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5.0 CONSTRUCTION

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

- Section 5.1 – Pre-construction activities to be completed prior to construction commencing.
- Section 5.2 – Construction activities for the + 600 kV DC transmission line and associated access roads.
- Section 5.3 – Construction activities for the northern and southern terminals.
- Section 5.4 – Construction activities for the ground electrodes.
- Section 5.5 – Construction activities for the communications system.
- Section 5.6 – Post-construction clean up and restoration.
- Section 5.7 – Special construction methods to be used in specific sensitive locations, including blasting and helicopter construction techniques; roadless construction methods in IRAs; construction techniques applicable to sensitive water resource areas; and water use during construction.
- Section 5.8 – TWE Project construction schedules, manpower, and equipment requirements.

Construction of the TWE Project will require surface access to all structures and work areas during construction and operation of the Project to allow construction vehicles and equipment to access the location of each transmission structure or Project facility. In most cases, existing public roads (identified as the backbone access network) would be used to transport construction labor, equipment and materials to the approved work areas.

Although the number of construction vehicles needed for the Project is not expected to substantially increase traffic volumes, 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. Additionally, short-term traffic diversions and brief road closures (if needed) may be required to complete wire stringing activities. All traffic impacts resulting from any construction activities including short-term traffic diversions, traffic congestion, traffic warning systems and brief road closures (if needed) will comply with the Traffic and Transportation Management Plan (Appendix U).

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.

5.1.1 Permitting

The Applicant will acquire all federal, state, and local permits, licenses and agreements. A list of potential applicable permit requirements has been provided through the NEPA process and incorporated into this POD (see Section 1). 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.

5.1.2 ROW and Property Rights Acquisition

The acquisition of ROW or properties necessary to construct, operate, and maintain the TWE Project will be completed by Western or the Applicant conditioned on Western's continued involvement in the TWE Project. New ROW 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 terminals, substations, series compensation (as may be required for Design Options 2 and 3; see Section 7.0), and communication 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.

To the extent that Western acquires land for the TWE Project, Western 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).

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. These ground-based land surveys will include staking of the boring location and layout and staking (as needed) of access roads to the boring locations.

A desktop study will initially be conducted to identify geologic hazards. Specifically, the desktop study will research available published data related to soils, expansive soils, mapped bedrock, surficial geology, corrosivity, faulting and folding, seismicity and earthquakes, surface and groundwater, flood areas and hazards, landslides, rock fall hazards, subsidence, liquefiable soils and wells. The desktop study will be used for preliminary engineering designs.

Field geological and geotechnical studies will reference the desktop study to prepare the appropriate exploration programs given the planned structure locations, foundation loading, access, and geologic setting. The proposed studies will be performed to evaluate potential geologic and geotechnical hazards and to determine specific requirements (soil/rock types, depth to rock, depth to groundwater, soil strength properties, etc.) for foundation design and construction. These studies will be used for final engineering designs necessary for construction.

Geological evaluation will occur at generally the same time as geotechnical investigations, and will be a part of the final Geotechnical Plan. The framework Geotechnical Plan is provided in Appendix J. 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 access roads in potentially hazardous areas. In the event that a structure site cannot be relocated, the Geotechnical Plan 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. Initial recommendations will be incorporated into the ROD POD and final recommendations incorporated into the NTP POD, 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 foundation design requirements, geotechnical investigations will be performed in the field to evaluate site conditions and determine the soil/rock type, strength and design properties. This study will entail a geotechnical drilling program at select structure locations along the selected Alternative. At sampling sites, borings will be performed 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 and they will be advanced with continuous flight hollow-stem auger, mud rotary, or ODEX drilling techniques. Where bedrock is encountered, standard rock coring techniques will be used. Soil borings are commonly taken at structure site locations at intervals of approximately one mile and at PIs (Points of Intersection/Inflection).

Soil borings will be performed with rubber tired, track or low impact drill rigs using approved access routes and methods in accordance with the appropriate land management agency or private landowner requirements with applicable mitigation measures applied. 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) with the disturbed area contained approximately within a 5 feet diameter circle.

Small 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 very small amount of water may exit the drill holes. Following the completion of drilling and before leaving each site, the soil boring will be backfilled with the cuttings removed from it during drilling per the appropriate federal agency requirements. Excess spoils not backfilled into the bore hole will be removed from the site and disposed of in accordance with the appropriate land management agency or private landowner requirements with applicable mitigation measures applied. No open holes will be left unattended, and all holes will be fully backfilled before moving to the next boring.

Ground disturbance from geotechnical investigations would occur within the structure work areas and would not cause additional disturbance. Access roads used for geotechnical investigations would be the same as those used to access structures for construction. Although none is anticipated, any additional ground disturbance from geotechnical investigations on federal lands prior to the issuance of the TWE Project ROW grants may require additional authorizations. The Applicant will apply for and obtain all necessary federal, state, and local authorizations.

5.1.4 Pre-Construction Surveys

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. Access for engineering surveys will be with 4-wheel drive and all terrain vehicle (ATV) type vehicles using existing roads. All off-road access will be by low-impact rubber-tired ATV or on foot depending upon terrain and vegetation and in accordance with the appropriate land management agency or private landowner requirements with applicable mitigation measures applied.

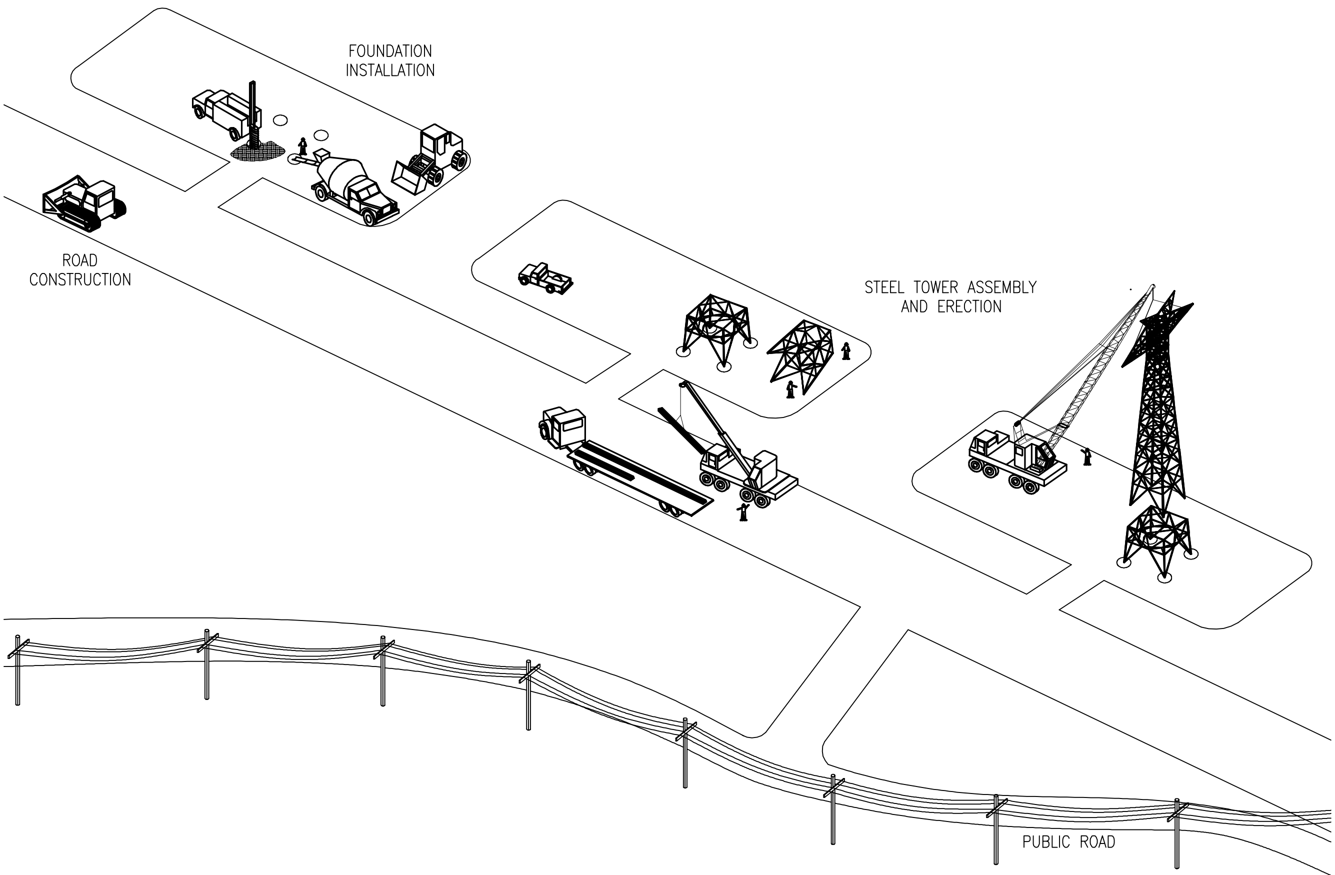
Pre-construction environmental surveys will be conducted, as required by permitting agencies, for the identification, flagging, and avoidance of sensitive resources. The timing of pre-construction surveys will vary depending upon the resource being surveyed. Requirements for environmental pre-construction surveys will be documented in the FEIS and the regulatory agencies' decision documents and stipulations. Documents currently under development which may identify additional biological and cultural pre-construction surveys include the Biological Assessment/Biological Opinion (BA/BO) and the PA, respectively. Pre-construction environmental surveys may include, but are not limited to: (1) migratory bird and raptor nest surveys; (2) special status wildlife and botanical species, including those protected by USFWS, BLM, USFS, and respective state resource management agencies; (3) noxious weed identification; (4) cultural resource surveys; (5) paleontological resource survey, and (6) wetlands delineations in accordance with requirements of the Clean Water Act (CWA) Section 404 permit.

