Appendix D
Project Description Technical Report (TWE 2012)

TransWest Express Transmission Project

Project Description Technical Report

Submitted by

TRANSWEST EXPRESS LLC

Submitted to

NATIONAL SYSTEM OF PUBLIC LANDS

Wyoming State Office

Western Area Power Administration

October 2012

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ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AC	alternating current
AC/DC	alternating current/direct current
ACSR	aluminum conductor steel reinforced
ANSI	American National Standards Institute
APLIC	Avian Power Line Interaction Committee
APS	Arizona Public Service
ATV	all terrain vehicles
BLM	Bureau of Land Management
BMP	Best Management Practices
COM Plan	Construction, Operation and Maintenance Plan
CWA	Clean Water Act
DC	direct current
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DOT	Department of Transportation
EHV	extra high voltage
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
E.O.	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act of 1976
FPEIS	Final Programmatic Environmental Impact Statement
GIS	Geographic Information System
HV	high voltage
HVDC	high voltage direct current
IPP	Intermountain Power Plant
IRA	Inventoried Roadless Areas
IVM	integrative vegetation management
kV	kilovolt
LADWP	Los Angeles Department of Water and Power
LP	liquid propane
LPP	laminated polypropylene paper
MI	Mass impregnated
MVCD	Minimum Vegetation Clearance Distance
MW	megawatt
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act of 1969
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act
NOI	Notice of Intent

NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
NTTG	Northern Tier Transmission Group
OPGW	optical ground wire
PA	Programmatic Agreement
PDTR	Project Description Technical Report
POD	Plan of Development
POWER	POWER Engineers, Inc.
ROD	Record of Decision
ROW	Right-of-Way
RPPR	Regional Planning Project Review
SCADA	Supervisory Control and Data Acquisition
SCFF	Self-contained fluid filled
SHPO	State Historic Preservation Office
STS	Southern Transmission System
TransWest	TransWest Express LLC
TWE Project	TransWest Express Transmission Project
UHF	ultra high frequency
USACE	U.S. Army Corps of Engineers
USDI	United States Department of Interior
USFS	United States Forest Service
VHF	very high frequency
VRM	Visual Resource Management
WECC	Western Electricity Coordinating Council
Western	Western Area Power Administration
WIA	Wyoming Infrastructure Authority
WWEC	West-wide Energy Corridor
XLPE	Cross linked polyethylene

1.0 INTRODUCTION

1.1 PDTR Purpose and Scope

TransWest Express LLC (TransWest/Applicant) has prepared this Project Description Technical Report (PDTR) in support of the Draft Environmental Impact Statement (DEIS) for the TransWest Express Transmission Project (TWE Project). The DEIS is being prepared by the U.S. Department of the Interior (USDI), Bureau of Land Management (BLM), the U.S. Department of Energy (DOE), and Western Area Power Administration (Western), in compliance with the requirements and guidelines of the National Environmental Policy Act of 1969 and the Federal Land Policy and Management Act of 1976 (FLPMA). The PDTR provides a description of the TWE Project for the lead agencies' use in preparing Chapter 2 (Project Description and Alternatives) of the DEIS. The PDTR addresses the proposed TWE Project and alternatives presented by the lead agencies during public scoping. The PDTR also contains detailed design, construction, operation and maintenance information for the agencies' use in the analyses of environmental impacts and mitigation measures adopted by the Applicant for the proposed TWE Project and DEIS alternatives.[1]

The PDTR is presented in the following major sections:

Section 2.0 TransWest Proposed Action, including: a summary of the TWE Project components; purpose and need; technical reliability and commercial requirements; and the TWE Project history, including early planning studies and alternatives considered by the Applicant in determining the proposed TWE Project.

Section 3.0 Project Description, including: the typical design characteristics of the proposed transmission system, terminal stations, ground electrode systems and communication systems; the construction, operation, and maintenance practices; and environmental protection measures adopted by TransWest as part of the TWE Project.

Section 4.0 Alternatives including alternative locations for the terminals and ground electrodes; two system alternatives; and undergrounding.

The appendices provide pertinent background information to the PDTR. Appendix A contains information regarding the methodology used for estimating temporary and permanent disturbances resulting from the TWE Project components and access roads. Appendix B contains maps related to early planning studies and environmental constraint analyses. Appendix C provides supplemental information requested by the lead agencies regarding the TWE Project Vegetation Management Program; and Appendix D provides technical information regarding the potential for induced currents on alternating current (AC) and direct current (DC) transmission lines (AECOM 2010).

1.2 Definitions of Key Terms

Key terms used throughout the PDTR are defined below.

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[1] The PDTR does not address the full range of alternatives, which the lead agencies will determine for the DEIS. The PDTR provides information pertinent to the proposed TWE Project and National Environmental Policy Act (NEPA) scoping alternatives.

Transmission Line Corridors – Corridors are defined as geographic areas generally varying in width between two and six miles within which the proposed 250 foot-wide TWE Project transmission line right-of-way (ROW) would be located. Corridor widths have varied among the various studies completed for TWE Project planning. For purposes of the DEIS analysis, the Proposed and Alternative Corridors have been refined to generally two miles wide. In limited areas, the corridor widths may be greater or lesser due to routing constraints, as requested by the joint lead agencies. These corridors will be evaluated in the DEIS to document the range of resource impacts which could result from transmission line construction, operation, and maintenance within the corridors. Corridor locations and widths have been, and will continue to be, refined throughout the National Environmental Policy Act (NEPA) process.

Transmission Reference Lines – Reference lines are preliminary, non-engineered routes within corridors that were determined based on environmental and engineering constraints and constructability review. The reference line is generally bounded on each side by one mile of corridor. For purposes of the DEIS analysis, reference lines serve as preliminary centerlines for the location of the ±600 kV DC transmission line ROW. Reference line locations will be refined within the transmission line corridors throughout the NEPA process.

Route Segments – Reference lines defined above are divided into route segments, which are identified by a nomenclature of letters and numbers. The route segments will be used to identify alternative end-to-end routes for the transmission line and to quantify and compare potential impacts resulting from these alternative routes.

Alternative Routes – Alternative routes for the TWE Project are defined as a series of corridor segments, which, when combined, define a potential corridor and reference line location for the TWE Project between common geographic points. For the TWE Project DEIS analysis, the lead agencies are identifying and comparing alternative routes according to four distinct regions: Region I - Sinclair, Wyoming, to Northwest Colorado near Rangely, Colorado; Region II - Northwest Colorado to IPP near Delta, Utah; Region III – IPP to North Las Vegas, Nevada; and Region IV - North Las Vegas to Marketplace Hub near Boulder City, Nevada.

TWE Project Alignment – The TWE Project alignment is defined as an engineered route, which will be prepared for the Agency Preferred Alternative. The Project Alignment will be based on engineering and design of the transmission line including specific structure locations. The Agency Preferred Alternative will be determined by the lead agencies, following the public review period on the DEIS, and in consultation with federal, state, and local cooperating agencies.

System Alternatives – System alternatives are alternative transmission configurations, which may have the potential to meet the TWE Project purpose and need, depending on future energy market conditions and permitting decisions for other regional transmission systems. Two system alternatives are described in the PDTR.

2.0 TRANSWEST PROPOSED ACTION

2.1 TWE Project Components

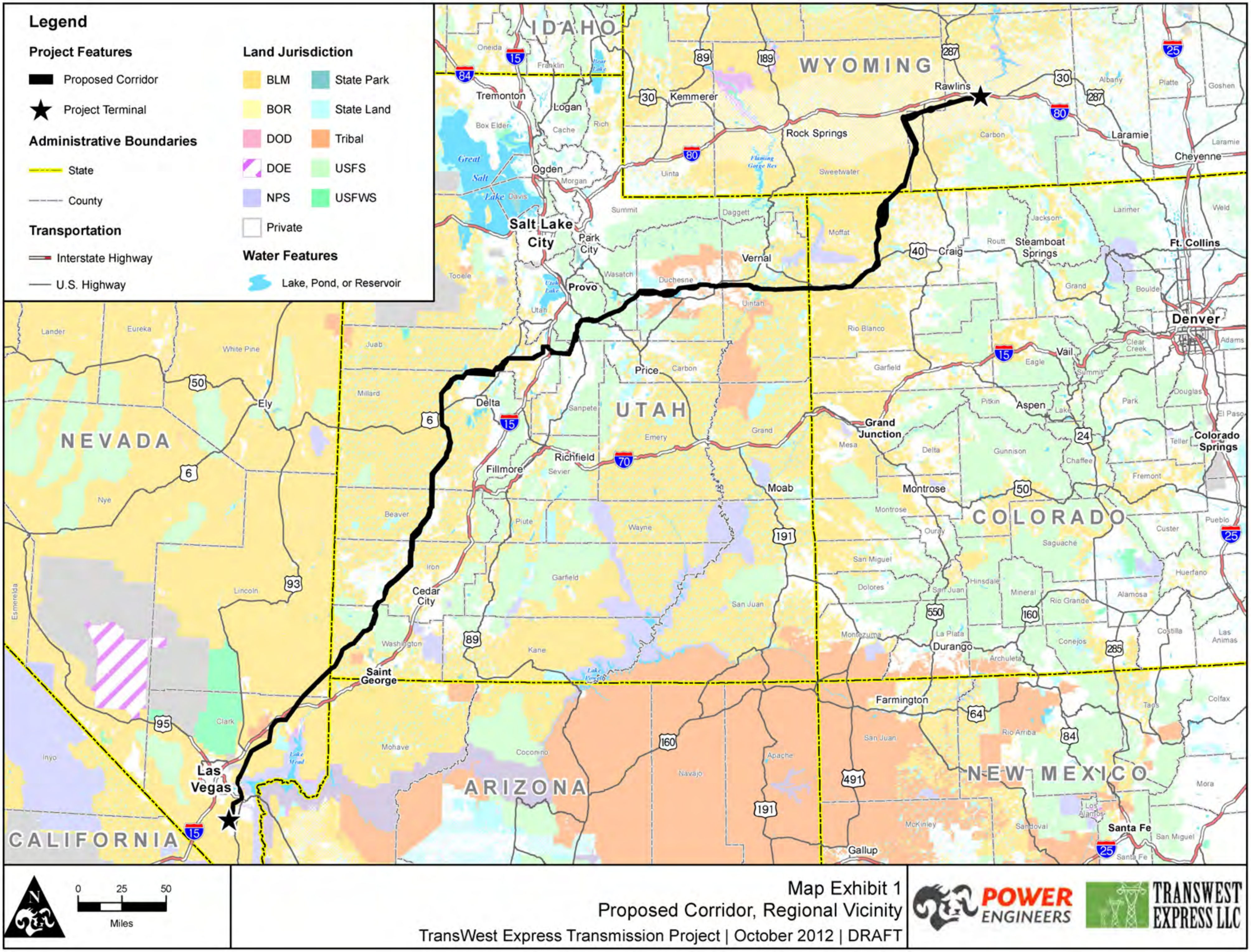
The proposed TWE Project consists of the following components:

- A ±600 kV DC transmission line between south-central Wyoming and southern Nevada. A 250 foot wide ROW will generally be required for the ±600 kV DC transmission line.
- Two terminals for the alternating current/direct current (AC/DC) converter stations and related substations, to be located at either end of the ±600 kV DC transmission line. The proposed TWE Project includes a Northern Terminal near Sinclair, Wyoming, and a Southern Terminal south of Boulder City, Nevada near the Marketplace Hub in the Eldorado Valley, with interconnections to the existing and planned regional AC transmission grid.
- Two independent communications systems, including a dedicated fiber optic network, for command and control of the transmission system. The fiber optic network will require regeneration sites at periodic distances along the ±600 kV DC transmission line. In most cases the regeneration sites will be located within the transmission line ROW. The second communication system will use existing private networks. Microwave antennas may be located at the terminals to connect into these private systems.
- Two ground electrode systems, to be located within approximately 100 miles of the terminals. A low voltage overhead line will be needed to connect the ground electrode systems and AC/DC converter stations.
- Access roads to the TWE Project facilities. The TWE Project's proposed Access Road Plan entails making improvements to existing roads, constructing new roads and using overland access methods for the construction, operation, and maintenance of the TWE Project. Existing roads will be used to the extent feasible. Roadless construction methods are proposed in limited areas where the transmission line would cross Inventoried Roadless Areas (IRAs).
- Temporary work areas will be required during construction of the TWE Project including terminals; ground electrode systems; structures; staging areas; material storage areas; fly yards; pulling, tensioning, and splicing sites; communication and regeneration sites; and batch plants.

2.2 TWE Project Location

2.2.1 Regional Vicinity

The proposed TWE Project crosses portions of Wyoming, Colorado, Utah and Nevada. Map Exhibit 1 shows the regional setting of the proposed TWE Project with respect to state and counties crossed.



Map Exhibit 1

Proposed Corridor, Regional Vicinity

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2.2.2 Designated Utility Corridors

The TWE Project transmission line will be approximately 725 miles long, and will follow designated utility corridors for approximately 78 percent of the entire length of the line. Map Exhibit 2 shows the location of the proposed TWE Project corridor and identifies where the transmission line follows utility corridors. Designated corridors, identified on Map Exhibit 2, include corridors designated: (1) by the Department of Energy in November 2008 as West-wide Energy Corridors (WWEC) pursuant to Section 368 of the Energy Policy Act; (2) by the Bureau of Land Management (BLM) and the United States Forest Service (USFS) in their respective land management plans (various dates); (3) by state and county land use plans (i.e., Millard County, Utah major utilities corridor); (4) by connection to federally designated corridors on private and state lands because of their proximity to the federal lands with these designations; and (5) by locating the line adjacent to existing utility line corridors.

2.3 TWE Project Technical Requirements

2.3.1 NERC Standards and WECC Regional Criteria Guidelines

The Reliability Standards used within the electric utility industry for the bulk power electrical grid are developed by the North American Electric Reliability Corporation (NERC). The Western Electricity Coordinating Council (WECC) develops Regional Criteria that supplement the NERC Standards. The West-Wide Energy Corridor (WWEC) Final Programmatic Environmental Impact Statement (FPEIS) includes a comprehensive overview of this subject in Chapter 2, Section 2.6.3, *What Steps Are Being Taken To Ensure The Reliability of Bulk Electricity Transmission* (DOE et al. 2008). The overview includes a description of how NERC and WECC regulate the industry through a wide series of standards that address all facets of the bulk electricity transmission grid, including design, planning, operations, infrastructure and cyber security, communication, coordination and operational safety.

These reliability standards affect the technical aspects of the TWE Project in several ways. Reliability standards limit the operational capacity of any single transmission system element based on a complex contingency analysis that considers the impact to grid operations following various events (e.g. equipment failures, line outages).

Reliability standards affect the TWE Project ROW requirements and separation requirements from other high voltage lines. As a single transmission system element, the TWE Project is effectively limited in capacity to approximately 3,000 megawatts (MW).

The contingency analysis required for new transmission projects such as the TWE Project involves examining several types of events including the loss of "Adjacent Transmission Circuits" and the loss of multiple transmission lines within a corridor.

WECCs Regional Criteria addresses separation distances based upon the location of a project from Adjacent Transmission Circuits. WECC requires a minimum separation distance between high voltage transmission lines. The WECC Regional Criteria specifies that to avoid being rated as Adjacent Transmission Circuits, or common transmission system elements, circuits must be separated by "at least 250 feet between the transmission circuits" (WECC 2012). The applicability of this portion of the Regional Criteria is for circuits greater than or equal to 300 kV. The loss of multiple lines within a corridor involves analyzing impacts after a line outage of the TWE Project transmission line and any other transmission line(s) within the corridor. The most likely event would be the loss of the TWE Project and an adjacent transmission line.

The likelihood of having a line outage of two transmission lines is even higher at places where transmission lines cross one another. The mechanical failure of the top line would typically cause the line below to also fail. The practicality of needing transmission lines to cross is recognized in the standards; however, the number of crossings needs to be minimized to reduce the likelihood of such an event. This same concept of the practical need for line crossings and the treatment of these within the siting criteria have been extended to develop a TWE Project Transmission Line Co-location Framework. The framework allows for the use of various separation distances depending on localized siting constraints and the voltages of other transmission lines within the corridor.

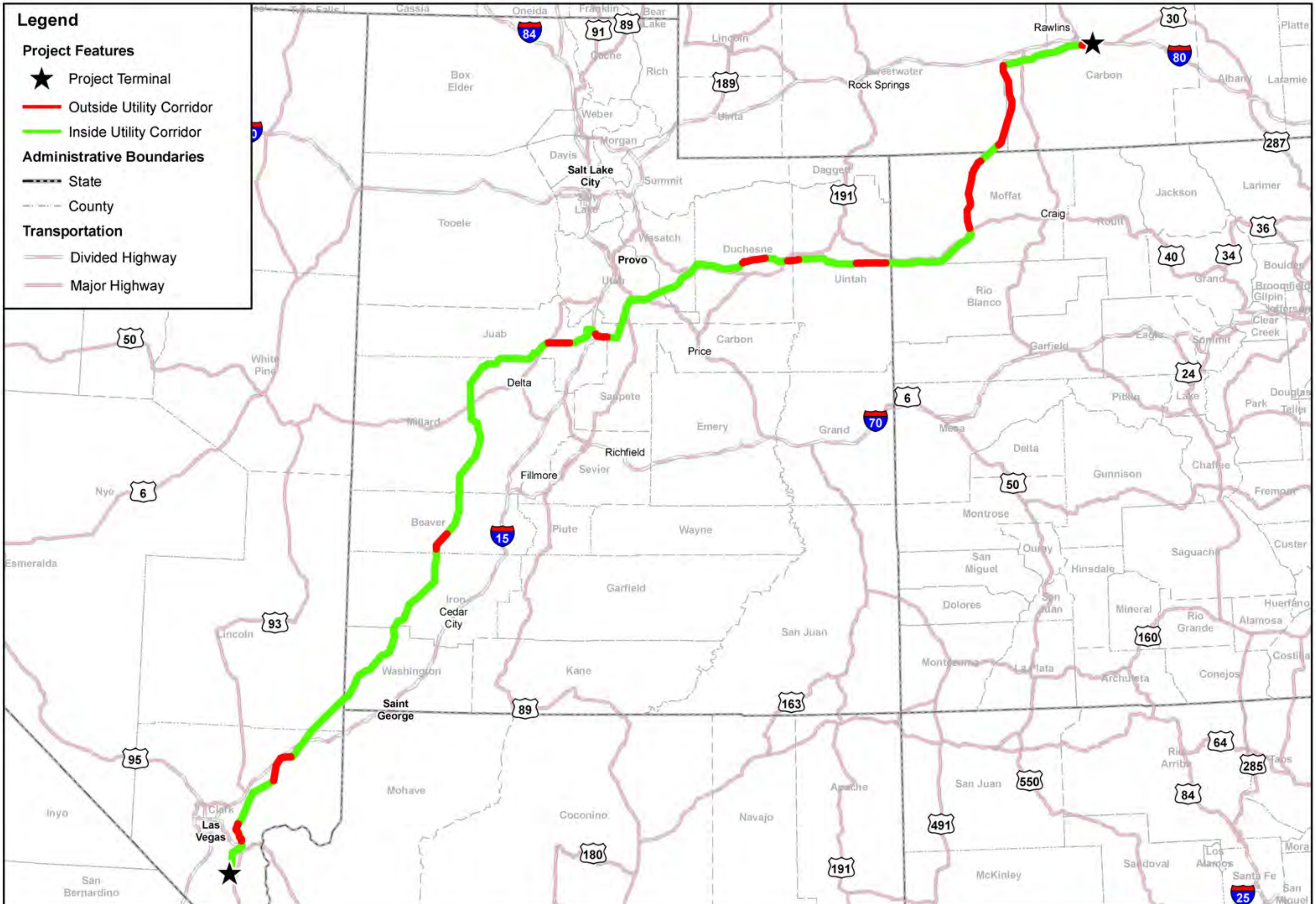
Reliability analysis examining the scenario where multiple lines are lost including the TWE Project has shown this loss will have a significant impact on transmission grid performance, including local and widespread transmission grid blackouts. This reliability analysis has found that the higher the capacity of the line lost along with the TWE Project, the more severe the transmission grid performance consequences. The reliability analysis also demonstrated that it is not feasible for the TWE Project and another transmission project to use common structures for any portion of the route.

The TWE Project Co-location framework outlined below provides for: (1) the application of TransWest's desired separation criteria; and (2) the selective use of a less stringent separation criteria depending on the circumstances. The framework utilizes two different separation distances, either a tower span distance of 1,500 feet or a tower height distance of 250 feet; separation distances in the framework are applied based on different variables including the TWE Project design, the voltage of the Adjacent Transmission Circuit(s), and the localized siting conditions and constraints. The 250 foot separation distance represents the absolute minimum separation distance for the TWE Project and other transmission lines of any voltage. The framework set out below addresses co-location requirements and implementation measures for three levels or situations: (1) standard co-location distances; (2) selective situational co-location distances; and (3) extreme situational co-location distances.

2.3.1.1 Level 1 – Standard Co-Location Distances

Level 1 represents the TWE Project separation criteria to be applied to the majority of situations involving Adjacent Transmission Circuits and is TransWest's preferred standard. Meeting Level 1 separation criteria is the most effective and prudent way to meet and exceed the Reliability Standards and WECC Regional Criteria. Level 1 will allow TransWest to meet its objectives for the TWE Project of providing 3,000 MW of transmission capacity while improving electrical grid reliability, and utilizing existing and designated utility corridors. Level 1 entails:

- Maintaining a separation distance of at least 1,500 feet between the TWE Project and transmission lines with a voltage rating of 345 kV and above, and
- Maintaining a minimum separation distance of at least 250 feet between the TWE Project and transmission lines with a voltage rating below 345 kV.



Map Exhibit 2
Proposed Route Utility Corridor Utilization
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2.3.1.2 Level 2 – Selective Situations Co-location Distances

Level 2 represents separation criteria that will be acceptable for limited portions of the TWE Project transmission line route depending on the situation. Level 2 can be utilized where impacts to highly sensitive resources or land use areas identified through the environmental analysis process can be effectively mitigated by using Level 2 co-location distances. Level 2 co-location distances would meet the Reliability Standards, but is less desirable than Level 1 given the increased impact on reliability. Consequently Level 2 would be applied selectively to only those portions of the route where the TWE Project would be co-located near 345 kV transmission lines and where the implementation of Level 2 would effectively mitigate potential impacts to highly sensitive resources or land use areas. Level 2 entails:

- Maintaining a separation distance of at least 1,500 feet between the TWE Project and transmission lines with a voltage rating above 345 kV, and
- Within selective areas of highly sensitive resources or land uses, maintaining a separation distance of at least 250 feet between the TWE Project and transmission lines with a voltage rating of 345 kV, and
- Maintaining a minimum separation distance of at least 250 feet between the TWE Project and transmission lines with a voltage rating below 345 kV.

2.3.1.3 Level 3 – Extreme Situations Co-location Distances

Level 3 represents separation criteria to be utilized only for very limited portions of the TWE Project transmission line route and only in extreme situations. For instance, Level 3 Extreme Situations Co-location Distances can be used where there are extreme physical or other siting constraints or where the environmental analysis identifies impacts that can be effectively mitigated with Level 3 co-location distances. Level 3 Extreme Co-location Distances would meet the Reliability Standards, but only if they are applied to the shortest possible distance and for a very limited number of times. System analysis has shown that outage of the TWE Project along with other 500 kV transmission lines would result in extreme consequences for the transmission grid in the form of widespread blackouts. The Level 1 Standard Co-location Distances for the TWE Project and other 500 kV lines reduces the likelihood of a failure of the transmission grid resulting in blackouts as compared to utilizing the 250 foot distance. The Reliability Standards require an examination of the possibility of single and multiple line failures and their potential impact on transmission grid performance. The Reliability Standards also require the development of additions to the grid, such as the TWE Project, to be designed in such a way to decrease the likelihood of these events occurring over the life of the project. The Level 1 Standard Co-location Distances meet this requirement for the TWE Project. Any deviation from the Standard Co-location Distances for the TWE Project and other 500 kV lines increases the likelihood of transmission grid blackouts from the loss of multiple lines. Therefore, the number and extent of these deviations need to be minimized to meet the Reliability Standards. Consequently, Level 3 Extreme Situations Co-location Distances would be applied very selectively for short distances where its implementation would effectively mitigate potential impacts to extreme physical or other siting constraints. Level 3 entails:

- Reducing the separation distance within areas of extreme physical or other siting constraints for as short a distance as practical and for only a limited number of occurrences to no less than 250 feet between the TWE Project and transmission lines with a voltage rating above 345 kV; and

- Within selective areas of highly sensitive resources or land uses, maintaining a separation distance of at least 250 feet between the TWE Project and transmission lines with a voltage rating of 345 kV, and
- Maintaining a minimum separation distance of at least 250 feet between the TWE Project and transmission lines with a voltage rating below 345 kV.

The Transmission Line Co-location Distances Framework for the TWE Project has been established based on preliminary reliability analysis in accordance with industry reliability standards. This analysis is ongoing and is subject to the review of WECC members. Therefore, if underlying assumptions used in the preliminary analysis are found to be inaccurate or if those assumptions change, then the minimum siting criteria for the TWE Project may need to be revised further.

2.3.2 Commercial Requirements

In addition to the NERC and WECC standards and guidelines, TransWest has identified a commercial need for the TWE Project to include the potential for a future interconnection with the IPP system. Planning for a possible interconnection will provide future flexibility for transmitting available renewable energy resources through the existing transmission grid if and when transmission capacity becomes available (TWE 2010b).

2.4 TWE Project History

The history of alternatives considered in early planning studies, and documented in the ROW Application SF 299 and POD submittals to BLM, is described below. Map Exhibits referenced in this PDTR section are located in Appendix B.

2.4.1 Alternatives Considered Early On (Pre-BLM Application Filings)

2.4.1.1 2006-2008 Electrical Transmission System Planning Studies

Electrical transmission system planning studies were initially undertaken in September 2006 to assist in identifying a range of alternatives for the TWE Project and other regional-scale transmission projects planned to facilitate the transmission of power to markets in the Desert Southwest region.

Pertinent early planning studies included:

- In 2007, the TWE Project was the subject of a Regional Planning Project Review (RPPR), conducted in accordance with WECC Planning Procedures. The purpose of the planning process was to review projects on a regional basis, using an open and transparent process to identify, and potentially reconfigure or combine, the proposed projects under review. This review was conducted jointly with the Energy Gateway South 500 kV Project, sponsored by PacifiCorp, doing business as Rocky Mountain Power, which was originally planned to start in Wyoming and terminate in southern Nevada. As a result of this review, the TWE Project was reconfigured to have the Northern Terminal moved from northeast Wyoming to south central Wyoming and the Southern Terminal moved from central Arizona to southern Nevada. The findings of the RPPR Conceptual Technical Report concluded that the TWE Project's proposed ±600 kV DC transmission system, coupled with Energy Gateway South's 500 kV AC Project, would serve the needs of the broader region of Utah, Arizona, Nevada and Southern California most cost effectively, while minimizing potential environmental impacts (TWE 2008a).

- The TWE Project was included in the study work performed as part of the Northern Tier Transmission Group (NTTG) 2007 Annual Planning Report (NTTG 2007). The NTTG is a sub-regional transmission group that, among other responsibilities, coordinates regional planning efforts in the Northwest and Mountain states.

- The TWE Project was included in the WestConnect 2008-2017 Transmission Plan. WestConnect is another sub-regional transmission group that coordinates regional planning efforts in Nevada, Arizona, New Mexico, and Colorado (WestConnect 2005).

2.4.1.2 2006-2008 Regional Corridor Studies

Initial regional corridor studies were conducted in 2006 (APS 2006). The study area extended from Wyoming to Arizona, including corridors in the states of Idaho, Utah, Colorado, Nevada, and New Mexico. Regional environmental studies were conducted during the same time period, using available secondary data. A series of preliminary corridors up to four miles wide, which had been identified as desirable by electrical system planners, were evaluated. Results of these studies indicated the general environmental feasibility of system planning alternatives.

A second regional corridor study was initiated in September 2007 to identify preliminary alternative transmission corridors for both the TWE Project and Energy Gateway South 500 kV Project. This study was completed in February 2008 (APS, et al. 2008) to document environmental constraints and opportunities within the region and to identify and refine potential alternative corridors that would meet the electrical system planning requirements of the TWE Project. During this study, a more detailed review of environmental data and federal land management plans was completed, as well as communication and consultation with federal agencies.

