MPA Phytoremediation Design
Former Coastal Refinery, El Dorado, Kansas

Prepared For:
El Paso Merchant Energy-Petroleum Company
Colorado Springs, CO

Prepared By:
PARKES Ecological LLC

October 2018

Stantec

Approved with Comments
Date(s) BH 11-1-2018
# Table of Contents

1.0 INTRODUCTION ............................................................................................................................... 1

2.0 DESIGN BASIS ................................................................................................................................. 2

2.1 EXISTING CONDITIONS .................................................................................................................... 2

2.2 CONCEPTUAL DESIGN .................................................................................................................... 3

2.2.1 GROUNDWATER ELEVATION MODEL AND HABITAT SELECTION ............................................. 3

2.2.2 CONCEPTUAL PLANT MATERIALS AND PLANTING METHODS .................................................. 4

2.3 DETAILED DESIGN (SEE APPENDIX B FOR DESIGN DRAWINGS AND SPECIFICATIONS) ............. 6

2.3.1 SOIL FERTILITY TESTING AND SOIL AMENDMENTS .................................................................. 6

2.3.2 SITE PREPARATION ....................................................................................................................... 7

2.3.3 PLANTING ZONES ....................................................................................................................... 7

2.3.4 MATERIALS MANAGEMENT ....................................................................................................... 10

2.3.5 IRRIGATION ............................................................................................................................... 10

2.3.6 PLANT MAINTENANCE .............................................................................................................. 11

2.3.7 SUBSURFACE DEBRIS/OBSTRACTIONS .................................................................................... 11

3.0 PROJECT SCHEDULE ........................................................................................................................ 11

4.0 REFERENCES .................................................................................................................................. 13

FIGURES .................................................................................................................................................. 15

Appendix A: Illustrations of Tallgrass Prairie Rooting Depth

Appendix B: Phytoremediation Design Drawings and Specifications

Appendix C: Agricultural Soil Testing Results
1.0 Introduction

The former Coastal Refinery is located north of the City of El Dorado, Kansas and includes the former Main Process Area (MPA) of the facility, as well as vacant property to the west (the Asphalt Handling Area), the former tank farm located due south of the refinery and water treatment wetlands ponds (former wastewater/stormwater) to the east (Figure 1). The West Branch Walnut River (the River) defines the northeastern boundary of the property. The area of interest for this design (the Site) is exclusive to the MPA.

The refinery was constructed in 1917 for the Pester Refining Company. The crude unit and most of the other operational units were shut down in 1985. In 1986 Coastal Refining Company purchased most of the land and equipment at the refinery from Pester. The refinery produced regular and unleaded gasoline, #2 and #6 fuel oils, propane, and asphalt (MWH 2014).

Phytoremediation involves the design and installation of plants to enhance hydraulic containment and contaminant mass removal and destruction through a variety of root and leaf-based processes. Phytoremediation has been used in the remediation of contaminated soil, sludge, sediment, groundwater, surface water, and wastewater (ITRC 2009).

The mechanisms for phytoremediation include:

- Phytosequestration: Immobilization of compounds in the rhizosphere;
- Rhizodegradation: Biodegradation of contaminants in the rhizosphere;
- Phytohydraulics: The evaporation and/or transpiration of water;
- Phytoextraction: Contaminants are absorbed and stored in the plant, then harvested;
- Phytodegradation: Degradation of contamination occurring via photosynthetic processes; and
- Phytovolatilization: Contaminants absorbed and transpired (e.g., volatilized).

The main goal of the MPA phyto-system is the remediation of organic chemicals of concern in the soil and groundwater. Shallow soil petroleum impacts are scattered, which is indicative of many individual source areas, and deep impacts are more widespread, where the LNAPL encountered groundwater. Groundwater contaminants are a range of petroleum-related compounds present in moderate to elevated concentrations across all but the far northern end of the MPA.

Hydrological control via the phyto-system is not expected. Ancillary phyto-benefits from removed groundwater (phyto-pumping) would be supplementary to the existing hydraulic containment features (i.e., pump and treat system). However, the hydrological pumping of groundwater into more aerobic areas (e.g., the vadose zone) will be a key mechanism for promoting rhizodegradation (Andersen 2006).

Rhizodegradation will be the primary mechanism to achieve phyto-remediation goals and will be optimized by maximizing root contact with contaminated media. Rhizodegradation will lead to the destruction of large organic molecules, including petroleum hydrocarbons in the soil and groundwater contacted by roots and root exudates. The smaller molecules may be taken into the plant and subject to further degradation processes and volatilization in the leaves.
Processes that break down contamination primarily occur in the rhizosphere, an area in the soil that extends the entire depth of plant root systems plus the capillary fringe. The area with the greatest microbial activity is within approximately 2 cm of the root surface where a symbiotic relationship develops between plants and soil microbes. Plants exude sugars and organic acids that are used as carbon and energy sources by the microbes. In return for these exudates, microbes provide various benefits to the plants including decreasing plant stress hormones; providing chelating agents that deliver key plant nutrients; protecting against plant pathogens; and degrading contaminants before they can impact the plant (Gerhardt et al. 2009). Because of this symbiosis, there are between 10 and 100 times more soil microbes in vegetated soil as compared with non-vegetated.

Rhizoremediation is complex and includes interactions of roots, root exudates, soil, and microbes resulting in the degradation of organic compounds to less toxic or non-toxic substances. Many of these exudates are aromatic and similar in structure to some organic contaminants including PCB's, PAH's, and petroleum hydrocarbons. The presence of soil contamination tends to select for organisms adapted to these conditions, especially bacteria, yeast and arbuscular mycorrhizal fungi (AMF) that can utilize certain contaminant compounds for energy. Plants provide essential nutrients for the microbes while the microbes improve soil quality for the plants by altering the nature of the contamination. Field tests in California and Texas resulted in a 25 to 40% reduction of petroleum hydrocarbon concentrations over 2-3 years, approximately double the rate versus unvegetated control plots (Siciliano et al. 2003, Banks et al. 1999).

With rhizodegradation the microbes are doing the work, not the plants. The plants are enhancing the soil ecosystem to allow the amount and diversity of the microbes to be maximized, thus maximizing the breakdown of the target molecules.

Microorganisms are capable of degrading a large range of mineral and organic contaminants, including most petroleum hydrocarbons; therefore, contaminant mass can be reduced in-situ. Similarly, many common metals and metalloids including cadmium, chromium, mercury, lead, boron, selenium, and arsenic can be fixed in place or in the plant matter (phytosequestration). Dissolved-phase contaminants are also entrained in root groundwater uptake and can be removed by plant transpiration.

2.0 Design Basis

2.1 Existing Conditions
The Site is located in the Flint Hills Uplands physiographic province and Flint Hills tallgrass prairie ecoregion (Ricketts et al. 1999). This region is distinct from other grassland regions due to the dominance of tallgrass species (and relative lack of species diversity) growing on a thin soil layer atop distinct beds of limestone. These limestone beds made the area difficult to till and thus less desirable for farming crops such as wheat and corn. Historically, grazing, most importantly by bison, drought and fire kept these areas grassy instead of transitioning to woodland. The dominant grass species here are big bluestem (Andropogon gerardii), switchgrass (Panicum virgatum), little bluestem (Schizachyrium scoparium), and Indian grass (Sorghastrum nutans). The MPA was seeded with a warm-season grass seed mix including these species as well as a diversity of wildflowers after infrastructure removal. The current plant community reflects this mixture and the MPA is mowed several times annually to prevent the invasion of woody species. Tree species such as cottonwood (Populus deltoides), and willow (Salix spp.) can be observed in areas that remain unmowed, such as the fringe of the MPA Basin.
Overall, the Site slopes from west to east towards the River. Based on Natural Resources Conservation Service soil data, MPA soils are Labette Silty Clay Loam and Labette-Dwight Complex. These series are well drained, silty-clay-loams and silty clays characteristic of native grasslands. Alluvium and weathered bedrock residuum from the surface to the top of bedrock are described in boring logs as predominantly silty clay with a thickness ranging from approximately 0 to 26 ft. Agronomic tests from soils collected in the top two feet just south of the MPA indicate these soils possess suitable characteristics (e.g., texture, pH, nutrients, etc.) for plant establishment and growth.

Groundwater includes both unconfined and confined groundwater, as well as areas of localized perched groundwater (MWH 2014). Site investigations have found that the groundwater flow direction is predominantly east toward the River. The groundwater potentiometric surface generally emulates the topographic contours of the Site as well as the structure-contour of the top of bedrock surface.