The following appendices in this POD provide details of required pre-construction surveys:

- Avian Protection Plan (Appendix B);
- Cultural Resources Protection and Management Measures Plan (Appendix D);
- Noxious Weed Management Plan (Appendix N);
- Paleontological Resources Management and Mitigation Plan (Appendix P);
- Water Resources Protection Plan (Appendix W); and
- Wildlife and Plant Conservation Measures Plan (Appendix X).

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; installation of foundations; assembly and erection of structures; installing ground rods/counterpoise; installing shield wires and conductors; and site cleanup and reclamation. Typical transmission line construction activities and sequencing are depicted in Figures 13 and 14. Various construction activities will occur during the construction process, with several construction crews operating simultaneously at different locations. Section 5.8.3 summarizes the types and quantities of equipment to be used for the transmission line construction.



TYPICAL TRANSMISSION LINE CONSTRUCTION ACTIVITIES

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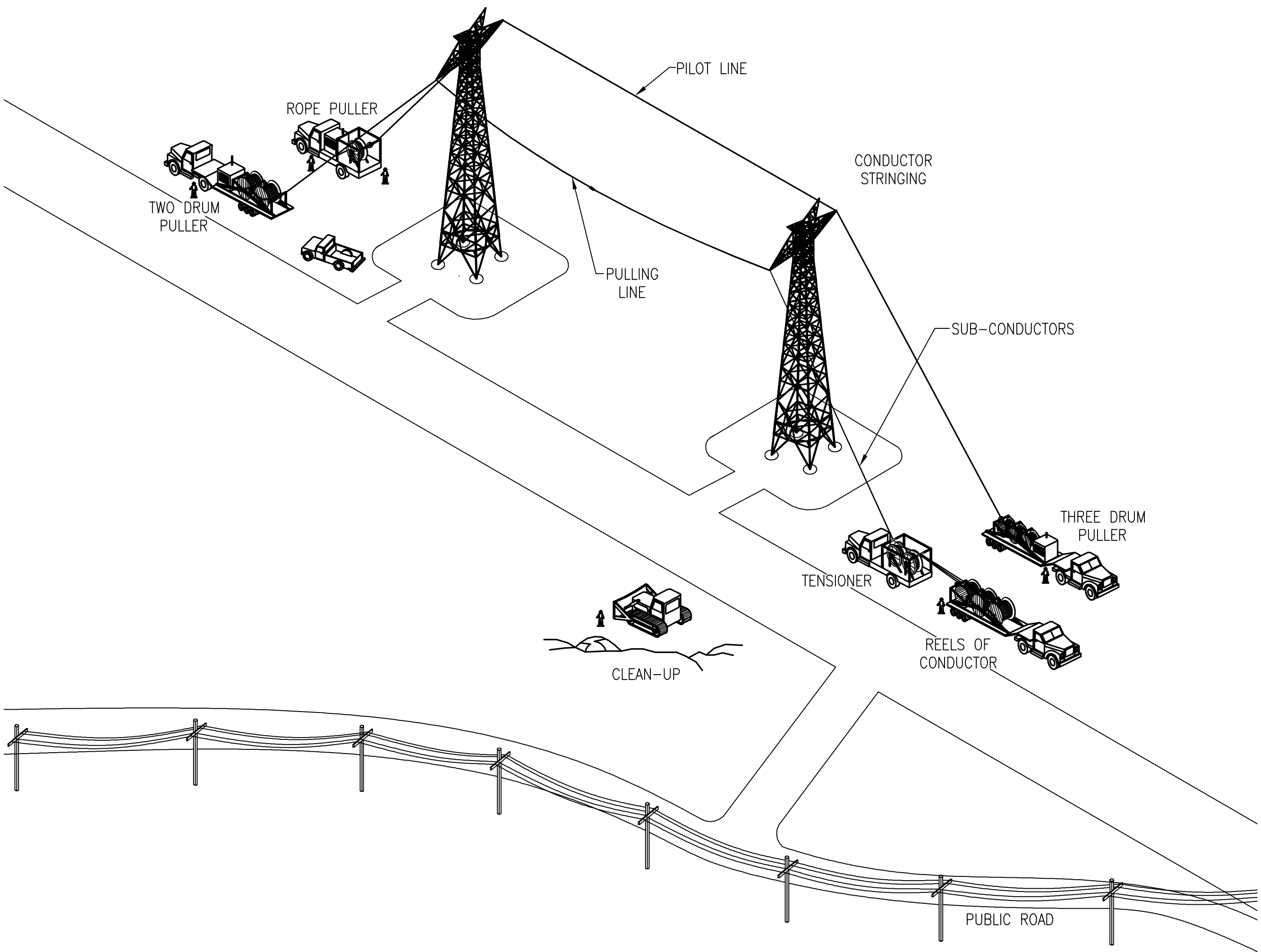
FIGURE 13

STRUCTURE FOUNDATION INSTALLATION,
TOWER ASSEMBLY, &
ERECTION ACTIVITIES



BASIC WIRE HANDLING EQUIPMENT
SINGLE CIRCUIT TOWER

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TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 14
CONDUCTOR STRINGING ACTIVITIES

5.2.1 Access Road Construction

Access roads are an essential part of the construction and operation of the TWE Project. As such, 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 and Project facility. Access roads constructed as part of the Project but not required for operations will be restored to their original condition or left as-is per the appropriate land management agency or private landowner requirements. Access in Inventoried Roadless Areas (IRAs) is discussed in Section 5.7.3 Roadless Construction. The TWE Project has been designed to utilize existing access roads wherever practicable in order to minimize environmental impacts associated with new road construction.

Table 7 summarizes typical road requirements for construction and routine and non-routine operations.

TABLE 7 TYPICAL ROAD REQUIREMENTS FOR TRANSMISSION LINE SYSTEM

ROAD TYPE	ACCESS ROADS FOR CONSTRUCTION	ACCESS ROADS FOR ROUTINE OPERATIONS	ACCESS ROADS FOR NON-ROUTINE OPERATIONS USE
Existing Improved Roads	No change	No change	No change
Existing Roads Needing Improvement	Unsurfaced - use as-is with improvements as needed throughout construction	For routine activities, an 8-foot portion of the road will be used and vehicles will drive over the vegetation ("two-track").	For non-routine maintenance requiring access by larger vehicles, the full width of the access road may be used. Roads will be repaired, as necessary, but will not be routinely graded. In order to preserve the ability to enter rapidly, the road structure (cuts and fills) will be left in place.
New roads	Unsurfaced – "drive and crush", "clear and cut" or bladed roads as required by terrain, use, local conditions, regulatory requirements, etc.	For routine activities, an 8-foot portion of the road will be used and vehicles will drive over the vegetation ("two-track").	
Temporary Roads (roads constructed to access temporary work areas)	Unsurfaced – similar treatment to new roads	None—contours will be restored, and the road will be ripped and seeded.	None

Existing roads will be used to access work areas whenever practicable. Two types of existing roads are "Existing Improved Roads" and "Existing Roads Needing Improvement". "Existing Improved Roads" are roads that appear to either be hard-surfaced roads or have well maintained surfaces. No improvement or maintenance of "Existing Improved Roads" is anticipated as a result of TWE Project construction. "Existing Roads Needing Improvement" will have varied conditions across the Project and include trails, two-track roads, and non-maintained dirt roads. It is anticipated that the Contractor may need to perform some level of improvement to provide the safe travel way required for construction. Based on the Contractor's construction plan and the construction techniques employed, it is anticipated that sections of the access roads classified as "Existing Roads Needing Improvement" will receive one of the following treatments.

- The existing road will be sufficient and provide a safe travel way throughout the duration of Project construction.

- The existing road will be sufficient and provide a safe travel way during a portion of the line construction period. Weather events, progressive damage due to heavy use and larger heavier equipment needed are examples of reasons that an existing road would need some level of construction at one or more intermediate points during line construction.

- The existing road at project initiation needs more extensive construction, including blading, prior to the start of line construction.

- Portions of these roads will involve “clear and cut”, or “drive and crush”.

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. A new access road refers to implementing all activities required to establish a travel-way that allows vehicular access from an existing road to the required work location and does not imply construction of a new road with a ditch and raised shoulder. Where terrain and soil conditions are suitable, non-graded overland access (“drive and 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., access to structure work areas or wire-pulling and tensioning sites).

Where new roads are required or where improvements to existing roads are required, access roads will be designed in accordance with standards and guidelines for Non-constructed Roads and Routes as described in “The Gold Book – Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development” (AASHTO 2006). Portions of the access road network requiring design and construction to a more stringent standard will be identified in the Access Road Siting and Management Plan submitted with the NTP POD.

An Access Road Siting and Management Plan will be developed for the selected Alternative during final engineering and design, which will define site-specific access to each structure and work area. A framework Access Road Siting and Management Plan is provided in Appendix A.

Prior to finalizing access road locations during final engineering and design, a methodology was developed to estimate the miles of access roads and to ultimately approximate the area of potential ground disturbance associated with access roads to be used in the EIS analysis. This methodology is described in detail in the Revised Access Road Methodology for the FEIS Memorandum (February 2014) provided in Appendix Z. Table 8 summarizes the access road categories used to estimate access road requirements by greenfield vs. co-located route segments for different terrain types and for roads inside and outside of the proposed right-of-way. Figure 15 illustrates typical access road cross-sections in the various terrain conditions.

