoring systems currently in place in the project area to track tornadic activity, and to communicate elevated risk levels to interconnecting utilities in order to ensure operational readiness.

A spare parts inventory would be put in place along the route to address both high and low probability weather events. Standby contracts for labor and emergency equipment would provide for quick responses to any outages.

Preventative Activities

Typical preventative maintenance activities anticipated would include various levels of physical inspections of the facility within specific periods. For example, the type of inspections for the HVDC transmission line would include:

- Aerial inspection of the line as specified in the PLG's typically on a 6 month rolling schedule. The aerial inspections would typically require a helicopter with a pilot and an observer to perform and record the aerial inspection. This activity might be pursued on a six month PLG and could involve the use of cameras, both visual and thermo vision, to detect hot spots. This activity could increase noise but has essentially no impact on agricultural activities.
- Ground based working patrols with each structure visited and visually inspected including the span ahead and back of each structure typically every 24 months. The ground based working patrols would require a line truck with typically two line hands to perform the inspection at each structure once a year. This activity would have low impact for land issues. In agricultural lands the inspections could be either staged to not conflict with crops during the off season or alternately performed from a modest distance to avoid driving on cultivated land. The activity is essentially limited to driving or walking to the site and performing a visual inspection.
- Climbing inspections of perhaps 10% of the lattice structures to identify loose or bent members, missing bolts, etc. annually. This specific PLG would have all the lattice structures with a climbing inspection performed on a ten year rolling schedule. The climbing inspections would typically require two line trucks or a larger line truck that carries four passengers. The actual climbing inspection would involve either one or two climbers and ground support for each climber requiring about four line hands. This activity would also have low impact for land issues. In agricultural lands, or in other areas of sensitive habitats or land uses, the inspection could be staged during times when there would be minimal impact. Tubular steel structures would likely be excluded from climbing inspections.

Staffing

Clean Line's TLM resources will consist of one of the following personnel mixes:

- Entirely maintained in-house as utility employees;
- Base TLM crews augmented with contract support line-hands; or
- Entirely contracted to qualified providers.

Standards and Work Practices (SWPs)

The TLM Program may include the supported and expected TLM Standards and Work Practices (SWPs) for safely and efficiently accomplishing the PLGs. Essentially the PLGs specify what shall be done, how often it shall be done, and resources to accomplish the goals of the TLM Program. The SWP specifies the standards by which the work shall be accomplished and accepted work practices to safely perform the work. Examples of SWP specifics include, but may not be limited to the following:

- TLM maintenance practices will support the use of helicopter platforms for maintenance activities.
- Minimum approach distances are specified in the TLM standards and shall be honored at all times when working in the vicinity of conductors or shield wires regardless of whether energized or de-energized.

- All de-energized maintenance work shall commence only after a clearance hold from Operations is secured by the Foreman I and all grounds have been installed and inspected and declared safe before work may commence.

4.4 Vegetation Management Program

Pursuant to the NERC Reliability Standard FAC-003-2, Clean Line is required to create and implement a documented vegetation management strategy for the Project's permanent ROW to prevent vegetation-caused outages on the transmission system. Clean Line will develop a Vegetation Management Program (Vegetation Program) that will provide the framework for implementing treatments prescribed by the Project's Transmission Vegetation Management Plan (TVMP). The Vegetation Program will recommend broad vegetation management objectives and identify appropriate vegetation management actions for implementing the TVMP. The TVMP will define site-specific standards, measurable metrics and management objectives; and prescribe controls or treatment options to achieve defined objectives and support the Vegetation Program's goals.

The Vegetation Program and TVMP will comply with federal, state, and local regulations and standards for reliability and ROW vegetation clearing and maintenance, including NERC Reliability Standard FAC-003-2. The Vegetation Program and TVMP will also comply with relevant regulations applicable to all lands, including but not limited to the Clean Water Act (CWA) Sections 303(d) and 404 and the Endangered Species Act (ESA) of 1973, as amended in Section 7(a)(2). Vegetation management treatment types, methods, and activities will be developed in accord with applicable stipulations and protection measures identified in other Project Plans, including but not limited to the following documents:

- Right-of-Way Easement agreements
- Clean Line's Avian Program and related Avian Protection Plan
- Reclamation and Revegetation Plan
- Storm Water Pollution Prevention Plan
- Agriculture Impact Mitigation Policy and Missouri Agricultural Impact Mitigation Protocol