Bedrock is approximately 2 to 5 ft. below grade on the west side of the MPA, but the clayey overburden thickens to the east and a modest bedrock trough exists in the MPA Basin where bedrock depths approach 20 ft. below grade. The groundwater flow occurs through several feet of weathered limestone immediately above competent bedrock. The capillary fringe, estimated to be 16 to 24 inches in thickness for silty clays, extends above the top of the groundwater (Mausbach 1992).

These site conditions, as well as the nature and extent of the contaminants of concern, led to phytoremediation being promulgated as a component of the site remedy. As the goal of the phyto-system for the MPA is to maximize rhizodegradation, the selection of plant communities that would achieve this goal was the next step. The biggest design constraints were to develop strategies to obtain significant rooting (and therefore treatment) at depths greater than five feet while simultaneously promoting rooting and treatment at shallower depths. These constraints were addressed via a deep planting system integrated with shallower rooting plants across the Site depending upon sub-site specific factors.

### 2.2 Conceptual Design

#### 2.2.1 Groundwater Elevation Model and Habitat Selection

Although some of the target phyto-treatment areas of the MPA are drier, with non-saturated soils close to ground surface, it was apparent that some of the target treatment areas, both deep and shallow, would be wetter. The area of moisture variability as the water table and its associated capillary fringe rise and fall over time (e.g. seasonal and annual fluctuation, rising groundwater after significant precipitation, drawdown during drought, etc.), known as the “smear zone” is a primary target treatment area. Another target treatment area for rhizodegradation is within the water table itself.

To treat these moist areas, plants adapted to saturated conditions, that are known to foster rhizodegradation, grow in this climate, are non-invasive and commercially available are necessary. Phreatophytes, including species of willow, poplar, and dogwood, among others, are a group of trees and shrubs with these properties (Keenan and Kirkwood 2015, ITRC 2009). Usually, at least a portion of their roots are in constant contact with water. They can also be deep-rooted and have high transpiration rates which are desirable for phyto-applications.

Both surface water and groundwater at the Site generally flow west to east. With the bedrock diving to approximately 20 ft. below ground surface (bgs) in areas of the southeast portion of the Site and groundwater generally following top of bedrock topography, it was appropriate to model the saturated area
to include the estimated capillary fringe. A model was built using groundwater elevation data collected in May 2015 compared with elevations at ground surface. A raster model was created by averaging models using two interpolation methods, kriging and inverse distance weighting (Figure 2). This model facilitated a more informed layout of planting zones and enabled more specificity concerning the best size and type of plants (i.e., trees versus shrubs versus grasses) to install, to what depth, and thus determine planting methods.

This model determined that there were three broad conditions where different planting treatments were appropriate:

1) Areas that may be comparatively drier due to limited surface runoff and/or where the water table is sufficiently below bedrock. These areas are located in the west and northernmost areas of the Site and are not wet enough to support phreatophytes.

2) Areas of the Site which are wet and have fairly shallow depths (<~4ft) to the top of the capillary fringe and are susceptible to saturation will be conducive to shallow planting of phreatophytes using standard methodologies and materials (e.g., hand-held augers, shovels, small containers, etc.).

3) Areas of the Site where the capillary fringe (and therefore top of groundwater and bedrock) are relatively deep (>~8ft), require a specialized planting strategy to force a portion of the roots deeper into the target treatment zone.

A secondary goal of the phytoremediation system is to promote site sustainability. In many cases, using native plants and habitats has been shown to be an effective strategy in phytoremediation as they have deeper root systems and are more likely to establish, survive, and thrive thus resulting in robust and diverse rhizospheres over the time scales necessary for phytoremediation (Divinny et al. 2005). Native species and habitats also require less management (irrigation, fertilizer, etc.), are adapted to local climates, and are more disease resistant than non-native species and habitats (Dorner 2002). Therefore, our goal was to design the phytoremediation system using native species and habitats where practical, and where it was impractical, design for long term ecological succession to native habitats.

The results of groundwater elevation modelling, observations of current ecological site conditions (e.g., topography, dominant plant species, soil types, average annual rainfall, etc.), and considering the habitats native to the region resulted in four conceptual planting zones; tallgrass prairie, oak savannah (originally called oak woodland), shallow poles (a.k.a. shrubland), and deep poles (Kindscher et al. 2010, Chapman et al. 2001). These are shown in plan-view (Figure 3), as a section (Figure 4) and further described below.

### 2.2.2 Conceptual Plant Materials and Planting Methods

Tallgrass prairies and oak savannas have been employed and are suitable for phytoremediation of hydrocarbons due to their dense and deep root systems making them ideal to promote rhizodegradation (Cook and Hesterburg 2013, Negri 2003). Root depths of tallgrass prairie and oak savannahs can extend to over 10 ft. bgs (Packard and Mutel 1997, Weaver 1968, see Appendix A).

**Tallgrass Prairie:** The site currently exhibits some features of tallgrass prairies like the presence of dominant tallgrass prairie grass species, soils conducive to prairie development, and a lack of woody species due to the current mowing regime. A robust tallgrass prairie will be installed using standard prairie restoration methods such as disking, tilling, and applying herbicide before drill seeding a tallgrass prairie seed mix. Prairie establishment will be promoted post-seeding via a mowing regime, spot herbicide application to discourage invasive species invasion, and eventually, prescribed burning.
Trees/Oak Savannah: Adding trees to a portion of the tallgrass prairie system will provide greater rhizodegradation at depth as the trees are deeper rooted than the grasses on average. Therefore trees will be added in areas comparatively deeper to capillary fringe (~4ft to ~8ft bgs) to create an oak savannah. The oak savannah zone will be prepared and seeded in the same way as the tallgrass prairie except that trees, mostly bur oak (Quercus macrocarpa), will be planted. Bur oak was selected due to its tolerance of variable climatic and hydrological conditions, nativity, deep rooting, large size (and therefore extensive below ground root mass) at maturity, aesthetic and because of its resistance to fire.

Cuttings/Live Stakes/Poles: Cuttings, live stakes, and poles (these are synonymous, with live stakes being thicker and longer than cuttings, and poles wider than live stakes) appear as unbranched (or debranched) sticks of varying sizes where all but approximately the top one foot are placed below ground (see photos below). These species and materials can be employed in this manner because their shoot buds, located along the length of the stem, produce branches aboveground and roots below ground (ITRC 2009). Additional advantages of using these materials over others such as bare root stock is that they are easier to store, transport, and handle; require narrower boreholes for installation, and are more economical. These materials are commonly used in riparian restoration (Hoag 2007).

Photos: Willow Live Stakes and Cuttings

Photos: Hybrid Poplar Poles
Shrubland: A variety of woody species will be installed in shrubland areas including willows and dogwoods. Plant materials will be live stakes. After shrub installation this area will be seeded with a mix of annual and perennial grasses and forbs to prevent invasive species invasion and erosion until shrubs mature.

Deeper Stakes/Poles: Longer live stakes and poles of willow, hybrid poplar, and cottonwood will be installed to promote rooting at their bottom ends and extend deep into the soil of the deep planting area (Figure 5). Deep plantings in this area will be between 8 and 10 feet in length. The bottom of the bore hole will be approximately the top of the water table and the pole end will be set at approximately the top of the capillary fringe. This area will also be seeded with tallgrasses.

2.3 Detailed Design (see Appendix B for Design Drawings and Specifications)

2.3.1 Soil Fertility Testing and Soil Amendments

MPA soils were sampled at twelve locations at two depths, 6 and 18 inches bgs, and sent to Kansas State University Soil Testing Laboratory for agronomic fertility testing (Figure 6). Parameters evaluated included pH, phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), conductivity, organic matter, copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), and texture. In general, the results were positive for native plant establishment and confirmed our previous assumptions concerning soil characteristics based upon previous sampling on areas nearby the site.

Phosphate Addition: Nutrients were sufficient for plant establishment, however, similar to nearby areas, the level of P was low. Therefore, P (triple super phosphate (0-46-0) will be broadcast onto soils just prior to final tilling to promote plant establishment. Native plants are well adapted to low nutrient conditions therefore no other nutrients/fertilizers will be applied surficially. However, nutrient levels at depth are unknown and likely variable, therefore a more balanced fertilizer (Osmocote 18-6-12) will be added to deep planting media to ensure initial nutrient availability.

Elevated Parameters: Some parameters, such as pH, Ca, and Mg are at the high end of normal ranges or had a few elevated readings. These conditions are not unexpected for a former refinery site, should not inhibit widespread plant establishment (i.e., are non-toxic to native plants), and should be partially alleviated through the soil mixing (tilling) prior to seeding and planting.