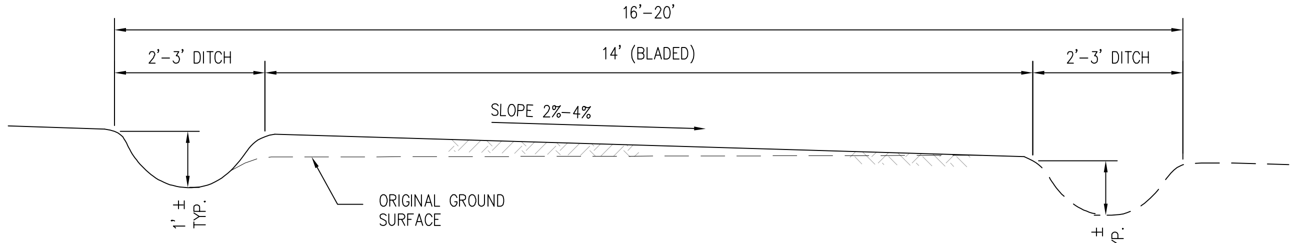
TABLE 8 ACCESS ROAD CATEGORIES AND DISTURBANCE ASSUMPTIONS FOR FEIS ANALYSIS

ACCESS ROAD CATEGORY	TERRAIN TYPES	ASSUMPTIONS FOR ESTIMATING DISTURBANCE
	Backbone Access Road Network Outside FEIS 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 FEIS Corridor Requiring	All terrain types	GIS data provided. Access roads widths estimated 16 to 24 feet wide depending on terrain.

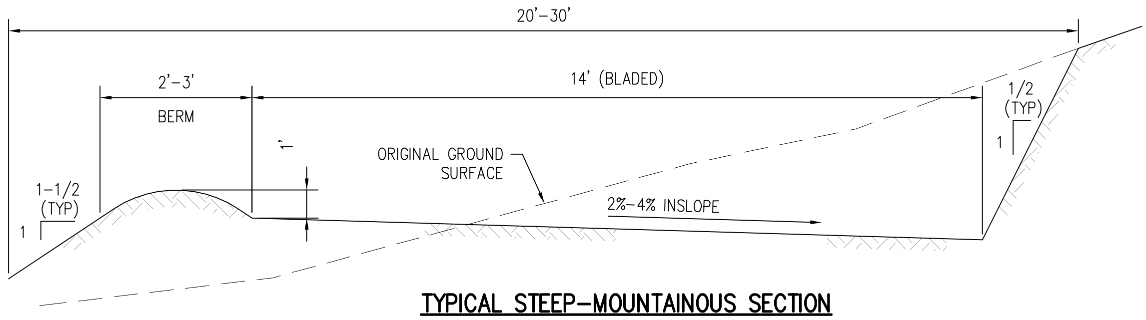
ACCESS ROAD CATEGORY	TERRAIN TYPES	ASSUMPTIONS FOR ESTIMATING DISTURBANCE
Improvements		
	Access Roads Inside FEIS Corridors for Greenfield Alternatives	
Category 1 – Existing Improved Roads	All terrain types	GIS data provided. No ground disturbances would occur.
Category 2 (B) – Existing Roads Inside FEIS Corridor Requiring Improvements	All terrain types	For the FEIS analysis, a percentage of the length of Category 2B roads is considered 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 – 1.2 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 – 1.3 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 – 2.7 miles Access Road Width – 24 feet
	Access Roads Inside FEIS Corridors for Co-Located Alternatives	
Category 1 – Existing Improved Roads	All terrain types	GIS data provided. No ground disturbances would occur.
Category 2 (B) – Existing Roads Inside FEIS Corridor Requiring Improvements	All terrain types	For the FEIS analysis, a percentage of the length of Category 2B roads is considered 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 – 0.8 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 – 1.1 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 – 1.6 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 – 2.4 miles Access Road Width – 24 feet

Construction of new access roads will begin with vegetation removal to the extent required for new road development. Vegetation management is described in Appendix R, ROW Preparation and Vegetation Management Plan. 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. Based on terrain and grade of the road, new bladed access roads will be constructed with an inslope or outslope design with water dips, water bars, water breaks and wings in the berm as necessary to manage water flow on the road and mitigate erosion. Figure 16 illustrates typical water bar cross-sections to be used to manage water flow on access roads in areas of steep terrain. 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 cut and fill as needed to achieve a safe, workable surface.

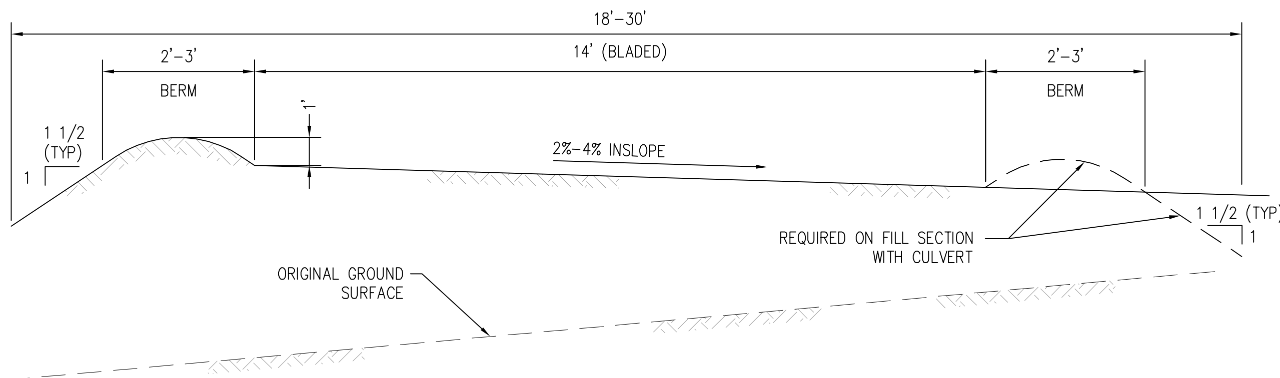
Access road construction may employ heavy equipment including bulldozers, front-end loaders, dump trucks, backhoes, excavators - both tracked and rubber-tired, and graders. Other specialized equipment including boom trucks to install culverts in some areas will be used where needed.