2.4.2 Transmission Corridors and Facility Sites Identified in BLM Application Filings

The TWE Project Preliminary ROW Application SF 299 submitted in 2007 initiated the BLM's review of the Project and NEPA compliance process. This section of the PDTR provides a chronology of the BLM filings for the TWE Project and documents the alternative corridors considered in those submittals (NGTSC 2007, TWE 2008b, TWE 2009, TWE 2010b and TWE 2010c). Map Exhibits B-1 to B-6 in Appendix B show the results of these early planning studies in relationship to the proposed and alternative corridors and reference lines.

- *TransWest Express Transmission Project, Preliminary ROW Application SF 299, November 2007 – prepared by National Grid.*

The Preliminary ROW Application SF 299 and preliminary POD submitted in November 2007 identified a broad array of potential alternative corridors, extending between east-central Wyoming and central Arizona. These alternatives had been identified through the APS 2006 corridor studies. The proposed corridor extended approximately 1,300 miles. Map Exhibit B-1 shows the proposed and alternative corridors associated with the November 2007 application. At that point in the planning process, both AC and DC transmission systems were under study; and alternative corridors were typically four miles wide.

- *TransWest Express Transmission Project, Preliminary ROW Application SF 299, December 2008 and Preliminary POD, January 2009 (Amended from November 2007) – prepared by TransWest Express LLC.*

TransWest acquired the TWE Project in 2008 and filed an amended Preliminary ROW Application SF 299 with the BLM Wyoming State Office for a ±600 kV DC transmission line in December 2008. The amended preliminary POD was subsequently submitted in January 2009. The Project area was amended to extend between renewable energy sources in south-central Wyoming and southern Nevada, where Project power could connect to transmission systems for load centers in the southwest. A proposed corridor and seven corridor alternatives were addressed in the amended Preliminary ROW Application SF 299. The proposed TWE Project corridor was routed to follow designated energy corridors to the greatest extent possible, including those designated by the DOE in November 2008 as WWEC, pursuant to Section 368 of the Energy Policy Act of 2005; and corridors identified by the BLM and the USFS in their respective land management plans (various dates).

Alternatives shown in the December 2008 Preliminary ROW Application SF 299 incorporated pre-scoping alternatives that were under review by the BLM at the time. Preliminary reference lines for corridors were defined based on available information on environmental constraints (APS 2006), designated energy corridors, existing utilities and transportation systems, and land ownership. Map Exhibits B-2 and B-3 show the proposed and alternative reference lines and six mile-wide corridors from the December 2008 Preliminary ROW Application SF 299.

- *TransWest Express Transmission Project, Preliminary ROW Application SF 299 (Amended from December 2008) January 2010 - prepared by TransWest Express LLC.*

In January 2010, TransWest submitted an amended Preliminary ROW Application SF 299 to provide additional information and clarifications regarding the TWE Project purpose and need, and proposed Project facilities. The amended Preliminary ROW Application SF 299 identified the need to provide for a potential interconnection with IPP near Delta, Utah. Based on TransWest's review of the BLM's October 2009 alternative route segments, which were under review by BLM as part of the pre-scoping process with federal, state, and local cooperating agencies, TransWest recommended that certain route segments be eliminated from further consideration because they would not facilitate an interconnection with IPP. These eliminated segments included: U125, U190, U195, U225, U230, U235, U240, and U245. Concurrently, TransWest recommended that several route segments, which BLM had eliminated early on from consideration, be reconsidered, specifically segments U781, U784, and U785 (TWE 2010d). In June 2010, TransWest further recommended that alternative routes N35A, N40A, and N90A also be eliminated, based on routing congestion in Nevada (TWE 2010e). Map Exhibits B-4 and B-5 show the proposed and alternative routes from the January 2010 amended Preliminary ROW Application SF 299, which includes some of these route segment eliminations.

- *TransWest Express Transmission Project, Preliminary POD (Amended from January 2009) July 2010 - prepared by TransWest Express, LLC.*

The proposed and alternative TWE Project corridors and preliminary reference lines were subsequently refined in 2010. At the request of BLM, TransWest provided recommendations to BLM and Western on the refinement of corridors and revisions to reference lines (POWER 2010).

Corridors were generally recommended to be reduced in width from six miles to two miles based on pre-scoping agency input and known environmental constraints. The reference lines were refined, based on the most current available information on environmental constraints and engineering criteria. Updated information included, but was not limited to, proposed wilderness areas identified in the Colorado Wilderness Act of 2009, updated sage-grouse lek data for Wyoming, and more precise data on the locations of existing utilities. Recommendations on the narrowed corridors and revised preliminary reference lines were submitted to BLM as part of the amended preliminary POD in July 2010. The amended POD also provided additional information on TransWest's ancillary facilities, NERC standards, WECC criteria for transmission reliability and line separation, and TransWest's committed mitigation measures. Map Exhibit B-6 illustrates the July 2010 refined corridors.

- *TWE Project Corridor Reference Line Refinements - March 2011*

In March 2011, further refinements to the TWE Project proposed and alternative corridor reference lines were submitted to BLM (TWE 2010f). Refinements were made to the corridor reference lines, where necessary, to ensure the DEIS alternatives would meet TransWest's updated line separation criteria (TWE 2010a, 2010f). All reference line adjustments were made within the boundaries of the corridors presented by BLM and Western during public scoping.

- *TransWest Express Transmission Project, Preliminary ROW Application SF 299 (Amended from January 2010) – August 2011 - prepared by TransWest Express LLC.*

In August 2011, TransWest submitted a letter that amended the Preliminary ROW Application SF 299 to incorporate corridors supported by certain counties in Wyoming, Colorado and Utah. By Joint Resolution Regarding Preferred Power Line Corridors between the Boards of County Commissioners of Moffat County, Colorado; Carbon County, Wyoming; and Sweetwater County, Wyoming adopted in July 2011, the counties expressed their preference that the TWE Project transmission line follow the Old Dad Road corridor in Wyoming, and the Seven Mile Ridge corridor in Colorado. TransWest supported siting of the transmission line in both of these corridors and revised its Proposed Action to incorporate the Old Dad Road corridor in Carbon and Sweetwater Counties and the Seven Mile Ridge corridor in Moffat County as TransWest's proposed route. By Joint Resolution Regarding Preferred Power Line Corridors between the Boards of County Commissioners of Millard, Utah, and Juab counties, Utah adopted in August 2011, the counties expressed their preference that the TWE Project transmission line follows the UNEV route in Juab County and the West Wide Corridor in Millard County. TransWest supported siting of the transmission line in these corridors and revised its Proposed Action to incorporate the UNEV route in Juab County and the West Wide Corridor in Millard County.

- *TransWest Express Transmission Project, Preliminary ROW Application SF 299 (Amended from August 2011) – August 2012 - prepared by TransWest Express LLC.*

In August 2012, TransWest submitted a letter that amended the Preliminary ROW Application SF 299 to eliminate System Alternative 1 from further consideration. As stated in the ROW Application, System Alternative 1 would be required if interconnections with PacifiCorp's planned 500 kV system, which consists of the Energy Gateway West and Energy Gateway South Projects could not be made near the TWE Project Northern Terminal. TransWest has requested interconnections with PacifiCorp's existing 230 kV system and planned 500 kV system in Wyoming. To best utilize existing and planned transmission infrastructure and to minimize environmental impacts associated with building additional infrastructure, TransWest is seeking the shortest possible interconnection distance between the TWE Project and PacifiCorp's system. Therefore, the need for System Alternative 1 has been dependent on the design, construction and routing of the Energy Gateway

Projects in south-central Wyoming. TransWest understands that all routing alternatives under consideration for the Energy Gateway Projects are located within the Interstate 80 (I-80) corridor between Fort Steel and Rawlins, Wyoming. Placing the Energy Gateway Projects in the I-80 corridor facilitates interconnection with the TWE Project Northern Terminal and eliminates the need for System Alternative 1. In addition, locating the Energy Gateway Projects within the I-80 corridor complies with BLM's policy to avoid proliferation of ROW and has the least cumulative impacts.

- *TransWest Express Transmission Project, Preliminary ROW Application SF 299 (Amended from August 2012) – October 2012 - prepared by TransWest Express LLC.*

TransWest submitted a letter that amended the Preliminary ROW Application SF 299 to modify the Southern Terminal siting area to exclude certain lands with a conservation easement and other lands for which there may be development conflicts and to include a feasible location for the TWE Project Southern Terminal on lands administered by the BLM within the Eldorado Valley near Boulder City, Nevada. The ROW application describes the Southern Terminal as being located on private land. After review of the siting constraints and opportunities for the Southern Terminal, TransWest has modified the terminal siting area to exclude the Multi-Species Habitat Conservation Easement and to include a portion of BLM land immediately east of the existing transmission line corridor running directly north of the existing 500 kV substations. This area has been added due to reduction of the area within the conservation easement and the congestion caused by the existing and potential transmission facilities that may be sited within the area. The BLM administered portion of the Southern Terminal siting area provides a site that is in alignment with the Applicant Proposed Route, will avoid the need for additional line crossings and has adequate terrain. Map Exhibit 4 shows the modified terminal siting area and the potential location of the terminal site on BLM land.

2.4.3 System Alternatives Identified by Applicant

A range of system configurations has been evaluated for the TWE Project. TransWest identified three system alternatives in the *TransWest Express Transmission Project ROW Application SF 299 (Amended from December 2008) January 2010*, which may have the potential to meet the TWE Project purpose and need (TWE 2010b). In August 2012, TransWest submitted an amendment to this application eliminating System Alternative 1 from further consideration in the EIS (TWE 2012). Consideration of the remaining System Alternatives 2 and 3 in the NEPA process would provide the TWE Project flexibility to adapt to potential regional transmission system changes, which could occur in the next two to three years. The feasibility of these system alternatives depends on future permitting decisions for other regional systems and/or future energy and transmission market conditions. System alternatives are described in PDTR Section 4.3.

3.0 PROJECT DESCRIPTION

Sections 3.1 through 3.4 describe the typical design characteristics for the proposed TWE Project facilities:

- Section 3.1 – the TWE Project ±600 kV DC Transmission Line, including structure designs and foundations, conductors, insulators and associated hardware, overhead shield (ground) wires, grounding rods, and minor hardware; and grid interconnection lines.

- Section 3.2 – the TWE Project Northern and Southern Terminals, including the AC/DC converter stations, and substation equipment.

- Section 3.3 – the TWE Project ground electrode systems, including the ground electrode facilities and low voltage electrode connector line(s).

- Section 3.4 – the TWE Project communications system for command and control of the transmission system.

Sections 3.5 describes the construction practices that would be performed for the TWE Project, including standard construction activities, schedules and equipment/manpower requirements, and special construction practices which will be used in selective or sensitive environments.

Section 3.6 discusses operation and maintenance practices for the TWE Project, including routine maintenance and vegetation management of the transmission line ROWs, emergency response, fire protection, and ROW safety requirements.

Section 3.7 summarizes the TWE Project mitigation measures, which are part of the proposed TWE Project Description, and would be common to all the DEIS Alternatives.

3.1 TWE Project ±600 kV DC Transmission Line

The TWE Project proposed ±600 kV DC transmission line will be approximately 725 miles long, located in a ROW 250 feet wide. The design characteristics of the ±600 kV DC transmission line are summarized in Table 1 and are described in this section.[2]

TransWest has determined that a ROW width of 250 feet is sufficient for the long-term maintenance and operation of the transmission line and will accommodate any of the transmission structure designs under consideration. Increased ROW width may be required in a small number of site specific locations to accommodate rough terrain or unusually long spans. These exceptions will be identified and addressed on a case-by-case basis during final design and engineering of the transmission line. ROW width for the TWE Project is based upon engineering studies that considered:

- Structure configuration (horizontal vs. vertical configurations), pole spacing, and insulator configuration (I-string vs. V-string insulator configurations)

[2] Short segments of 500 kV AC and 230 kV AC transmission lines will be required near the Northern and Southern Terminals to connect to the existing and planned regional transmission grid. The design characteristics of these transmission structures are described in Section 3.1.8.

- Operating voltage, elevation and clearance criteria (National Electrical Safety Code (NESC) and project-specific)
- Conductor size, weight, number and configuration of conductors in the bundle, tensions, and sag
- Span length between structures and conductor blowout (conductor movement envelope under pre-defined wind conditions)
- Structure footprint (guyed vs. self-supported), terrain and maintenance access (space requirements for maintenance equipment at each structure site)
- Audible noise levels at the edge of the ROW
- Potential co-location with buried underground high pressure natural gas and other petroleum pipelines within the same corridor. The DC transmission line can be located in its ROW adjacent to the ROW for such pipelines.

TABLE 1 TYPICAL ±600 KV DC TRANSMISSION LINE DESIGN CHARACTERISTICS

FEATURE	DESCRIPTION
Physical Properties	
Line Length	Would vary by routing alternative.
Structure Design	Proposed Structure Design: guyed steel lattice; Alternative Structure Designs: self supporting steel lattice, tubular steel poles
Structure Height	Guyed steel lattice -120 to 180 feet; self supporting steel lattice -120 to 180 feet; tubular steel poles - 100 to 150 feet
Span Length	Guyed lattice - 900 to 1,500 feet; self supporting steel lattice - 900 to 1,500 feet; tubular steel poles - 700 to 1,200 feet
Number of Structures per Mile	Four to eight - depending on structure type, terrain, and other factors to be identified through detailed design studies
ROW Width	250 feet; Increased ROW may be required in a small number of site specific locations to accommodate rough terrain or unusually long spans
Land Temporarily Disturbed	
Structure Work Area	ROW width x 200 feet per structure
Wire-Pulling and Tensioning Sites	ROW width x 500 feet for dead-end structure (two sites at all dead-end structures) ROW width x 500 feet for mid-span conductor and shield wire (approximately every 9,000 feet) 100 x 500 feet for fiber optic cable set-up sites (approximately every 18,000 feet)
Material Storage Yards	Located approximately every 30 miles Typical material storage yard area: approximately 20 acres
Staging Areas / Fly Yards	Located approximately every 5 miles. Typical fly yards/staging areas: approximately 7 acres
Batch Plant Sites	Located approximately every 15 miles Stand-alone temporary batch plants, estimated size: approximately 5 acres
Guard Structures	100 x 100 feet at road and existing electrical line crossings
Land Permanently Disturbed	
Structure Base[3]	Guyed lattice (tangent) - 500 square feet (100 square feet mast foundation + 4 x 100 square feet for anchors) Self Supporting Lattice (tangent) - 900 square feet (30 x 30 feet tower base)

[3] Structure types to be used in site-specific settings will be determined during engineering and design of the Agency Preferred Alternative.

TABLE 1 TYPICAL ±600 KV DC TRANSMISSION LINE DESIGN CHARACTERISTICS	
FEATURE	DESCRIPTION
	Self Supporting Lattice (angle) - 1,225 square feet (35 x 35 feet tower base) Self Supporting Lattice (dead-end) - 1,600 square feet (40 x 40 feet tower base) Tubular Steel Pole (tangent) - 40 square feet (7-foot diameter foundation) Tubular Steel Pole (dead-end/angle) - 100 square feet (two poles x eight-foot diameter foundations)
Regeneration Sites	Located approximately every 50 miles, most located on the transmission line ROW and each approximately 10,000 square feet (100 x 100 feet).
Access Roads	
Paved Roads	These roads are typically highways and state routes, and will be used for travel to existing and new dirt roads to access the ROW.
Dirt/Gravel Roads (no improvement)	Requires no improvement to dirt/gravel roads.
Dirt Road (with improvements)	Improvement of existing dirt roads 16 to 24 feet wide depending on terrain.
New Access Road (bladed)	Typically, 14 foot wide bladed surface with two to three foot berms or ditches on either side, but can be wider in steep and mountainous terrain because of cut and fill requirements according to ground slope.
Overland Access	Non-graded overland access (“drive & crush”) where terrain and soil conditions are suitable.
Electrical Properties	
Nominal Voltage	±600 kV DC
Nominal Capacity	3,000 MW (as measured at the Southern Terminal)
Circuit Configuration	DC Bi-Pole Bundled
Conductor Size	Approximately 1.5 inch diameter ACSR conductor bundled with three or four subconductors per pole.
Ground Clearance of Conductor	37 feet minimum at a conductor temperature of 176 degrees Fahrenheit
Notes: ACSR = aluminum conductor steel reinforced	

3.1.1 Structure Designs

The TWE Project ±600 kV DC transmission line will be constructed primarily with guyed lattice structures (Figure 1). Self supporting steel lattice and single shaft tubular steel poles (Figures 2 and 3) would be used in selective locations where engineering or other site-specific considerations determine that the guyed lattice steel structure is not appropriate. Table 2 indicates the general suitability of the transmission structure designs by characteristic settings. Figure 4 shows each structure design within a typical 250 foot-wide ROW.

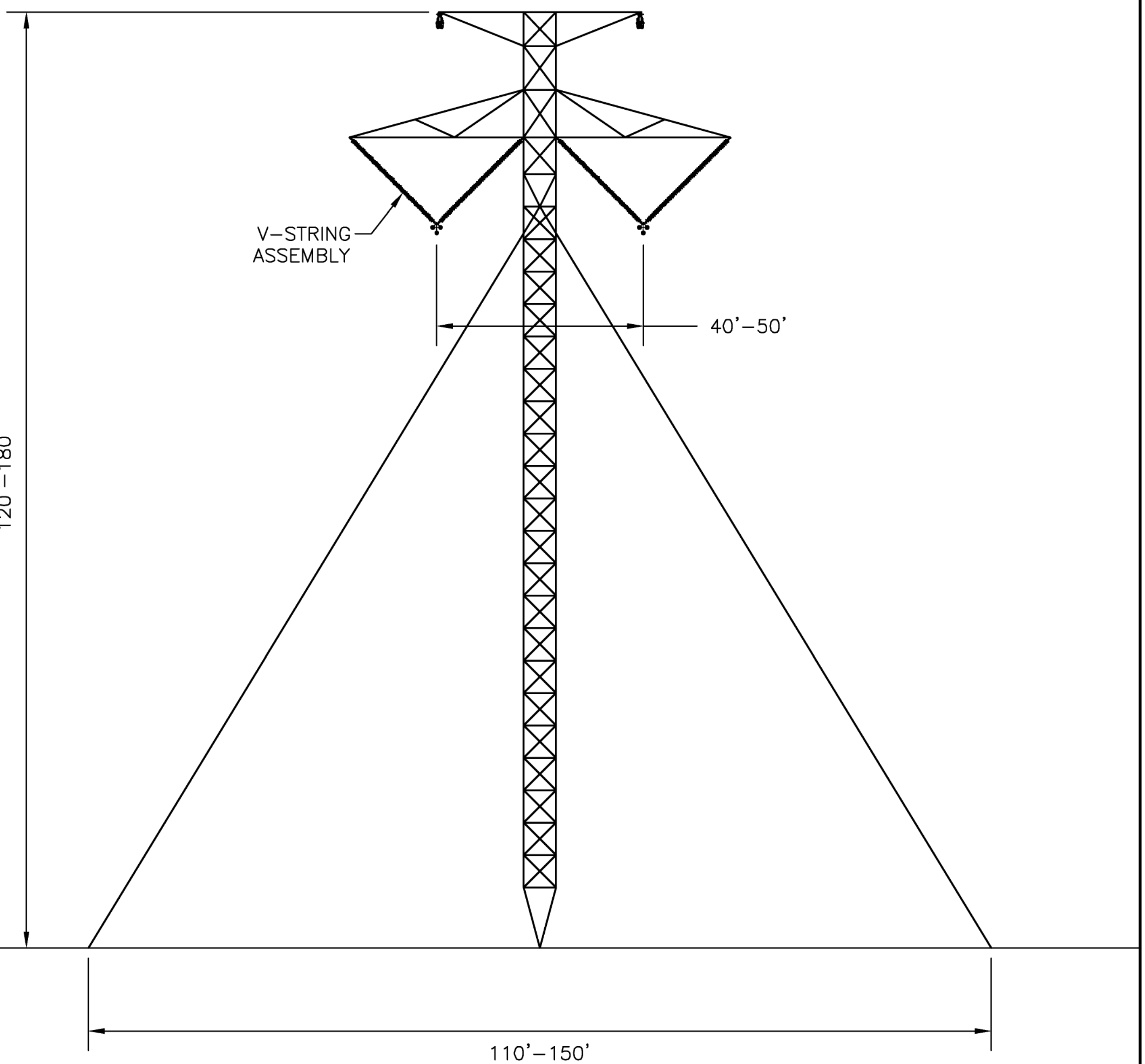
The guyed lattice structure shown on Figure 1 is the proposed tangent design for most locations due to its constructability and overall cost considerations. In addition to tangent structure configurations, specialized structures will be engineered wherever the line must change direction. Each angle structure will be individually designed, taking into consideration both the degree of the angle and site-specific geologic conditions, to withstand the increased lateral stress of conductors pulling in two different directions. Angle structures are stronger and have deeper foundations than tangent structures. The term ‘dead-end’ or ‘strain’ structure typically refers to a structure where the conductors are separated and connected together (electrically) by a jumper. These dead-end structures are typically placed at locations where the transmission line significantly changes direction.

The TWE Project will be designed in accordance with guidelines established by the Avian Powerline Interaction Committee (APLIC 1994, 2006).

TABLE 2 ±600 KV DC TRANSMISSION LINE DESIGN ALTERNATIVES POTENTIALLY USED IN CHARACTERISTIC SETTINGS

CHARACTERISTIC SETTING	GUYED STEEL LATTICE	SELF SUPPORTING STEEL LATTICE	TUBULAR STEEL POLE
Flat to Rolling Terrain	X		
Steep to Mountainous Terrain & Steep Side Slopes	*	X	X
Open Lands	X		
Agricultural Fields, Urban Areas		X	X
Highly constrained ROW			X
Line Angle 0-2°	X		
Heavier Line Angles and Dead-end Strain Structures		X	X

* Should helicopter erection of structures be preferred or required, guyed lattice steel structures may be utilized in steep to mountainous terrain as long as specific structure locations do not have excessively steep side slopes.



NOTES

1. DIMENSIONS SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY.
2. TOWER OUTLINE AND BRACINGS ARE INDICATIVE ONLY.

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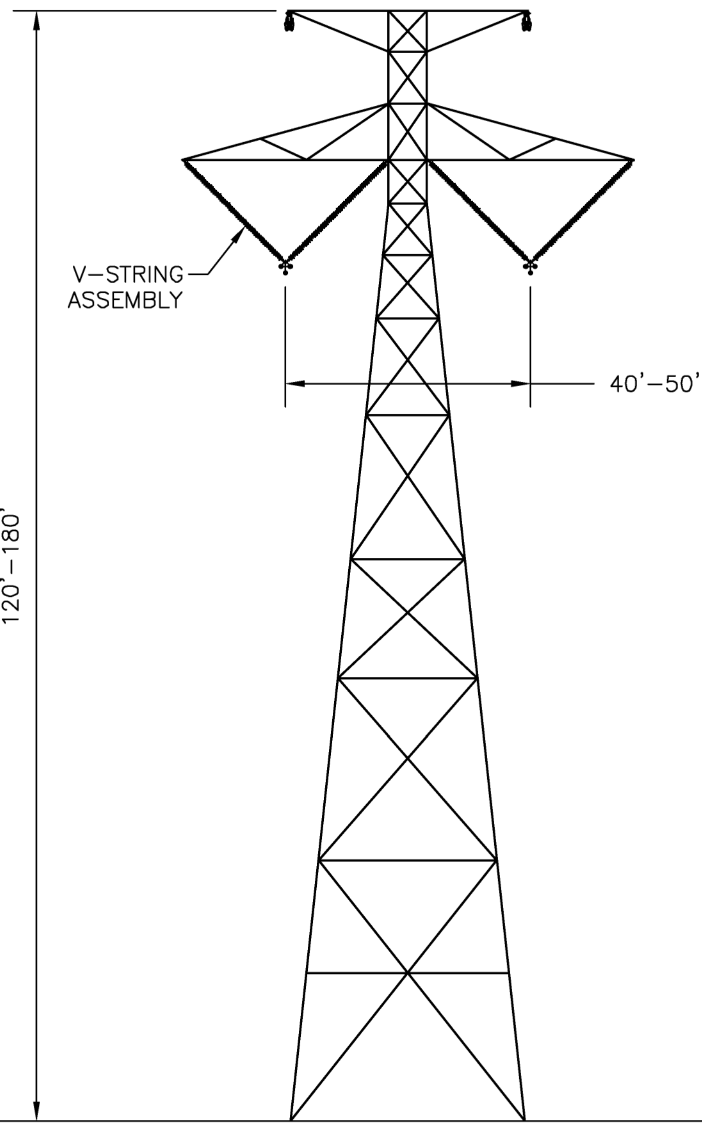
TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 1

TYPICAL ±600kV DC
GUYED V-STRING
LATTICE STRUCTURE



NOTES

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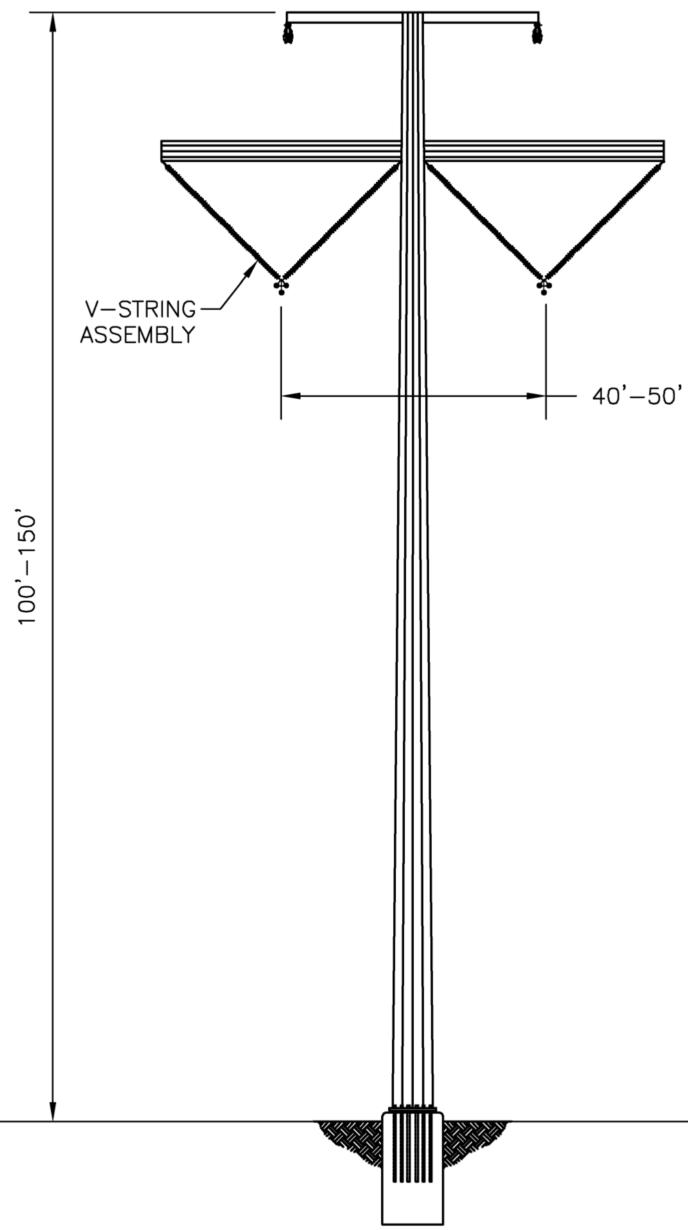
TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 2

TYPICAL ±600kV DC
SELF SUPPORTING LATTICE
V–STRING STRUCTURE



NOTES

1. DIMENSIONS SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY.

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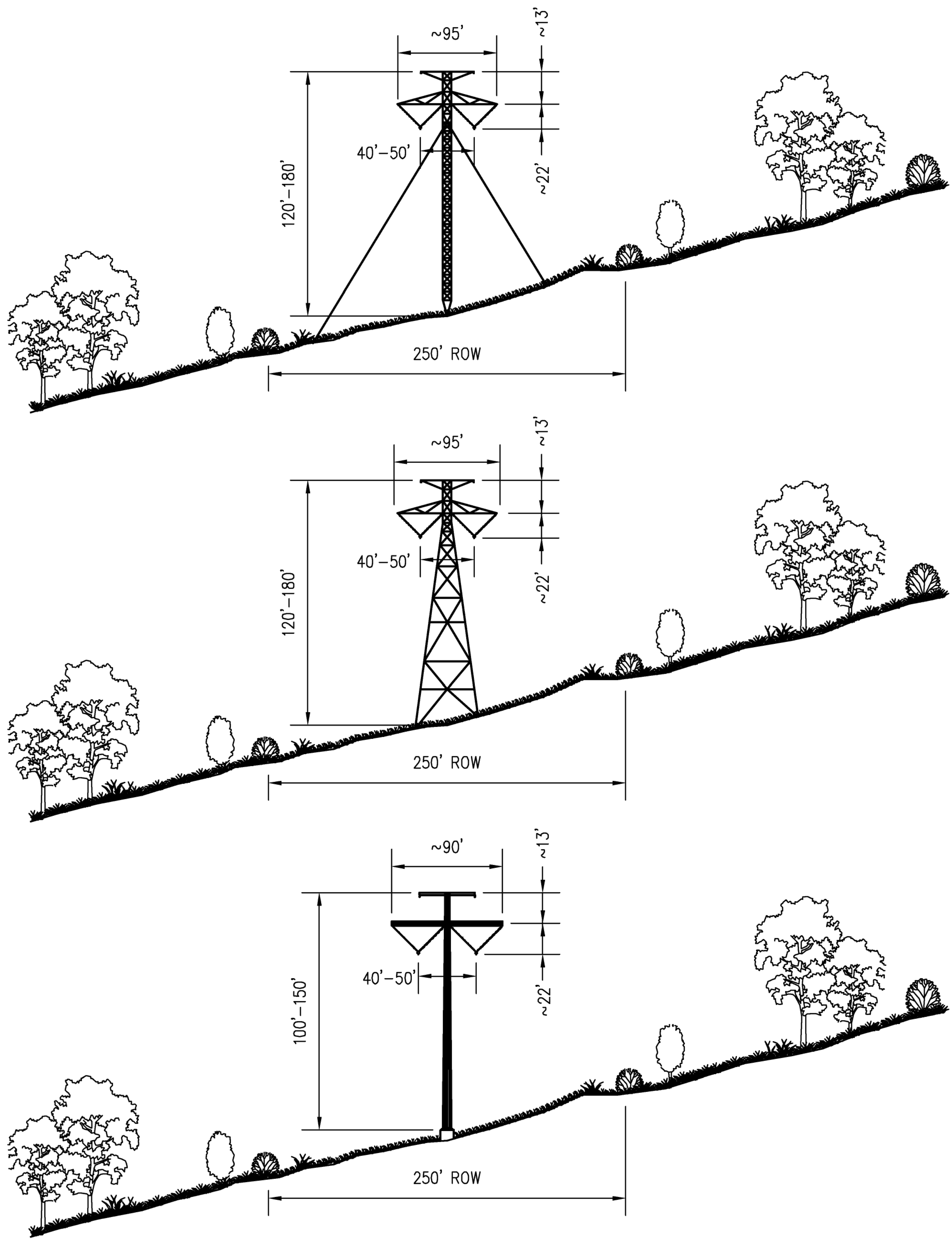
TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 3

TYPICAL ±600kV DC
TUBULAR STEEL POLE
V–STRING STRUCTURE



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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 4

TYPICAL ROW CROSS SECTIONS
BY STRUCTURE TYPE

3.1.2 Structure Foundations

The guyed steel lattice towers will generally require one precast concrete support pedestal for the tower base and four anchors for guy cables. The typical precast concrete support pedestal will be three to six feet in diameter and four to six feet in depth. Due to site-specific characteristics, some foundations may require a cast-in-place reinforced concrete support pedestal. The anchors for attachment of the guy cables will be plate anchors or rock anchors depending on soil/rock conditions at each site.