Mycorrhizal (fungi) Inoculant: The addition of mycorrhizal inoculant to seeding areas and plantings is critical to establish and promote rhizodegradation. Mycorrhizae are fungi that form symbiotic relationships with plant roots whereby the fungi colonize the roots then send their filaments (mycelium) into the surrounding soil to greatly enlarge effective plant root mass and the capacity for absorption. This inoculation is especially critical on disturbed sites where these natural relationships may have been diminished. A diversity of inoculum species, including both endo- and ecto-spores will be utilized as different plants, habitats, and geographies prefer different types and species of mycorrhizae. A granular mycorrhizal formula will be broadcast before tilling into the soil as well as added directly to plantings and the deep planting media. The use of local topsoil as an amendment to compacted areas and as the base for the deep planting media may also enhance mycorrhizal inoculation of the site (Emam 2015).

Oxygenation: Although phreatophytes (the selected trees and shrubs) are tolerant of anaerobic conditions, they have been shown to perform better (e.g. produce more biomass) when exposed to ORM in addition to aeration tubes (Rentz et al. 2003). Ensuring the presence of available oxygen is especially important for plant establishment as these materials are rootless when planted and roots will need to be quickly generated to ensure survival. Therefore, granular ORM will be added to the deep planting media.
2.3.2 Site Preparation

Proper soil preparation is critical to any ecological restoration project, but especially those involving prairie establishment and promotion of rhizodegradation. Adequate and thorough site preparation will exhaust weed seed sources, decompact soils, and eliminate nutrient deficiencies to promote target plant establishment and reduce the likelihood and scale of unwanted species invasions. Proper soil preparation will result in increased plant survivorship, reduced replanting/reseeding, less management of invasive species, and a shorter period to rhizodegradation at depth.

Onsite soils will proceed through the following preparation process:

- Except for compacted areas, tilling, herbicide application, and annual cover crop seeding the fall before seeding/planting;
- Decompaction where necessary by deep ripping, adding topsoil and fertilizer, then subsoiling;
- Additional rounds of tilling and herbicide application in the spring before seeding/planting;
- Fertilizer will be added just prior to final tilling, and
- Cultipacking to firm the planting/seeding bed.

Weed Seed Depletion: Tilling and herbicide/fertilizer application will remove existing plants, cause weed seeds to germinate then die, aerate and remove debris from the seed bed, and add nutrients just prior to planting/seeding. Installing an annual cover crop in the fall will stabilize the soil during the winter and provide humus when turned over in the spring.

Decompaction: Approximately 6.24 acres of the Site is substantially compacted and parts are graveled from historical use as access roads and/or parking areas. It will be necessary to process these areas more intensely for plants to establish and trigger rhizodegradation. Decompaction and the addition of six inches of topsoil will occur before planting so these areas can be integrated with non-compacted areas for final tilling and cultipacking.

Cultipacking: Proper cultipacking is critical for seed germination and plant establishment. Packing of the soil promotes seed to soil contact, eliminates air pockets that dry out the soil, and creates a crust at the surface which helps preserve soil moisture. The site should be so firm after cultipacking and before seeding that a footprint barely registers. If a footprint sinks more than a half an inch it should be repacked (Packard and Mutel 1997).

Invasive Species/Herbicide: Invasive species of concern are those that may afflict agricultural areas of the region including Eastern red cedar (Juniperus virginiana), smooth brome (Bromus inermis), quackgrass (Elymus repens), reed canary grass (Phalaris arundinacea), Canada thistle (Cirsium arvense), bull thistle (Cirsium vulgare), leafy spurge (Euphorbia esula), tall fescue (Festuca arundinacea), Japanese brome (Bromus japonicas) and Johnson grass (Sorghum halepense). Glyphosate, a non-selective herbicide, will be broadly applied during site preparation to control these and other unwanted species.

2.3.3 Planting Zones

As discussed in Section 2.2.1, four planting zones were selected for this site as shown on Sheet L101 of Appendix B. Species of plants and seeds were selected by considering their nativity and appropriateness for the site; specific for the target habitats; their rooting habit, preferentially selecting those species that are deep rooted; and their availability from commercial nurseries, especially the specialty materials for the deep planting areas.
Tallgrass Prairie

The tallgrass prairie zone is 21.4 acres as shown on Sheet L102 of Appendix B. After site preparation, this zone will be seeded in May with a drill at a rate of 10 lbs. per acre with a diverse mixture of tallgrasses (7 species, 75% of the total mix) and forbs (16 species, 25% of the total mix). Wetter areas will be seeded with a similar mix that's more suited to wetter conditions. These ratios and species were selected for their deep rooting, quick development, suitability for the site, and promotion of future burning (Packard and Mutel 1997). A significant portion of the forbs are nitrogen fixers. An annual mix of oats and rye will be drilled simultaneously at a rate of 28 lbs. per acre. The annual nurse mix germinates quickly to provide erosion control and help prevent invasion of unwanted cool-season grasses while the desired warm-season grasses build underground biomass early in the season, emerging later. This area will be watered for three weeks post-seeding. Implementation of a mowing regime the year after seeding is essential to prevent cool season and annual grasses from going to seed therefore promoting the selection of the warm season grasses. Prairie areas will be spot treated with herbicide and selectively reseeded via broadcasting later in the year. Further details on maintenance and monitoring can be found in the MPA Phytoremediation Operations and Maintenance Plan (MPA O&M Plan).

Oak Savannah

The oak savannah (woodland) zone will be 12.1 acres as shown on Sheet L103 of Appendix B with an average depth to capillary fringe of ~6.0 ft. bgs. This area will be prepared and seeded in the same way as the tallgrass prairie after being planted with groves of trees, mostly bur oak, but also blackjack oak (Quercus marilandica), Shumard's oak (Quercus shumardii), and post oak (Quercus stellata). Addition of these species will add diversity and resilience to the system as these species are also native, drought resistant, and fire tolerant. Fifty-five trees in 11 groves of five will be planted across this zone. This spacing allows for targeting of deeper areas, allows for a mowing regime of the interspersed grassland until the trees are mature enough to tolerate fire (10 years), and will result in a more natural aesthetic. Trees about five feet in height in five gallon containers will be utilized to maximize initial survivorship and to promote establishment. This area will be maintained like the tallgrass prairie in the first growing season with supplemental irrigation of the trees. Further details on maintenance and monitoring can be found in the MPA O&M Plan.

Shrubland

The shrubland zone will be 3.6 acres in size as shown on Sheet L103 of Appendix B with an average depth to capillary fringe of 2.7 ft. bgs and prepared as outlined above. Live stakes will be planted to a depth of 3 ft. bgs. These materials will be installed with standard hand tools although some of the longer live stakes may be installed with a handheld power auger or similar. Six shrub species, all phreatophytes, will be installed directly into the shallow saturated soils. Live stakes will be installed after being soaked in water between 3 and 7 days and should be planted as early as possible, preferably in March or early April, so they will break dormancy after planting. Shrubs will be spaced 10 ft. on-center (o.c.) to enable mowing between rows during establishment. Species will be installed semi-randomly in single species clumps consisting of 10-20 plants each.

The same seed mixture as the wetter portion of the tallgrass prairie will be installed post-planting. Watering will be required in this zone for twelve weeks post planting to promote establishment. Control of grasses near the shrubs will be critical to prevent the grasses from outcompeting the shrubs during the first two years post-planting. Further details on maintenance and monitoring can be found in the MPA O&M Plan.
Deep Poles

The deep pole planting zone is approximately 4.0 acres in size as shown on Sheet L104 of Appendix B with an average depth to capillary fringe of 9.0 ft. This area will be initially prepared like the other areas the fall prior to planting, but then only tilled early in the spring, as soon as the frost leaves the ground, immediately before planting operations begin. The more extensive tilling/herbicide application protocols will not be employed here because of the necessity to perform this planting as early in the season as possible.

Pole Lengths: The deep pole zone has been split into two planting areas using depth to capillary fringe. Areas expected to be deeper to capillary fringe will require longer poles to reach saturation. Zone 1 will consist of 9 foot poles and Zone 2 will be 11 foot poles.

Species: Poles will consist of three species, 'Imperial' Carolina poplar (Populus x canadensis), 'Streamco' purpleosier willow (Salix purpurea var. streamco), and eastern cottonwood (Populus deltoides).

- Sixty percent of the poles will be Imperial Carolina poplar due to their demonstrated effectiveness for these applications, adaptability, straight growing habit, and commercial availability (NRCS 2014). This species is hybrid developed by USDA Natural Resources Conservation Service (NRCS) and has been widely used on plantations and for stream and shoreline protection. It is a male-sterile hybrid so it will not contribute to the eventual vegetative succession of the site.