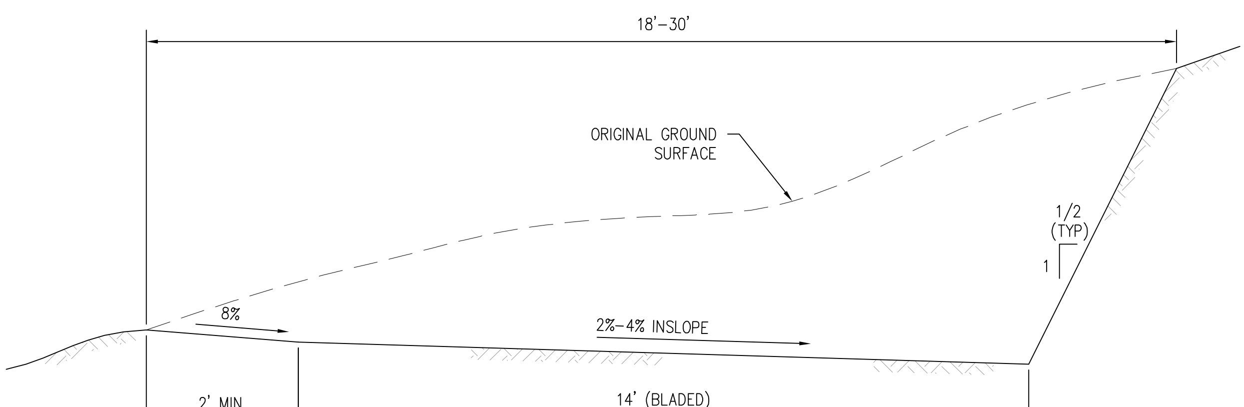
TYPICAL FLAT-ROLLING SECTION



TYPICAL STEEP-MOUNTAINOUS SECTION



TYPICAL FULL FILL SECTION



TYPICAL FULL CUT SECTION

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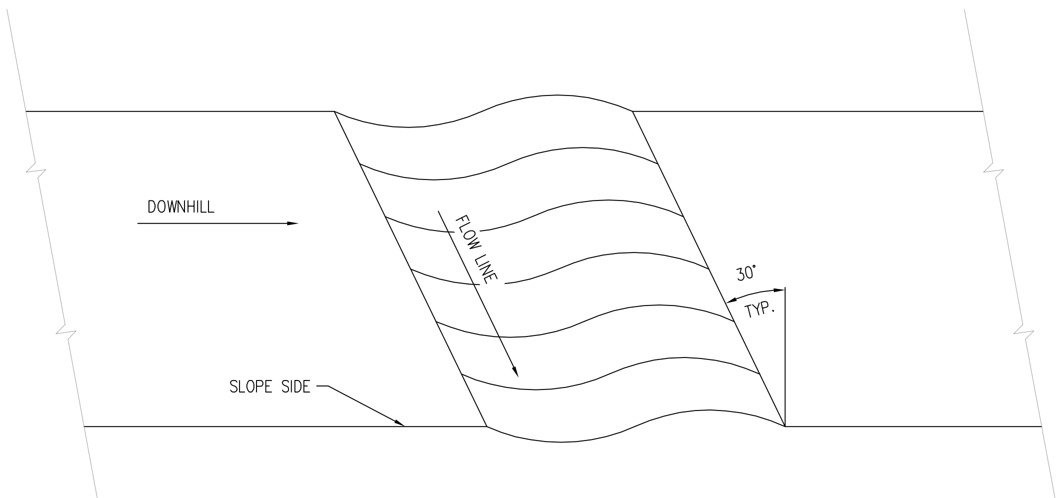
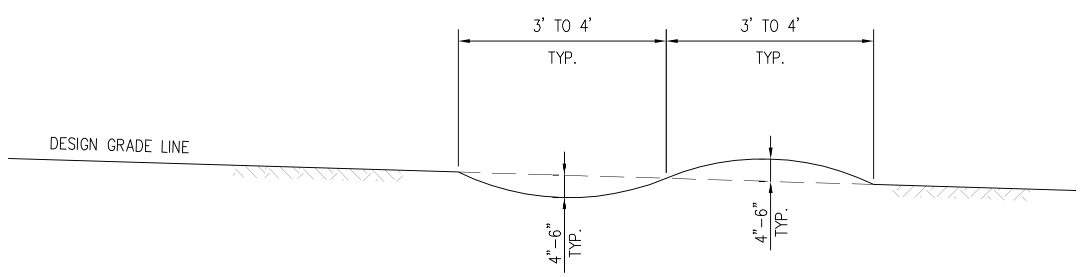
FIGURE 15
TYPICAL ACCESS ROAD CROSS-SECTIONS BY TERRAIN TYPE

WATER BARS





TYPICAL PROFILE

DISTANCE BETWEEN WATER BARS

ROAD GRADE PERCENT	SPACING FEET
2	250
5	135
10	80
15	60
20	45

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FIGURE 16
TYPICAL ROADS – WATER BARS

5.2.2 Clearing of Transmission ROW and Temporary Work Areas

Vegetation within the ROW will be cleared in accordance with the ROW Preparation and Vegetation Management Plan in Appendix R. Figure 17 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 9 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 9 SUMMARY OF TEMPORARY LAND DISTURBANCE FOR WORK AREAS

TEMPORARY WORK AREA	DIMENSIONS/ SIZE	LOCATION AND NUMBER OF FREQUENCY NEEDED
TWE Project 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	Two sites at every dead-end structure
	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
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
Interconnection Line Wire Pulling, Tensioning, Splicing Sites	ROW width x 500 feet	Mid-span conductor and shield wire sites – every 9,000 feet
	(230 kV ROW width – 100 feet)*	Fiber optic cable set-up sites – every 18,000 feet
	(500 kV ROW width – 250 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	Mid-span conductor sites – every 9,000 feet
	75 feet x 150 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.

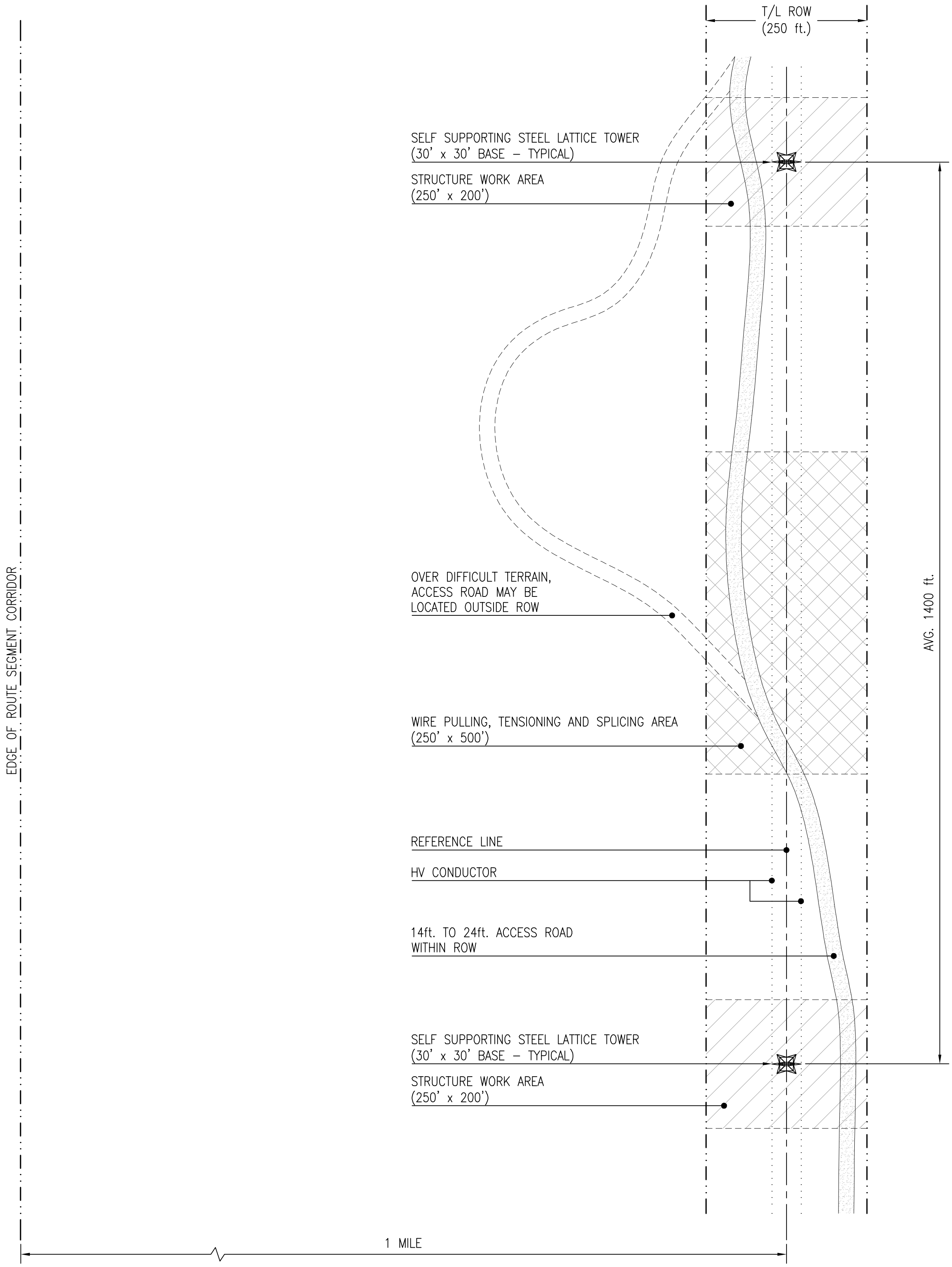

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FIGURE 17

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 as 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 8. After line construction, all areas disturbed for wire pulling, tensioning and splicing sites will be restored as described in Appendix Q, ROW Preparation and Vegetation Management 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 9. 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.

Depending upon location, use, type of material or equipment stored, adjacent land use or agency or landowner requirements, the Contractor may be required to provide necessary security arrangements at staging areas such as fencing and/or security guards. 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.

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 adjacent to or near hard surface roadways. Initial site selection will be identified in the ROD POD with final sites identified in the NTP POD. 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.

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 where helicopters are parked or refueled may be fenced with security guards stationed as needed.

5.2.3 Excavation and Installation of Foundations and Anchors

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. Although not anticipated, site-specific foundation design other than the concrete pedestals could be warranted depending on subsurface conditions. 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.

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 (Appendix C) is being prepared as part of the POD. It details 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 5.7.1.

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 are anticipated. These excess subsoil spoils will be disposed of in locations and methods as previously agreed upon by the Applicant and the appropriate land management agency or private landowner.

Methods and locations of disposal of material excavated from any type of foundation will consider hauling offsite to an approved disposal area, spreading within the general disturbance area to maintain grades and runoff, and to facilitate restoration (in these instances, topsoil will be salvaged and set aside to be placed over the subsoil material during restoration) and using spoil material as backfill for fill areas or to maintain graded access roads. Each of these disposal options will be mitigated on a case-by-case basis as 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 (see Appendix C Blasting Plan). In extremely sandy areas, water or an appropriate land management agencies' approved gelling agent may 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 available and economically feasible. Concrete trucks will be washed in designated areas within the ROW more than 100 feet from streams and wetlands. The hardened waste concrete will be removed from the site and properly recycled or disposed of.

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 anchors 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.

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 will then tighten all the bolts in the required joints. Refer to Figure 13 for a general illustration of this procedure. The use of helicopters for structure erection is described in Section 5.7.2 Helicopter Construction.

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 typically 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., USDOT, county road and bridge department). 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 the Applicant 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.

All traffic impacts resulting from wire stringing including short-term traffic diversions, traffic congestion and brief road closures (if needed) will comply with the Traffic and Transportation Management Plan (Appendix U). 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 Department of Transportation (DOT), will be employed. These activities would be coordinated with the appropriate State DOTs. Traffic disruptions will be kept to a minimum and the Applicant 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 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 3 a.m. to 5 a.m. 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.).

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, and 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 9. 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.

Caution 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.

5.3 Terminal and Substation Construction

Terminal construction activities will occur at the Northern and Southern Terminals. Section 5.8.3 summarizes the types of construction equipment to be used at each terminal, substation or series compensation station.[1]

[1] Terminal construction for the proposed Project includes the adjacent substations. Separate substations and/or series compensation stations are required for Design Options 2 and 3. Descriptions of the construction for the

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 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 contain 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 Borings

Typically, soil borings will be made on 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

substations and series compensation station for Design Options 2 and 3 are included within this section for convenience and completeness.