Clean Line will develop a Vegetation Program and TVMP using principles of Integrated Vegetation Management (IVM) following the guidelines presented in the American National Standards for Tree Care Operations - *Tree, Shrub, and Other Woody Plant Management - Standard Practices* (Integrated Vegetation Management a. Utility Rights-of-Way) (ANSI A300, Part 7) *and Best Management Practices* (Second Edition; 2014) and subsequent versions or similar future guidance documents, as appropriate. Integrated Vegetation Management is an established system for promoting and managing sustainable plant communities within transmission line ROWs that are compatible with safe, reliable operations and maintenance of the Project. The TVMP will adopt key IVM principles in order to encourage desirable vegetative communities that reduce the risk that incompatible vegetation poses for utility service reliability, accessibility of the ROW and facilities, and other security or safety risks.

As defined in *ANSI A300 Part 7*, key steps of IVM include:

- Gaining a science-based understanding of incompatible vegetation and ecosystem dynamics within and near the ROW;
- Setting specific, measurable management objectives and tolerance thresholds based on site-specific conditions, regulatory requirements, landowner's or tenant's input, and other factors;
- Selecting treatments from a variety of options and applying them responsibly to promote sustainable, desirable plant communities; and

- Monitoring treatments to determine their efficacy in creating desired plant communities and achieving management objectives over time.

An important benefit of creating a Vegetation Program and TVMP based on IVM principles is the opportunity for continuous improvement. Routine monitoring and adaptive management are fundamental to IVM and require diligent monitoring of treatments and inherently dynamic ecological conditions. Over time, this information is used to inform and refine future vegetation management decisions that are, in turn, monitored for efficacy and efficiency. This system of feedback encourages selection of the most effective treatment types that balance socioeconomic and environmental considerations. Integrated Vegetation Management allows for an array of different treatment options to achieve desired management objectives and, while emphasizing biological controls, also encourages other treatment types, such as manual, mechanical, cultural, and chemical.

While IVM is an established management method, it "is not a set of rigid prescriptions based upon set time periods, repeated unselective mowing, or broadcast [herbicide] spraying across entire rights-of-way widths without the objective of establishing diverse, compatible plant communities" (ANSI A300 part 7: IVM BMPs; Second Edition, 2014). Herbicide application is a valuable tool in IVM that, when implemented properly and in a targeted manner, reduces the need for future intervention, minimizes soil disturbance, and can selectively and efficiently target undesirable plant species and encourage growth of desirable vegetative communities. Selective herbicide use, for example, can be applied manually to prevent the stumps of undesirable woody species from re-sprouting and growing in high densities that become increasingly more hazardous to the transmission system, often provide poor habitat value, and are more difficult to manage over time. As with all potential control options consistent with IVM, Clean Line will evaluate herbicidal treatment options in consideration of site-specific ecological conditions, surrounding and underlying land uses, and any environmental sensitivities before selecting and applying a control.

The TVMP will apply to the ROW, temporary work areas, access roads, and other facilities associated with the Project during pre-construction clearing activities, construction, site restoration, and Operations and Maintenance. Any project-related ground disturbing activities outside these areas require prior approval by the appropriate landowners and/or agencies. Clean Line will develop the Vegetation Program based on the approved project route and Clean Line's preliminary design and engineering.

Clean Line retains the primary responsibility of directing and monitoring vegetation management activities for the Project. Clean Line and/or its construction contractor may choose to utilize a contractor that specializes in vegetation management to implement the protocols identified in the TVMP or Vegetation Program during and following construction, including site restoration. During Operations and Maintenance, Clean Line Operations and Maintenance staff will work with a professional consulting forester to set management objectives, evaluate the ROW and Project areas to assess field conditions, define action thresholds, and evaluate and select control methods or treatment options. Clean Line will then work with a certified professional arborist to implement the treatment options or control methods to achieve the established management objectives. Typically, the resources required to accomplish the specifics of the Vegetation Program are based on the TVMP and tend to be a mix of in-house resources and contract resources.