- Twenty percent of the poles will consist of Streamco purpleosier willow, which was also developed by NRCS and is a male clone (Dickerson 2002). Therefore, this tree will not spread by producing seeds or suckers. It is highly adaptable, well suited for unpredictable hydrological regimes, and grows in almost any soil texture. This species is a major source of bioengineering materials because of its quick growth, strength, and flexibility.

- Twenty percent of the poles will be eastern cottonwood. Eastern cottonwood is native, very fast growing and adaptable to variable conditions, especially varying soil textures and pH values (NRCS 2002).

Spacing: Poles will be spaced 22 ft. o.c. in a triangular pattern. The triangular pattern is denser than the standard linear pattern and will result in more complete treatment over space and a more naturalistic look. Species will be installed semi-randomly in single species clumps consisting of 5-15 poles each.

Rooting: Poles will be installed to promote rooting at their bottom end and extend deep into the soil. As with the live stakes in the shrubland, these longer poles will be soaked in water for up to a week before installation and should be planted as early in the season as possible, preferably in March or early April.

MPA Basin Interceptor Trench Dewatering: Groundwater pumping from the MPA Basin Interceptor Trench (IT) will be reduced or shut off prior to planting to raise the groundwater level in the vicinity, promoting tree poles contact with groundwater. The degree of flow reduction will depend on upgradient depth to water measurements in monitoring wells. For example, the MPA Basin IT may be pumped aggressively in the spring and early summer if water elevations remain high and it may be turned off in late summer/fall if precipitation and hence groundwater is low. Root establishment is anticipated within one year, although this revised operation could be extended for a second year under drought conditions. Regardless, containment will not be impacted because the Seep IT is located downgradient and will remain active, capturing water not captured by the MPA Basin IT. The MPA Basin IT's purpose is primarily for light non-aqueous phase liquid (LNAPL) recovery and secondarily for supplemental hydraulic containment.

Borings & Aeration Tubes: Bore holes eighteen inches in diameter will be drilled to 2.5 ft. below where the bottom of the pole will be set. The bottom of the bore hole will be approximately the top of the water table.
and the pole end will be set at approximately 0.5 ft. into the capillary fringe. Boring depths correspond to 1.5 ft. greater than the length of the poles in each zone (i.e., Zone 1: 9.5 ft. bgs, Zone 2: 11.5 ft. bgs). These dimensions correspond to one foot of the pole sticking out of the top of the hole and 2.5 ft. of planting media between the bottom of the pole and the bottom of the hole (see Drawing L.104 in Appendix B). An aeration tube of perforated PVC pipe, perforations beginning 1.5’ bgs will be inserted to the bottom of the hole. Aeration will promote both the plant and soil microbes to grow at depth supporting rhizodegradation. These tubes could also be used for irrigation.

**Planting Media:** Approximately 2.5 ft. of manufactured planting media will be placed in the hole before the pole is installed. This planting media is intended to promote rooting within the saturated zone as well as plant establishment. The planting media consists of topsoil with a broad texture specification (loam, sandy loam, or sandy clay loam) to be amended with fertilizer, ORM, and mycorrhizal inoculant. These components will be mixed and liquefied into a thick slurry using clean water. An additional six inches of planting media will be added following pole placement. The rest of the hole will be backfilled with liquefied boring tallings in a similar manner to the planting media. Aeration from the tube as well as the addition of oxygen releasing material (ORM) will promote root and soil microbe establishment at depth supporting aerobic rhizodegradation (Rentz et al. 2003).

**Protection:** It is important to protect the deep pole plantings from herbivory and competition from surrounding plants, especially grasses, until they become firmly established. Protection from herbivory will be accomplished by installing temporary seedling protection around the plantings. Reduction of competition from surrounding plants will be accomplished by tamping the borehole post installation, adding gravel within 12 inches of the borehole, and through mowing and trimming.

**Permanent Cover:** A prairie seed mix will be installed upon the completion of planting following cultipacking. Watering and mowing of the seeded area will be the same as the tallgrass prairie (watering for three weeks followed by mowing every three weeks of the first growing season). Trimming around plantings twice a year during the growing season will be necessary to eliminate any competition from grasses. Further details on maintenance and monitoring can be found in the MPA O&M Plan.

### 2.3.4 Materials Management

No waste material will be generated from the tallgrass prairie/oak woodland prairie plantings, and a majority of the cuttings from the shallow and deep plantings will be replaced in the borehole as backfill; however, excess soil generated from soil conditioning will require management.

Clean and lightly petroleum-impacted soil from auger cuttings that contains rock less than three inches in diameter can be used for bore-hole backfill. Excess clean and lightly-impacted soil shall be transported to an onsite staging area, placed on plastic sheeting in piles and covered with plastic. These materials will then be tested and characterized. Soil exceeding standards will be placed in a roll-off bin, and clean soil will be thin spread across the work area prior to seeding. If petroleum is draining from soil or waste-like materials are encountered, these soils will be separated and immediately placed in a roll-off bin for further characterization. If rock greater than three inch diameter is encountered during drilling activities or if rock/debris greater than six is exposed during soil management or conditioning activities, it will be separated and placed in a roll-off bin.

### 2.3.4 Irrigation

As discussed in prior sections, proper watering is necessary to ensure high initial establishment and survival rates to accomplish long term remedial goals and to reduce maintenance costs such as reseeding and replanting. Early spring plantings will help minimize irrigation needs; however, supplemental water
A minimum of one inch of water addition per week (more if there are heavy rains is acceptable/normal) from either precipitation or irrigation is optimal for establishment within the prairie grass seeding areas during the first three weeks post-seeding. After this period water additions should cease unless dry conditions defined as less than 0.5" of rain per week are experienced for three consecutive weeks. In this case prairie areas should be irrigated at a rate of 0.5" per week until a week where precipitation exceeds that threshold is experienced or the growing season ends (September 30th). While the deep poles are not expected to require irrigation, the other trees (i.e. oaks) must be watered weekly using irrigation bags throughout the growing season unless particularly wet conditions (greater than 2" of precipitation in a week) are experienced. The shrubland will require more consistent watering if dry conditions occur, needing an average of one inch of water per week via precipitation or supplemental irrigation until September 30th. The site receives an average of an inch of precipitation per week during the growing season. Therefore, supplemental irrigation will only be necessary if less than 0.25 inches of precipitation was experienced the previous week. This will prevent consecutive weeks without significant hydration. These details and limitations (e.g. if extreme drought occurs, it may be more reasonable to reseed the following year) are discussed in Section 2.1.2 of the MPA O&M Plan.

### 2.3.5 Plant Maintenance

After the initial planting, evaluation of plant health and growth will be conducted for each of the subsequent three years. Actions resulting from this monitoring may include replacing trees that did not survive, replacing these trees with species demonstrating higher survivorship, identifying areas where soil conditions need further amendment for sufficient tree growth, and altering the irrigation regime. Deep pole plantings will not be replaced in-kind, instead shorter poles four foot in length will be installed using hand held equipment and irrigated via a drip emitter to promote establishment. See the replacement deep planting detail in Appendix B. Details of the monitoring program are included in the MPA O&M Plan.

### 2.3.6 Subsurface Debris/Obstructions

There are significant remaining buried concrete structures and debris from the former refinery that will complicate initial soil conditioning (disking/tilling) and plantings. Although all above-ground structures and slab were removed, former piping, foundations/footers, and other structures from decades of operation and processes remain. Given this, installation plans will need to be changed in the field as obstructions are encountered. If a shrub or tree boring encounters refusal, up to two attempts will be made to relocate the boring nearby or the planting depth adjusted if it is sufficiently close; however, if overall plant spacing (e.g. final canopy) would be too disrupted or the planting would remain too shallow, the location will not be installed. The owner may at their discretion chose to relocate that plant elsewhere, such as along the perimeter of the proposed planting zone; however, a larger portion of the construction cost is in the borings; therefore, total linear footage limits cannot be exceeded.

### 3.0 Project Schedule

The spring seeding window is between March 15th and June 15th while fall seeding will take place between October 1st and when the ground becomes hard frozen. The spring planting season for all plant materials except live stakes is April 15th through June 15th. Live stakes will be planted between March 1st and May
The fall planting season for replacements is September 1st through October 15th. A generalized schedule is provided below.