Self supporting lattice towers will require four foundations with one foundation on each of the four corners (legs) of the lattice towers. The foundation diameter and depth will be determined during final design and are dependent on the type of soil or rock present at each specific site. Typically, the foundation for each leg of the structure will be a reinforced cast-in-place concrete drilled pier, with a typical diameter of three to four feet and a depth of approximately 12 to 25 feet. Foundations for dead-end and angles structures will be larger, typically ranging from five to eight feet in diameter and 20 to 50 feet in depth.

Tubular steel pole towers will require one cast-in-place foundation. These tubular steel towers will be installed on a single reinforced concrete pier with anchor-bolts connecting the tubular pole base plate to the foundation. The foundation diameter and depth will be determined during final design and are dependent on the type of soil or rock present at each specific site. Foundations for these structures will typically be six to ten feet in diameter and 20 to 60 feet in depth.

3.1.3 Conductors

Design Characteristics. The proposed conductor for the TWE Project ±600 kV DC transmission line is an ACSR (Aluminum Conductor Steel Reinforced) conductor approximately 1.5 inches in diameter. Each pole of the ±600 kV bipole[4] line will be composed of three or four subconductors in a triple-bundle or quad-bundle configuration. The individual conductors will be bundled in either a triangular configuration (triple-bundle) or a diamond configuration (quad-bundle) with spacing of approximately 18 inches between subconductors. The bundled configuration is proposed to provide adequate current carrying capacity and to provide a reduction in audible noise and radio interference as compared to a single large-diameter conductor. Each ±600 kV subconductor will have a non-specular finish[5].

Ground Clearance Requirements and Guidelines. Conductor phase-to-phase and phase-to-ground clearance parameters are determined in accordance with the NESC, ANSI C2, produced by the American National Standards Institute (ANSI). The NESC provides for minimum distances between the conductors and ground, crossing points of other lines and the transmission support structure and other conductors, and minimum working clearances for personnel during energized operation and maintenance activities. The clearance requirements for conductor heights above ground are based on the current and potential use of the land being crossed. The clearance requirements for vertical separation at crossings over existing transmission lines are governed by NESC 2007 Rule 233. In addition to the minimum NESC requirements, additional clearances or buffers are added to account

[4] A bipole HVDC transmission line consists of two poles – positive and negative. A pole may consist of one conductor or multiple conductors (i.e., subconductors) bundled together.
[5] Non-specular finish refers to a “dull” finish rather than a “shiny” finish.

for additional safety, construction tolerances, wire movements, wire temperatures, and landowner or land use specific requirements.

The minimum ground clearance for the TWE Project ±600 kV DC conductor is 37 feet at a conductor temperature of 176 degrees Fahrenheit. For a ±600 kV DC transmission line, the minimum conductor heights will typically range from 37 feet for range lands to 50 feet or more above railroad tracks. Clearances above highways would typically be 40 to 50 feet. Lands with center pivot irrigation or lands that are aerially sprayed would typically use a minimum ground clearance of 37 feet. The exact clearance criteria for each type of land use and each type of facility being crossed will be determined during detailed design.

The clearance requirements for vertical separation at crossings over existing transmission lines are also governed by NESC 2007 Rule 233. In addition to the minimum NESC requirements, additional clearances or buffers are added to account for additional safety, construction tolerances, wire movements, differential wire temperatures, and utility specific requirements. The vertical separation typically ranges from approximately 25 feet for distribution and lower voltage lines to approximately 50 feet or more for 500 kV extra high voltage (EHV) or HVDC lines. The exact clearance criteria for each voltage class being crossed will be determined during detailed design.

Standard industry practice suggests that the higher voltage line would cross over the lower voltage line. This standard would be followed at the line crossing locations in coordination with each facility owner or manager. To optimize the crossing structure heights, the line crossing locations are typically at mid-spans of the lines being crossed and at right angles to each other. Depending on the terrain and heights of the facility being crossed, taller structures for the TWE Project transmission line may be required at the line crossing locations. Guard structures will be installed, if required, to protect underlying wires and structures during wire stringing operations. These structures intercept the wire should it drop below a conventional stringing height, preventing damage to underlying wires and structures. In addition to guard structures, during construction, the Contractor for the TWE Project will be required to coordinate with the owner or operator of the line being crossed to comply with outage and other utility-specific requirements.

Due to the static nature of DC electrical and magnetic fields, the proposed DC transmission line will not induce any current in oil and gas well heads. The HVDC transmission line will be sited such that oil or gas wellheads, and associated above ground facilities at the wellhead, will not be located on the transmission ROW. Additionally, a 250-foot buffer from oil and gas wellheads will be used as a siting criteria for locating the final centerline of the ±600 kV HVDC transmission line.

3.1.4 Insulators and Associated Hardware

As shown in Figures 1, 2, and 3, insulator assemblies for ±600 kV DC tangent structures will consist of two strings of insulators normally in the form of a "V." These insulator strings are used to suspend each conductor bundle (pole) from the structure, maintaining the appropriate electrical clearance between the conductors, the ground, and the structure. The V-shaped configuration of the ±600 kV DC insulators also restrains the conductor so that it will not swing into contact with the structure in high winds. Dead-end insulator assemblies for ±600 kV DC transmission lines will use an I-shaped configuration, which consists of insulators connected horizontally from either a tower dead-end arm or a dead-end pole in the form of an "I." Individual insulators for both suspension and dead-end applications will be composed of a single unit polymer (non-ceramic insulators).

3.1.5 Overhead Shield (Ground) Wires

To protect the ±600 kV DC transmission line from direct lightning strikes, two lightning protection shield wires, also referred to as ground wires, will be installed on the peaks or top arms of each structure. Electrical current from lightning strikes will be transferred through the shield wires and structures into the ground.

One of the shield wires will be composed of extra high strength steel wire approximately 0.5 inch in diameter. In short sections of the transmission line, near the terminals, this shield wire will also serve as the overhead electrode line connecting the AC/DC converter station to the ground electrode facility. The second shield wire will be an optical ground wire (OPGW) constructed of aluminum and steel, which will carry 36 to 48 glass fibers within its core. The optical ground wire will have a diameter of approximately 0.65 inch. The glass fibers inside the OPGW will facilitate data transfer between the two AC/DC converter stations at the Northern and Southern Terminals. The data will be used for system control and monitoring.

3.1.6 Grounding Rods

A grounding system will be installed at the base of each transmission tower and will consist of copper ground rods embedded in the ground in immediate proximity to the tower foundation, and connected to the tower by a buried copper lead. After the ground rods have been installed, the grounding will be tested to determine the resistance to ground. If the resistance to ground for a transmission tower is excessive, then counterpoise will be installed to lower the resistance. Counterpoise consists of a bare copper-clad or galvanized-steel cable buried a minimum of 12 inches deep, extending from one or more legs of a tower for approximately 100 feet within the ROW.

3.1.7 Minor Additional Hardware

In addition to the conductors, insulators, and overhead shield wires, other associated hardware will be installed on the structures as part of the insulator assembly to support the conductors and shield wires. This hardware will include clamps, shackles, links, plates, and various other pieces composed of galvanized steel and aluminum.

Other hardware not associated with the transmission of electricity may be installed as part of the Project. This hardware may include aerial marker spheres or aircraft warning lighting as required for the conductors or structures per Federal Aviation Administration (FAA) regulations.[6] Tower proximity to airports and tower height are the determinants of whether FAA regulations would apply based on an assessment of wire/tower strike risk. The Applicant does not anticipate that tower lighting will be required because proposed towers will be less than 200 feet tall and will be located to the greatest extent to avoid airport impacts. However, if special circumstances (e.g., a tall crossing) require structures taller than 200 feet, FAA regulations regarding lighting and marking will be followed.

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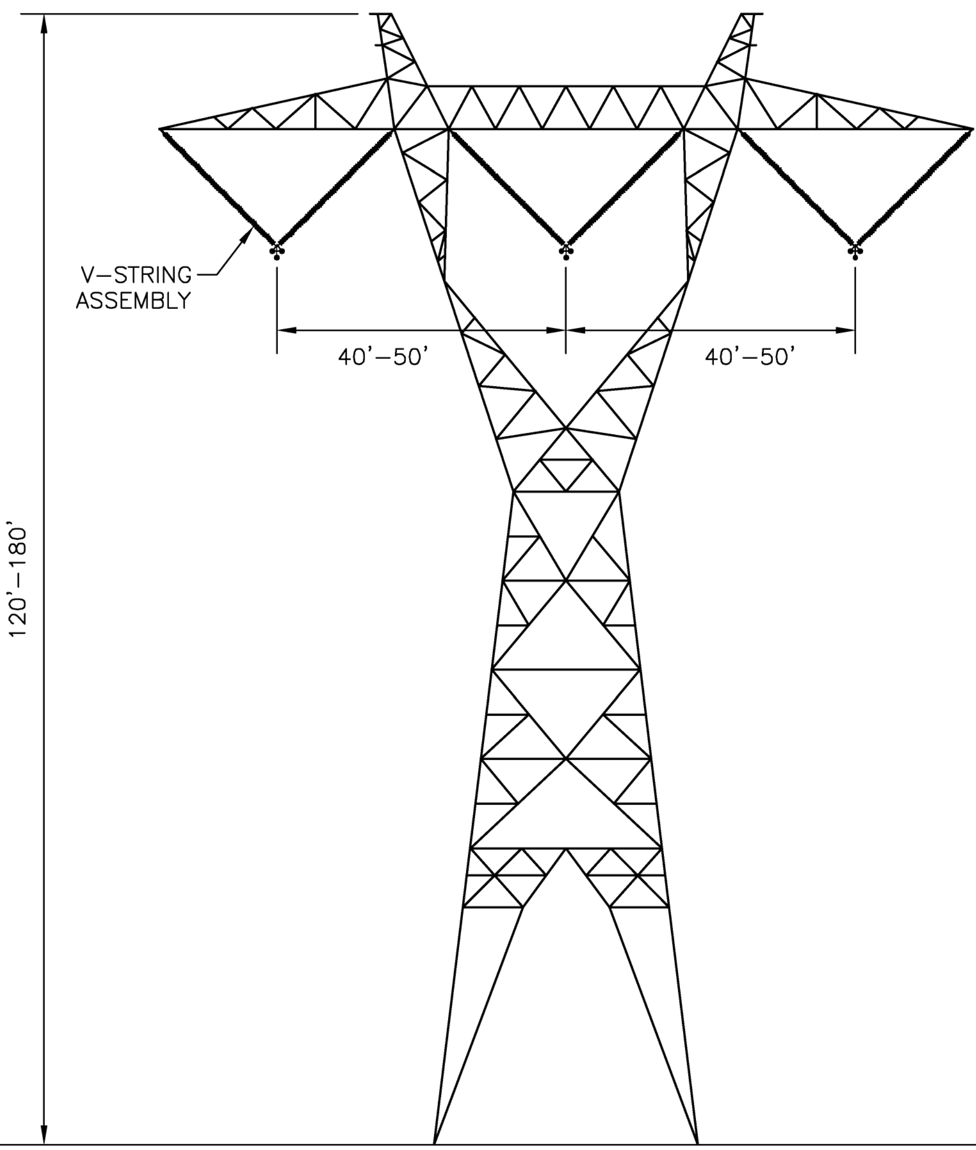
[6] U.S. Department of Transportation, Federal Aviation Administration, Advisory Circular AC 70/7460-1K Obstruction Marking and Lighting, August 1, 2000; and Advisory Circular AC 70/7460-2K Proposed Construction or Alteration of Objects that May Affect the Navigable Airspace, March 1, 2000.

3.1.8 Grid Interconnections

The TWE Project will need to connect to planned or existing 500 kV and 230 kV transmission grids in Wyoming and to existing 500 kV transmission grids in Nevada, near each terminal. Specific structure types are not known at this time and will be determined during final engineering and design. A typical self supporting lattice structure, used for a single circuit 500 kV AC line connection, is shown on Figure 5. Typical single circuit and double circuit 230 kV AC single pole structures are shown on Figure 6. The components for the 500 kV and 230 kV structures including foundations, conductors, insulators, and associated hardware, overhead shield (ground) wires, and grounding rods, are similar to those described for the ±600 kV DC transmission line.



NOTES

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2. TOWER OUTLINE AND BRACINGS ARE INDICATIVE ONLY.

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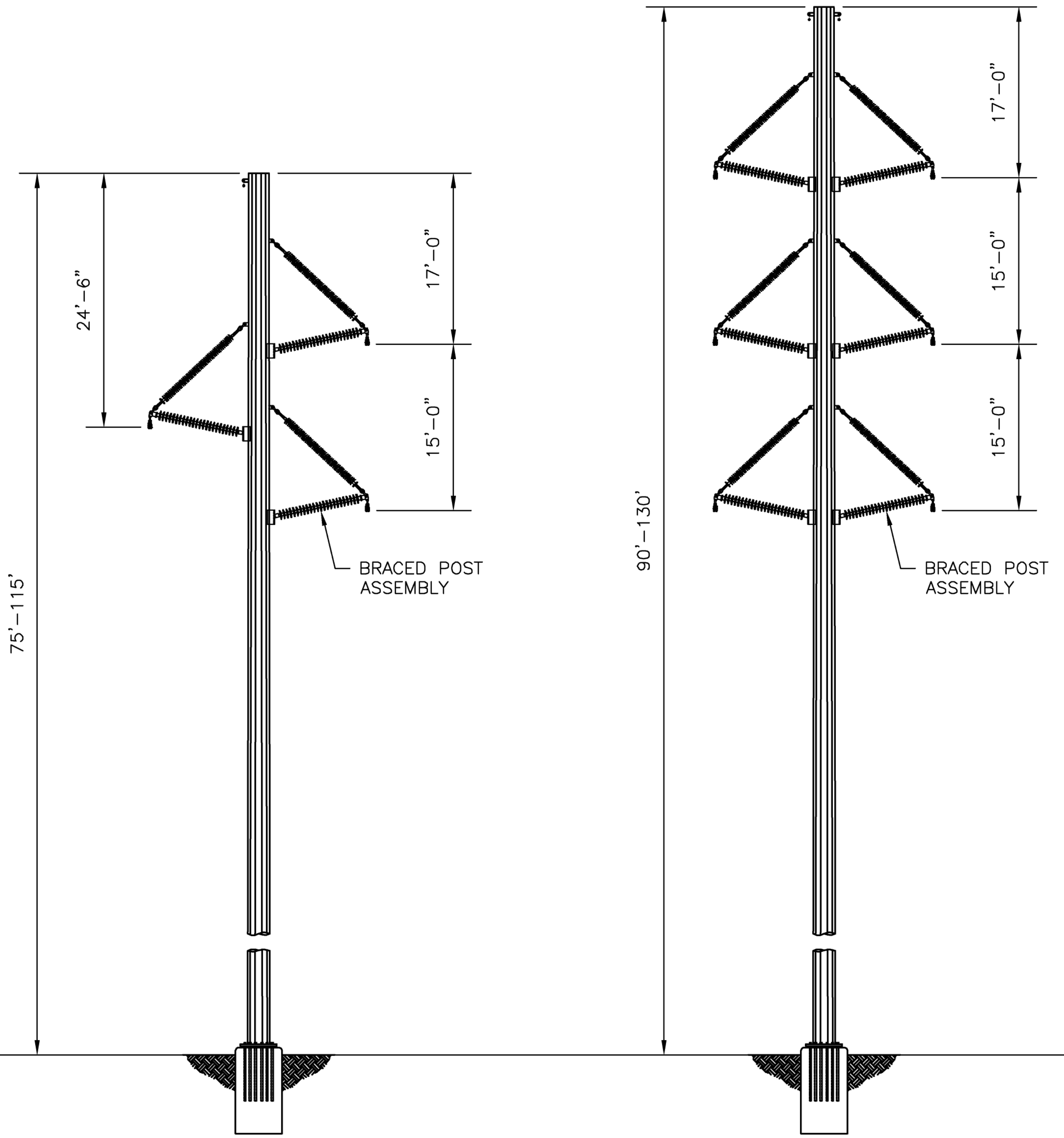
FIGURE 5

TYPICAL 500kV AC SINGLE CIRCUIT SELF SUPPORTING LATTICE STRUCTURE



NOTES

1. DIMENSIONS SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY.

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FIGURE 6
TYPICAL 230kV AC SINGLE & DOUBLE CIRCUIT POLE STRUCTURE

3.2 Northern and Southern Terminals

The terminal stations will be designed to include the AC/DC converter station and an adjacent AC substation. The AC/DC converter station will include a ±600 kV DC switchyard, AC/DC conversion equipment, transformers, and multiple equipment, control, maintenance and administrative buildings. There will be two buildings to house the AC/DC conversion equipment, each approximately 200 feet long by 80 feet wide by 60 to 80 feet high. Additionally, there will be smaller buildings to house the control room, control and protection equipment, auxiliary equipment, and cooling equipment. The AC substations will be either a 500/230 kV substation (Northern Terminal) or a 500 kV substation (Southern Terminal). The AC substations will include a switchyard, transformers, control equipment, and control buildings. Figure 7 is a photograph of a representative AC/DC terminal (converter station and adjacent AC Substation).

FIGURE 7 TYPICAL AC/DC CONVERTER STATION

Table 3 summarizes the general design characteristics of the terminals.

TABLE 3 TYPICAL DESIGN CHARACTERISTICS OF TERMINALS	
FEATURE	DESCRIPTION
Northern Terminal	Six 500 kV AC line positions, two 500/230 kV transformer banks, twelve 230 kV line positions, two AC filter bank line positions, two reactive support device positions, two DC line positions with transformers, converter building(s), and AC and DC filter yards. The reactive support equipment will require other structures and building development within the proposed complex. Maintenance and storage facilities will be developed as required and as appropriate for this remote location. Certain assigned shift operators, maintenance staff, and site security staff may be on-site at all times, although no permanent residence(s) will be established. On-site fire protection and emergency/security staff will support operations and maintenance staff at the facility in accordance with state, county, and federal requirements.
Southern Terminal	Six 500 kV AC line positions, two 500 kV AC filter line positions, two DC line positions with transformers, converter building(s), and AC and DC filter yards. Maintenance and storage facilities will be developed as required and as appropriate for this remote location. Certain assigned shift operators, maintenance staff, and site security staff may be on site at all times, although no permanent residence(s) will be established. On site fire protection and emergency/security staff will support operations and maintenance staff at the facility in accordance with state, county, and federal requirements.

3.2.1 Northern Terminal

The Northern Terminal will consist of an AC/DC converter station (a ±600 kV DC switchyard and a converter building containing power electronics and control equipment), a 500/230 kV AC substation, and a 230 kV AC substation. The facilities will be located on private lands in Carbon County, Wyoming, approximately 2.5 miles southwest of the town of Sinclair, Wyoming. The Northern Terminal will connect to the existing Platte – Point of Rocks 230 kV line located within a mile of the terminal. The Northern Terminal will also connect to the planned Energy Gateway West and Gateway South 500 kV transmission lines being developed by PacifiCorp.

The Northern Terminal will require the following components:

- An AC/DC converter station approximately 30 acres in size.
- A 500/230 kV AC substation approximately 135 acres in size.
- A 230 kV AC substation approximately 40 acres in size.
- An electrical connection from the AC/DC converter station to the ±600 kV DC transmission line connecting to the Southern Terminal. All facilities for this connection are incorporated into the ±600 kV DC transmission line.
- Two electrical connections from the proposed single circuit Energy Gateway West 500 kV transmission line to the 500/230 kV substation. These connections will connect the Northern Terminal to both the Aeolus and Anticline substations via the Energy Gateway West 500 kV transmission line. These two connections may require 500 kV transmission facilities, assumed to be four miles total or less in length, to connect the 500/230 kV substation to the route of the Energy Gateway West 500 kV transmission line. Figure 5 shows a typical structure design for the 500 kV transmission line connections.

- Two electrical connections from the proposed single circuit Energy Gateway South 500 kV transmission line to the 500/230 kV Substation. These connections will connect the Northern AC/DC converter station to both the Aeolus and Mona Substations via the Energy Gateway South 500 kV transmission line. These two connections may require 500 kV transmission facilities, assumed to be four miles total or less in length, to connect the 500/230 kV substation to the route of the Energy Gateway West 500 kV transmission line. Figure 5 shows a typical structure design for the 500 kV transmission line connections.
- Two electrical interconnections to the existing Platte – Point of Rocks 230 kV line, which will be rerouted into and out of the 230 kV substation. This 230 kV connection is assumed to require four miles or less of double circuit 230 kV transmission line. Figure 6 shows a typical structure design for the 230 kV transmission line connections.
- Up to six electrical interconnections from proposed and planned generation facilities by 230 kV transmission lines. Figure 6 shows a typical structure design for the 230 kV transmission line connections.

Construction of the Northern Terminal is estimated to require approximately 520 acres. Approximately 250 acres of this area will be permanently dedicated for the AC/DC converter station and substations, terminal access road, transmission line structures, and interconnection line access roads. Approximately 205 acres will be fenced for the Northern Terminal. Approximately 275 acres are estimated to be temporarily disturbed for construction work areas, including land for storage and a concrete batch plant, transmission line structure work areas, and pulling, tensioning and splicing sites.

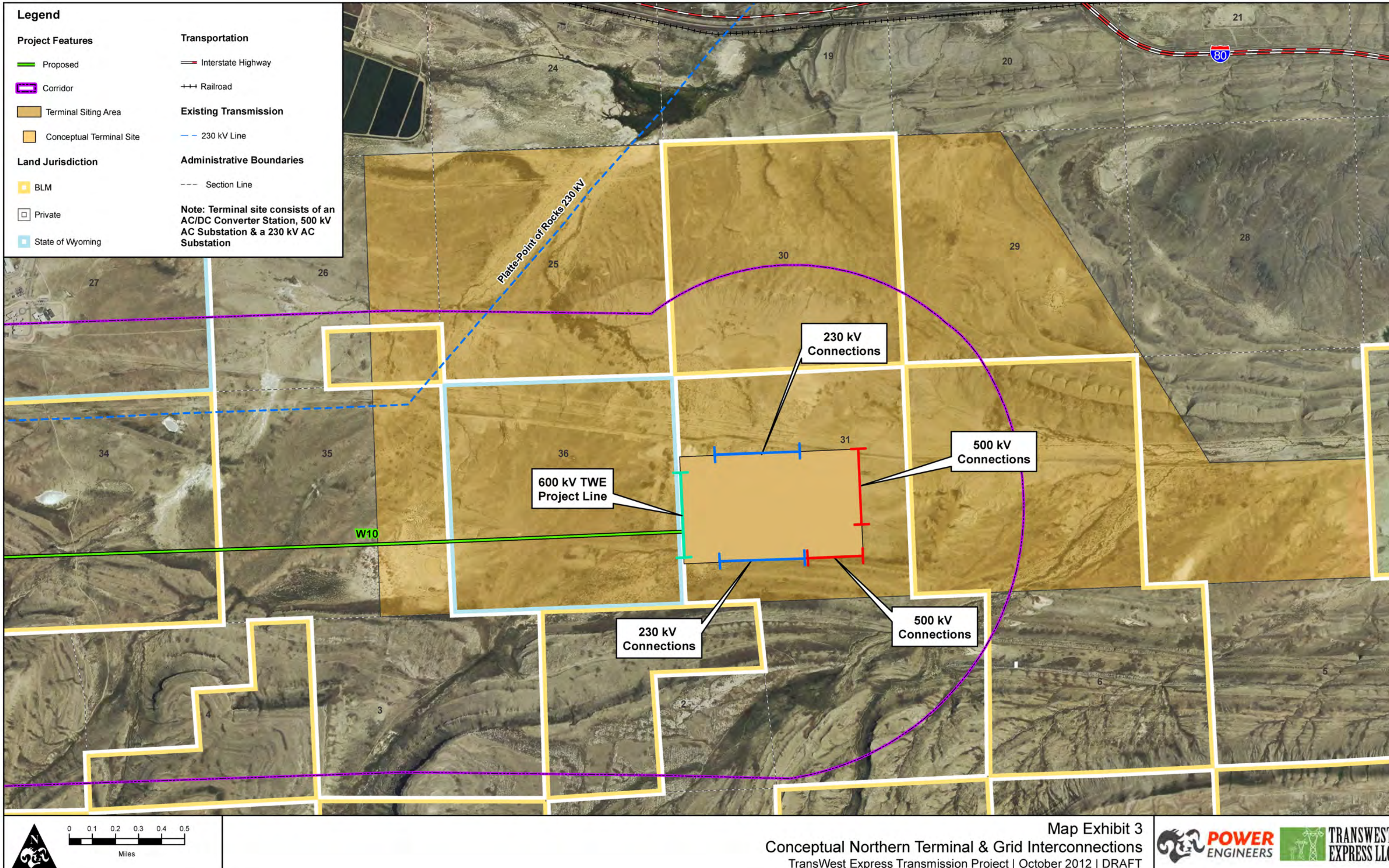
The general planned locations for the Northern Terminal and grid interconnections are shown on Map Exhibit 3. The location for the Northern Terminal site is proposed to be within the siting area shown. The final site location will be determined during final engineering and design. The criteria used in selecting the siting area and the final site location are:

- Land Ownership - use of private lands over public lands is preferable.
- Land Use - other current and planned land uses in the area, in particular other infrastructure that is being planned and permitted.
- Environmental Constraints - avoidance of sensitive resources, including sensitive wildlife habitats, cultural resource sites, wetlands, and major drainages.
- Topography - use of level dry land over more rugged terrain is preferable.
- Access to the TWE Project transmission line corridors coordinated with other existing and planned infrastructure and which minimize line crossings.
- Interconnections with existing, planned, and potential transmission lines such that line crossings are minimized, and conflicts with other existing and planned infrastructure are avoided.