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. Discharge of stormwater during construction will require State specific Stormwater Pollution Prevention Plans. A framework Stormwater Pollution Prevention Plan is provided in Appendix T. 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 pre-construction 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 liquid. Containment structures are required to prevent equipment insulating liquids 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 containment is a pit, of a calculated capacity, under the equipment that has an impervious liner. The pit is filled with rock to grade level. In case of a leak or rupture, the liquid captured in the containment pit is pumped into tanks or barrels and transported to a disposal facility. If required, more elaborate containment systems can be installed. This may take the form of an on-site or off-site storage tank and/or insulating liquid-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 is 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.

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 ground electrode site using existing roads and the ground electrode 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 trenches 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 gas fuel tank will be installed adjacent to the control building inside the fenced area.

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 liquid propane 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).

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 Appendix Q Reclamation Plan and in accordance with appropriate land management agency or private landowner requirements; and
- Contacting property owners and processing claims for settlement.

5.7 Special Construction Practices

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 selected 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 (Appendix C), and will detail the general concepts proposed to achieve the desired excavations. In addition, the Blasting 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.

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” 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 (Appendix L).

5.7.3 Roadless Construction Methods

The standard construction methods described in this POD are the preferred methods for the TWE Project. Under specific conditions where access road construction is restricted or prohibited such as in IRAs, roadless construction methods will be used to eliminate the need for access roads and allow all construction activities to take place with specialized techniques, vehicles, and equipment. The roadless construction methods described in this section will be used to construct the Project in IRAs and other restricted areas.

The Applicant is not proposing to build or maintain any new temporary or permanent roads across IRAs. There will be no addition of Forest classified or temporary road miles for either construction or maintenance of the TWE Project. Where existing National Forest System roads are available and open to motor vehicle use, they will be used to access structure work areas in the TWE Project transmission line ROW. These system roads in or outside IRAs may need to be improved or widened depending on the condition of the road. However, existing roads will not be widened or otherwise upgraded for construction, as determined by the land management agency, where soils and vegetation are particularly sensitive to disturbance, except in areas where repairs are necessary to make existing roads passable and safe. Roadless construction methods include the use of helicopter construction techniques supported by minimal impact overland travel. A detailed description of helicopter construction techniques is provided in Section 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 for transport of personnel, equipment and material also could be accomplished by overland travel using low-impact vehicles. These low-impact vehicles would only be used in suitable terrain to the extent that no visible road or pathway is created. No blade work would be performed to assist overland travel within the IRAs.

Within a restricted area, 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 restricted area 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 restricted areas and airlifted to the tower site locations by helicopter for erection.

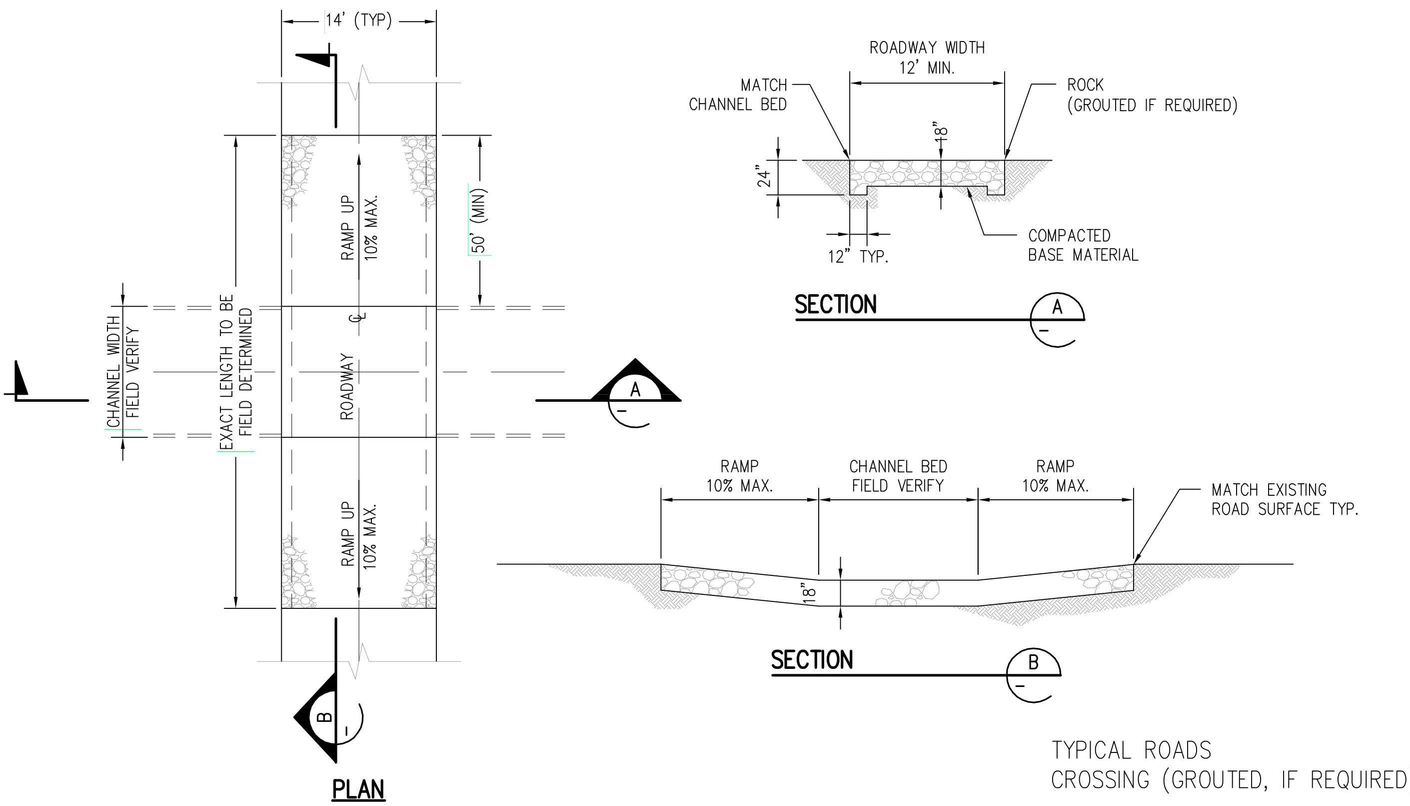
Following the completion of construction activities, any temporary disturbance, including any associated with overland travel to access the ROW would be reclaimed. The use of low-impact vehicles and equipment for overland access and ground-based site work will result in minimal disturbance in the temporary work areas. Any disturbance that does occur will be re-contoured, topsoil replaced, and revegetated with vegetation consistent with USFS requirements and the Reclamation Plan (Appendix Q). Revegetation treatments would be monitored in accordance with USFS requirements and the Reclamation Plan. Once the roadless construction area 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 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 POD 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.

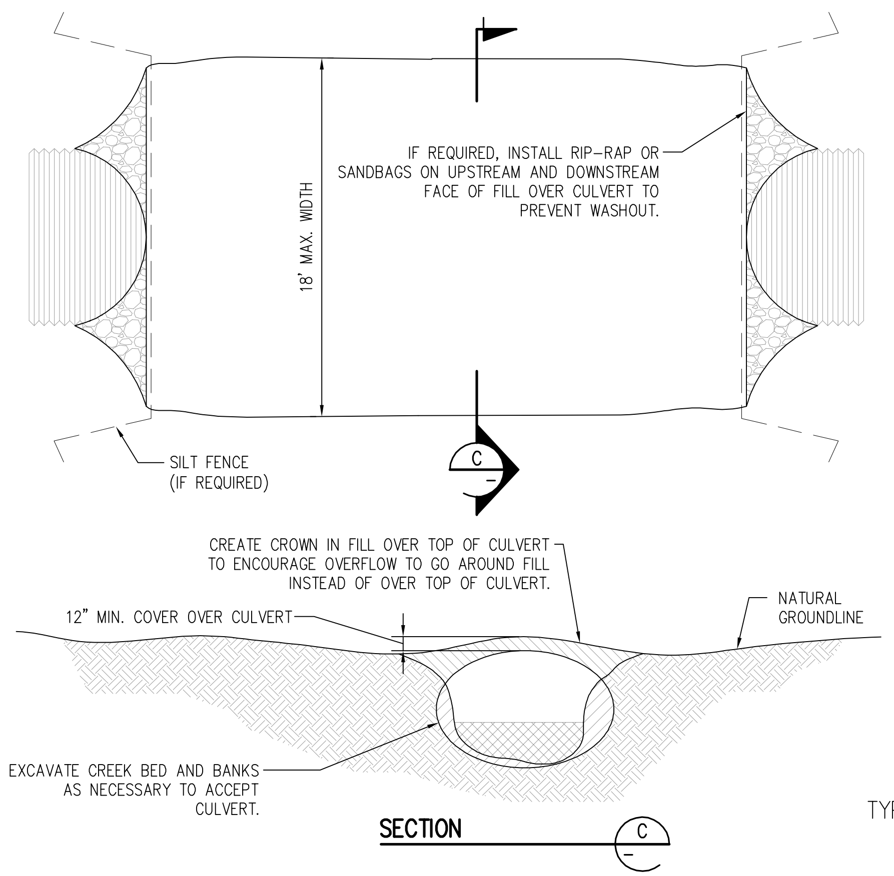
5.7.4 Water Crossings

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 18 shows typical road designs for low-water crossings and culvert stream crossings.