<table>
<thead>
<tr>
<th>Date</th>
<th>Zone(s)</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4-18</td>
<td>All</td>
<td>Tilling, Debris removal, Decompaction, Herbicide application, Annual cover crop.</td>
</tr>
<tr>
<td>Q1-19</td>
<td>SH, DP</td>
<td>Additional site preparation, and live stake pole planting as early as practicable.</td>
</tr>
<tr>
<td>Q2-19</td>
<td>All</td>
<td>Tilling &amp; herbicide application, Cultipacking, seeding, Planting, Begin watering.</td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td>Cease watering, Short mow once, high mow every three weeks.</td>
</tr>
<tr>
<td>OS</td>
<td></td>
<td>Cease watering prairie, Water trees, Short mow once, high mow every three weeks.</td>
</tr>
<tr>
<td>SH</td>
<td></td>
<td>Water, Short mow once, high mow every three weeks, Trim shrub line.</td>
</tr>
<tr>
<td>DP</td>
<td></td>
<td>Cease watering, Short mow every three weeks, Trim tree line, Materials management.</td>
</tr>
<tr>
<td>Q3-19</td>
<td>TP, OS, SH, DP</td>
<td>High mow once, Trim around plantings. Install replacements.</td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td>Cease watering prairie, Water trees, High mow every three weeks, Spot herbicide application.</td>
</tr>
<tr>
<td>OS</td>
<td></td>
<td>Water, High mow every three weeks, Trim shrub line, Spot herbicide application.</td>
</tr>
<tr>
<td>SH</td>
<td></td>
<td>Water, High mow every three weeks, Trim shrub line, Spot herbicide application.</td>
</tr>
<tr>
<td>DP</td>
<td></td>
<td>Short mow every three weeks, Trim tree line, Spot herbicide application.</td>
</tr>
<tr>
<td>Q4-19</td>
<td>All</td>
<td>None.</td>
</tr>
<tr>
<td>Q1-20</td>
<td>DP</td>
<td>Prepare and install replacements.</td>
</tr>
<tr>
<td>Q2-20</td>
<td>TP, OS, SH, DP</td>
<td>High mow once, Trim around plantings. Install replacements.</td>
</tr>
<tr>
<td>Q3-20</td>
<td>TP, OS, SH, DP</td>
<td>Trim around plantings, Spot herbicide application, Install replacements.</td>
</tr>
<tr>
<td>Q4-20</td>
<td>All</td>
<td>None.</td>
</tr>
</tbody>
</table>

TP = Tallgrass Prairie, OS = Oak Savannah, SH = Shrubland, DP = Deep Planting
4.0 References


Weaver, J.E. 1968. Prairie Plants and their Environment. University of Nebraska Press. Lincoln, NE.
FIGURES
Figure 1: Site Overview
Figure 2: Raster Model of Depth from Ground Surface to Top of Capillary Fringe (ft)
Figure 3: Conceptual Planting Zones

- **Tallgrass Prairie**
- **Shrubland**
- **Oak Savannah**
- **Deep Poles**
- **Limit of Work**
Figure 4: Planting Zone Section
Figure 5: Deep Planting Detail

- Tall Grass Prairie
- Scarification
- Boring Tailings
- Silty Clay
- Capillary Fringe
- Water Table
- Y WT
- Dormant Pole [Willow/Poplar]
- Aeration Tube
- Root Dip
- Planting Media
Figure 6: Soil Fertility Sampling Plan, July 2016
APPENDIX A

Figures from Weaver 1968 illustrating rooting depth of tallgrass prairie species

---

**Fig. 5.** Roots of big bluestem (*Andropogon gerardii* [left]) and switchgrass (*Panicum virgatum*) from monolith of soil 12 inches wide, 3 inches thick into the trench wall, and 3 feet deep. The bluestem was 3 feet and the switchgrass more than 6 feet deep. From Weaver and Darland, Ecological Monograph, 1949a.

**Fig. 6.** Characteristic development of tops and roots of big bluestem (*Andropogon gerardii* [left]), switchgrass (*Panicum virgatum* [center right]), and prairie cordgrass (*Seralimus patens* [right]). When flower stalks are fully developed and flower spikes of 6 or more feet are attained.
FORMER COASTAL REFINERY
MPA PHYTOREmediATION Design
EL DORADO, KANSAS
August 2018
TALLGRASS PRAIRIE (21.44 acres)

LEGEND

- TALLGRASS PRAIRIE SEEDING AREA
- TALLGRASS PRAIRIE SEEDING AREA - AREA MAY BE COMPACTED

NORTHERN AREAS

SOUTHERN AREAS

EXISTING ROAD

EXISTING MPA RIP-RAPPED CHANNEL

EXISTING MPA RIP-RAPPED CHANNEL

EXISTING MONITORING WELL (TY)

EXISTING MONITORING WELL (TY)

EXISTING ROAD

LIMIT OF WORK

MONITORING (WELL)

EXISTING MPACTED

PETROLEUM COMPANY

EL PASO MERCHANT ENERGY

FORMER COASTAL REFINERY

SCALE AS SHOWN

PLANTING PLAN

PARKES ECOLOGICAL LLC

August 2018

L102
DEEP POLE PLANTING (3.97 acres)

LEGEND

- DEEP POLE PLANTING AREA
- DEEP POLE PLANTING AREA - AREA MAY BE COMPACTED
- SEEDING ONLY

TYPICAL TRIANGULAR TREE LAYOUT
1. GENERAL NOTES AND REQUIREMENTS

1.1. OVERVIEW: This phytoremediation system is intended to promote the remediation of organic chemicals in site soils and groundwater by maximally utilizing site-specific vegetation. The objective is not hydraulic control, however, any resulting reduction in groundwater flux will be beneficial to the remediation of the existing groundwater contaminant system.

1.2. SUBCONTRACTS: The Contractor shall submit evidence of completing similar projects that include drilling, landscape construction, ecological restoration, or any other contractual terms that are not limited to hydraulic control. However, any resulting reduction in groundwater flux will be beneficial to the remediation of the existing groundwater contaminant system.

1.3. HAZARDOUS: All on-site personnel handling tailings from borings shall receive hazardous waste operations and emergency response (HAZWOPER) documentation training within 1010.506.3. Hazardous waste operations and emergency response (HAZWOPER). Documentation of the training is the responsibility of the Contractor. All on-site personnel handling tailings shall be able to provide proof of training upon request.

1.4. SITE-SPECIFIC HEALTH & SAFETY: THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING ALL PERSONNEL HANDLING TAILINGS FROM BORINGS, AS LONG AS THE NPA IS NOT LOCATED IN THE AREA. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING THE SITE AND ENVIRONMENT FROM HAZARDS. THE CONTRACTOR MAY BE REQUIRED TO PROVIDE SUBMITTAL MATERIALS IN THE PHASE DETAILED IN 2.4.5. PROPOSED STAGING AREAS AND CONSTRUCTION EQUIPMENT TO BE USED, INCLUDING EQUIPMENT HANDLING ISSUES. THE CONTRACTOR WILL BE RESPONSIBLE FOR PROVIDING INFORMATION AND SUBMITTAL MATERIALS TO THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE FOR MAXIMIZING BIO DEGRADATION WITHIN THE SITE. THE CONTRACTOR IS RESPONSIBLE FOR RECEIVING AND UTILIZING ALL PROPERLY SUBMITTED DOCUMENTATION WITHIN TWO WEEKS OF SUBMISSION.

2. CONTRACT DOCUMENTS

2.1. GENERAL: THE CONTRACT DOCUMENTS ARE PROVIDED TO THE CONTRACTOR PRIOR TO PERFORMANCE OF ALL WORK. THE CONTRACTOR SHALL REVIEW THE CONTRACT DOCUMENTS WITH THE OWNER FOR CONFIRMATION OF THE CONTRACTOR'S PROPOSED APPROACH TO ALL CONTRACT PROVISIONS.

2.2. CONTRACTOR: THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING THE SITE AND ENVIRONMENT FROM HAZARDS. THE CONTRACTOR MAY BE REQUIRED TO PROVIDE SUBMITTAL MATERIALS IN THE PHASE DETAILED IN 2.4.5. PROPOSED STAGING AREAS AND CONSTRUCTION EQUIPMENT TO BE USED, INCLUDING EQUIPMENT HANDLING ISSUES. THE CONTRACTOR WILL BE RESPONSIBLE FOR PROVIDING INFORMATION AND SUBMITTAL MATERIALS TO THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE FOR MAXIMIZING BIO DEGRADATION WITHIN THE SITE. THE CONTRACTOR IS RESPONSIBLE FOR RECEIVING AND UTILIZING ALL PROPERLY SUBMITTED DOCUMENTATION WITHIN TWO WEEKS OF SUBMISSION.