Map Exhibit 3 illustrates a conceptual layout of the Northern Terminal and associated 230 kV and 500 kV connections to existing and planned facilities. The location of the Northern Terminal and the alignments of the 230 kV and 500 kV transmission line connections will be located within the proposed terminal siting area and will be determined during final design.[7]

Based on final ownership/operating agreements and interconnection contracts, it is possible that the 500/230 kV AC substation and/or the 230 kV AC substation could each be broken into two separate facilities. The total required acreage of the separate 500/230 kV AC substation(s) and the 230 kV AC substation(s) would not be greater than the 175 acres (135 plus 40) described above. The total fenced acreage for the Northern Terminal would be 205 acres in either one contiguous facility or 70 acres in one location and an additional 135 acres in a remote location. Land outside of this area would be used for access roads. Terminal access will require an estimated ten acres of permanent disturbance. With the exception of the associated interconnection lines, no other permanent development outside of the fenced area for this facility is anticipated.

[7] The three major components of the Northern Terminal (AC/DC converter station, 500/230 kV AC substation, and 230 kV AC substation) are planned to be co-located and contiguous. Although each of these three components are stand-alone facilities and could be located on separate parcels connected together by short "transmission" lines, it is common practice and preferable for the AC/DC converter station and 500/230 kV AC substation(s) to be located adjacent to each other. Although it is also preferable to locate the 230 kV AC substation next to the 500 kV AC substation, depending on the availability of space and other constraints in this area, these stand-alone facilities could be separated by a distance of up to two miles.



Map Exhibit 3
Conceptual Northern Terminal & Grid Interconnections
TransWest Express Transmission Project | October 2012 | DRAFT

3.2.2 Southern Terminal

The Southern Terminal will consist of an AC/DC converter station (a ±600 kV DC switchyard and a converter building containing power electronics and control equipment) and a 500 kV AC substation. The facilities will be located in the Eldorado Valley on private or BLM administered land, approximately 15 miles south of Boulder City, in Clark County, Nevada. The Southern Terminal will connect to all four of the existing 500 kV substations located at the Marketplace Hub. These four substations are the Eldorado, Marketplace, Merchant, and McCullough substations.

The Southern Terminal will require the following components:

- An AC/DC converter station approximately 30 acres in size.
- A 500 kV AC substation approximately 110 acres in size.
- An electrical connection from the AC/DC converter station to the ±600 kV DC transmission line connecting to the Southern Terminal. All facilities for this connection are incorporated into the ±600 kV DC transmission line.
- Two electrical connections from the existing Mead – Marketplace 500 kV transmission line to the new 500 kV AC Substation. These connections will connect the Southern Terminal to both the Mead and Marketplace substations via the existing Mead – Marketplace 500 kV transmission line. These two connections may require 500 kV transmission facilities, assumed to be five miles total or less in length, to connect the new 500 kV AC substation to the existing Mead – Marketplace 500 kV transmission line. Figure 5 shows a typical structure design for the 500 kV transmission line connections.
- Construction of a 500 kV transmission line from the new 500 kV AC substation to the Eldorado substation. This single circuit 500 kV transmission line is estimated to be five miles in length or less. Figure 5 shows a typical structure design for the 500 kV transmission line connections.
- Construction of a 500 kV transmission line from the new 500 kV AC substation to the McCullough substation. This single circuit 500 kV transmission line is estimated to be five miles in length or less. Figure 5 shows a typical structure design for the 500 kV transmission line connections.
- Although not anticipated at this time, one or more of the existing 138/230 kV lines within the Proposed Terminal Siting Area may need to be re-routed/re-configured to accommodate the Southern Terminal due to congestion within the area. If necessary, this reroute or reconfiguration of 138/230 kV transmission line facilities is not anticipated to impact more than a total of five miles of line. Figure 6 shows a typical structure design for the 230 kV transmission line connections.

Construction of the Southern Terminal on private land is estimated to require approximately 555 acres whereas the terminal construction on BLM land is estimated to require approximately 750 acres. Approximately 230 to 260 acres of this area will be permanently dedicated for the AC/DC converter station and switchyards, terminal access road, transmission line structures, and interconnection line access roads. Approximately 140 acres will be fenced for the Southern Terminal. Approximately 335 acres on the private land site and 500 acres of the BLM land site are estimated to be temporarily disturbed for construction work areas, including land for storage and a concrete batch plant, transmission line structure work areas, and pulling, tensioning and splicing sites.

The general planned location for the Southern Terminal and grid interconnections are shown on Map Exhibit 4, which illustrates a conceptual layout of the Southern Terminal and associated 500 kV connections to existing substations. The location of the Southern Terminal and the alignments of the 500 kV transmission line connections will be located within the terminal siting area and will be determined during engineering and design.[8]

Terminal access on the private land site and BLM land site will require an estimated 15 and 20 acres of permanent disturbance, respectively. With the exception of the associated interconnection lines, no other permanent development outside of the fenced area for this facility is anticipated.

3.3 Ground Electrode Systems

Two ground electrode facilities are proposed, one connecting to the Northern Terminal and one connecting to the Southern Terminal. The general proposed siting area for the northern ground electrode facility is termed 'Separation Flat' and shown on Map Exhibit 5. The proposed siting area for the southern ground electrode facility is termed 'Mormon Mesa-Carp Elgin Road' and shown on Map Exhibit 6.[9] The siting and site selection criteria are described in section 4.4.2. The location of the ground electrode systems within the siting areas and the layout of the wells and control facilities will be defined during final engineering and design. Once construction is completed, approximately 0.5 of an acre, or less, near the center of the electrode containing the control house will be fenced. Agricultural land uses outside the fenced area such as grazing and cultivated crops would be permissible.

These two ground electrode facilities will be built, each within approximately 100 miles of the Northern and Southern Terminals, to establish and maintain electrical current continuity during normal operations, and immediately following an unexpected outage of one of the two poles (or circuits) of the ±600 kV DC terminal or converter station equipment.

Each ground electrode facility will consist of a network of approximately 60 deep-earth electrode wells arranged along the perimeter of a circle expected to be about 3,000 feet in diameter. All wells at a site will be electrically interconnected and wired to a small control building via low voltage underground cables. A typical site plan for a ground electrode system is shown in Figure 8 and a photograph of a typical above ground facility is provided in Figure 9. A low voltage electrode line will be required to connect the ground electrode facilities to the AC/DC converter stations. To the

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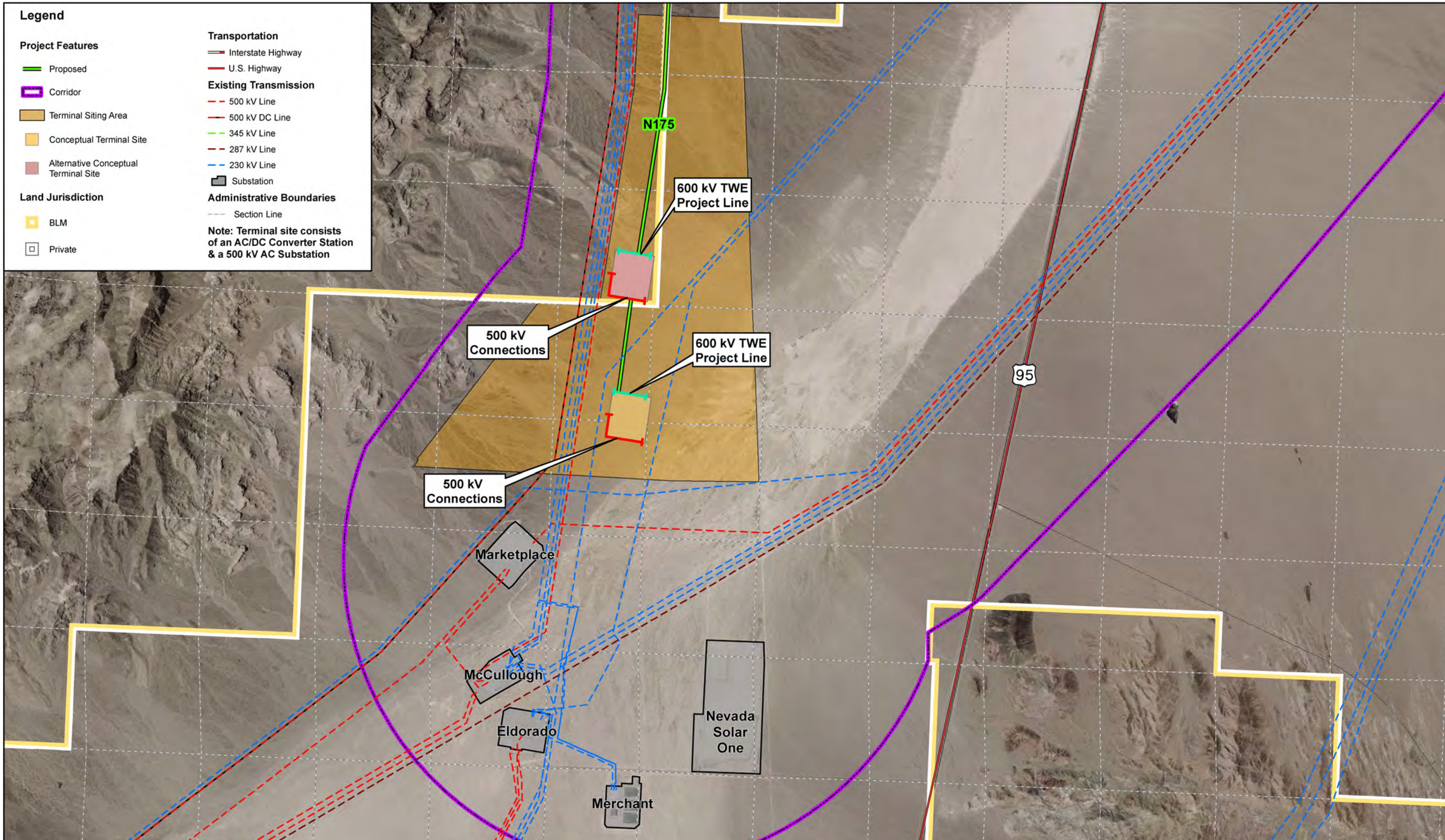
[8] The two major components of the Southern Terminal (AC/DC converter station and the 500 kV AC substation) are planned to be co-located and contiguous. Although these two components are stand-alone facilities and could be located on separate parcels connected together by short "transmission" lines, it is common practice and preferable for the AC/DC converter station and 500 kV AC substation to be located adjacent to each other.

[9] Map Exhibits 5 and 6 show both the proposed and alternative ground electrode sites and siting areas. See Section 4.2.2 for discussion of siting criteria and alternative siting areas.

extent practical, the overhead electrode line will be co-located on the ±600 kV DC structures in the overhead shield wire position. Where the electrode line diverges from the ±600 kV DC transmission line, it will be located on single pole structures, similar to those used for a modified 34.5 kV/69 kV distribution transmission line, built within a separate 50-foot-wide ROW. Figure 10 shows a typical single pole structure design that would be used for the overhead electrode line.

During a DC transmission disturbance where one pole becomes inoperable, the ground electrodes will carry a short-term large current that was previously flowing in the inoperable pole. The electrodes will be sized and designed to disperse this current into the ground at levels which are safe for people and animals in the vicinity. Such contingency conditions that result in high ground electrode currents are most often the result of an unexpected outage on the transmission line or equipment in the AC/DC converter station. The high current operation of the ground electrode facilities and the use of the earth as a return path is limited to unexpected emergency conditions and typically only operated for 10 minutes to less than an hour following the loss of a pole. For planning and preliminary engineering purposes, 12 to 16 unexpected disturbances resulting in the loss of a pole are anticipated on a yearly basis. Although the ground electrode facilities will be designed to operate at high current levels for up to 200 hours per year, typical yearly use at high currents is expected to be less than 30 hours per year.

The use of these ground electrode facilities allows system operators to maintain a portion of the TWE Project's power transmission capacity to support power network reliability. This feature will allow critical time for network operators to determine the extent of the electrical disturbance and reconfigure the transmission and generation systems into a more stable configuration that minimizes disruption of customer loads.



0 0.25 0.5 0.75 1 1.25
Miles

Map Exhibit 4
Conceptual Southern Terminal & Grid Interconnections
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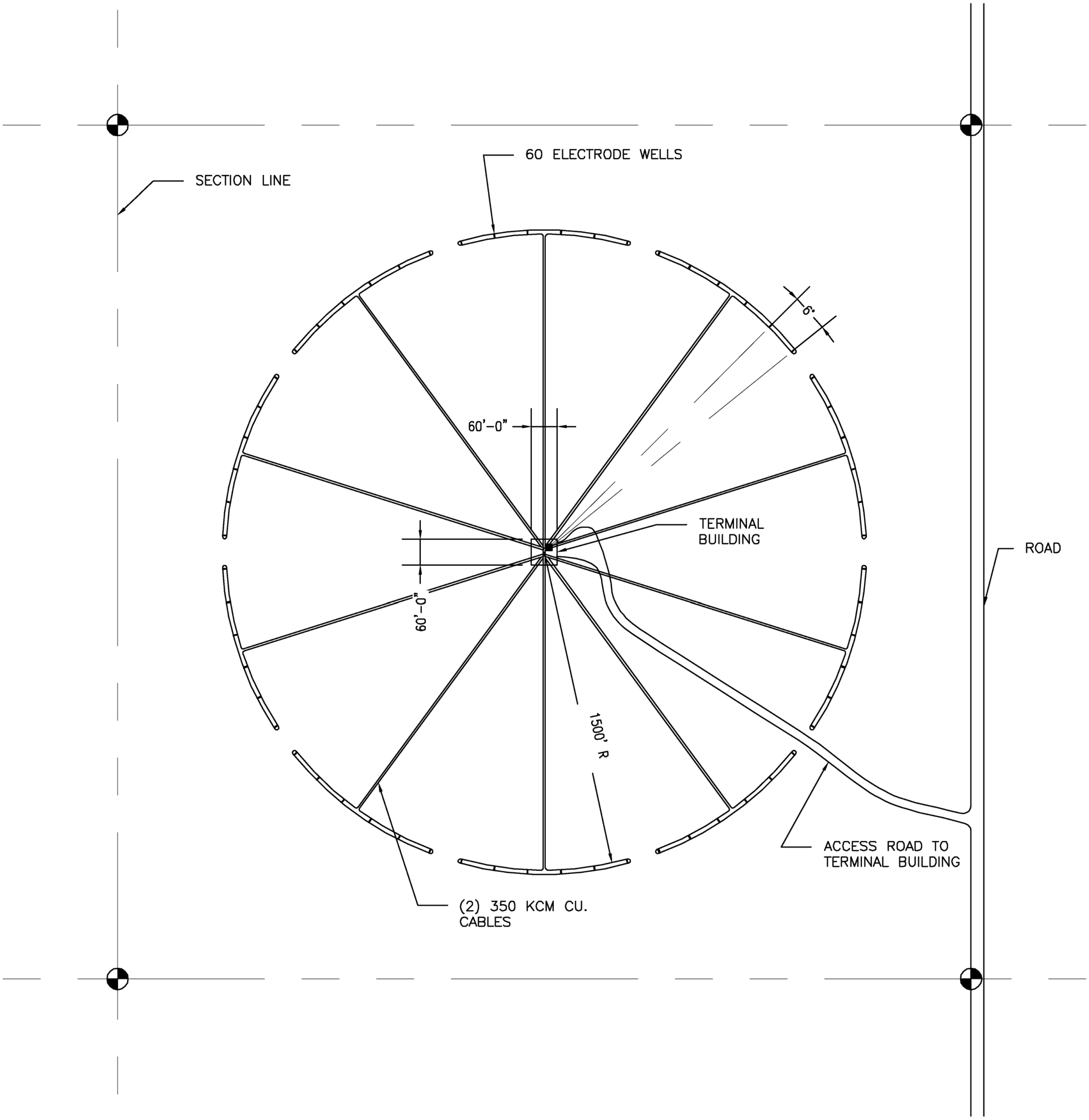

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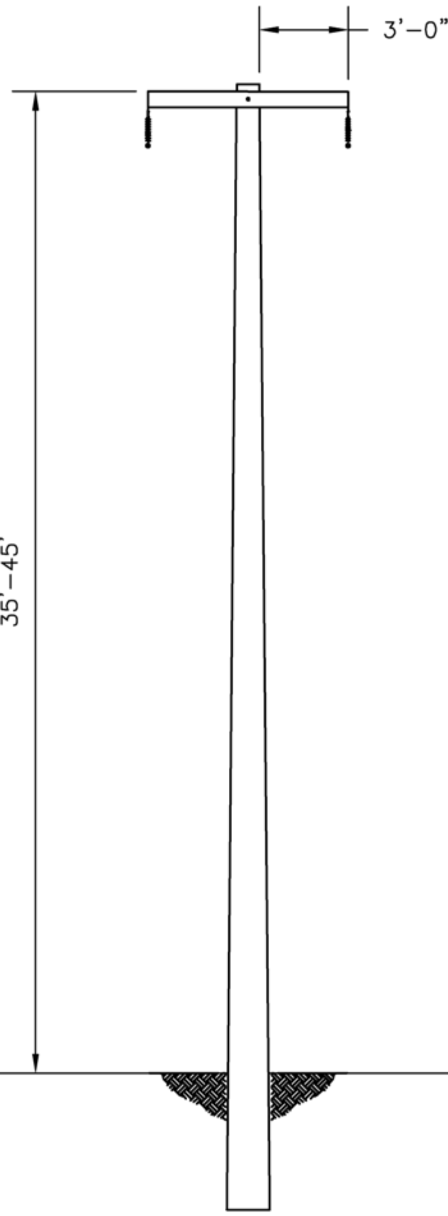
FIGURE 8

TYPICAL SITE PLAN FOR
GROUND ELECTRODE SYSTEM

FIGURE 9 TYPICAL ABOVE GROUND CONSTRUCTION AT THE GROUND ELECTRODE FACILITY



NOTES

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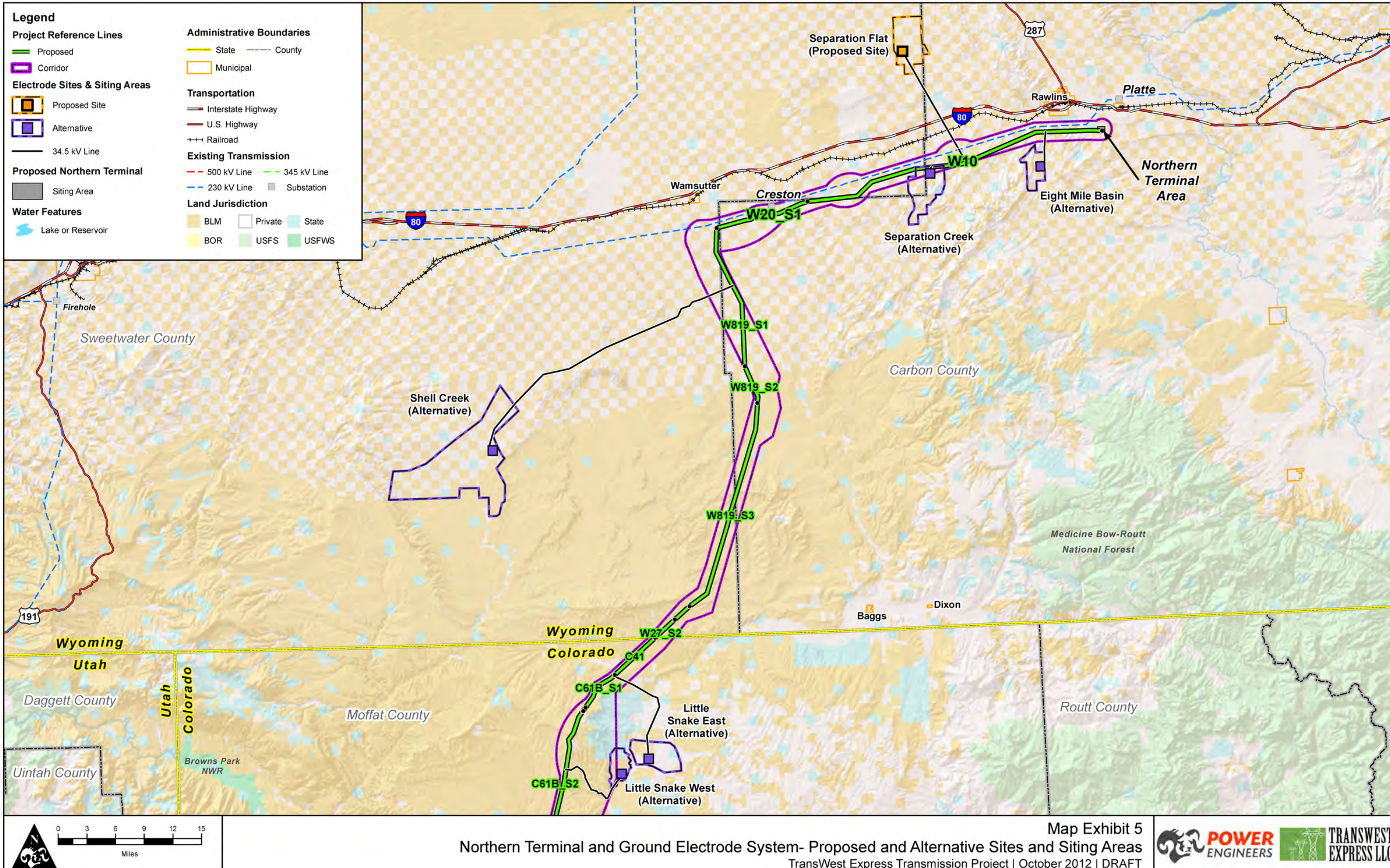
FIGURE 10

TYPICAL POLE STRUCTURE FOR OVERHEAD ELECTRODE LINE



Map Exhibit 5

Northern Terminal and Ground Electrode System- Proposed and Alternative Sites and Siting Areas

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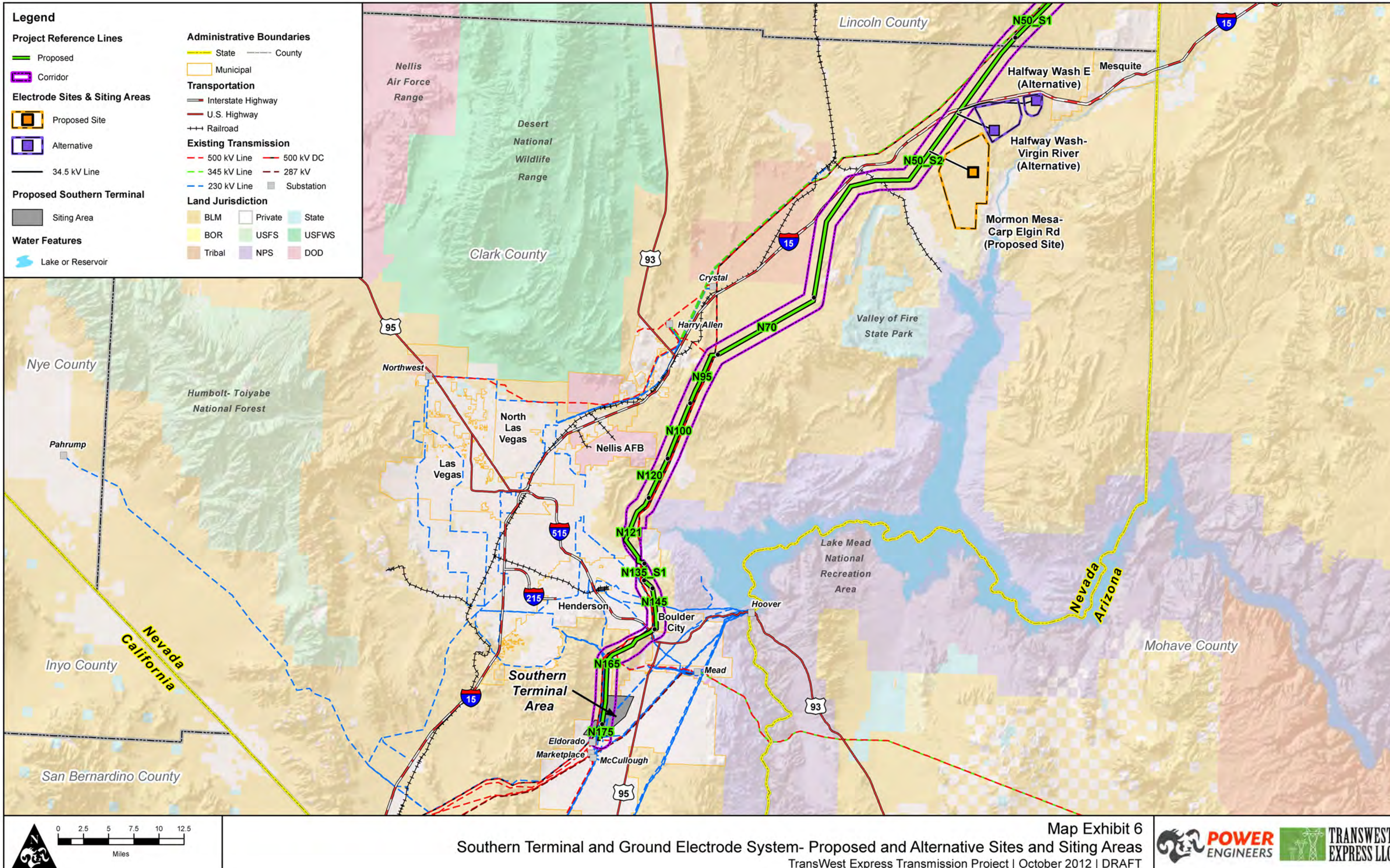

Map Exhibit 6

Southern Terminal and Ground Electrode System- Proposed and Alternative Sites and Siting Areas

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3.4 Communications System

The TWE Project will require a number of critical telecommunications support subsystems. These systems will be configured and designed to support the overall availability and reliability requirements for the operation of the HVDC terminal facilities and supporting substations. To provide secure and reliable communications for the control system real-time requirements, protection and day-to-day operations and maintenance needs, a mix of telecommunications systems will be used. The primary communications for protection and control will be provided via the one OPGW installed in the shield wire position on the transmission line. For redundancy purposes, a secondary communications path will be provided via existing or expanded/upgraded microwave systems or existing alternate buried fiber paths in the TWE Project region.

In addition to protection and control, the communications system will be used for Supervisory Control and Data Acquisition (SCADA). The SCADA system is a computer system for gathering and analyzing real time data which is used to monitor and control the substation (e.g., transformers and transmission lines), and auxiliary (e.g., pumps and cooling systems) equipment. A SCADA system gathers information, such as the status of a transmission line, transfers the information back to a central site, alerting the central site that the line has opened, carrying out necessary analysis and control, such as determining if outage of the line is critical, and displaying the information in a logical and organized fashion.

The primary communications will be an all-digital fiber system with repeater/regeneration facilities utilizing the OPGW located on the transmission line structures. The optical data signal degrades with distance as it travels through the optical fiber cable. Consequently, signal regeneration sites are required to amplify the signals if the distance between stations or regeneration sites exceeds approximately 50 miles. In total, approximately 15 to 20 regeneration sites will be required for the proposed TWE Project. In most cases, the regeneration communication sites will be located within the transmission line ROW and will typically be 100 feet by 100 feet in size. Figure 11 shows a typical communications regeneration site. The Applicant may also contract with third parties for the sale and use of excess fiber optic capacity. No additional facilities are anticipated for third party use of excess fiber optic capacity.