TYPICAL ROADS
CROSSING (GROUTED, IF REQUIRED)



TYPICAL ROADS – CULVERT

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FIGURE 18

TYPICAL ROAD DESIGNS FOR
LOW WATER & CULVERT 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 travel way 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 maximum extent practicable in siting transmission line structures, terminals, ground electrode facilities, temporary work areas, and access roads. Wetlands can typically be spanned by transmission lines to avoid impacts. Timber or other types of matting can be used to support construction equipment in wetlands to avoid the need to fill a wetland either temporarily or permanently for access during construction. Impacts to wetlands and waters of the U.S. will require a CWA Section 404 permit from USACE, NPDES Construction Stormwater Permit (Section 402), and Section 401 water quality certification.

5.7.5 Water Use

Construction of the transmission line and substation/converter stations will require water. Major water uses are required 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 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.

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.

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.

5.8 Construction Schedule, Workforce, and Equipment

The proposed construction schedule for the TWE Project will be developed for the selected Alternative during final engineering and design and will be presented in the NTP POD. 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 FEIS analysis, conceptual schedules have been developed, which provide general estimates on the duration of activities for each of the proposed TWE Project facilities. Conceptual construction schedules are described in Section 5.8.1. Estimated workforce and equipment needs are described in Sections 5.8.2 and 5.8.3, respectively.

5.8.1 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 19, 20, 21 and 22. Figure 19 provides a bar chart construction schedule for a typical 20-mile stretch of the ±600 kV DC transmission line. Figure 20 shows the entire conceptual schedule for constructing the 750 mile long ±600 kV DC transmission line, including access roads and communication facilities. Figure 21 is a schedule for the proposed Northern and Southern Terminals, and Figure 22 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; (2) North-East Utah to West-Central Utah; and (3) West-Central Utah to the Southern Terminal. 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 19 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. The ground electrode facilities will take approximately one year to construct and is planned to start 18 months after the start of construction of the transmission line.

TASK	DURATION (WEEKS)	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	Wk 39	Wk 40	Wk 41	Wk 42	Wk 43	Wk 44	Wk 45	Wk 46	Wk 47	Wk 48	Wk 49	Wk 50	Wk 51	Wk 52	Wk 53	Wk 54	Wk 55
SURVEY / STAKE ACCESS ROADS & STRUCTURE PADS	2.5	■	■	■																																										
CONSTRUCT ACCESS ROADS AND / OR STRUCTURE PADS	2.5		■	■	■																																									
GEOLOGICAL INVESTIGATIONS	3					■	■	■																																						
SURVEY / STAKE STRUCTURE LOCATIONS	3						■	■	■																																					
EXCAVATE HOLES FOR SELF SUPPORTING LATTICE STRUCTURE	1														■																															
INSTALL FOUNDATIONS FOR SELF SUPPORTING LATTICE STRUCTURE	1															■																														
HAUL MATERIALS FOR SELF SUPPORTING LATTICE STRUCTURE	3																			■	■	■																								
ASSEMBLE SELF SUPPORTING LATTICE STRUCTURE	3																					■	■	■																						
ERECT SELF SUPPORTING LATTICE STRUCTURE	4																													■	■	■	■													
WIRE INSTALLATION	3																																			■	■	■								
FINAL CLEAN UP / RECLAMATION / RESTORATION	4																																									■	■	■	■	

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FIGURE 19
CONSTRUCTION SCHEDULE FOR 20 MILE SECTION OF ±600kV DC TRANSMISSION LINE

SECTION 1 - NORTHERN TERMINAL - NORTHEASTERN UTAH

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 - NORTHEASTERN UTAH - WEST CENTRAL UTAH

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 - WEST CENTRAL UTAH - 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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FIGURE 20

CONSTRUCTION SCHEDULE FOR ±600kV DC TRANSMISSION LINE BY SEGMENT
SHEET 1

SECTION 1 - NORTHERN TERMINAL - NORTHEASTERN UTAH

TOTAL DURATION: 111 weeks

Wk 55 – Wk 108

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 - NORTHEASTERN UTAH - WEST CENTRAL UTAH

TOTAL DURATION: 131 weeks

Wk 55 – Wk 108

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 - WEST CENTRAL UTAH - SOUTHERN TERMINAL

TOTAL DURATION: 120 weeks

Wk 55 – Wk 108

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 20
CONSTRUCTION SCHEDULE FOR ±600kV DC TRANSMISSION LINE BY SEGMENT
SHEET 2

SECTION 1 - NORTHERN TERMINAL - NORTHEASTERN UTAH

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 - NORTHEASTERN UTAH - WEST CENTRAL UTAH

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 - WEST CENTRAL UTAH - SOUTHERN TERMINAL