2.3. SCHEDULE: A DRAFT D&M CHEMICAL SOLUTIONS INTEGRATION SCHEDULE WILL BE SUBMITTED DURING THE PROJECT KICK-OFF MEETING INCLUDING ALL MAJOR PROJECT MILESTONE SCHEDULES.

2.4. DELAYS: SHALL INCLUDE DELAYS DUE TO WORK OR NO WORK, PERSONNEL O N-SITE SHALL ALSO BE REQUIRED TO PROVIDE SUBMITTAL MATERIALS IN THE PHASE DETAILED IN 2.4.5. PROPOSED STAGING AREAS AND CONSTRUCTION EQUIPMENT TO BE USED, INCLUDING EQUIPMENT HANDLING ISSUES. THE CONTRACTOR WILL BE RESPONSIBLE FOR PROVIDING INFORMATION AND SUBMITTAL MATERIALS TO THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE FOR MAXIMIZING BIO DEGRADATION WITHIN THE SITE. THE CONTRACTOR IS RESPONSIBLE FOR RECEIVING AND UTILIZING ALL PROPERLY SUBMITTED DOCUMENTATION WITHIN TWO WEEKS OF SUBMISSION.

2.5. MAINTENANCE: THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING THE SITE AND ENVIRONMENT FROM HAZARDS. THE CONTRACTOR MAY BE REQUIRED TO PROVIDE SUBMITTAL MATERIALS IN THE PHASE DETAILED IN 2.4.5. PROPOSED STAGING AREAS AND CONSTRUCTION EQUIPMENT TO BE USED, INCLUDING EQUIPMENT HANDLING ISSUES. THE CONTRACTOR WILL BE RESPONSIBLE FOR PROVIDING INFORMATION AND SUBMITTAL MATERIALS TO THE CONTRACTOR. THE CONTRACTOR WILL BE RESPONSIBLE FOR MAXIMIZING BIO DEGRADATION WITHIN THE SITE. THE CONTRACTOR IS RESPONSIBLE FOR RECEIVING AND UTILIZING ALL PROPERLY SUBMITTED DOCUMENTATION WITHIN TWO WEEKS OF SUBMISSION.

3. SUBMITTALS

3.1. ADDITIONAL SUBMITTAL INFORMATION IS PROVIDED IN THIS GENERAL NOTES AND REQUIREMENTS.

3.2. CONSTRUCTION DOCUMENTS: THE CONSTRUCTION DOCUMENTS ARE PROVIDED TO THE CONTRACTOR PRIOR TO PERFORMANCE OF ALL WORK.

4. AS-BUILT DRAWINGS

4.1. CONSTRUCTION DOCUMENTS: THE CONTRACTOR SHALL SUBMIT A CONSTRUCTION PLAN THAT DETAILS THE CONTRACTOR'S PROPOSED APPROACH TO THE PROJECT. THE CONSTRUCTION PLAN SHALL INCLUDE THE CONSTRUCTION DOCUMENTS. THE CONTRACTOR SHALL SUBMIT A CONSTRUCTION PLAN THAT DETAILS THE CONTRACTOR'S PROPOSED APPROACH TO THE PROJECT. THE CONSTRUCTION PLAN SHALL INCLUDE THE CONSTRUCTION DOCUMENTS.
8. TO BE CONSIDERED

9.3. TILLING:

10.1. APPLICABILITY:

10.3. REQUIREMENTS: TOPSOIL SHALL BE CONSIDERED CLAY, SLAG, CONCRETE.

GENERAL:

COMPLETE USING BORING FOR DEEP DEPTH AND DEBRIS, OR PLOWING IN A DEPTH OF 6 INCHES. SIX INCHES OF TOPSOIL SHALL BE CLEAR AND BE PAID AS ITEMIZED ON THE LIMIT OF WORK AREAS. THE TOPSOIL IS CURED AND REMOVED.

10.6. LOCAL BULK MATERIALS:

1. ON SITE MATERIALS TO BE USED IN SOUTH TANK FARM BERRYS

2. SOUTHWEST BUTLER QUARRY

3. CORNEJO AND SONS

4. APPROVED EQUAL

11. SOIL-WASTE MANAGEMENT

OWNERS REPRESENTATIVE WILL COMPLETE FIELD SCREENING OF AUGER CUTTINGS/SoILS PRIOR TO SEEDING. OWNERS REPRESENTATIVE WILL BE RESPONSIBLE TO KEEP ALL DOCUMENTATION ON THE PROJECT SITE.

11.4. DELIVERY:

AUGER CUTTINGS MUST BE DELIVERED TO THE PROJECT SITE AS SPECIFIED. EACH PASS OF AUGER CUTTINGS SHOULD BE BROADCAST AT A RATE OF 120 PLS PER ACRE. EACH PASS SHALL BE BROADCAST AT A RATE OF 120 PLS PER ACRE.

11.5. CULTIPACKING:

BE USED FOR EACH 1/4 TO 1/2 AN INCH OF COMPOSTINESS. PERPENDICULAR PASSES USING THE CULTIPACK ING ASSEMBLY OR CULTIPACK ING PRIO R TO DRI ll SEED ING IS REQU IRED IF SEEDING INITIATION. PROCEED ONLY AFTER THE CULTIPACKING IS COMPLETED. BE ADDED WHEN THE SEEDING IS COMPLETED.

11.6. SEEDING:

SEEDING MACHINERY IS NOT TO BE USED FOR BROADCASTING SEED. SEEDING MACHINERY IS NOT TO BE USED FOR BROADCASTING SEED.
13.1 GENERAL: PLANTS SHALL BE PLACED WITH LIKE PLANT MATERIAL.

13.2 EXCEPT FOR LIVE STAKES, SUBMITTAL AND TIMING REQUIREMENTS:

- SUBMITTAL: SEPTEMBER 1
- TIMING RESTRICTIONS: SPRING PLANTING SEASON FOR INDIVIDUAL TREES IDENTIFIED SOON AFTER THE PROJECT SITE IS MOWED, LIT-Up, AND PLANTED. THE VIGOROUS STOCK, WHEN PLANTED, SHALL BE PROTECTED FROM DAMAGE DUE TO FREEZING OR IRRIGATION.
- APPLICATION IN CASE OF DAMAGE TO TARGET SPECIES, DOES NOT SPRAY HERBICIDE SO HEAVY THAT IT DROPS OFF THE TARGET VEGETATION. HERBICIDE USED IS APPLIED TO GRASSES AND 2,4-D APPLIED TO BROAD LEAVED PLANTS.

16. MYCORRIZAL INOCULANT

16.1 GENERAL: THE ADDITION OF MYCORRIZAL INOCULANT TO SEEDING AREAS AND PLANTINGS IS CRITICAL TO ESTABLISH AND PROMOTE RHIZODEGRADATION.

16.2 APPLICATION: APPLY A GRANULAR INOCULANT FORMULATED WITH BOTH (AT LEAST 4 SPECIES) AND ECTO (AT LEAST 3 SPECIES) FORMULA. FORMULATION HAVE AT LEAST 600,000 AND 110 MILLION ECTO PROPAGULES PER POUND.

18. OXYGEN RELEASING MATERIAL (GMB)
### Potentia Vendor

1. [Panther Techologies](https://www.panthertechnologies.com)
   - Address: 330 Route 59 East, Suite B Somerville, NJ 08876
   - Phone: 908-714-2420

2. [Regenesis](https://www.regenesis.com)
   - Address: 151 Sally Donora, CA 92802
   - Phone: 949-366-8000

### Total Maintenance

**19.1.** General: Initial planting conditions towards the bottom of the deep planting hole(s) may be anerobic. The addition of compost to the planting media will aid available oxygen to promote plant establishment.

**19.2.** Type: Calcium carbonate or magnesium carbonate with at least 10% active oxygen.

**19.3.** Application base: 4.80 cc per cubic yard of planting media.

**19.4.** Subtotal: The contractor shall submit an original invoice for the ORM which must be on the vendor's letterhead and must detail the amount, type, and percent active oxygen contained in the formula.

**19.5.** Potential Vendors:

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panther Technologies</td>
<td>330 Route 59 East, Suite B Somerville, NJ 08876</td>
<td>908-714-2420</td>
</tr>
<tr>
<td>Regenesis</td>
<td>151 Sally Donora, CA 92802</td>
<td>949-366-8000</td>
</tr>
</tbody>
</table>

### Maintenance and Repairs

**20.1.** General: Maintenance shall be conducted as needed to maximize plant survival and minimize (or eliminate) contamination to the area of undesirable species and to promote site sustainability.