The secondary communications path for the TWE Project will be provided either by a private Project microwave system or purchasing/leasing capacity on existing utility dedicated communication networks within the TWE Project region.

If required, a private microwave system will be structured to utilize existing developed communications sites, access roads and utility held sites to the maximum extent possible. A small number of new microwave sites may be required for the TWE Project. As a microwave system requires line-of-site communications, the number and location of microwave sites will be determined as engineering progresses. A typical microwave communication site is less than 100 feet by 100 feet, and consists of a fenced enclosure that contains a small building for the communications equipment and a tower for mounting the microwave antenna(s). The microwave tower may be 50 feet to 150 feet high to meet the line-of-site communications requirement. In addition, multiple antennas may be mounted on the microwave tower depending upon the communications needs. In some cases, such as very remote locations with limited access to a reliable power supply, a small back-up generator may be required.

To facilitate mobile communications along the transmission line route for transmission line patrol, inspection, routine maintenance and emergency operations, a mobile ultra high frequency (UHF)/very high frequency (VHF) radio communications system will be implemented. For planning purposes, UHF/VHF radio equipment, towers, antennae and repeaters are assumed to be installed at each regeneration station.

FIGURE 11 COMMUNICATIONS REGENERATION SITE

3.5 Proposed TWE Project Construction Practices

This section describes the construction practices that will be used for the proposed TWE Project, including the ±600 kV DC transmission line; northern and southern terminals; ground electrode systems; and communications systems. Construction activities are described in the following sections:

- Section 3.5.1 – Pre-construction activities to be completed prior to construction commencing.
- Section 3.5.2 – Construction activities for the ± 600 kV DC transmission line and associated access roads.
- Section 3.5.3 – Construction activities for the northern and southern terminals.

- Section 3.5.4 – Construction activities for the northern and southern ground electrode systems.
- Section 3.5.5 – Construction activities for the communications system.
- Section 3.5.6 – Post construction clean-up and restoration.
- Section 3.5.7 – Special construction methods to be used in specific, sensitive locations, including blasting and helicopter construction techniques; roadless construction methods in IRAs; and construction techniques applicable to sensitive water resource areas.
- Section 3.5.8 – Water use during construction.
- Section 3.5.9 – TWE Project construction schedules, manpower, and equipment requirements.

3.5.1 Pre-Construction Activities

Prior to construction, the Applicant will obtain all applicable federal, state, and local permits; acquire easements and ROW grants for the TWE Project facilities; conduct geotechnical surveys and testing; and conduct pre-construction engineering and environmental surveys.

3.5.1.1 Permitting

The Applicant will acquire all federal, state, and local permits, licenses and agreements. A list of applicable permit requirements will be provided through the NEPA process and incorporated into the Construction, Operation, and Maintenance Plan (COM Plan) for the TWE Project. The TWE Project will necessitate crossings of existing electrical transmission lines, U.S. and State Highways, and railroads. The proposed line crossings will be coordinated with the appropriate entity and TransWest will obtain all required licenses, permits, or agreements.

3.5.1.2 ROW and Property Rights Acquisition

The Applicant will acquire ROWs or properties necessary to construct, operate, and maintain the TWE Project. New ROWs will be acquired for the transmission line(s) through a combination of ROW grants and easements with various federal, state, and local governments; other companies (e.g., utilities and railroads); and private landowners. Property owners affected by the TWE Project would initially be contacted by a realty agent who would explain the steps involved in site selection, property rights acquisition, and construction. A realty agent would request permission (for workers or Contractors) to enter the property to conduct engineering and environmental surveys and studies. Landowners will be contacted early in the process to obtain right-of-entry for surveys. Each landowner along the final centerline route will be contacted to explain the Project and to secure right-of-entry and access to the ROW.

Studies will be conducted to select structure sites, based on engineering design criteria, terrain, geologic investigations, and property owner input regarding land use and how to minimize potential impacts to properties. Geotechnical drilling will be required at some sites. Property owners will be compensated for damages to crops, fences, and other property caused by surveys and studies.

Property rights, in the form of perpetual easements or ROW, will be needed to construct, operate, and maintain the transmission line. Land for the Northern and Southern Terminals, substations, series compensation (as may be required for System Alternatives 2 and 3; see Section 4.3), and regeneration stations will be obtained in fee simple where located on private land. Easements and fee simple properties will be purchased through negotiations with landowners based on independent appraisals. Independent appraisals are used to determine the fair market value of the easement or property. Every effort will be made to acquire easements and properties through landowner negotiations to obtain an agreement, which is fair and reasonable to both parties. For transmission line easements, the landowner will retain title to the land and may continue to use the property in ways that are compatible with the transmission line. If in place of TransWest, Western were to acquire the private land property rights for the Project, it will do so in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

Federal and state laws enable public agencies, and in some cases private parties, to acquire property rights for facilities to be built in the public interest. If a negotiated agreement cannot be reached, easements can be acquired through eminent domain (condemnation) proceedings. Through the eminent domain process, a court determines the compensation to be paid to the property owner(s).

3.5.1.3 Geotechnical Surveys and Testing

Prior to construction of the TWE Project, ground-based land surveys will be required at soil boring locations required for geotechnical investigations.

Geologic evaluation and geotechnical investigations will be performed as a part of general construction activities to evaluate potential geologic and geotechnical hazards and to determine specific requirements (ground conditions, soil types, depth to rock, depth to water, soil strength properties, etc.) for foundation design and construction. The work will be completed in time to develop final engineering specifications necessary for construction.

Geological evaluation will occur at generally the same time as geotechnical investigations, and will be a part of the final geotechnical report. For this activity, an engineering geologist will evaluate fault lines, landslide prone areas, steep slopes, and unstable soils to identify potential hazards, primarily at structure sites. Geologic review and evaluation will also be performed in the immediate vicinity of structure sites, and for access roads crossing steep slopes and unstable soils. The primary purpose of the geologic evaluation is to identify potential hazards with sufficient lead time to evaluate options for avoiding or mitigating potential hazards. The Project geotechnical engineer and geologist will prepare a report including recommendations for any necessary relocation of structure sites or roads in potentially hazardous areas. In the event that a structure site cannot be relocated, the geotechnical report will also specify construction methods designed to stabilize the site as well as any adjacent areas that might pose a hazard to the main site. These recommendations will be incorporated into the COM Plan including construction details for grading, drainage, and specialized slope treatments. The Contractor will implement the plans. All geologic/geotechnical field studies required will be coordinated with the appropriate land management agencies or private landowner and the appropriate permits will be obtained by the Applicant.

To determine proper structure foundation requirements, geotechnical investigations will be performed in the field to evaluate the strength and bearing capacity of site soils. This study will entail a core drilling program at structure site locations along the Agency Preferred Alternative. At sampling sites, borings will be extracted from which soil and/or bedrock material samples will be taken for laboratory testing and analysis. Soil borings are typically six to eight inches in diameter and as much as 70 feet deep. Soil borings are commonly taken at structure site locations at intervals of approximately one mile.

Soil borings will be performed with rubber tired or low impact drill rigs using approved access routes and methods in accordance with the appropriate land management agency or private landowner requirements, and applicable mitigation measures. Equipment typically used for geotechnical evaluations includes a drill rig, water truck, and 4-wheel drive support vehicles. The average estimated drilling time at each site is approximately one-half day. Work areas are typically 40 feet by 40 feet in size (1,600 square feet/0.37 acre).

Surface disturbances may occur at the structure site drill locations caused by parking, use of equipment, and associated field crew activities in the work area. Water may be used during the drilling process and a small amount of water may exit the drill holes. Following the completion of drilling at each site, soil boring holes will be backfilled with the drilled materials. Any remaining material would be spread at the site. The area of excess soil spreading will be small, and typically will not exceed 10 feet by 10 feet in size. No open holes will be left unattended and all holes will be backfilled prior to leaving the site.

Any geotechnical investigations involving ground disturbance on federal lands prior to the issuance of the TWE Project ROW grants may require additional authorizations. TransWest will apply for and obtain all necessary federal, state, and local authorizations.

3.5.1.4 Pre-Construction Surveys and Flagging

Pre-construction engineering surveys will be conducted to identify the transmission line ROW centerline and width, structure sites, vegetation clearance boundaries, property boundaries, ground profiles, access routes, temporary work areas, and stream crossings.

Pre-construction environmental surveys will be conducted, as required by permitting agencies, for the identification, flagging, and avoidance of sensitive resources. Requirements for environmental pre-construction surveys will be documented in the Final Environmental Impact Statement (FEIS) and the regulatory agencies' decision documents and stipulations. Investigations may include, but are not limited to: (1) desert tortoise and greater sage-grouse surveys; (2) rare and sensitive plant surveys; (3) noxious weed surveys; (4) cultural resource surveys; and (5) wetlands delineations in accordance with requirements for the Clean Water Act (CWA), Section 404 permit. Section 3.7 identifies the Applicant-committed environmental mitigation measures, including pre-construction surveys for sensitive resources.

3.5.2 Transmission Line Construction

The following sections detail the transmission line construction activities associated with the proposed ±600 kV DC transmission line and access roads. The general sequence of transmission line construction includes: construction of access roads; clearing of ROW and temporary work areas clearing; installation of foundations; assembly and erection of structures; installing shield wires and conductors; installing ground rods/counterpoise; and site cleanup and reclamation. Typical transmission line construction activities and sequencing are depicted in Figures 12 and 13. Various construction activities will occur during the construction process, with several construction crews operating simultaneously at different locations. Section 3.5.9.3 summarizes the types and quantities of equipment to be used for the transmission line construction.

3.5.2.1 Access Road Construction

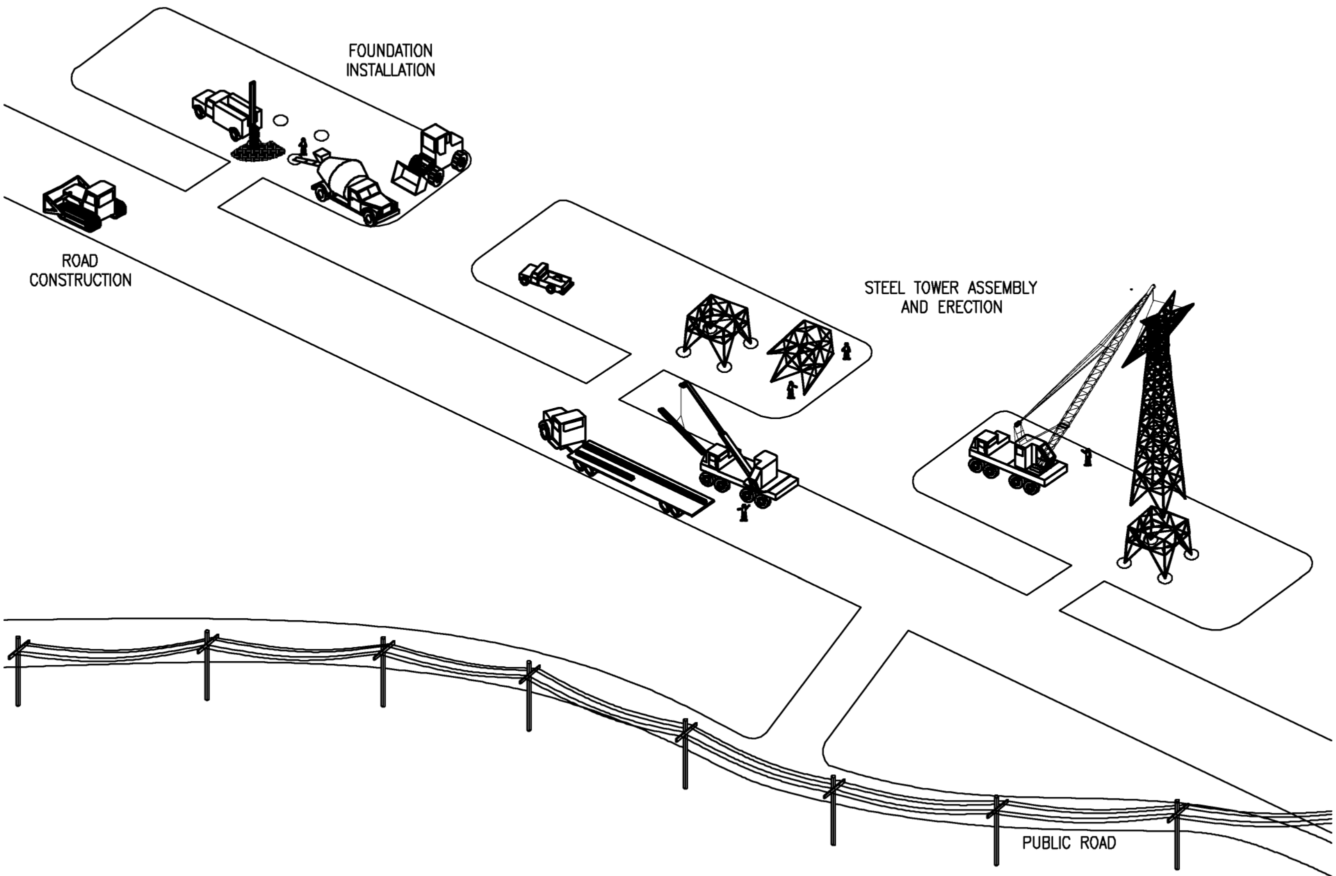
The TWE Project will require surface access to all structures and work areas during construction and operation to allow construction vehicles and equipment to access the location of each transmission structure. Access in IRAs is discussed in Section 3.5.7.3 Roadless Construction. The TWE Project has been designed to utilize existing access roads wherever practical in order to minimize environmental impacts associated with new road construction.

The construction of new access roads will be required only as necessary to access structure sites lacking direct access from existing roads, or where topographic conditions (e.g., steep terrain, rocky outcrops, and drainages) prohibit safe overland access to the site. Where terrain and soil conditions are suitable, non-graded overland access ("drive & crush") will be utilized. New access roads will be located within the ROW whenever practical and will be sited to minimize potential environmental impacts. The number of new access roads will be held to a minimum, consistent with their intended use (e.g., structure construction or conductor stringing and tensioning).

Where new roads are required, access roads will be designed in accordance with standards and guidelines set by the American Association of State Highway and Transportation Officials (AASHTO). On public lands, BLM and USFS road requirements will be followed, including standards set forth in "The Gold Book – Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development" (AASHTO 2006).

As part of the COM Plan, an Access Road Plan will be developed for the Agency Preferred Alternative during final engineering and design, which will define site-specific access to each structure and temporary work area. Appendix A documents the methods used to estimate indicative access roads by terrain type for the proposed TWE Project and Alternative Route Segments. Roadless construction methods are described under Special Construction Methods, in Section 3.5.7.3.

Table 4 summarizes the access road categories used to estimate access road requirements by route segment. Figure 14 illustrates typical access road cross-sections in the various terrain conditions.



TYPICAL TRANSMISSION LINE CONSTRUCTION ACTIVITIES

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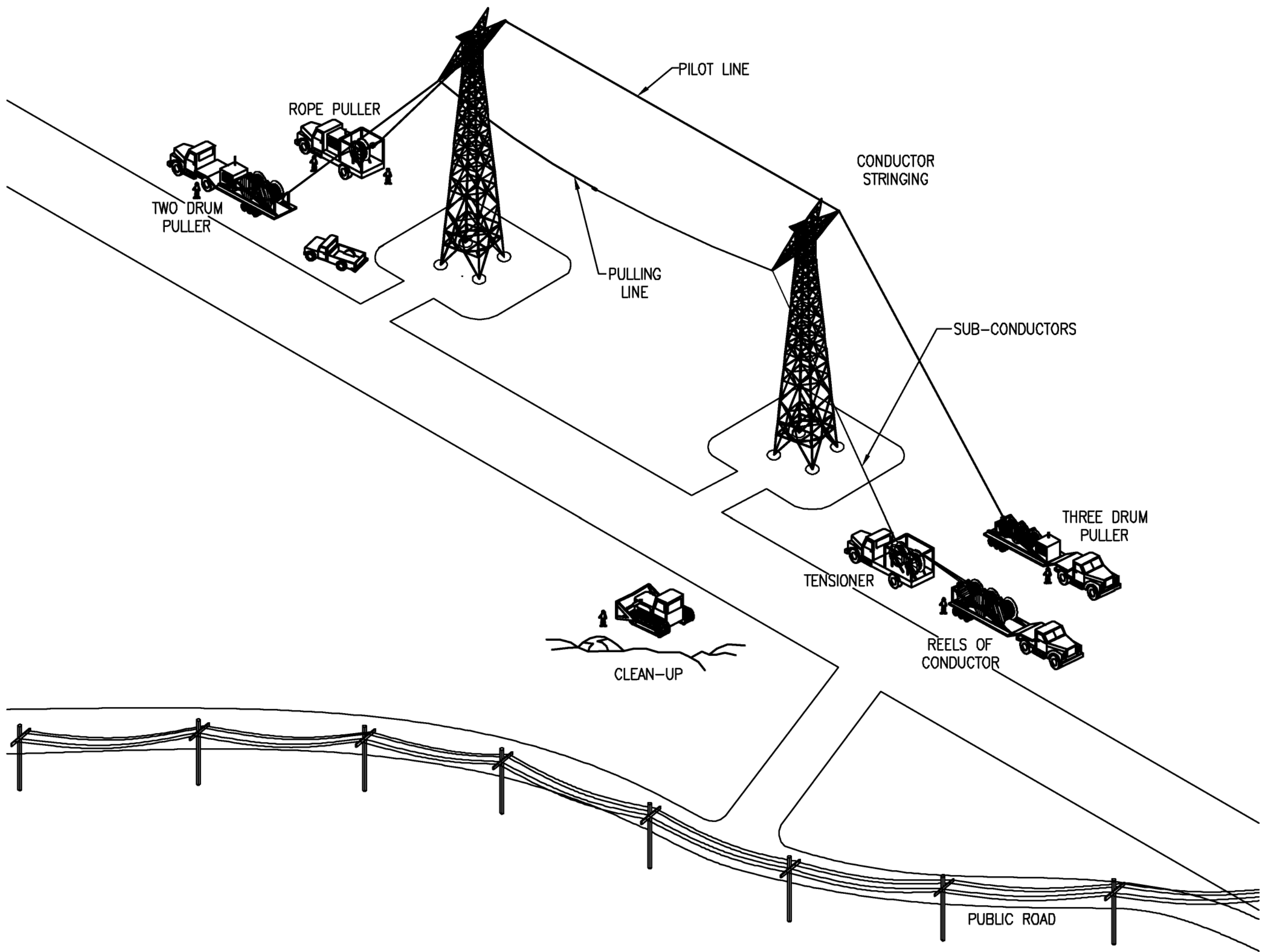
FIGURE 12

STRUCTURE FOUNDATION INSTALLATION,
TOWER ASSEMBLY, &
ERECTION ACTIVITIES



BASIC WIRE HANDLING EQUIPMENT
SINGLE CIRCUIT TOWER

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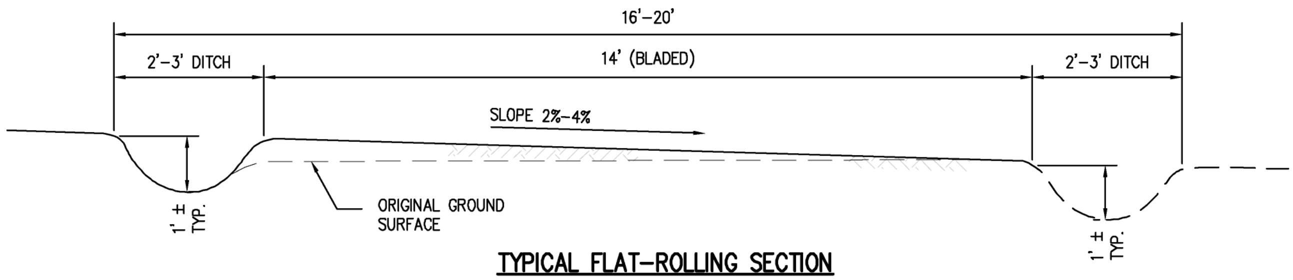
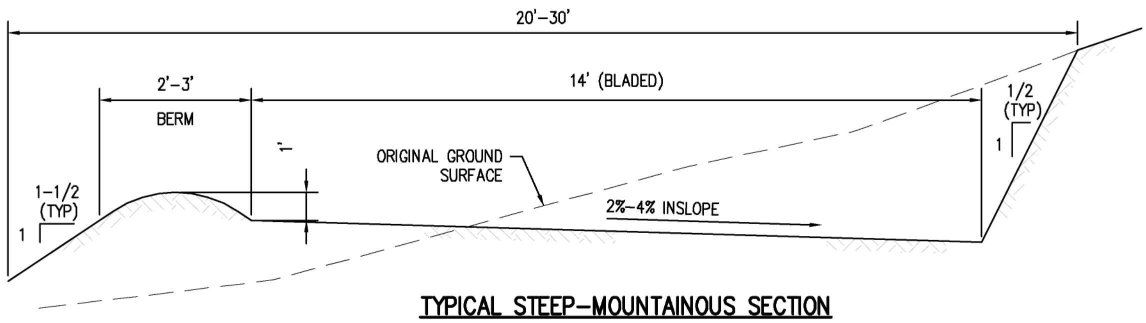
FIGURE 13
CONDUCTOR STRINGING ACTIVITIES

TABLE 4 ACCESS ROAD CATEGORIES AND DISTURBANCE ASSUMPTIONS FOR DEIS ANALYSIS		
ACCESS ROAD CATEGORY	TERRAIN TYPES	ASSUMPTION FOR ESTIMATING DISTURBANCES
Backbone Access Road Network Outside Corridors		
Category 1 – Existing Improved Roads	All terrain types	Geographic Information System (GIS) data provided. No ground disturbances would occur.
Category 2 (A) – Existing Roads Outside Corridor Requiring Improvements	All terrain types	GIS data provided. Access roads should conservatively be estimated as 24 feet wide.
Access Roads Inside Corridors		
Category 1 – Existing Improved Roads	All terrain types	GIS data provided. No ground disturbances would occur.
Category 2 (B) – Existing Roads Inside Corridor Requiring Improvements	All terrain types	For the DEIS analysis, Category 2B roads are estimated conservatively, as new roads, under Road Categories 3-6.
Category 3 – New Access Roads in Flat Terrain	Flat – 0-8% slopes	Ratio of access road miles to one mile of transmission line – 1.3 miles Access Road Width – 16 feet
Category 4 – New Access Roads in Rolling Terrain	Rolling – 8-15% slopes	Ratio of access road miles to one mile of transmission line – 1.4 miles Access Road Width – 18 feet
Category 5 – New Access Roads in Steep Terrain	Steep – 15-25% slopes	Ratio of access road miles to one mile of transmission line – 1.8 miles Access Road Width – 22 feet
Category 6 – New Access Roads in Mountainous Terrain	Mountainous – greater than 25% slopes	Ratio of access road miles to one mile of transmission line – 2.8 miles Access Road Width – 24 feet

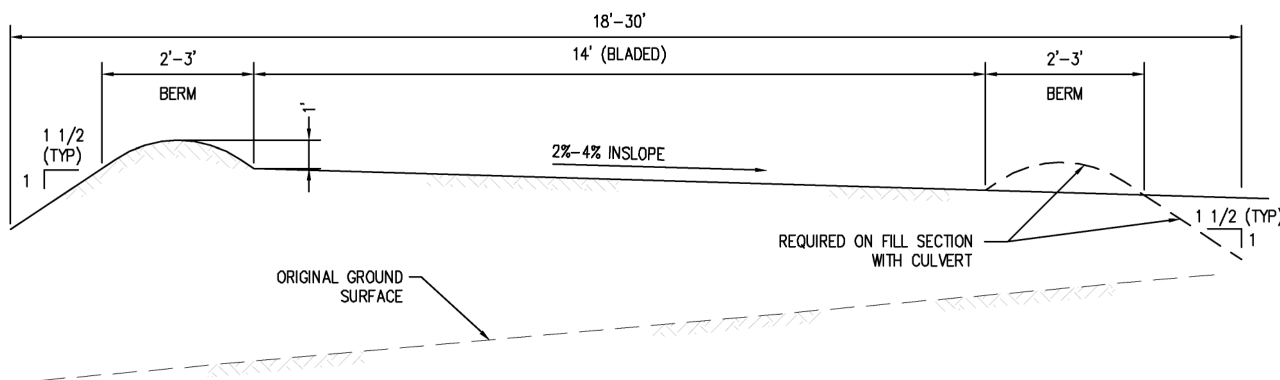
Construction of new access roads will begin with vegetation removal. Merchantable timber will be cut and stockpiled in locations where the logs can be loaded on to trucks and hauled to market. Non-merchantable logs will be stored along the edge of the ROW for later use in site restoration. Smaller vegetation will be lopped and scattered outside the road construction area. For bladed roads and where appropriate, topsoil will be removed and salvaged from the road construction area as required by the appropriate land management agency or private landowner. Topsoil will be stored adjacent to the road or in a nearby workspace. Appropriate erosion control devices will be installed to prevent erosion or loss of the topsoil, including measures to prevent wind erosion and fugitive dust, and silt fencing to prevent sediment runoff. As needed, the structure site construction pads and access roads will be bladed/graded to allow for safe access and construction. The blading/grading may include minor cut and fill as needed to achieve a safe, workable surface.



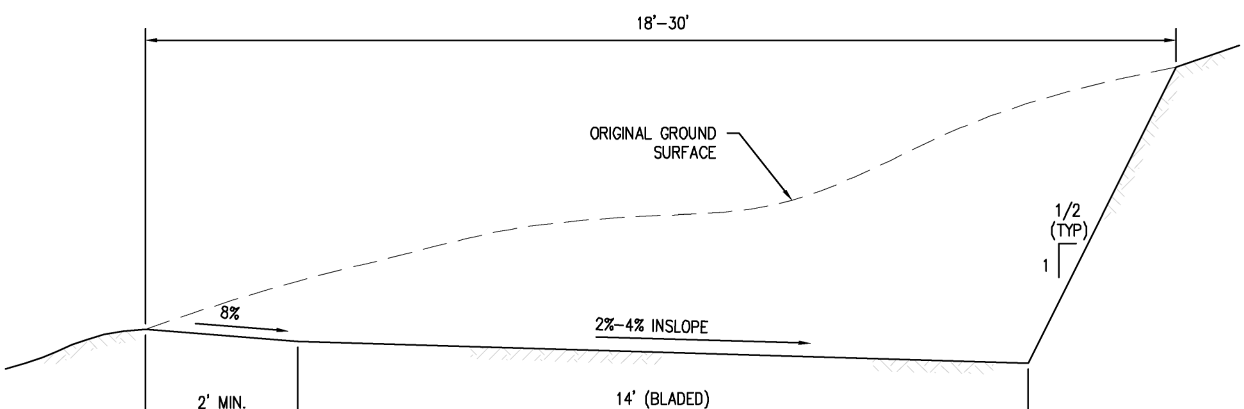
TYPICAL FLAT–ROLLING SECTION



TYPICAL STEEP–MOUNTAINOUS SECTION



TYPICAL FULL FILL SECTION



TYPICAL FULL CUT SECTION

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FIGURE 14

TYPICAL ACCESS ROAD CROSS–SECTIONS BY TERRAIN TYPE

Access road construction may employ heavy equipment including bulldozers, front-end loaders, dump trucks, backhoes, excavators - both tracked and rubber-tired, and graders. Other specialized equipment including boom trucks to install culverts in some areas will be used where needed.

3.5.2.2 Clearing of Transmission ROW and Temporary Work Areas

Vegetation within the ROW will be cleared in accordance with the TWE Project Vegetation Management Program, described in Section 3.6.2.1 and 3.6.2.2. The appropriate land management agencies and private landowners will be consulted before ROW clearing begins. Figure 15 provides a plan view of typical transmission ROW and temporary work areas.

Temporary work areas will be cleared of vegetation or flagged, as needed, prior to construction. Temporary work areas will include staging areas; material storage yards; fly yards; pulling, tensioning and spicing sites; work areas at each structure site; batch plant sites; and guard structures. Table 5 summarizes the temporary land disturbance that would be required for Project construction including the typical size and spacing required for the TWE Project facilities and activities.