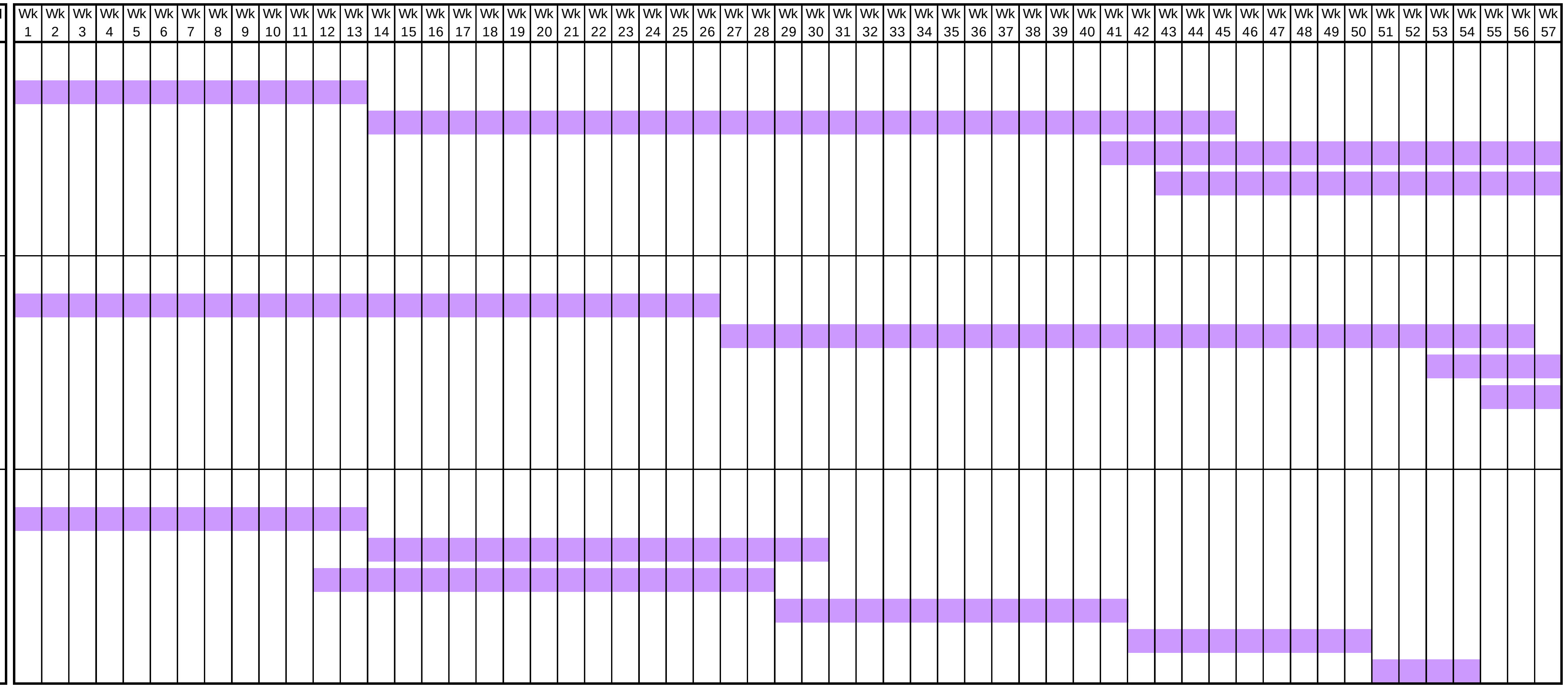
TOTAL DURATION: 120 weeks

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

NORTHERN TERMINAL

TOTAL DURATION: 111 week

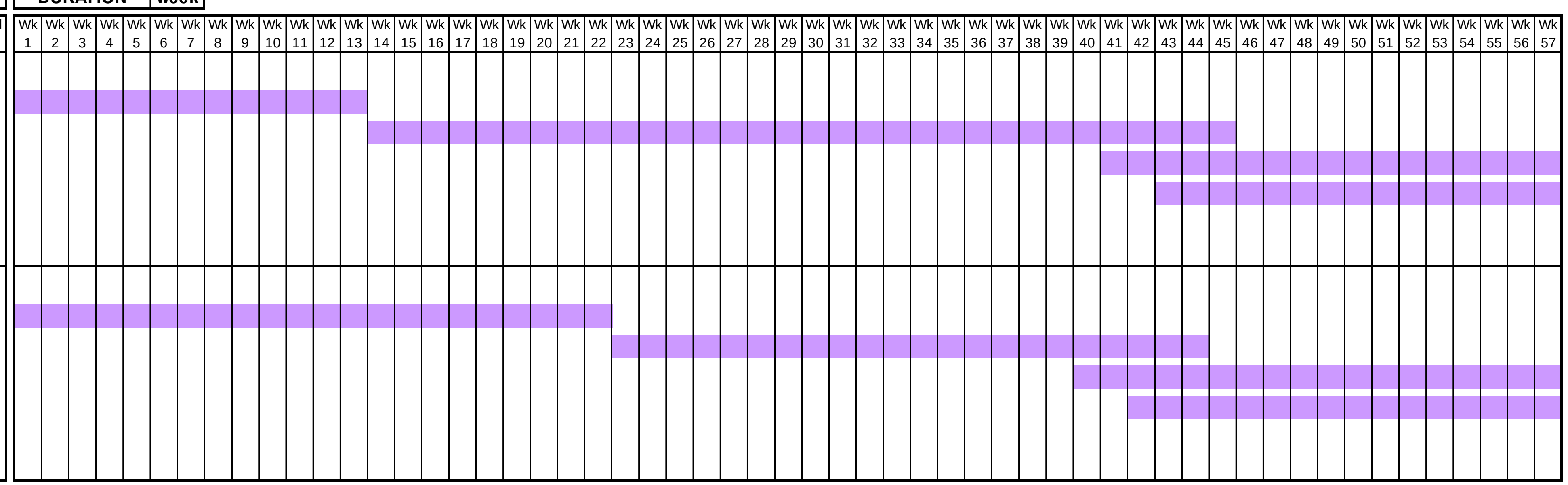
TASK	DURATION (WEEKS)
AC/DC CONVERTER STATION	
SITE GRADING	13
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	32
BUILDING CONSTRUCTION	35
EQUIPMENT INSTALLATION	39
EQUIPMENT TESTING	21
OPERATIONAL	9
500 kV AC SUBSTATION	
SITE GRADING	26
BELOW-GRADE WORK (FOUNDATIONS, CONDUIT, GROUNDING)	30
BUILDING 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 21
CONSTRUCTION SCHEDULE FOR NORTHERN & SOUTHERN TERMINALS
SHEET 1

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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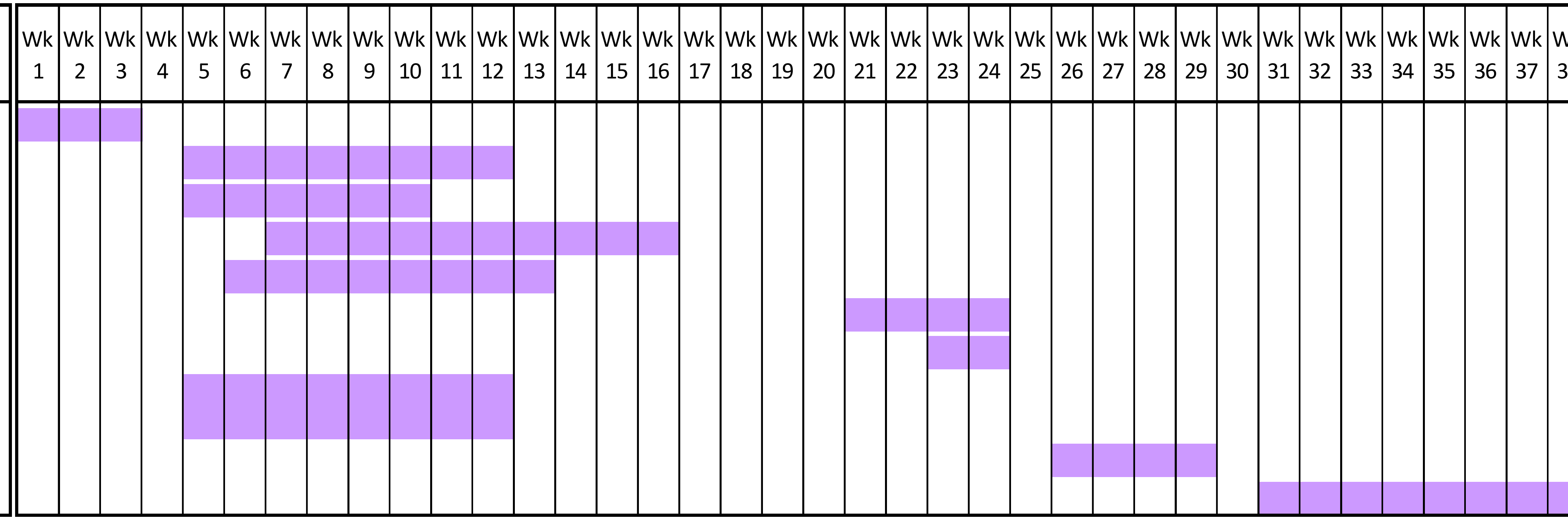
TRANSWEST EXPRESS TRANSMISSION PROJECT
FIGURE 21
CONSTRUCTION SCHEDULE FOR NORTHERN & SOUTHERN TERMINALS
SHEET 2

CONSTRUCTION SCHEDULE FOR ONE GROUND ELECTRODE LOCATION

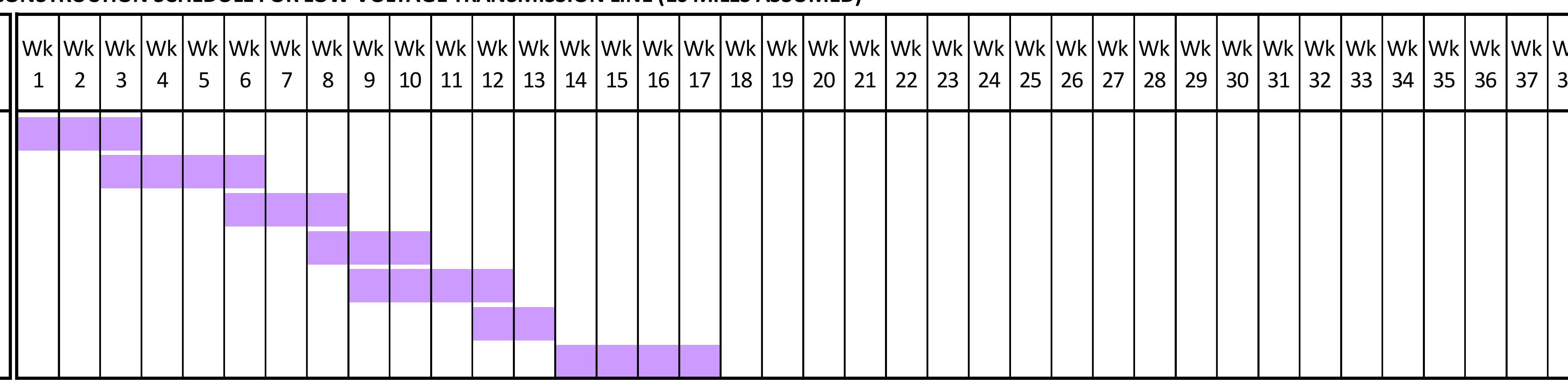
TASK	DURATION (WEEKS)
SITE GRADING	3
DRILLING 60 WELLS	8
EXCAVATE CABLE TRENCHES	6
BUILD CONCRETE CABLE TRENCHES	10
INSTALL ELECTRODE ELEMENTS	8
INSTALL LV CABLES, SWITCHES	4
INSTALL TEMPERATURE & CURRENT TRANSDUCERS, WIRING	2
BUILD CONTROL / COMMUNICATION BUILDING & FENCED AREA	8
INSTALL SITE COMMUNICATIONS 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)
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



5.8.2 Construction Workforce

The proposed TWE Project will be constructed by contract personnel, with the Applicant responsible for Project management, Project administration, and inspection. The construction workforce will consist of laborers, craftsmen, supervisory personnel, support personnel, and construction management personnel who will perform the construction tasks. Estimated construction workforce requirements by major activity are summarized in Tables 10 and 11.

Table 10 identifies the estimated personnel and equipment that is required for each of the three transmission line spreads. The total estimated number of construction personnel for construction of the entire transmission line is 630 people. Table 11 identifies the estimated personnel and equipment that is required for each of the two terminals and each of the two ground electrodes. The total estimated number of construction personnel for construction of both terminals and both ground electrodes is 360 people. The total estimated workforce for the complete proposed Project is approximately 1,000 people.

Construction will generally occur between 7 a.m. and 7 p.m., Monday through Saturday. Additional hours may be necessary to make up schedule deficiencies or to complete critical construction activities.

Temporary work camps are not expected to be necessary for the construction of the TWE Project. Variables considered in determining if work camps would be required are:

- The total distance between living facilities for construction workers and designated work areas. A general one-way travel time of two hours may be considered as a limit in determining if temporary work camps are necessary.
- Workers' Union wage agreement regarding the driving time one-way (to worksite) or round trip (to/from worksite). If the agreement allows for driving time then the camp consideration may not be required.
- The ability of existing communities to provide housing for workers or to make improvements to meet the workers' accommodation demands.
- Socioeconomic impacts on communities along the route with or without the work camps.
- Economic feasibility of permitting a work camp.
- Service life of the work camps and the restoration requirements after tear down.

The TWE Project does not appear to have areas that are more than 50 miles (on paved roads) from the ROW to existing communities or towns. The average travel distance for the Project is approximately 15 miles. The populations of these towns indicate their capability to handle the housing and/or accommodation demands of the construction workers. It should be noted during typical transmission line construction, the entire work force and support personnel generally do not all work in one area at any given time. Generally one or more activities are completed and the associated crews move to a new location prior to all the other activities becoming fully operational in that area.

5.8.3 Construction Equipment

Equipment required for construction of the TWE Project transmission lines, terminals and ground electrode facilities will include, but is not limited to, that listed in Tables 10 and 11.