Vegetation Specialists typically rely on helicopter inspection reports, TLM working patrol reports, and contract field inspectors to identify vegetation which requires removal or trimming based on the standards and metrics of the TVMP. These identified vegetation issues are aggregated into contract or statement of work (SOW) instruments to provide specifics to a vegetation management contract crew qualified to work in the vicinity of OH electrical facilities. The vegetation management contractor accomplishes the vegetation removal or trimming to the satisfaction of the Vegetation Specialist based on the SOW.

The Vegetation Management Program also carries PLGs and SWPs for danger tree (vegetation) identification, marking, and removal which is contained within the TVMP.

4.5 Right of Way Management Program

The Right of Way Management Program will manage the ROW to identify any encroachments on the ROW which either threaten the safe and reliable operation of the HVDC and AC transmission lines or are not compliant with any ROW easement limitations. When encroachments are identified, Clean Line will resolve them with the landowner or tenant to bring the ROW back into a state where land use activities are compatible with the overhead transmission lines.

Clean Line ROW Specialists would review helicopter inspection reports, TLM working patrol reports, and contract field inspectors as appropriate to identify activities encroaching on the ROW. Once identified, the ROW Specialist would inform and work with the landowner or tenant to resolve the encroachment issues. Examples of encroachments that occur after the transmission line is in place might include, for example:

- Non-permitted communication or electrical facilities in the ROW.
- Non-permitted pipelines crossing the ROW.
- Structures such as buildings, swimming pools, or grain elevators, that are not compliant with the ROW easement.
- Earth grading that significantly altered the ground elevation for agricultural or road construction activities such that required electrical clearances are no longer maintained.

4.6 Safety and Reliability

Clean Line's primary concern is the safe and reliable operation of the transmission facilities. The Project will be designed to meet or exceed applicable criteria and requirements outlined by organizations such as the Federal Energy Regulatory Commission, the North American Electric Reliability Corporation, NESC, SPP, MISO, PJM, the American Society of Civil Engineers, and other applicable federal, state, or local requirements. Safety measures will meet or exceed applicable occupational safety and health standards. The transmission line will be protected with circuit interruption equipment (circuit breakers, disconnects, etc.). If conductor failure occurs, the line will be automatically de-energized. Lightning protection will be provided by overhead ground wires. Electrical equipment and fencing at the converter stations and substations will be grounded. Vegetation management will occur to minimize potential hazards; trees will be trimmed or removed to prevent accidental grounding contact.

Clean Line will turn over functional control of the Project to a Regional Transmission Organization (RTO)/Independent System Operator (ISO) or an RTO-like entity. For the Project, this could include SPP, MISO, PJM, or a third party. Functional control of a facility means that the RTO ensures compliance with reliability standards for issues such as maintenance outages and the like. Coordination agreements – also known as "seams agreements" – will be negotiated and executed with all interconnection parties. Balancing area functions will be performed by Clean Line or a third party acting as the Transmission Operator on behalf of Clean Line. Clean Line will be subject to all national (NERC) and regional (SPP, MISO, and PJM) reliability standards and compliance.

5.0 Decommissioning

Decommissioning could occur at the end of the useful life and if the facility were no longer required. However, a transmission system lifetime can exceed 80 years with proper maintenance. If, at the end of the service life of the Project, and assuming that the facilities are not upgraded or otherwise kept in service, conductors, insulators, and structures could be dismantled and removed. The converter stations and regeneration stations, if not needed for other existing transmission line projects, could also be dismantled and removed. The station structures would be disassembled and either used at another station or sold for scrap. Access roads that have a sole purpose of providing maintenance crews access to the transmission lines could be decommissioned following removal of the structures and lines, or could be decommissioned with the lines in service if determined to no longer be necessary. Clean Line will consult with landowners to assess whether access roads may be serving a larger purpose for landowners, at which point in time, Clean Line may elect to leave the access roads in place. A Decommissioning Plan would be developed prior to decommissioning, but due to the uncertainty of future technology and unknown future environmental requirements, any document would follow appropriate governing requirements at that time.

6.0 References

American National Standards for Tree Care Operations (ANSI) *Tree, Shrub, and Other Woody Plant Management - Standard Practices* (Integrated Vegetation Management a. Utility Rights-of-Way) (ANSI A300, Part 7) *and Best Management Practices* (Second Edition; 2014)

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U.S. Geological Survey (USGS). 2014. Directory of State Listings of Crushed Stone and Sand and Gravel Producers. http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/statedir03.pdf . Accessed April 2014.

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Appendix A
Figures

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