TABLE 5 SUMMARY OF TEMPORARY LAND DISTURBANCE FOR WORK AREAS

TEMPORARY WORK AREA	DIMENSIONS/ SIZE	LOCATION AND NUMBER OF FREQUENCY NEEDED
TWE Project ±600 kV DC Transmission Line		
Staging Areas / Fly Yards	Average size: 7 acres	Approximately every 5 miles
Material Storage Yards	Average size: 20 acres	Approximately every 30 miles
Wire Pulling, Tensioning and Splicing Sites	ROW width x 500 feet for dead-end structure ROW width x 500 feet for mid-span conductor and shield wire 100 x 500 feet for fiber optic cable set-up sites	Two sites at every dead-end structure Approximately every 9,000 feet Approximately every 18,000 feet
Structure Work Areas	ROW width x 200 feet per structure	All structure sites, average 4 per mile
Batch Plants	Average size: 5 acres	Approximately every 15 miles
TWE Project Northern and Southern Terminals		
Storage and Concrete Batch Plant	7.5 acres	On-site
Interconnection Line structure work areas	200 feet x 200 feet (230 kV structures)* ROW width x 200 feet (500 kV structures)	All structure sites Approximately 6 per mile for 230 kV* Approximately 4 per mile for 500 kV

TABLE 5 SUMMARY OF TEMPORARY LAND DISTURBANCE FOR WORK AREAS		
TEMPORARY WORK AREA	DIMENSIONS/ SIZE	LOCATION AND NUMBER OF FREQUENCY NEEDED
Interconnection Line wire pulling, tensioning, splicing sites	ROW width x 500 feet (230 kV ROW width – 100 feet)* (500 kV ROW width – 250 feet)	Mid-span conductor and shield wire sites – every 9,000 feet Fiber optic cable set-up sites – every 18,000 feet Splicing sites typically at the same locations as the pulling/tensioning sites per common construction practices
TWE Project Northern and Southern Ground Electrode Systems		
Ground Electrode Site	65 acres	On-site
Overhead electrode line, structure work areas	ROW width x 100 feet (34.5 kV ROW width – 50 feet)	All structure sites, average 18 per mile
Overhead electrode line, pulling, tensioning, and splicing sites	75 feet x 100 feet 75 feet x 150 feet	Mid-span conductor sites – every 9,000 feet All dead-end structure sites – two sites each
Material Storage Yards	10 acres	One at each ground electrode site (total of two)
Notes: *Only applies to Northern Terminal		

The following is a summary of the purpose and use of structure work areas; wire-pulling, tensioning and splicing sites; construction staging areas/fly yards; concrete batch plants; and equipment staging and refueling sites.

Structure Work Areas

Individual structure sites will be cleared to install the transmission line structures and facilitate access for future transmission line and structure maintenance. At each structure location (±600 kV DC and 500 kV), an area up to approximately 250 by 200 feet, will be needed for construction laydown, structure assembly, and erection at each structure site. This temporary disturbance will occur within the ROW. To the extent necessary, the work area will be cleared of vegetation and bladed to create a safe working area for placing equipment, vehicles, and materials. After line construction, all areas not needed for normal transmission line maintenance, including fire and personnel safety clearance areas, will be graded to blend as near as possible with the natural contours, then revegetated as required.

Additional equipment may be required if solid rock is encountered at a structure location. Rock-hauling, hammering, or blasting may be required to remove the rock. Excess rock that is too large in size or volume to be spread at the individual structure sites will be hauled away and disposed of at approved landfills or at a location specified by the appropriate agency or landowner. See *Excavating and Installing Foundations* below for additional information on blasting activities.

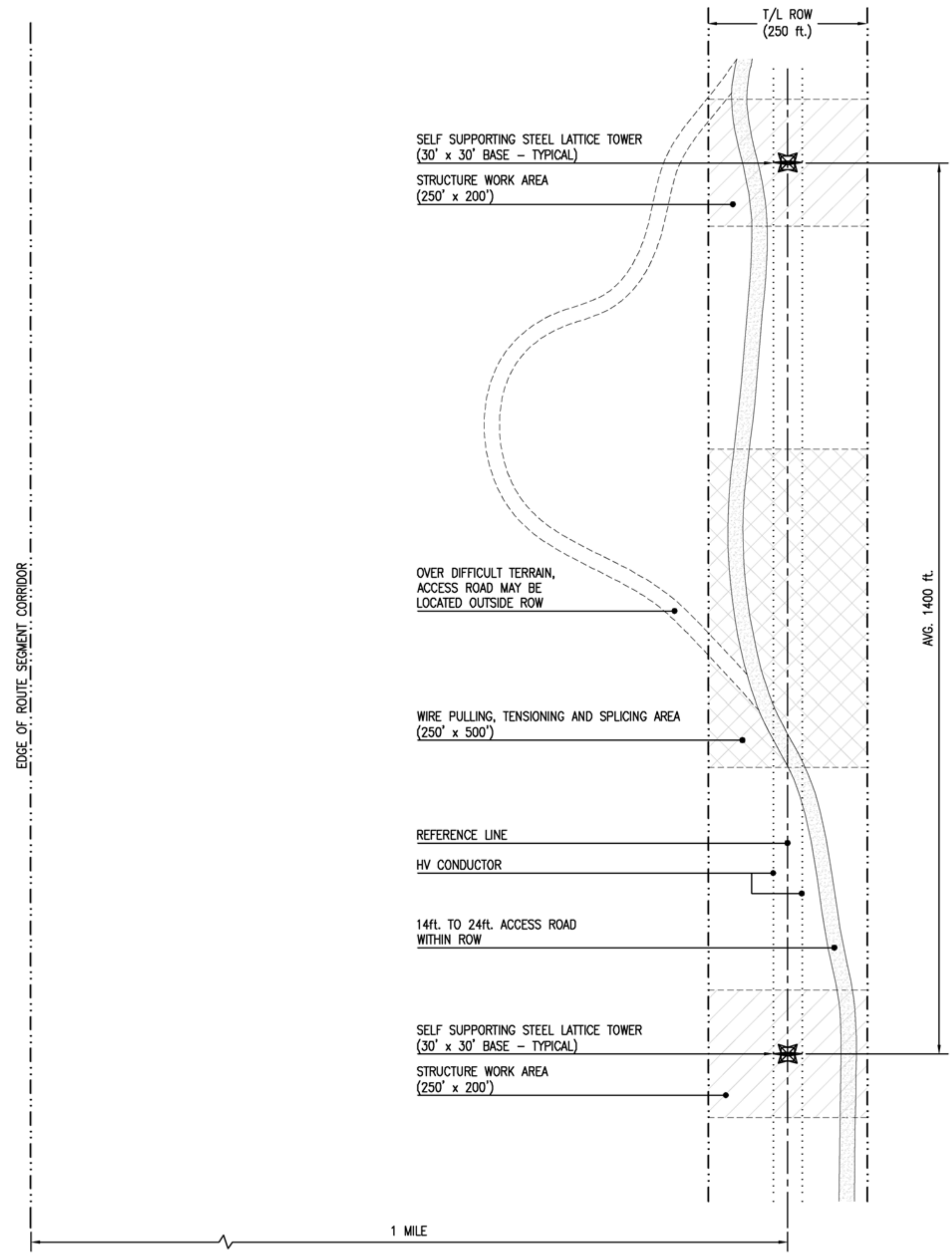

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FIGURE 15
PLAN VIEW OF TYPICAL TRANSMISSION ROW & CONSTRUCTION WORK AREAS

Wire Pulling, Tensioning, and Splicing Sites

Wire pulling, tensioning and splicing sites will be cleared and bladed only to the extent necessary to perform safe wire installation construction activities. During planning for wire installation activities wire pulling, tensioning and splicing sites will be selected to minimize clearing and blading to the extent practical such that actual disturbance areas will not exceed those described in Table 5. After line construction, all areas disturbed for wire pulling, tensioning and splicing sites will be restored as described in the COM Plan.

Construction Staging Areas/Fly Yards

The staging areas will be located in previously disturbed sites or in areas of minimal vegetative cover where possible. The staging areas will serve as field offices; reporting locations for workers; parking space for vehicles and equipment; and sites for material storage, fabrication assembly, concrete batch plants, and stations for equipment maintenance. Staging area dimensions and disturbance areas are summarized in Table 5. Additionally, fly yards for helicopter operations will be located approximately every five miles along the route where helicopter construction is planned, and will occupy approximately seven acres.

Concrete Batch Plant Sites

Concrete for use in the structure foundations will be dispensed from portable concrete batch plants located at approximately 15-mile intervals along the ROW, most located at staging areas. Sites will be identified in the COM Plan. Equipment typically required at a batch plant site includes generators, concrete trucks, front-end loaders, Bobcat loaders, dump trucks, transport trucks and trailers, water tanks, concrete storage tanks, scales, and job site trailers. Rubber-tired trucks and flatbed trailers will be used to assist in relocating the portable plant along the ROW. Commercial ready-mix concrete may be used when access to structure construction sites is economically feasible. Batch plant sites, although temporary in nature, will also be fenced.

Equipment Staging and Refueling Sites

Staging of equipment will be located at staging areas, pulling and tensioning sites, or other temporary work areas previously described. These areas will be used to temporarily lay out equipment to be used for work on specific TWE Project activities at nearby locations.

During construction, the Contractor will implement standard refueling procedures for heavy equipment that is left on the ROW for long periods of time such as cranes, blades, dozers, drill rigs, etc. This equipment will be refueled in place. As a rule, no personal or light-duty vehicles will be allowed to refuel on the ROW. Procedures and precautions similar to those used for helicopter refueling (discussed below) will be utilized.

Staging areas and helicopter fly yards will be fenced and their gates locked. Security guards will be stationed where needed. Staging area locations will be finalized following discussion with the land management agency or negotiations with landowners. In some areas, the staging area may need to be scraped by a bulldozer and a temporary layer of rock laid to provide an all-weather surface. Unless otherwise directed by the landowner, the rock will be removed from the staging area upon completion of construction and the area will be restored.

3.5.2.3 Excavation and Installation of Foundations and Anchors

The single shaft tubular steel poles and self supporting steel lattice towers will typically be supported by cast-in-place drilled concrete pier foundations. For these structure types, vertical excavations for foundations will be made with power drilling equipment. Where soils permit, truck-or track-mounted augers of various sizes, depending on the diameter and depth requirements of the hole to be drilled, will be used. Foundations for guyed steel lattice towers will typically be small precast or cast-in-place concrete pedestals. The precast pedestals will be hauled to the tower site on a flatbed truck and set in a small excavation dug by a backhoe or digger.

In rocky areas, the foundation holes may be excavated by drilling or blasting methods, or installing special rock anchor or micro-pile type foundations. The rock anchoring or micro-pile system will be used in areas where site access is limited, or adjacent structures could be damaged as a result of blasting or rock hauling activities. If hard rock is encountered within the planned drilling depth of tower foundations, blasting may be required to loosen or fracture rock. Potential areas requiring blasting will be identified based on geological setting of the proposed alignment. A Blasting Plan will be prepared as part of the COM Plan detailing the general concepts proposed to achieve the desired excavations, proposed methods for blasting warning, use of non-electrical blasting systems, provisions for controlling fly rock, vibrations, and air blast damage. Blasting is described in detail in Section 3.5.7 Special Construction Practices.

In environmentally sensitive areas with very soft soils, a HydroVac, which uses water pressure and a vacuum, may be used to excavate material into a storage tank. Alternatively, a temporary casing may be used during drilling to hold the excavation open, and then the casing is withdrawn as the concrete is placed in the hole. In areas where it is not possible to operate large drilling equipment due to access or environmental constraints, hand-digging may be required.

In areas where single shaft tubular steel pole structures are used, increased volumes of excavated subsoil spoils, based on foundation size and depth may require spreading beyond the general disturbance area to maintain grades and runoff, and to facilitate restoration. In these areas, topsoil will be salvaged and set aside to be placed over the subsoil material during restoration. These locations will be mitigated on a case-by-case basis. Spoil material will be used for backfill where suitable, and the remainder will be spread at the tower site or along graded access roads or in locations previously agreed upon by the Applicant and the appropriate land management agency or private landowner.

Foundation or anchor holes left open or unguarded will be covered to protect the public and wildlife. If practical, fencing may be used. All safeguards associated with using explosives (e.g., blasting mats) will be employed. Blasting activities will be coordinated with the appropriate agencies, particularly for purposes of safety and protection of sensitive areas and biological resources. In extremely sandy areas, water or an appropriate land management agencies' approved gelling agent will be used to stabilize the soil before and during excavation.

Reinforced-steel anchor bolt cages will be installed after excavation and prior to structure installation. These cages are designed to increase the structural integrity of the foundations, will be assembled at the nearest laydown yard or staging area, and delivered to the tower site via flatbed truck. These cages will be inserted in the holes prior to pouring concrete. The excavated holes containing the reinforcing anchor bolt cages will be filled with concrete.

Typically, and because of the remote location of much of the transmission line route, concrete will be provided from portable batch plant areas as described above. Concrete will be delivered directly to the site in concrete trucks with a capacity of up to ten cubic yards. In the more developed areas along the route, the Contractor may use local concrete providers to deliver concrete to the site when economically feasible.

Guyed lattice structures require the installation of anchors and guy wires to support the structure. Depending upon the soil type and engineering strength requirements, anchors will be either excavated plate anchors, drilled and epoxy, or grouted anchors.

Drilled anchors will require a small truck or track mounted drilling equipment that will drill a hole four to eight inches in diameter, 20 to 40 feet or more in depth. The anchor rod is inserted into the open bore and secured to the soil or rock either with epoxy or grout.

Plate anchor are installed in a three to four foot diameter excavation, 10 to 20 feet in depth, drilled by a small truck or track mounted drilling rig. The anchor rod is attached to the plate anchor, placed in the hole and the excavation is backfilled and compacted.

3.5.2.4 Erection of Transmission Structures

Bundles of steel members and associated hardware (insulators, hardware, and stringing sheaves) will be transported to each structure site by truck. Wood blocking will be hauled to each location and laid out; the tower steel bundles will be opened and laid out for assembly by sections and assembled into subsections of convenient size and weight. Typically, the leg extensions for the towers will be assembled and erected by separate crews with smaller cranes to make ready for setting of the main tower assembly. The assembled subsections will then be hoisted into place by means of a large crane and fastened together to form a complete tower. A follow-up crew then will tighten all the bolts in the required joints. Refer to Figure 12 for a general illustration of this procedure. The use of helicopters for structure erection is described in Section 3.5.7 Special Construction Practices.

3.5.2.5 Stringing of Conductors, Shield Wire, and Fiber Optic Ground Wire

Insulators, hardware, and stringing sheaves will be delivered to each tower site. The towers will be rigged with insulator strings and stringing sheaves at each shield (ground) wire and conductor position.

Interruption of road traffic on all types of roads (county, state, federal, interstate) is not anticipated during conductor stringing and tensioning activities unless required under the terms and conditions of a specific road or highway crossing permit. As described below, pilot lines will be pulled from tower to tower by either a helicopter (most commonly) or land operated equipment. The use of a helicopter to pull the pilot lines is commonly used so that impacts to road traffic are minimized or avoided. For safety and efficiency reasons, wire stringing and tensioning activities are typically performed during daylight hours and are scheduled to coincide to the extent practical with periods of least road traffic in order to minimize traffic disruptions.

Railroad crossing operations and procedures are controlled by and permitted through the railroad company operating the affected rail line (see the Union Pacific Railroad website for Overhead Wire Crossings as an example). Terms and conditions to be followed are specified in the crossing permit. Typically, stoppage of railroad traffic is not required during construction or conductor stringing and tensioning activities. Crossing activities are similar to those for road crossings and typically involve the use of guard structures as discussed below. Stringing and tensioning activities will be performed in coordination with the appropriate railroad authorities. For safety and efficiency, stringing and tensioning activities are performed during daylight periods and scheduled to coincide with times of least railroad traffic. The railroad will typically provide a switchman who is present at all times when work is being performed near or over any railroad line.

For protection of the public during stringing activities, temporary guard structures will be erected at road crossing locations where necessary. Guard structures will consist of H-frame wood poles placed on either side of the road to prevent ground wires, conductors, or equipment from falling on underlying facilities and disrupting road traffic. Typically, guard structures are installed just outside of the road ROW. Although the preference is for access to each of these guard structures to be located outside the road ROW, it may be necessary for access to be within the road ROW depending on topography and access restrictions imposed by the regulatory agency (i.e., State Department of Transportation (DOT), county road and bridge department, etc.). Access use within the road ROW will be performed in compliance with the stipulations of the crossing permit and regulatory agency requirements.

Site specific road crossing locations with excessive widths (generally greater than 200 to 300 feet) such as may occur on interstate highways would require installation of temporary guard structures in medians between opposite traffic flow lanes. Although TransWest does not currently anticipate needing guard structures in medians, as final engineering design progresses, locations requiring center median guard structures may be identified. The erection and dismantling of these temporary guard structures may require short-term traffic diversions. These short-term traffic diversions, which may last from a few hours to a day, are most commonly a short duration closure of the shoulder of the road or in more congested locations might consist of the closure of one lane of traffic. Complete closure of one direction of traffic is not anticipated. Temporary traffic diversion signs, signals, markers, barriers and traffic control personnel, if required by the State DOT, will be employed. These activities would be coordinated with the appropriate State DOTs. Traffic disruptions will be kept to a minimum and TransWest will comply with crossing permit requirements which typically limit durations of traffic interruptions.

In urban locations or for extremely high volume roadways (such as interstate highways), the State DOTs may require the installation of protective steel netting above the roadway for the duration of wire stringing and tensioning operations (generally ranging from a few days to two to three weeks). The installation of protective steel netting requires a brief closure of the roadway (generally 3 - 20 minutes) while the netting is pulled across the roadway and hoisted onto the temporary support structures. This process is repeated when the netting is removed. Because of the heavy traffic volume and the impact of stopping traffic, netting is typically installed during the lowest traffic period (normally 3am to 5am on a Sunday morning) per the requirements of the State DOT. Although not anticipated, any road stoppage will employ all appropriate State DOT traffic safety requirements (signage, flagmen, lighting, signals, temporary barriers, law enforcement, etc.).

The delivery of large pieces of equipment or material as part of the construction process may slow or interrupt traffic on state or county roads on a short-term basis. The duration of these types of traffic disruption are typically very short, a few minutes or less while the delivery truck passes down a roadway or turns a corner. The limited number of large pieces of equipment or material that are delivered to any one portion of the project tends to make traffic disruptions infrequent and generally unnoticed by the motoring public.

Equipment for erecting guard structures will include augers, backhoes, line trucks, boom trucks, pole trailers, and cranes. Guard structures may not be required for small roads. In such cases, other safety measures such as barriers, flagmen, or other traffic controls will be used. Following stringing and tensioning of all ground wires and conductors, the guard structures will be removed and the area restored.

Pilot lines will be pulled (strung) from tower to tower by either a helicopter or land operated equipment, and threaded through the stringing sheaves at each tower. Following pilot lines, a stronger, larger diameter line will be attached to conductors to pull them onto towers. This process will be repeated until the shield wire, optical ground wire, or conductor is pulled through all sheaves.

Shield wires, fiber optic cable, and conductors will be strung using powered pulling equipment at one end and powered braking or tensioning equipment at the other end of a conductor segment. Site dimensions for pulling and tensioning equipment are provided in Table 5. These sites may differ in size and dimensions, however, depending on the structure's purpose (e.g., mid-span or dead-end), site-specific topography, and whether anchoring of the shield wire or conductor will be located at these sites. The tensioner, in concert with the puller, will maintain tension on the ground wires or conductor while they are fastened to the towers. Once each type of wire has been pulled in, the tension and sag will be adjusted, stringing sheaves will be removed, and the conductors will be permanently attached to the insulators.

Tension will be maintained on all insulator assemblies to ensure positive contact between insulators, thereby avoiding sparking. Caution also will be exercised during construction to avoid scratching or nicking the conductor surface, which may provide points for corona to occur. Refer to Figure 13 for a general illustration of this procedure.

At tangent and small-angle towers, the conductors will be attached to the insulators using clamps while at the larger angle dead-end structures the conductors are cut and attached to the insulator assemblies by "dead-ending" the conductors, either with a compression fitting or an implosive type fitting. Both are industry-recognized methods. When utilizing the implosive type fitting, pertinent land management agencies, private landowners, and public safety organizations will be notified before proceeding with this method.

Part of standard construction practices prior to conductor installation will involve measuring the resistance of the ground to electrical current near the towers. If the measurements indicate a 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 inches in cultivated land, with a ground rod driven at the end. The counterpoise will be contained within the limits of the ROW and may be altered or doubled back and forth to meet the requirements of the TWE Project. Typical equipment used for installing ground rods includes line trucks, backhoes, and trenchers.

3.5.2.6 Clean-up and Site Reclamation

Construction sites, material storage yards, and access roads will be kept in an orderly condition throughout the construction period. Refuse and trash will be removed from the sites and disposed of in an approved manner (e.g., in an approved landfill). In remote areas, trash and refuse will be removed to a construction staging area and contained temporarily until such time as it can be hauled to an approved site. No open burning of construction trash will occur. Contaminants such as oils, hydraulic fluids, antifreeze, and fuels will not be dumped on the ground, and all spills will be cleaned up. A Hazardous Materials Management Plan will be prepared with the COM Plan.

For permanent access roads, the primary road surface will remain and not be restored to original contours so that a stable road will be present if equipment is needed to access a tower during operation and maintenance. Construction roads and trails not required for maintenance will be restored to the original contour, seeded, and be left in a condition acceptable to the land management agency or private landowner. The surfaces of these construction roads and trails will be scarified as needed to provide conditions that will facilitate natural revegetation, provide for proper drainage, and prevent erosion (Western 2010).

Following construction, where reasonable, in the areas where it has been determined the access roads will be temporary, the topsoil may be bladed back across the disturbed road section and the access blocked as determined through mutual agreement by the Applicant and the appropriate land management agency or private landowner. In these areas, seeds and roots contained within the respread topsoil layer normally provide a natural source for new growth. A ROW Preparation, Rehabilitation, and Restoration Plan will be developed.

Disturbed areas not required for access roads and maintenance areas around structures will be restored and revegetated, as required by the appropriate land management agency or private landowner. Temporary access roads will be decompacted and the topsoil replaced. The land-management agency, private landowner or local National Resource Conservation Service (NRCS) office will be consulted regarding the appropriate seed mix and rate to revegetate the road surface. Vegetation on an eight-foot wide road surface may be periodically managed to allow equipment travel if necessary. Temporary culverts will be removed. Drivable at-grade waterbars will be installed where needed with frequency proportional to road slope to prevent erosion of the roadbed. Applicable agency Best Management Practices (BMPs) will be implemented. All practical means will be made to restore the land outside the minimum areas needed for safe operation and maintenance to its original contour and to restore natural drainage patterns along the ROW.

3.5.3 Terminal and Substation Construction

Terminal construction activities will occur at the Northern and Southern Terminals. Section 3.5.9.3 summarizes the types of construction equipment to be used at each terminal, substation or series compensation station.[10]

Construction of the AC/DC converter stations, substations or series compensation stations will initially consist of survey work, geotechnical sample drillings approximately 20 to 50 feet deep, and soil resistivity measurements that will be used in the final design phases of the station. Once the final design of the station has been completed, a Contractor will mobilize to perform site development

[10] Terminal construction for the proposed Project includes the adjacent substations. Separate substations and/or series compensation stations are required for System Alternatives 2 and 3. Descriptions of the construction for the substations and series compensation station for System Alternatives 2 and 3 are included within this section for convenience and completeness.

work, including grubbing and then reshaping the general grade to form a relatively (one percent slope) flat working surface. This effort also will include the construction of permanent all-weather access roads. An eight-foot-tall chain link fence will be erected around the perimeter of the terminal, substation or series compensation station to prevent unauthorized personnel from accessing the construction and staging areas. The perimeter fence will be a permanent feature to protect the public from accessing the facility. The excavated and fill areas will be compacted to the required densities to allow structural foundation installations. Oil containment structures required to prevent oil from transformers, reactors, circuit breakers, etc., from getting into the ground or water bodies in the event of rupture or leak, will be installed.

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 with 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 converter valve hall and ancillary buildings will be erected. 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, the enclosures that contains the control and protection equipment for the terminal, substation and series compensation station will be constructed, equipped, and wired. A final crushed rock surface will be placed on the subgrade to make for a stable driving and access platform for the maintenance of the equipment. After the equipment has been installed, testing of the various systems will take place, followed by electrical energization of the facility. The energization of the facility generally is timed to take place with the completion of the transmission line work and other required facilities.

Soil Boring

Typically, soil borings will be made on a 600-foot grid spacing within the terminal, substation or series compensation station, particularly at the approximate location of large structures and equipment such as substation dead-ends and transformers, to determine the engineering properties of the soil for foundation design. Borings will be made with truck- or track-mounted equipment. The borings will be approximately four inches in diameter, range from 20 to 50 feet deep, and be backfilled with the excavated material upon completion of soil sampling.

Clearing and Grading

The Contractor will mobilize to perform site development work including grubbing, grading and construction of an all-weather access road (gravel). Clearing of all vegetation will be required for the entire terminal, substation or series compensation station area, including a distance of approximately eight to ten feet outside the fence.

Once the vegetation is cleared, the entire site will be graded essentially flat, with enough slope to provide for runoff of precipitation. The site will be graded to use existing drainage patterns to the extent possible. Depending upon the size of the site a more complex drainage design may be required to handle larger volumes of runoff. Drainage design for large sites may require drainage zones, retention basins, and drainage structures such as ditches or culverts. After grading, the entire site will be treated with a soil sterilizer to prevent vegetation growth to minimize future maintenance. Clearing and grading material will be disposed of in compliance with local ordinances. Material from off-site will be obtained at existing borrow or commercial sites and will be trucked to the site using existing roads and the site access road.

Once installation of foundations, underground electrical raceways and copper ground grid are completed, a four to six inch layer of crushed rock will be applied to the finished surface of the station to provide a solid all-weather working surface and to protect personnel from high currents and voltages during electrical fault conditions.

Storage and Staging Yards

Construction material storage yards may be located outside the terminal, substation or series compensation station-fenced area near the facility being constructed. These storage yards may be part of the terminal, substation series compensation station property or leased by the Contractor. After construction is completed, all debris and unused materials will be removed and the staging/storage yards returned to preconstruction conditions by the Contractor.

Grounding

A grounding system will be required in each terminal, substation and series compensation station for detection of faults and for personnel safety. The grounding system typically consists of buried copper conductor arranged in a grid and driven ground rods, typically eight to ten feet long. The ground rods and any equipment and structures are connected to the grounding conductor. The amount of conductor and length and number of ground rods required will be calculated based on fault current and soil characteristics.

Fencing and Lighting

Security fencing will be installed around the entire perimeter of each terminal, substation and series compensation station to protect sensitive equipment and prevent accidental contact with energized conductors by third parties. This seven-foot-high fence would be constructed of chain link with steel posts. One foot of barbed wire or similar material will be installed on top of the chain link yielding a total fence height of eight feet. Locked gates will be installed at appropriate locations for authorized vehicle and personnel access.

Safety and security lighting at the terminals, substations and series compensation stations will be provided inside the fence for safety and security, and for uncommon emergency night repair work. Dusk to dawn safety and security lighting will be used at the terminals and 500 kV AC substations.

Foundation Installation

Foundations for supporting structures and large buildings are of two types: spread footings or drilled piers. Spread footings are placed by excavating the foundation area, placing forms and reinforced-steel and anchor bolts, and pouring concrete into the forms. After the foundation has been poured, the forms would be removed, and the surface of the foundation finished. Drilled pier foundations are placed in a hole generally made by a track or truck-mounted auger. Reinforced-steel and anchor bolts are placed into the hole using a track or truck-mounted crane. The portion of the foundation above ground would be formed. The portion below ground uses the undisturbed earth of the augured hole as the form. After the foundation has been poured, the forms would be removed, the excavation would be backfilled, and the surface of the foundation finished.