**20.2.** Maintenance Period: 2 growing seasons following installation.

**20.3.** Activities: Maintenance shall include watering, weeding, herbicide application, mowing, reseeding, control of insects, fungal infections, and other diseases by means of spraying with an approved insecticide or fungicide, and other horticultural operations necessary for the proper establishment of a healthy, viable landscape.

**20.4.** Vegetative Repairs: Maintenance and repairs to the vegetative cover shall be completed in areas of drill erosion with a depth of greater than 3 inches, and width greater than 3 feet. Repairs shall be completed on individual bare areas greater than 10 square feet. Costs of maintenance and repairs shall be at the expense to the owner. The contractor shall be responsible for the maintenance and repairs described herein until final acceptance of the project by the engineer.

### Landscaping Operations and Maintenance

See the landscape O&M plan for a more detailed overview of maintenance requirements.

### Tallgrass Prairie

**21.1.** Site Preparation (Non-compactated Areas):

- **Field Tilling**: 4 inches deep between August 25th and September 16th.

**21.2.** Fall Herbicide: Broad application 1 week after tilling.

**21.3.** Annual Cover Crop: Apply 2 to 12 days following herbicide application (see Specification 12).

**21.4.** First Spring Tilling: Till at 10 inches deep with a width of a 15% of the area of the tilling. Best performed after significant rain.

**21.5.** Spring Herbicide: Broad application 2 to 3 weeks after first tilling.

**21.6.** Broadcast Granular Mycorrhizal Inoculant A rate of 20 lbs per acre. Applied immediately following spring tilling. See specifications 16 and 17.

**21.7.** Additional Spring Tilling: Till at 6 inches deep one week after herbicide application.

**21.8.** Calibrating: Immediately following second spring tilling.

### Site Preparation (Compactated Areas):


**22.2.** Seed Schedule:

- **Drill Schedule**: Immediately after cutback in early May.

- **Drill Mix**: Prairie mix mixed with native mix.

- **Different Seed Mixes**: Shall be applied to two different zones 1.5 to 1.6 times heavier than zone 2.

### Tallgrass Prairie Seed Mix

<table>
<thead>
<tr>
<th>Field Mix</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% Misc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>Andropogon gerardii</td>
<td>Tallgrass Big Bluestem</td>
</tr>
<tr>
<td>15%</td>
<td>Panicum virgatum</td>
<td>Bluestem Big Bluestem</td>
</tr>
<tr>
<td>10%</td>
<td>Sorghastrum nutans</td>
<td>Indian Grass</td>
</tr>
<tr>
<td>10%</td>
<td>Schizachyrium scoparium</td>
<td>Little Bluestem</td>
</tr>
<tr>
<td>5%</td>
<td>Rotala curvifolia</td>
<td>Illinois Sweetgrass</td>
</tr>
<tr>
<td>5%</td>
<td>Schizachyrium scoparium</td>
<td>Little Bluestem</td>
</tr>
<tr>
<td>5%</td>
<td>Elymus canadensis</td>
<td>Canada Wildrye</td>
</tr>
<tr>
<td>5%</td>
<td>Panicum virgatum</td>
<td>Blackgirl Big Bluestem</td>
</tr>
</tbody>
</table>

### Tallgrass Prairie Seed Mix Zone 2 (10 lbs. per acre)

<table>
<thead>
<tr>
<th>Field Mix</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% Misc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>Andropogon gerardii</td>
<td>Tallgrass Big Bluestem</td>
</tr>
<tr>
<td>15%</td>
<td>Panicum virgatum</td>
<td>Bluestem Big Bluestem</td>
</tr>
<tr>
<td>10%</td>
<td>Sorghastrum nutans</td>
<td>Indian Grass</td>
</tr>
<tr>
<td>10%</td>
<td>Schizachyrium scoparium</td>
<td>Little Bluestem</td>
</tr>
<tr>
<td>5%</td>
<td>Rotala curvifolia</td>
<td>Illinois Sweetgrass</td>
</tr>
<tr>
<td>5%</td>
<td>Schizachyrium scoparium</td>
<td>Little Bluestem</td>
</tr>
<tr>
<td>5%</td>
<td>Elymus canadensis</td>
<td>Canada Wildrye</td>
</tr>
<tr>
<td>5%</td>
<td>Panicum virgatum</td>
<td>Blackgirl Big Bluestem</td>
</tr>
</tbody>
</table>

### Watering

**21.4.1.** Water until soil surface is saturated immediately following seeding. Ensure the area receives the equivalent of 1 inch of water per week to help establish the initial plantings. Additional water may be required for continued survival of the plantings for three weeks post-seeding then cease watering unless dry conditions occur. Dry conditions are defined as three consecutive weeks with less than 6 inches of rain. Irrigate at a rate of 0.5 inches per week until dry conditions abate on the growing season ends in September.

**21.4.2.** Contractor to assume for building purposes that adequate irrigation is available in the BMP (basis for irrigation needs). See O&M plan.

### Petal Maintenance (2 Years):

**21.5.1.** Year 1 - weeds reach 10 to 12 inches high (21-20 weeks post-seeding) Mow 2.4 ft. High with a rotary mower then mow 2 to 3 ft. High every 3 weeks with a mower from September 10th.

**21.5.2.** Year 2 - Mowing: Mow in late May/June to 6-8 inches high using a flat mower.

**21.5.3.** Apply Herbicide as necessary to prevent invasion of invasive species (see Specification 18). At least one round of spot herbicide application is recommended in the first two years to prevent invasion of undesirable species.

**21.5.4.** Replacement bare areas greater than 15 square feet shall be treated each October with the area specified seed mix and mulched.