TABLE 10 ESTIMATED PERSONNEL AND EQUIPMENT FOR TRANSMISSION LINE CONSTRUCTION FOR EACH SPREAD

ACTIVITY	PEOPLE	QUANTITY	TYPE OF EQUIPMENT	TRACK OR RUBBER TIRES
Survey Crew	6	2	Pickup trucks	Rubber
		2	ATV	Rubber
Geologic/ Geotechnical Investigations	6	2	Pickup trucks, 4-wheel drive	Rubber
		1	ATV	Rubber
		2	Rubber tire drill trucks (2-ton)	Either (should change description)
Road Construction Crew	6	2	Dozer (D-8 Cat or equivalent)	Track
		1	Motor grader	Rubber
		1	Pickup truck	Rubber
		2	Carry alls	Rubber
		1	Water truck (for construction and maintenance)	Rubber
		1	Dump truck	Rubber
		1	Front end loader	Either
		1	Diesel tractor w/lowboy	Rubber
Foundation Installation Crew	26	4	Hole diggers	Either
		2	Dozers	Either
		2	Trucks (2-ton)	Rubber
		2	Trucks, flatbed, w/boom (5-ton)	Rubber
		4	Concrete trucks	Rubber
		2	Dump trucks	Rubber
		2	Diesel tractors (equipment hauling)	Rubber
		3	Pickup trucks	Rubber
		1	Mechanics truck	Rubber
		1	Water truck	Rubber
		1	Carry all	Rubber
		2	Cranes, all terrain (35-ton)	Either
		1	Front end loader	Either
		1	Backhoe, w/bucket	Rubber
		1	Wagon drill	Either
		3	Equipment-tool trailers	Rubber
Anchor Installation	20	2	Pickup trucks	Rubber
		4	Carry alls	Rubber

ACTIVITY	PEOPLE	QUANTITY	TYPE OF EQUIPMENT	TRACK OR RUBBER TIRES
		1	Truck, flatbed (2-ton)	Rubber
		2	Trucks, flatbed, w/boom (5-ton)	Rubber
		1	Dump truck	Rubber
		1	Water truck	Rubber
		2	Concrete trucks	Rubber
		1	Mechanics truck	Rubber
		2	Diesel tractors, w/lowboy	Rubber
		2	Dozers	Track
		1	Loader, front end	Either
		3	Backhoes, w/bucket	Either
		3	Wagon drills	Either
		3	Cranes, all terrain (35-ton)	Either
Structure Steel Haul Crew	8	1	Equipment-tool trailer	Rubber
		2	Diesel tractors (steel hauling)	Rubber
		1	Pickup truck	Rubber
		1	Truck, flatbed (2-ton)	Rubber
		1	Carry all	Rubber
		5	Cranes, all terrain (35-ton)	Either
		3	Fork lifts	Rubber
Structure Assembly Crews 8-9 Crews	72	2	Pickup trucks	Rubber
		10	Carry alls	Rubber
		5	Cranes, all terrain (35-ton)	Either
		1	Water truck	Rubber
		5	Air compressors	Rubber
		2	Trucks (2-ton)	Rubber
		1	Mechanics truck	Rubber
		2	Tool-equipment trailers	Rubber
Structure Erection Crews 1-2 Crews	20	2	Cranes (120 – 300-ton)	Either
		2	Trucks (2-ton)	Rubber
		2	Pickup trucks	Rubber
		5	Carry alls	Rubber
		1	Mechanics truck	Rubber
		2	Air compressors	Rubber

ACTIVITY	PEOPLE	QUANTITY	TYPE OF EQUIPMENT	TRACK OR RUBBER TIRES
		1	Tool-equipment trailer	Rubber
Wire Installation Crew	36	6	Wire reel trailers	Rubber
		4	Haul trailers	Rubber
		4	Diesel tractors	Rubber
		4	Cranes (2) 20-ton, (2) 30-ton	Either
		5	Trucks, flatbed, w/bucket (5 -ton)	Rubber
		4	Pickup trucks	Rubber
		2	Splicing trucks	Rubber
		2	3-drum pullers (one medium, one heavy)	Rubber
		2	Single drum pullers (large)	Rubber
		1	Backhoe, w/bucket	Rubber
		1	Water truck	Rubber
		2	Trucks, flatbed (2-ton)	Rubber
		4	Double bull-wheel tensioner (two light and two heavy)	Rubber
		2	Sagging equipment (D-8 Cat)	Track
		6	Carry alls	Rubber
		2	Static wire reel trailers	Rubber
		3	Tool-equipment trailers	Rubber
		2	Mechanics trucks	Rubber
Clean-up Crew	4	1	Truck, flatbed, w/bucket (5-ton)	Rubber
		1	Pickup truck	Rubber
		1	Carry all	Rubber
Road Rehabilitation Crew (ROW Restoration)	6	1	Dozer (D-8 Cat or equivalent)	Track
		1	Front end loader w/bucket	Either
		1	Backhoe, w/bucket	Either
		1	Diesel tractor, w/lowboy	Rubber
		1	Seeding/harrowing equipment, w/tractor	Either
		1	Motor grader	Rubber
		1	Pickup truck	Rubber
		1	Dump truck	Rubber
		1	Carry all	Rubber

Estimated maximum personnel required for all transmission line tasks including maintenance, management, and quality control personnel = 210 for each of the three spreads.

TABLE 11 ESTIMATED PERSONNEL AND EQUIPMENT FOR EACH TERMINAL AND GROUND ELECTRODE FACILITIES

ACTIVITY	PEOPLE	QUANTITY	TYPE OF EQUIPMENT	TRACK OR RUBBER TIRE
Survey Crew	4	2	Pickup trucks	Rubber
Site Management Crew	10-12	4	Office trailers	Rubber
		4	Pickups	Rubber
		4	Generators	Rubber
Site Development – Civil Work Crew	30-35	4	Scrapers	Rubber
		2	Dozers (ripper)	Track
		2	Motor graders	Rubber
		2	Roller compactors	Rubber
		2	Excavators	Either
		4	Dump trucks	Rubber
		3	Water trucks	Rubber
		1	Mechanics truck	Rubber
		1	Fuel truck	Rubber
		2	Pickup trucks	Rubber
		6	Carry alls	Rubber
Fence Installation Crew	10-20	1	Pickup truck	Rubber
		1	Boom truck	Rubber
		2	Carry alls	Rubber
		1	Backhoe	Either
		1	Concrete truck	Rubber
		1	Reel stand truck	Rubber
		2	Bobcats	Either
Equipment Footings Installation Crew	24-30	2	Hole diggers	Either
		2	Boom trucks	Rubber
		1	Excavator	Either
		3	Concrete trucks	Rubber
		1	Dump truck	Rubber
		1	Roller compactor	Rubber
		2	Plate compactors	----------
		1	Backhoe	Either
		2	Bobcats	Either
		1	Mechanics truck	Rubber

ACTIVITY	PEOPLE	QUANTITY	TYPE OF EQUIPMENT	TRACK OR RUBBER TIRE
		1	Fuel truck	Rubber
		1	Water truck	Rubber
		2	Pickup trucks	Rubber
		4	Carry alls	Rubber
Cable Trench, Conduits, and Station Grounding Crew	12-16	2	Trenchers	Either
		2	Dozers (ripper)	Track
		2	Roller compactors	Rubber
		2	Plate compactors	----------
		2	Excavators	Either
		1	Boom truck	Rubber
		3	Pickup trucks	Rubber
		2	Flatbed trucks	Rubber
		4	Carry alls	Rubber
		1	Air compressor	Rubber
		1	Backhoe	Either
		1	Mechanics truck	Rubber
		1	Fuel truck	Rubber
		1	Dump truck	Rubber
		1	Reel stand truck	Rubber
Steel Structure and Bus Installation Crew, Converter Valve Hall, Ancillary Buildings Construction Crew, Equipment Assembly and Erection Crew	16-24	2	Cranes, RT	Either
		2	High capacity cranes	Either
		4	Boom trucks	Either
		6	Manlifts	Either
		4	Welder trucks	Rubber
		2	Carry alls	Rubber
		3	Pickup trucks	Rubber
		2	Flatbed trucks	Rubber
		1	Mechanics truck	Rubber
		4	Vans	Rubber
		2	Flatbed trucks	Rubber
Control Building and Wiring Crew	20-24	2	Boom trucks	Rubber
		4	Manlifts	Either
		3	Wire pullers-small	Rubber
		2	Reel stand trucks/trailers	Rubber

ACTIVITY	PEOPLE	QUANTITY	TYPE OF EQUIPMENT	TRACK OR RUBBER TIRE
		4	Vans	Rubber
		4	Pickup trucks	Rubber
		2	Carry alls	Rubber
		1	Splicing van	Rubber
		2	Concrete trucks	Rubber
		1	Bobcat	Either
		1	Trencher	Either
		2	Plate compactors	----------
Ground Electrode Construction Crew	12-18	2	Pickup trucks	Rubber
		1	Fuel truck	Rubber
		1	Water truck	Rubber
		2	Trenchers	Either
		2	Drill rigs	Either
		1	Boom truck	Rubber
		2	Flatbed trucks	Rubber
		1	Bobcat	Either
		1	Backhoe	Rubber
		1	Mechanics truck	Rubber
		1	Concrete trucks	Rubber
		1	Air compressor	Rubber

The above table reflects estimated personnel requirements, which may reach as high as 180 for each terminal, substation, and ground electrode construction, including maintenance, management, and quality control personnel.