Equipment foundations for circuit breakers, transformers, and small prefabricated buildings will be slab-on-grade type. These foundations are placed by excavating the foundation area; placing forms, reinforced steel, and anchor bolts (if required); and placing concrete into the forms. After the foundations have been poured, the forms are removed, and the surface of the foundation finished. Where necessary, provisions will be made in the design of the foundations to mitigate potential problems due to frost. Reinforced steel and anchor bolts will be transported to each site by truck, either as a prefabricated cage or loose pieces, which will then be fabricated into cages on the site. Concrete will be hauled to the site in concrete trucks. Excavated material will be spread at the site or disposed of in accordance with agency requirements or local ordinances. Structures and equipment will be attached to the foundations by means of threaded anchor bolts embedded in the concrete. Some equipment such as transformers and reactors may not require anchor bolts.

Oil Containment

Some types of electrical equipment, such as transformers, and some types of reactors and circuit breakers, are filled with an insulating mineral oil. Containment structures are required to prevent equipment oil from getting into the ground or waterbodies in the event of a rupture or leak. These structures take many forms depending on site requirements, environmental conditions, and regulatory restrictions. The simplest type of oil containment is a pit, of a calculated capacity, under the oil-filled equipment that has an oil-impervious liner. The pit is filled with rock to grade level. In case of an oil leak or rupture, the oil captured in the containment pit is pumped into tanks or barrels and transported to a disposal facility. If required, more elaborate oil-containment systems can be installed. This may take the form of an on-site or off-site storage tank and/or oil-water separator equipment depending on site requirements.

Structure and Equipment Installation

Supporting steel structures are erected on concrete foundations. These are set with a track or truck-mounted crane and attached to the foundation anchor bolts by means of a steel base plate. These structures will be used to support the energized conductors and certain types of equipment. This equipment will be lifted onto the structure by means of a truck-mounted crane and bolted to the structures; electrical connections are then made. Some equipment, such as transformers, reactors, and circuit breakers, will be mounted directly to the foundations without supporting structures. These will be set in place by means of a truck-mounted crane. Some of this equipment requires assembly and testing on the pad. Electrical connections to the equipment will then be made.

Equipment Housing, Control, Storage and Ancillary Building Construction

The Project will require several buildings at each terminal, substation or series compensation site. Depending upon size and function, these buildings will be either prefabricated or constructed on site as concrete block or metal clad steel frame buildings.

The following provides a brief description and approximate dimension of the building types generally required for the terminals:

> The **HVDC Converter Valve Hall** is a large building that contains the high-voltage electronics involved in the conversion process (referred to as valves), the valve cooling circulation system (pipes required to circulate the cooling medium), clean air exchange, and other supporting environmental conditions required for operation of the converter system. The valves are typically suspended from the ceiling of the building which requires large

clearance distances to the ground and surrounding structures due to the high voltages that are generated within the building during the conversion process. The building will be approximately 60 to 80 feet in height and the footprint will be approximately 200 by 80 feet. There will be two buildings of this size; one housing the valve equipment for the positive DC pole and the other housing the equipment for the negative DC pole.

An **HVDC Auxiliary Support Building** is typically placed between the two valve halls or very near the valve halls. This building contains the pumps and heat exchange system for cooling of the valves. The building is typically 100 feet wide, 100 feet long and approximately 20 feet high.

A **Main Operations Building** housing operations, general office and support functions is approximately 150 by 150 feet square and is typically a two-story building with a complete basement. The HVDC control room and supporting control systems are housed in a main operations building. The telecommunications equipment, the HVDC controls equipment, and the operational control room are typically located in separated secure spaces to assure safety and to restrict access to all levels of automation and telecommunication. Operations, administrative staff, and maintenance dispatch supporting facilities are also located within this building. Control spaces will be equipped with full ranges of uninterrupted power supply power protection, fire safety operations, and dispatcher coordination centers. This facility will also include the SCADA control and monitoring systems for the Project's entire AC substation, and transmission systems as necessary up to the points of interconnection with the regional grid.

The **Security Control Office Building** will be an approximately 30 by 30 foot single story building with a full basement, to facilitate life safety and other equipment including domicile facilities for security personnel on extended shift work.

The **Diesel Generator Building** will be an approximately 100 by 30 foot single story building. This building contains diesel generators and support equipment necessary to operate the facility on loss of the primary power source.

The **DC Switchyard Building** is typically a single story building of approximately 30 feet by 60 feet. One or more control buildings may be required at each terminal to house control devices, battery banks for primary control power, and remote monitoring equipment. The size and construction of the building will depend on DC switchyard requirements. Typically, the control building will be constructed of concrete block, pre-engineered metal sheathed, or composite surfaced materials. Once the control house is erected, protection and control equipment will be mounted and wired inside.

A **Hazardous Chemical and Dry Storage Building** will be developed to place the various chemical bulk storage and other items outside and apart from the other buildings in the terminal complex. This building will be approximately 30 feet by 30 feet. This building will be supplied with the code required containment, life, and fire safety systems.

A **Dry Indoor Storage Building** will be developed based on the requirements of the HVDC Contractor and is estimated to be approximately 100 feet by 150 feet, single story, high bay building.

The following provides a brief description and approximate dimension of the buildings types generally required for the terminals, substations and series compensation stations:

> The **AC Switchyard Control House** is typically a single story structure of approximately 30 feet by 60 feet. One or more control buildings may be required at each switchyard, substation or series compensation station to house protective relays, control devices, battery banks for primary control power, and remote monitoring equipment. The size and construction of the building will depend on individual substation requirements. Typically, the control building will be constructed of concrete block, pre-engineered metal sheathed, or composite surfaced materials. Once the control house is erected, protection and control equipment will be mounted and wired inside.

Conductor Installation

The two main types of high-voltage conductors used in terminals and substations are tubular aluminum for rigid bus sections and/or stranded aluminum conductor for strain bus and connections to equipment. Rigid bus will be a minimum of four inches in diameter and will be supported on porcelain or polymer insulators on steel supports. The bus sections will be welded together and attached to special fittings for connection to equipment. Stranded aluminum conductors will be used as flexible connectors between the rigid bus and the station equipment.

Conduit and Control Cable Installation

Most terminal and substation equipment requires low-voltage connections to protect relaying and control circuits. These circuits allow metering, protective functions, and control (both remote and local) of the power system. Connections will be made from the control building to the equipment through multi-conductor control cables installed in conduits and/or a pre-cast concrete cable trench system.

3.5.4 Ground Electrode Construction

Construction of the two ground electrode facilities will be initiated with a survey and staking to layout the location of the access road, deep earth electrode wells, control building and low voltage underground electrical, control and monitoring cables connecting the wells to the control building. The Contractor will mobilize to perform site development work including grubbing and grading and construction of an all-weather access road (gravel). Grubbing, grading, and contouring of the entire site is not required. Removal of vegetation will be required for the access road, control building site, well sites, alignments of the underground electrical, control and monitoring cables and on-site material storage yard/staging area.

Once the vegetation is cleared, the control building site will be graded essentially flat, with enough slope to provide for runoff of precipitation. After grading, the control building site will be treated with a soil sterilizer to prevent vegetation growth to minimize future maintenance. Next, a thin layer of gravel or crushed rock will be applied to the finished surface of the control building site. With the exception of the permanent and temporary access roads, no additional grading will be required. Clearing and grading material will be disposed of in compliance with local ordinances. Material from off-site will be obtained at existing borrow or commercial sites, and will be trucked to the regeneration site using existing roads and the regeneration site access road.

Security fencing will be installed around the perimeter of the control building site. This seven-foot-high fence would be constructed of chain link with steel posts. One foot of barbed wire or similar material will be installed on top of the chain link yielding a total fence height of eight feet. A locked gate will be installed for authorized vehicle and personnel access.

Foundations for the prefabricated building will be slab-on-grade type. These foundations are placed by excavating the foundation area; placing forms, reinforced steel, and anchor bolts; and placing concrete into the forms. After the foundations have been poured, the forms are removed, and the surface of the foundation finished. Where necessary, provisions will be made in the design of the foundations to mitigate potential problems due to frost.

Reinforced steel and anchor bolts will be transported to each site by truck which will then be fabricated into cages on the site. Concrete will be hauled to the site in concrete trucks. Excavated material will be spread at the site or disposed of in accordance with agency requirements or local ordinances. The pre-fabricated building will be transported to the site by truck and attached to the foundations by means of threaded anchor bolts embedded in the concrete.

Each ground electrode site will require drilling approximately 60 deep earth wells. Each electrode well will be a 12 to 18 inch diameter bore drilled to a depth of 200 to 700 feet (depth based upon engineering and design). The well drilling will require small amounts of water which will be procured from commercial or municipal sources. Ground water will not be removed although small amounts of water, mud and spoil will be brought to the surface as part of the drilling process. All excess water, mud, drilling fluids, and spoils will be contained adjacent to the drill rig and when completed will be disposed of per landowner and agency requirements.

Once drilling is completed, a wire will be grouted into the well, the well capped, and a small area excavated around the well head for the installation of the utility access vault. A precast concrete utility access vault is installed. This utility access vault provides access to the well in addition to preventing public access to the well connections or electrode components.

Several underground cables are installed in trench connecting each well to the control building. These cables provide a low voltage electrical connection from the control building to each well, and perform control and monitoring functions. Cables will be direct buried with the trench backfilled and compacted with spoil. Once backfilling is complete, the trenched area will be contoured back to match existing slopes and grades.

A communication system used for monitoring and control of the ground electrode facility will be installed. This communication link will require installation of either a buried or overhead fiber optic cable, and equipment or fixed radio communication equipment and antenna.

Connection to a local electric distribution circuit will be required to provide power to the site. Additionally, an emergency generator with a liquid propane (LP) gas fuel tank will be installed adjacent to the control building inside the fenced area.

3.5.5 Communications System Construction

The fiber optic network will require regeneration sites at periodic distances along the transmission line, as determined in the detailed engineering studies. In general, these regeneration sites are planned to be within the transmission line ROW. The communications system facilities will be constructed concurrently with the transmission line.

Construction will be initiated with a survey and staking to layout the location, and extent of the regeneration site. The Contractor will mobilize to perform site development work including grubbing, grading, and construction of an all-weather access road (gravel).

Clearing of all vegetation will be required for the entire regeneration site, including a distance of approximately eight to ten feet outside the fence. Once the vegetation is cleared, the entire regeneration site will be graded essentially flat, with enough slope to provide for runoff of precipitation. After grading, the entire site will be treated with a soil sterilizer to prevent vegetation growth to minimize future maintenance. Next, a thin layer of gravel or crushed rock will be applied to the finished surface of the regeneration site. Clearing and grading material will be disposed of in compliance with local ordinances. Material from off-site will be obtained at existing borrow or commercial sites, and will be trucked to the regeneration site using existing roads and the regeneration site access road.

Security fencing will be installed around the entire perimeter of each regeneration station. This seven-foot-high fence would be constructed of chain link with steel posts. One foot of barbed wire or similar material will be installed on top of the chain link yielding a total fence height of eight feet. A locked gate will be installed for authorized vehicle and personnel access.

Foundations for the prefabricated building(s) will be slab-on-grade type. These foundations are placed by excavating the foundation area; placing forms, reinforced steel, and anchor bolts; and placing concrete into the forms. After the foundations have been poured, the forms are removed, and the surface of the foundation finished. Where necessary, provision will be made in the design of the foundations to mitigate potential problems due to frost.

Reinforced steel and anchor bolts will be transported to each site by truck which will then be fabricated into cages on the site. Concrete will be hauled to the site in concrete trucks. Excavated material will be spread at the site or disposed of in accordance with agency requirements or local ordinances. Pre-fabricated building(s) will be transported to the site by truck and attached to the foundations by means of threaded anchor bolts embedded in the concrete.

The fiber optic cable will be connected from the splice box located near the bottom of the nearest transmission structure to the control building at the regeneration site via two diverse paths, either overhead or underground. The overhead path may require one, two or three short distribution type poles all located on the transmission ROW. An underground path will require trenching and burial of an underground fiber optic cable. All trenching is to occur on the transmission ROW.

Connection to a local electric distribution circuit will be required to provide power to the site. Additionally, an emergency generator with a LP gas fuel tank will be installed at the site inside the fenced area.

A short tower (generally less than 30 feet) with a UHF/VHF radio antenna will be installed to provide communication support for transmission line patrol and maintenance operations and allow emergency operations independent of commercial common carrier (i.e., cellular telephone).

3.5.6 Post Construction Clean-Up and Restoration

Terminal, ground electrode, series compensation station and transmission line construction will generate a variety of solid wastes including concrete, hardware, and wood debris. The solid wastes generated during construction will be recycled or hauled away for disposal. Excavation along the ROW and at terminals and substations will generate excavated subsoil spoil that could potentially be used as fill; however, some of the excavated material will be removed for disposal.

The majority of waste associated with terminal and substation construction results from spoils created during site grading. Very little of the soil excavated during foundation installation is waste product. Above-grade waste will be packing material such as crates, pallets, and paper wrapping to protect equipment during shipping. It is assumed a 12-yard dumpster will be filled once a week with waste material for the duration of each terminal or substation project.

Clean-up and restoration will consist of:

- Removing packing crate reels, shipping material and debris, and disposing of them at approved landfill sites;
- Backfilling holes and ruts in access roads, installing water bars, and doing final grading;
- Dressing work sites and structure sites to remove ruts;
- Mitigating soil compaction and leveling, disking, and preparing areas for seeding, as required;
- Maintaining permanent access roads as needed for future maintenance work;
- Leaving access roads in place, but not regularly maintaining them. Access roads will be graded, have water bars installed, and reseeded to encourage vegetation cover according to appropriate land management agency or private landowner requirements;
- Repairing fences and gates to their original condition or better;
- Grounding fences;
- Seeding and revegetating, as specified in the COM Plan and in accordance with appropriate land management agency or private landowner requirements; and
- Contacting property owners and processing claims for settlement.

3.5.7 Special Construction Practices

3.5.7.1 Blasting

As described earlier in this section, foundations for tubular steel poles and self supporting steel lattice towers will normally be installed using drilled shafts or piers. Foundations for guyed steel lattice towers will typically be small precast or cast-in-place concrete pedestals. If hard rock is encountered within the planned drilling depth, blasting may be required to loosen or fracture the rock to reach the required depth to install the tower foundations. Areas where blasting will likely occur will be identified during final design based on the geologic conditions of the Agency Preferred Alternative alignment as determined by the geotechnical investigation. The Contractor will be required to prepare a Blasting Plan for the Project, subject to the approval of the Applicant. The Blasting Plan will detail the Contractor's proposals for compliance with the Applicant's blasting specifications and Blasting Plan framework from the COM Plan, and will detail the general concepts proposed to achieve the desired excavations. In addition, the Plan will address proposed methods for controlling fly rock, for blasting warnings, and for use of non-electrical blasting systems. The Contractor will be required to provide data to support the adequacy of the proposed efforts regarding the safety of structures and slopes and to ensure that an adequate foundation is obtained. When utilized, blasting will take place between sunrise and sunset.

The Blasting Plan will contain shot plans which will detail the drilling and blasting procedures; the number, location, diameter, and inclination of drill holes; the amount, type, and distribution of explosive per hole and delay; and pounds of explosive per square foot for pre-splitting and smooth blasting. The Contractor will be required to maintain explosives logs.

Blasting near buildings, structures, and other facilities susceptible to vibration or air blast damage will be carefully planned by the Contractor and the Applicant, and controlled to eliminate the possibility of damage to such facilities and structures. The Blasting Plan will include provisions for control to eliminate vibration, fly rock, and air blast damage.

Blasting will be very brief in duration (milliseconds), and the noise will dissipate with distance. Blasting produces less noise and vibration than comparable non-blasting methods to remove hard rock. Non-blasting methods include track rig drills, rock breakers, jack hammers, rotary percussion drills, core barrels, and rotary rock drills with rock bits, which all require much longer time duration to excavate the same amount of rock as blasting.

3.5.7.2 Helicopter Construction

Helicopter construction techniques may be used for the erection of structures, stringing of conductor and shield wire, and other Project construction activities. The use of helicopters for structure erection is evaluated based on site- and region-specific considerations including access to structure locations, sensitive resources, permitting restrictions, construction schedule, weight of structural components, time of year, elevation, availability of heavy lift helicopters, and/or construction economics.

Helicopter erection of structures is a viable option for all locations without restrictions prohibiting or restricting helicopter use. As such “fly yards”, each seven acres in size have been incorporated into Project planning. In areas without restrictions on helicopter usage, the decision to employ helicopter construction techniques will be determined by the Contractor. However it is not anticipated that helicopter erection will be used except potentially in areas with extremely difficult access, in areas with some form of access restriction or in areas required by mitigation measures.

The use of helicopters for pulling shield wire and conductor lead lines is the normal and expected construction technique for wire stringing, as such, helicopters will be used for this purpose on the Project.

Other Project construction activities potentially facilitated by helicopters may include delivery of construction laborers, equipment, and materials to structure sites; structure placement and hardware installation. Helicopters may also be used to support the administration and management of the Project by the Applicant. Except in areas with restrictions on constructing or maintaining access roads, the use of helicopter construction methods would not change the length of the access road system required for operating the Project, because vehicle access will be required to each structure site regardless of the construction method employed.

When helicopter construction methods are employed, the structure assembly activities will be based at a fly yard. The fly yards will be approximately seven acres and will be sited typically at about five mile intervals within the section of the line employing helicopter erection. Optimum helicopter methods of erection will be used. Bundles of steel members and associated hardware for up to 15 to 20 towers (generally to include insulators, hardware, blocking, stringing sheaves, etc.) are transported to the appropriate fly yard by truck and stored. The steel bundles are opened and laid out by component section and then assembled into assemblies of convenient size and weight according to the helicopter's lifting capabilities. The leg extensions are typically transported to the tower location, assembled, and erected in place (with smaller equipment) in preparation for flying the completed tower sections to each location. After a planned quantity of towers is completely assembled, the helicopter and support force are mobilized and, within a few days, will set all the planned towers within a given section. A follow-up crew will then tighten all the bolts in the joints.

Prior to installation, each tower would be assembled in multiple sections at the fly yard. Tower sections or components would be assembled by weight, based on the lifting capacity of the helicopter in use. The lift capacity of helicopters is dependent on the elevation of the fly yard, the tower site, and the intervening terrain. The heavy lift helicopters that could be used to erect the complete towers or sections of a tower would be able to lift a maximum of 15,000 to 20,000 pounds per flight, depending on elevation.

After assembly at the fly yard, the complete tower or tower section would be attached by cables from the helicopter to the top of the tower section and airlifted to the tower location. Upon arrival at the tower location, the section would be placed directly onto the foundation or atop the previous tower section. Guide brackets attached on top of each section would assist in aligning the stacked sections. Once aligned correctly, line crews would climb the towers to bolt the sections together permanently.

It should be noted that the fly yard locations provided are considered approximate and subject to change, additions, or deletions upon acquisition of a Contractor prior to the beginning of construction. Upon completion of field review, a final determination would be made on the necessity of certain fly yards and the respective locations that provide the most efficient, economic, safest, and least impactful use of the fly yards that are needed.

A helicopter may be used to move personnel and equipment (e.g., pulling lines and assembling towers). Helicopters will set down in areas previously identified to receive temporary disturbance such as fly yards and staging areas. Travelers may be dropped at pulling and tensioning sites or other work areas previously described. Spill protection measures will be in place and all FAA regulations will be followed. Notification will be made to coordinate the air space with other possible helicopters or aircraft in the area (i.e., seeding operations, fire support, and Military Operation Areas).

If needed, additional temporary work areas within close proximity to or on the ROW will be identified by the Contractor and approved by the appropriate land management agency or private landowner for landing and refueling the helicopter. Each fuel truck will be equipped with automatic shutoff valves and will carry spill kits. In addition to the required preventive spill measures, a water truck may be required to spray the site to reduce dust. The Contractor will be required to clean up any materials released on the ROW. Any accidental spills will be handled according to the guidelines presented in the Hazardous Materials Management Plan.

3.5.7.3 Roadless Construction Methods

The proposed TWE Project corridor reference line crosses the edges of six IRAs in three national forests: Atchinson, Mogotsu, and Moody Wash IRAs in Dixie National Forest; 418008 and 418009 IRAs in Uinta-Wasatch-Cache National Forest; and Cedar Knoll IRA in Manti-La Sal National Forest. In total, the proposed TWE Project ROW crosses approximately 10 miles of IRAs of its total 725-mile length. In addition to the standard construction methods planned for the TWE Project, two specialized construction methods can be used where specific conditions are present that restrict the use of standard methods such as can be found in IRAs.

Within these IRAs, the TWE Project could be constructed by one of two specialized construction methods:

1. Construction zone method
2. Helicopter-only construction method

The standard construction methods described in this PDTR are the preferred methods for the TWE Project. Under specific conditions where access road construction is prohibited, the construction zone method eliminates the need for access roads and allows standard construction methods to take place with specialized vehicles. In extreme conditions where access road construction is prohibited and vegetation clearing is not needed along the entire ROW per Level 3 – Selective ROW Clearance-Based Vegetation Management described in Section 3.6.2.1, the helicopter-only construction method would be effective. These two specialized construction methods are described below.

<u>Construction Zone Method</u>

The Applicant is not proposing to build or maintain any temporary or permanent roads across IRAs. The proposed Project will entail establishing a construction zone for the sole purpose of accommodating motorized equipment needed to construct and bring in supplies necessary for the installation of the ±600 kV DC transmission line. There will be no addition of forest classified or temporary road miles for either construction or maintenance of the TWE Project. Existing forest system roads will be used to access the TWE Project transmission line construction ROW.

A 100-foot-wide construction ROW (construction zone) will be used for installing the transmission line. Helicopter construction methods may be used to the extent practical. Vegetation clearing, grading, and temporary work areas within the IRAs would occur within the construction zone. Topsoil will be salvaged and stockpiled. The extent of construction disturbances would be the same or similar, as previously described for the proposed TWE Project standard construction methods. Although construction of the entire Project is anticipated to occur over an approximately three-year period, construction within a particular IRA from initial ground disturbance to start of reclamation is expected to occur over a six to nine month timeframe.

Following the completion of construction activities, the construction zone will be reclaimed. Disturbed areas will be re-contoured, topsoil replaced, and disturbed lands revegetated with vegetation consistent with USFS requirements and the Vegetation Management Plan. Revegetation treatments would be monitored for three to five years, in accordance with USFS requirements. Once the construction zone is reclaimed, routine maintenance would be via aircraft or low-impact vehicles such as vehicles with rubber treading, low pressure tires, or specialized mechanical movement to accommodate the terrain and landscape, and all-terrain vehicles (ATVs), or by non-motorized methods (e.g., foot, horseback, or other non-motorized methods). Unless otherwise approved, the transmission line ROW would only be accessed with motorized equipment for emergency repairs, or to maintain NESC electrical line clearances. Long-term disturbances would include maintenance of a limited ROW width, in which active vegetation management would occur. Authorization for continued vegetation management and emergency repairs would be the responsibility of the USFS and conducted in accordance with the COM Plan and USFS stipulations.

The Applicant will work with the USFS to control the use of the ROW and prevent unauthorized travel along the ROW by off-road vehicles. Measures would be determined in consultation with the USFS and may include the following: a) installing gates or other man-made physical barriers; b) creating natural barriers (e.g. large boulders or debris); and c) stockpiling trees cut for ROW clearing at barrier locations.

Helicopter-Only Construction Method

The Applicant is not proposing to build or maintain any temporary or permanent roads across IRAs. This method would construct the Project in IRAs using helicopter-only construction methods supported by minimal impact overland travel. A detailed description of helicopter construction techniques are provided in Section 3.5.7.2. Helicopters would transport personnel, drilling equipment, towers and other construction materials to and from the ROW and would be used for wire stringing. Access to the ROW also could be accomplished by overland travel using low-impact vehicles as described above for the Construction Zone Method. No blade work would be performed to assist overland travel within the IRAs.

Within an IRA, the structure foundations could be constructed by several methods depending on soil conditions, terrain conditions, and final engineering design. Examples of construction options for installing tower foundations include using precast concrete support pedestals for the guyed steel lattice structures and micro-piles for the self supporting lattice tower foundations transported into the IRA by helicopter or by overland travel using low-impact vehicles. Tower structure sections would be preassembled at approved construction fly yards located outside of the IRAs and airlifted to the tower site locations by helicopter for erection.

Following the completion of construction activities, any temporary disturbance, including any associated with overland travel to access the ROW within the IRA, would be reclaimed and maintained as described above for the Construction Zone Method.

3.5.7.4 Construction in Sensitive Water Resource Areas

Waterbody and Wetland Crossings

Access roads will be designed and constructed to minimize disruption of natural drainage patterns and waterbodies including rivers, streams, ephemeral streams, ponds, lakes, reservoirs, and playas. Structure sites, new access roads, and other disturbed areas will be located away from waterbodies, wherever practicable. Each waterbody crossing will be designed in a distinct segment of the associated access roads as advanced engineering is completed. On all federally-managed lands, the Applicant will consult with the managing agency regarding relevant standards and guidelines pertaining to waterbody road-crossing methods.

Consultation will include site assessment, design, installation, maintenance, and decommissioning of the crossings. Wherever needed, culverts, low-water crossings, and other devices of adequate accepted design will be used to accommodate estimated peak flows of waterways, including crossings of all affected perennial, intermittent, and ephemeral streams. Construction disturbances of banks and beds of waterbodies will be minimized. Performance of low water stream crossings (i.e. drive thru and ford) will be monitored for the life of the access road, and maintained as necessary to preserve water quality. Figure 16 shows typical road designs for low-water crossings and culvert stream crossings.

Potential types of water crossings that would be implemented include:

- **Drive Thru (Arizona Crossing):** Crossing of a channel with minimal vegetation removal where no cut or fill is needed. This is typical for low-precipitation sagebrush country characterized by rolling topography and streams that rarely flow with water.

- **Ford:** Crossing of a channel that includes grading and stabilization. Stream banks and approaches will be graded and stabilized with rock or other erosion control devices to allow vehicle passage. With approval of the land management agency, streambeds in select areas will be reinforced with coarse rock material to support vehicle loads, prevent erosion, and minimize sedimentation of the waterways. Coarse rock will be installed in the streambed in a manner such that it will not raise the level of the streambed, thus allowing continued movement of water, fish, and debris. A typical ford crossing results in a disturbance footprint 25 feet wide (along the waterbody) and 50 feet long (along the roadway) for 1,250 square feet or 0.03 acre of disturbed area at each crossing. The 0.03 acre is based on an estimated disturbance based on the requirement to operate equipment within the riparian area to construct a 14-foot-wide travelway and install armoring to protect it from erosion.

- **Culvert:** Crossing of a waterbody that includes installation of a culvert and construction of a stable road surface for vehicle passage over the culvert. Culverts will be designed and installed under the direction of a qualified engineer who, in collaboration with a hydrologist and an aquatic biologist where required by the land management agency, will specify placement locations; culvert gradient, height, and sizing; and proper construction methods. Culvert design will consider roadbed loading and debris size and volume. The disturbance footprint for a typical culvert installation is estimated to be 50 feet wide (along the waterbody) and 150 feet long (along the road) for 7,500 square feet or 0.17 acre of disturbed area at each crossing. This disturbed area includes approaches to the crossing and side slopes. The amount of area disturbed by excavation and fill material at each crossing will typically be much less and will be determined during final design and engineering. Ground-disturbing activities will comply with agency approved BMPs. Construction will occur during periods of low water or normal flow. The operation of construction equipment in riparian areas will be minimized. All culverts will be designed and installed to meet specified riparian conditions, as identified in applicable unit management plans. Culvert slope will not exceed stream gradient.

  Culverts will typically be partially buried in the streambed to maintain streambed material in the culvert. Sandbags or other non-erosive material will be placed around culverts to prevent scour or water flow outside the culvert. Adjacent sediment control structures such as silt

> fences, check dams, rock armoring, or riprap may be necessary to prevent erosion or sedimentation. Stream banks and approaches may be stabilized with rock or other erosion control devices. Culverts will be inspected annually for proper operation and maintained to preserve water quality for the life of the Project (estimated at 50 years or longer).

Wetlands will be avoided to the extent possible and practical in siting transmission line structures, terminals, ground electrode systems, temporary work areas, and access roads. Wetlands can typically be spanned by transmission lines to avoid impacts. Temporary access roads requiring a wetland crossing can minimize impacts by implementing timber or other types of mats that can support construction equipment. The use of mats avoids having to fill the wetland causing permanent impacts. Impacts to wetlands and waters of the U.S. will require a CWA Section 404 permit from the U.S. Army Corps of Engineers (USACE), National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Permit (Section 402), and Section 401 water quality certification.

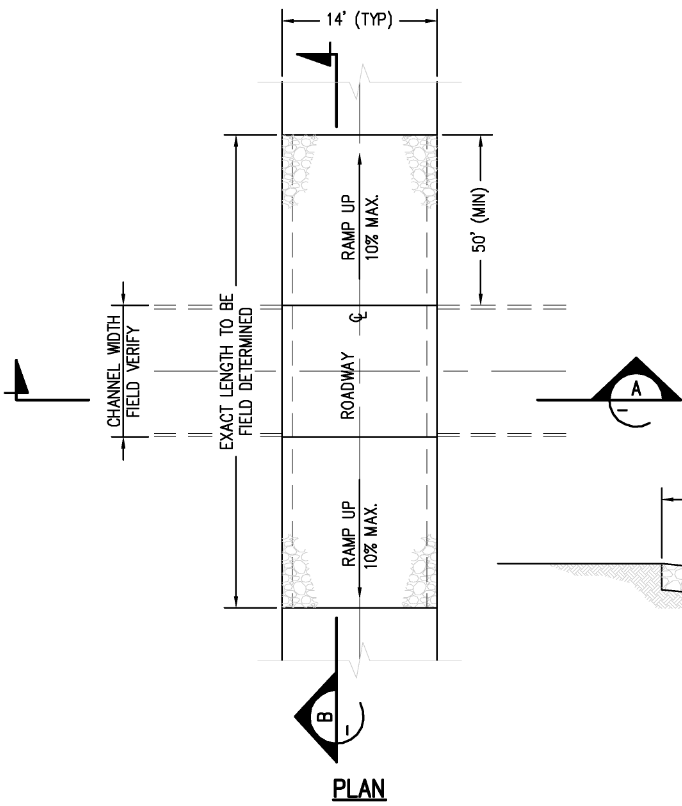
3.5.8 Water Use

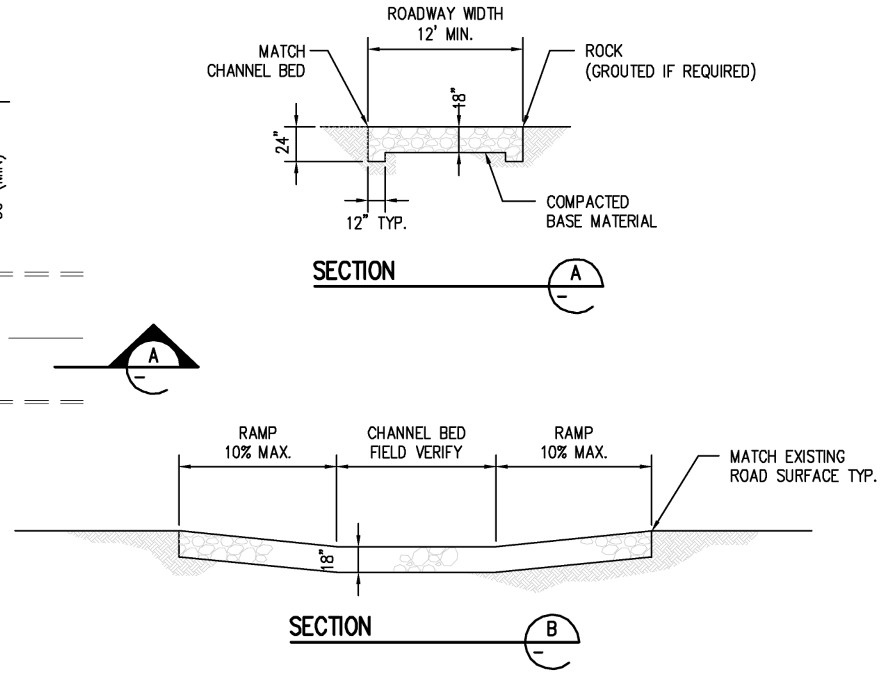
Water Uses and Purpose. Construction of the transmission lines and substation/converter stations will require water. Major water uses are for transmission line structure and substation foundations, and dust control during ROW and substation grading and site work. A minor use of water during construction would include the establishment of substation landscaping where required.

Water usage for transmission line construction is for two primary purposes: foundation construction and ROW dust control. In the construction of foundations, water is transported to the batch plant site where it will be used to produce concrete. From the batch plant, the wet concrete will be transported to the structure site in concrete trucks for use in foundation installation.

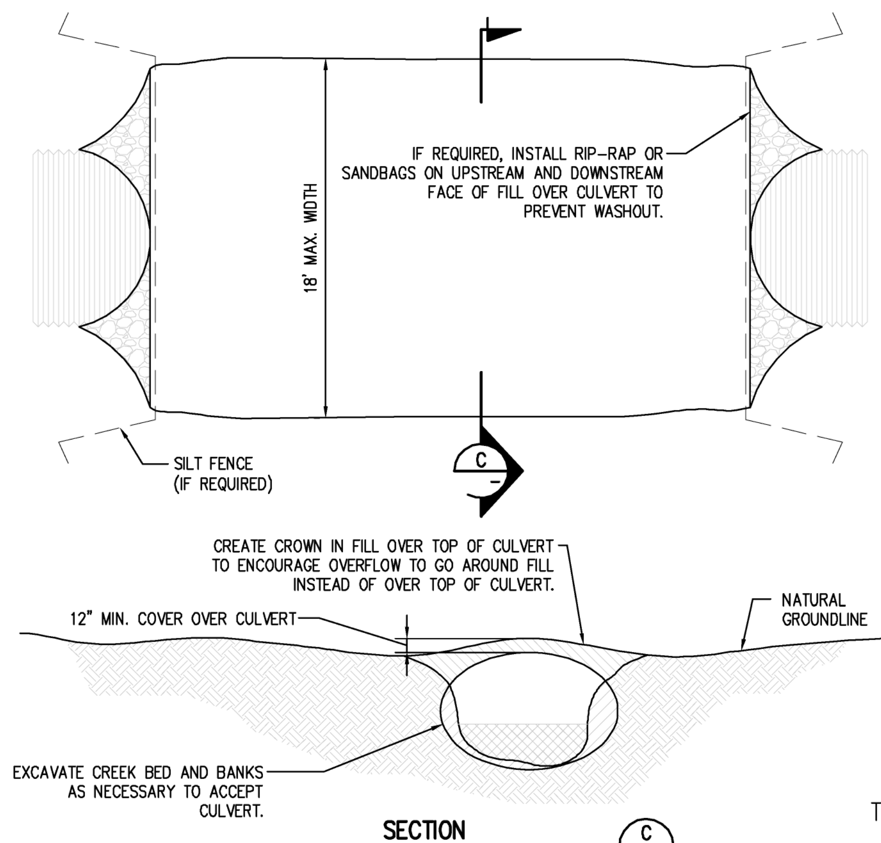
Construction of the transmission lines and related facilities will generate a temporary increase in fugitive dust. If the level of fugitive dust is too high in specific project areas, as determined in cooperation with the landowner or agency, water would be applied to disturbed areas to minimize dust.

Water usage for substation/converter station construction is primarily for dust control during site preparation work. During this period, construction equipment would be cutting, moving, and compacting the subgrade surface. As a result, water trucks patrolling the site to control dust would make as many as one pass per hour over the site. Once site preparation work is complete, concrete for the placement of foundations becomes the largest user of water and dust control becomes minimal.





TYPICAL ROADS
CROSSING (GROUTED, IF REQUIRED)



TYPICAL ROADS – CULVERT

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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 16

TYPICAL ROAD DESIGNS FOR
LOW WATER & CULVERT CROSSINGS

Once site grading is complete, the balance of the substation construction work would be performed on bare subgrade soil or subgrade with a thin layer of rock. Fire risk would be minimal due to the bare ground or rock surface and would be contained within the confines of station-fenced area.

Water Use Estimates. The estimated water required per mile of transmission line construction is approximately 3,400 gallons for foundation concrete and 240,000 gallons for dust control. Water required for construction of the Northern Terminal is estimated to be 600,000 gallons including dust control. Water required for construction of the Southern Terminal is estimated to be 400,000 gallons including dust control due to less disturbance and fewer foundations. Estimated water required for each ground electrode site is 150,000 gallons including dust control. The required water will be procured from municipal sources, from commercial sources, or under a temporary water use agreement with landowners holding existing water rights. No new water rights will be required.

3.5.9 Construction Schedule, Workforce and Equipment

The proposed construction schedule for the TWE Project will be developed for the Agency Preferred Alternative during engineering and design. The construction schedule for the TWE Project will incorporate timing restrictions for special status plant and animal species, as determined by the land management and regulatory agencies in their respective decision documents. For purposes of the DEIS analysis, conceptual schedules have been developed, which provide general estimates on the duration of activities for each of the proposed TWE Project facilities. Conceptual schedules are described in Section 3.5.9.1. Estimated workforce and equipment needs are described in Sections 3.5.9.2 and 3.5.9.3, respectively.

3.5.9.1 Construction Schedule

It is anticipated that total construction timeframe for the transmission line will be approximately three years, concurrent with terminals and ground electrode system construction.

Conceptual schedules for the proposed TWE Project are shown in Figures 17, 18, 19 and 20. Figure 17 provides a bar chart construction schedule for a typical 20-mile stretch of the ±600 kV DC transmission line. Figure 18 shows the entire conceptual schedule for constructing the 725 mile long ±600 kV DC transmission line, including access roads and communication facilities. Figure 19 is a schedule for the proposed Northern and Southern Terminals, and Figure 20 is a construction schedule for the ground electrode systems.

For planning purposes, the overall schedule for the transmission line has been separated into three construction spreads or operations by line segment. The transmission line schedules show a staggered start to allow time for setups, material and equipment logistics and coordination between spreads. The total elapsed time of the combined transmission line schedule is approximately 137 weeks. These construction schedules include consideration for the anticipated conditions; however, severe winter weather, delays in equipment manufacturing and/or delivery, seasonal restrictions required for permitting and/or unexpected mitigation could interrupt the schedule inserting delays of weeks to several months or more.

Construction spreads for the transmission line are anticipated at three different locations. The approximate geographic locations are: (1) Northern Terminal to North-East Utah (approximately 221 miles); (2) North-East Utah to West-Central Utah (approximately 235 miles); and (3) West-Central Utah to the Southern Terminal (approximately 269 miles). The line construction will progress simultaneously at these locations. The construction spreads for the transmission line have been designed such that one or more Contractors may be employed to construct the complete line.

The duration of transmission line construction activities on any given parcel of land may extend up to a year, although the total amount of time of actual construction activity would be much shorter, in the range of a few months. Over any particular section of the route, transmission line construction would be characterized by short periods (ranging from a day to one to two weeks) of relatively intense activity interspersed with periods with no activity. Figure 17 illustrates the typical durations for the construction of a 20-mile section of the transmission line.

The construction of the Northern and Southern Terminals is planned to start approximately three to six months after the start of the construction of the transmission line and run concurrently. The total elapsed time is scheduled for approximately two years. These construction schedules include consideration for the anticipated conditions; however, severe winter weather at the Northern Terminal could interrupt the schedule inserting delays of weeks to several months or more.

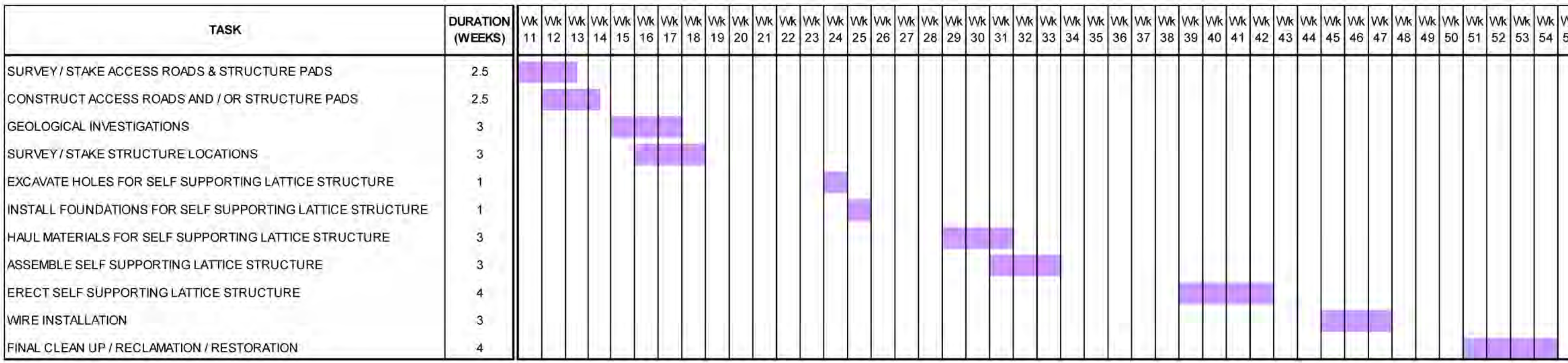

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FIGURE 17
CONSTRUCTION SCHEDULE FOR 20 MILE SECTION OF ±600kV DC TRANSMISSION LINE

SECTION 1 - APPROXIMATELY 221 MILES
NORTHERN TERMINAL - NORTHEASTERN UTAH
(NORTHERN TERMINAL - ROUTE SEGMENT U50)

TOTAL DURATION: 111 weeks

TASK	DURATION (WEEKS)
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	111
INSPECTION	109
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	109
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	49
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	49
GEOLOGICAL INVESTIGATIONS	56
SURVEY / STAKE STRUCTURE LOCATIONS	56
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	67
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	67
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	60
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	60
ERECT SELF SUPPORTING LATTICE STRUCTURE	70
WIRE INSTALLATION	61
FINAL CLEAN UP / RECLAMATION / RESTORATION	70

SECTION 2 - APPROXIMATELY 235 MILES
NORTHEASTERN UTAH - WEST CENTRAL UTAH
(ROUTE SEGMENT U55 - ROUTE SEGMENT U210)

TOTAL DURATION: 131 weeks

TASK	DURATION (WEEKS)
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	131
INSPECTION	129
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	129
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	60
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	60
GEOLOGICAL INVESTIGATIONS	69
SURVEY / STAKE STRUCTURE LOCATIONS	69
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	83
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	83
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	75
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	75
ERECT SELF SUPPORTING LATTICE STRUCTURE	87
WIRE INSTALLATION	76
FINAL CLEAN UP / RECLAMATION / RESTORATION	87

SECTION 3 - APPROXIMATELY 269 MILES
WEST CENTRAL UTAH - SOUTHERN TERMINAL
(ROUTE SEGMENT U220 - SOUTHERN TERMINAL)

TOTAL DURATION: 120 weeks

TASK	DURATION (WEEKS)
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	120
INSPECTION	118
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	118
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	56
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	56
GEOLOGICAL INVESTIGATIONS	64
SURVEY / STAKE STRUCTURE LOCATIONS	64
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	75
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	75
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	70
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	70
ERECT SELF SUPPORTING LATTICE STRUCTURE	80
WIRE INSTALLATION	70
FINAL CLEAN UP / RECLAMATION / RESTORATION	80

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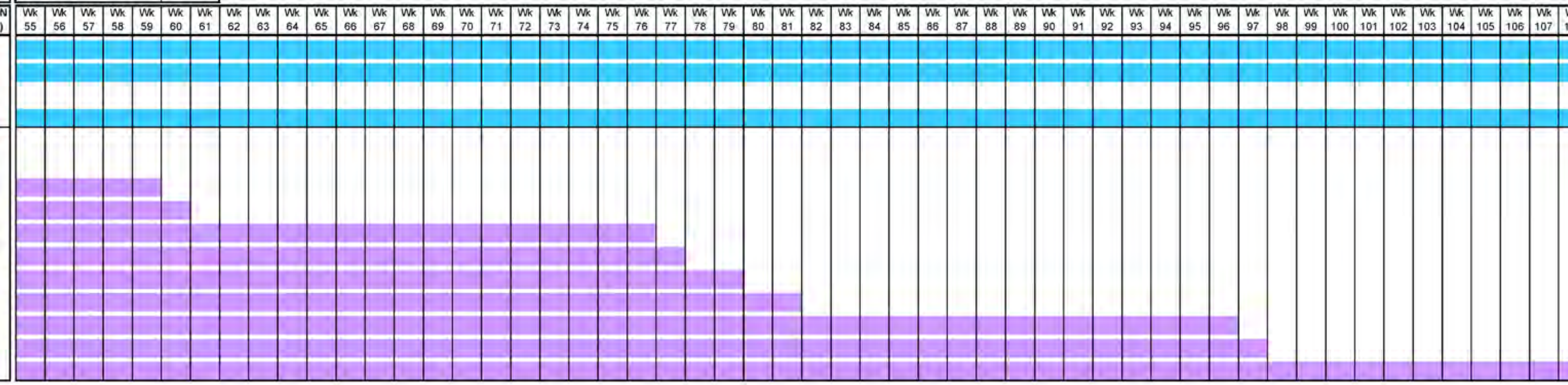
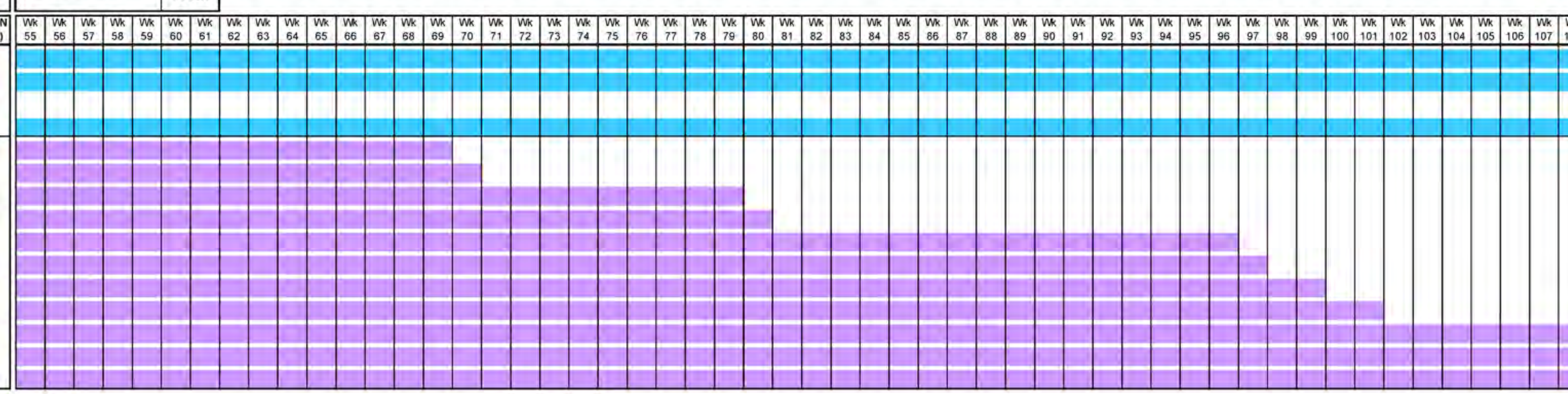
TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 18
CONSTRUCTION SCHEDULE FOR ±600kV DC TRANSMISSION LINE BY SEGMENT
SHEET 1

SECTION 1 - APPROXIMATELY 221 MILES NORTHERN TERMINAL - NORTHEASTERN UTAH (NORTHERN TERMINAL - ROUTE SEGMENT U50)	TOTAL DURATION: 111 weeks
TASK	**DURATION (WEEKS)**
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	111
INSPECTION	109
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	109
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	49
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	49
GEOLOGICAL INVESTIGATIONS	56
SURVEY / STAKE STRUCTURE LOCATIONS	56
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	67
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	67
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	60
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	60
ERECT SELF SUPPORTING LATTICE STRUCTURE	70
WIRE INSTALLATION	61
FINAL CLEAN UP / RECLAMATION / RESTORATION	70



SECTION 2 - APPROXIMATELY 235 MILES NORTHEASTERN UTAH - WEST CENTRAL UTAH (ROUTE SEGMENT U55 - ROUTE SEGMENT U210)	TOTAL DURATION: 131 weeks
TASK	**DURATION (WEEKS)**
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	131
INSPECTION	129
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	129
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	60
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	60
GEOLOGICAL INVESTIGATIONS	69
SURVEY / STAKE STRUCTURE LOCATIONS	69
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	83
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	83
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	75
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	75
ERECT SELF SUPPORTING LATTICE STRUCTURE	87
WIRE INSTALLATION	76
FINAL CLEAN UP / RECLAMATION / RESTORATION	87

SECTION 3 - APPROXIMATELY 269 MILES WEST CENTRAL UTAH - SOUTHERN TERMINAL (ROUTE SEGMENT U220 - SOUTHERN TERMINAL)	TOTAL DURATION: 120 weeks
TASK	**DURATION (WEEKS)**
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	120
INSPECTION	118
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	118
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	56
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	56
GEOLOGICAL INVESTIGATIONS	64
SURVEY / STAKE STRUCTURE LOCATIONS	64
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	75
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	75
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	70
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	70
ERECT SELF SUPPORTING LATTICE STRUCTURE	80
WIRE INSTALLATION	70
FINAL CLEAN UP / RECLAMATION / RESTORATION	80



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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 18
CONSTRUCTION SCHEDULE FOR ±600kV DC TRANSMISSION LINE BY SEGMENT
SHEET 2

SECTION 1 - APPROXIMATELY 221 MILES
NORTHERN TERMINAL - NORTHEASTERN UTAH
(NORTHERN TERMINAL - ROUTE SEGMENT U50)

TOTAL DURATION: 111 weeks

TASK	DURATION (WEEKS)
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	111
INSPECTION	109
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	109
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	49
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	49
GEOLOGICAL INVESTIGATIONS	56
SURVEY / STAKE STRUCTURE LOCATIONS	56
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	67
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	67
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	60
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	60
ERECT SELF SUPPORTING LATTICE STRUCTURE	70
WIRE INSTALLATION	61
FINAL CLEAN UP / RECLAMATION / RESTORATION	70

SECTION 2 - APPROXIMATELY 235 MILES
NORTHEASTERN UTAH - WEST CENTRAL UTAH
(ROUTE SEGMENT U55 - ROUTE SEGMENT U210)

TOTAL DURATION: 131 weeks

TASK	DURATION (WEEKS)
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	131
INSPECTION	129
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	129
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	60
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	60
GEOLOGICAL INVESTIGATIONS	69
SURVEY / STAKE STRUCTURE LOCATIONS	69
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	83
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	83
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	75
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	75
ERECT SELF SUPPORTING LATTICE STRUCTURE	87
WIRE INSTALLATION	76
FINAL CLEAN UP / RECLAMATION / RESTORATION	87

SECTION 3 - APPROXIMATELY 269 MILES
WEST CENTRAL UTAH - SOUTHERN TERMINAL
(ROUTE SEGMENT U220 - SOUTHERN TERMINAL)

TOTAL DURATION: 120 weeks

TASK	DURATION (WEEKS)
CONSTRUCTION MANAGEMENT / ENGINEERING SUPPORT / ADMINISTRATION	120
INSPECTION	118
MOBILIZE CONTRACTOR	6
RECEIVE / HANDLE MATERIALS	118
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	56
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	56
GEOLOGICAL INVESTIGATIONS	64
SURVEY / STAKE STRUCTURE LOCATIONS	64
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INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	75
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	70
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	70
ERECT SELF SUPPORTING LATTICE STRUCTURE	80
WIRE INSTALLATION	70
FINAL CLEAN UP / RECLAMATION / RESTORATION	80

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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 18
CONSTRUCTION SCHEDULE FOR ±600kV DC TRANSMISSION LINE BY SEGMENT
SHEET 3

NORTHERN TERMINAL

TOTAL DURATION	111 week

TASK	DURATION (WEEKS)
AC/DC CONVERTER STATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	32
BUILDING CONSTRUCTION	35
EQUIPMENT INSTALLATION	39
EQUIPMENT TESTING	21
OPERATIONAL	9
500 kV AC SUBSTATION	
SITE GRADING	26
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	30
BUILDING CONSTRUCTION	34
EQUIPMENT INSTALLATION	30
EQUIPMENT TESTING	17
OPERATIONAL	7
230 kV AC SUBSTATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	17
BUILDING CONSTRUCTION	17
EQUIPMENT INSTALLATION	13
EQUIPMENT TESTING	9
OPERATIONAL	4

SOUTHERN TERMINAL

TOTAL DURATION	111 week

TASK	DURATION (WEEKS)
AC/DC CONVERTER STATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	32
BUILDING CONSTRUCTION	35
EQUIPMENT INSTALLATION	39
EQUIPMENT TESTING	21
OPERATIONAL	9
500 kV AC SUBSTATION	
SITE GRADING	22
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	22
BUILDING CONSTRUCTION	26
EQUIPMENT INSTALLATION	22
EQUIPMENT TESTING	13
OPERATIONAL	6

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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 19
CONSTRUCTION SCHEDULE FOR NORTHERN & SOUTHERN TERMINALS
SHEET 1

NORTHERN TERMINAL

TOTAL DURATION: 111 week

Wk 58 – Wk 113

TASK	DURATION (WEEKS)
AC/DC CONVERTER STATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	32
BUILDING CONSTRUCTION	35
EQUIPMENT INSTALLATION	39
EQUIPMENT TESTING	21
OPERATIONAL	9
500 kV AC SUBSTATION	
SITE GRADING	26
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	30
BUILDING CONSTRUCTION	34
EQUIPMENT INSTALLATION	30
EQUIPMENT TESTING	17
OPERATIONAL	7
230 kV AC SUBSTATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	17
BUILDING CONSTRUCTION	17
EQUIPMENT INSTALLATION	13
EQUIPMENT TESTING	9
OPERATIONAL	4

SOUTHERN TERMINAL

TOTAL DURATION: 111 week

Wk 58 – Wk 113

TASK	DURATION (WEEKS)
AC/DC CONVERTER STATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	32
BUILDING CONSTRUCTION	35
EQUIPMENT INSTALLATION	39
EQUIPMENT TESTING	21
OPERATIONAL	9
500 kV AC SUBSTATION	
SITE GRADING	22
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	22
BUILDING CONSTRUCTION	26
EQUIPMENT INSTALLATION	22
EQUIPMENT TESTING	13
OPERATIONAL	6

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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 19
CONSTRUCTION SCHEDULE FOR NORTHERN & SOUTHERN TERMINALS
SHEET 2

CONSTRUCTION SCHEDULE FOR ONE GROUND ELECTRODE LOCATION

TASK	DURATION (WEEKS)	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11	Wk 12	Wk 13	Wk 14	Wk 15	Wk 16	Wk 17	Wk 18	Wk 19	Wk 20	Wk 21	Wk 22	Wk 23	Wk 24	Wk 25	Wk 26	Wk 27	Wk 28	Wk 29	Wk 30	Wk 31	Wk 32	Wk 33	Wk 34	Wk 35	Wk 36	Wk 37	Wk 38
SITE GRADING	3																																						
DRILLING 60 WELLS	8																																						
EXCAVATE CABLE TRENCHES	6																																						
BUILD CONCRETE CABLE TRENCHES	10																																						
INSTALL ELECTRODE ELEMENTS	8																																						
INSTALL LV CABLES, SWITCHES	4																																						
INSTALL TEMPERATURE & CURRENT TRANSDUCERS, WIRING	2																																						
BUILD CONTROL / COMMUNICATION BUILDING & FENCED AREA	8																																						
INSTALL SITE COMMUNICATIONS EQUIPMENT, SCADA	4																																						
ELECTRODE COMMISSIONING*	8																																						

*PERFORMED AFTER CONVERTER STATIONS ARE FUNCTIONAL

CONSTRUCTION SCHEDULE FOR LOW VOLTAGE TRANSMISSION LINE (10 MILES ASSUMED)

TASK	DURATION (WEEKS)	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11	Wk 12	Wk 13	Wk 14	Wk 15	Wk 16	Wk 17	Wk 18	Wk 19	Wk 20	Wk 21	Wk 22	Wk 23	Wk 24	Wk 25	Wk 26	Wk 27	Wk 28	Wk 29	Wk 30	Wk 31	Wk 32	Wk 33	Wk 34	Wk 35	Wk 36	Wk 37	Wk 38
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	3																																						
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	4																																						
FOUNDATION EXCAVATION	3																																						
HAUL STRUCTURES	3																																						
INSTALL STRUCTURES	4																																						
INSTALL WIRES	2																																						
FINAL CLEAN UP / RECLAMATION / RESTORATION	4																																						