### Oak Savannah


**22.1.** Site Preparation (Compactated Areas): See Specification 9.4.

**22.2.** Seed Mix: See Specification 21.3.

---

24. DEEP PLANTING (SHRUB,LAND 2.37 ACRES)

24.1. SITE PREPARATION (NON-COMPACTED AREAS): SAME AS SPECIFICATION 21.1.1

24.2. INITIAL MAINTENANCE (2 YEARS): SEE SPECIFICATION 21.1.1

24.3. PLANT SCHEDULE:

24.3.1. PLANTING:

24.3.2. PLANTING LIVES (STAKES):

24.4.3. SEEDLING PLANTING:

24.5. DEEP PLANTING:

24.5.1. SITE PREPARATION (COMPACTED AREAS): SAME AS SPECIFICATION 21.1.1

24.5.2. PLANT SCHEDULE:

24.5.3. PLANTING:

24.5.4. PLANTING LIVES (STAKES):

24.5.5. SEEDLING PLANTING:

24.5.6.ボードプレート（あるいは）プレートの数に付けるべきものである。

24.5.7. PLANTING:

24.5.8. PLANTING LIVES (STAKES):

24.5.9. SEEDLING PLANTING:

24.6. DEEP PLANTING:

24.6.1. SITE PREPARATION (COMPACTED AREAS): SAME AS SPECIFICATION 21.1.1

24.6.2. PLANT SCHEDULE:

24.6.3. PLANTING:

24.6.4. PLANTING LIVES (STAKES):

24.6.5. SEEDLING PLANTING:

24.6.6.ボードプレート（あるいは）プレートの数に付けるべきものである。

24.6.7. PLANTING:

24.6.8. PLANTING LIVES (STAKES):

24.6.9. SEEDLING PLANTING:
<table>
<thead>
<tr>
<th>Lab ID</th>
<th>Sample ID</th>
<th>Date/Time</th>
<th>pH</th>
<th>Mehlich P</th>
<th>K ppm</th>
<th>Ca ppm</th>
<th>Mg ppm</th>
<th>Na ppm</th>
<th>Summation CEC meq/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-1</td>
<td>301211</td>
<td>P-01 (6&quot;)</td>
<td>7/21/2016 - 1020</td>
<td>7.46</td>
<td>317</td>
<td>184.7</td>
<td>4607.6</td>
<td>200.1</td>
<td>53.0</td>
</tr>
<tr>
<td>T1-2</td>
<td>301212</td>
<td>P-01 (18&quot;)</td>
<td>7/21/2016 - 1025</td>
<td>7.33</td>
<td>217</td>
<td>144.6</td>
<td>4805.3</td>
<td>198.7</td>
<td>116.5</td>
</tr>
<tr>
<td>T1-3</td>
<td>301213</td>
<td>P-02 (6&quot;)</td>
<td>7/21/2016 - 1050</td>
<td>7.80</td>
<td>5.7</td>
<td>314.6</td>
<td>4451.4</td>
<td>494.4</td>
<td>94.8</td>
</tr>
<tr>
<td>T1-4</td>
<td>301214</td>
<td>P-02 (18&quot;)</td>
<td>7/21/2016 - 1055</td>
<td>7.87</td>
<td>7.0</td>
<td>164.6</td>
<td>5252.2</td>
<td>310.3</td>
<td>116.0</td>
</tr>
<tr>
<td>T1-5</td>
<td>301215</td>
<td>P-03 (6&quot;)</td>
<td>7/21/2016 - 1110</td>
<td>8.10</td>
<td>3.8</td>
<td>140.7</td>
<td>5363.9</td>
<td>266.2</td>
<td>113.9</td>
</tr>
<tr>
<td>T1-6</td>
<td>301216</td>
<td>P-03 (18&quot;)</td>
<td>7/21/2016 - 1115</td>
<td>7.81</td>
<td>1.3</td>
<td>224.7</td>
<td>5755.0</td>
<td>378.9</td>
<td>190.0</td>
</tr>
<tr>
<td>T1-7</td>
<td>301217</td>
<td>P-04 (6&quot;)</td>
<td>7/21/2016 - 1140</td>
<td>8.26</td>
<td>13.3</td>
<td>279.0</td>
<td>3034.7</td>
<td>465.8</td>
<td>913.8</td>
</tr>
<tr>
<td>T1-8</td>
<td>301218</td>
<td>P-04 (18&quot;)</td>
<td>7/21/2016 - 1145</td>
<td>8.08</td>
<td>6.1</td>
<td>264.7</td>
<td>2713.0</td>
<td>430.2</td>
<td>821.1</td>
</tr>
<tr>
<td>T1-9</td>
<td>301219</td>
<td>P-05 (6&quot;)</td>
<td>7/21/2016 - 1310</td>
<td>7.71</td>
<td>8.8</td>
<td>231.3</td>
<td>5713.6</td>
<td>312.4</td>
<td>297.8</td>
</tr>
<tr>
<td>T1-10</td>
<td>301220</td>
<td>P-05 (18&quot;)</td>
<td>7/21/2016 - 1315</td>
<td>7.43</td>
<td>9.7</td>
<td>191.4</td>
<td>4225.5</td>
<td>436.9</td>
<td>271.5</td>
</tr>
<tr>
<td>T1-11</td>
<td>301221</td>
<td>P-06 (6&quot;)</td>
<td>7/21/2016 - 1330</td>
<td>7.46</td>
<td>1.9</td>
<td>198.4</td>
<td>3978.8</td>
<td>561.7</td>
<td>49.6</td>
</tr>
<tr>
<td>T1-12</td>
<td>301222</td>
<td>P-06 (18&quot;)</td>
<td>7/21/2016 - 1335</td>
<td>5.00</td>
<td>9.3</td>
<td>95.8</td>
<td>743.3</td>
<td>66.4</td>
<td>9.5</td>
</tr>
<tr>
<td>T1-13</td>
<td>301223</td>
<td>P-07 (6&quot;)</td>
<td>7/21/2016 - 1350</td>
<td>7.72</td>
<td>8.3</td>
<td>275.3</td>
<td>5321.6</td>
<td>479.9</td>
<td>409.1</td>
</tr>
<tr>
<td>T1-14</td>
<td>301224</td>
<td>P-07 (18&quot;)</td>
<td>7/21/2016 - 1355</td>
<td>7.80</td>
<td>4.4</td>
<td>314.2</td>
<td>5314.1</td>
<td>289.7</td>
<td>344.0</td>
</tr>
<tr>
<td>T1-15</td>
<td>301225</td>
<td>P-08 (6&quot;)</td>
<td>7/21/2016 - 1410</td>
<td>7.88</td>
<td>3.5</td>
<td>235.4</td>
<td>5639.9</td>
<td>389.8</td>
<td>52.0</td>
</tr>
<tr>
<td>T1-16</td>
<td>301226</td>
<td>P-08 (18&quot;)</td>
<td>7/21/2016 - 1415</td>
<td>7.75</td>
<td>1.5</td>
<td>244.7</td>
<td>5324.3</td>
<td>558.3</td>
<td>94.6</td>
</tr>
<tr>
<td>T1-17</td>
<td>301227</td>
<td>P-09 (6&quot;)</td>
<td>7/21/2016 - 1440</td>
<td>8.19</td>
<td>1.1</td>
<td>79.1</td>
<td>4130.7</td>
<td>113.9</td>
<td>42.7</td>
</tr>
<tr>
<td>T1-18</td>
<td>301228</td>
<td>P-09 (18&quot;)</td>
<td>7/21/2016 - 1445</td>
<td>7.90</td>
<td>3.6</td>
<td>103.8</td>
<td>3933.8</td>
<td>96.2</td>
<td>49.5</td>
</tr>
<tr>
<td>T1-19</td>
<td>301229</td>
<td>P-10 (6&quot;)</td>
<td>7/21/2016 - 1510</td>
<td>7.80</td>
<td>3.1</td>
<td>207.6</td>
<td>5200.1</td>
<td>528.9</td>
<td>184.2</td>
</tr>
<tr>
<td>T1-20</td>
<td>301230</td>
<td>P-10 (18&quot;)</td>
<td>7/21/2016 - 1515</td>
<td>7.63</td>
<td>5.1</td>
<td>127.4</td>
<td>4237.9</td>
<td>284.9</td>
<td>393.8</td>
</tr>
<tr>
<td>T1-21</td>
<td>301231</td>
<td>P-11 (6&quot;)</td>
<td>7/21/2016 - 1530</td>
<td>7.93</td>
<td>5.7</td>
<td>196.2</td>
<td>4945.9</td>
<td>569.1</td>
<td>205.5</td>
</tr>
<tr>
<td>T1-22</td>
<td>301232</td>
<td>P-11 (18&quot;)</td>
<td>7/21/2016 - 1535</td>
<td>7.61</td>
<td>7.0</td>
<td>134.0</td>
<td>4091.2</td>
<td>434.9</td>
<td>376.9</td>
</tr>
<tr>
<td>T1-23</td>
<td>301233</td>
<td>P-12 (6&quot;)</td>
<td>7/21/2016 - 1550</td>
<td>8.03</td>
<td>199.</td>
<td>153.1</td>
<td>4750.9</td>
<td>333.1</td>
<td>174.0</td>
</tr>
<tr>
<td>T1-24</td>
<td>301234</td>
<td>P-12 (18&quot;)</td>
<td>7/21/2016 - 1555</td>
<td>7.83</td>
<td>411</td>
<td>200.9</td>
<td>4867.3</td>
<td>348.9</td>
<td>270.0</td>
</tr>
<tr>
<td>T2-1</td>
<td>301235</td>
<td>P-13 (6&quot;)</td>
<td>7/21/2016 - 1560</td>
<td>7.49</td>
<td>325</td>
<td>182.9</td>
<td>4625.0</td>
<td>206.3</td>
<td>55.9</td>
</tr>
<tr>
<td>T2-2</td>
<td>301236</td>
<td>P-13 (18&quot;)</td>
<td>7/21/2016 - 1565</td>
<td>6.67</td>
<td>1.6</td>
<td>204.7</td>
<td>3506.0</td>
<td>610.0</td>
<td>105.5</td>
</tr>
<tr>
<td>T2-3</td>
<td>301237</td>
<td>P-14 (6&quot;)</td>
<td>7/21/2016 - 1570</td>
<td>8.01</td>
<td>199.</td>
<td>146.4</td>
<td>4694.1</td>
<td>322.4</td>
<td>172.6</td>
</tr>
</tbody>
</table>
QC's are duplicates of highlighted samples for quality control checks.

ND= not detectable (<0.1% N)
<table>
<thead>
<tr>
<th>Sample</th>
<th>OM-LOI %</th>
<th>Cu ppm</th>
<th>Fe ppm</th>
<th>Mn ppm</th>
<th>Zn ppm</th>
<th>Sand %</th>
<th>Silt %</th>
<th>Clay %</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-1</td>
<td>5.49</td>
<td>50.9</td>
<td>32.3</td>
<td>4.1</td>
<td>10.4</td>
<td>26</td>
<td>42</td>
<td>32</td>
</tr>
<tr>
<td>T1-2</td>
<td>4.57</td>
<td>6.8</td>
<td>29.5</td>
<td>4.2</td>
<td>2.2</td>
<td>36</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>T1-3</td>
<td>3.64</td>
<td>2.1</td>
<td>32.5</td>
<td>5.9</td>
<td>1.2</td>
<td>16</td>
<td>44</td>
<td>40</td>
</tr>
<tr>
<td>T1-4</td>
<td>4.81</td>
<td>4.8</td>
<td>34.9</td>
<td>5.6</td>
<td>3.0</td>
<td>36</td>
<td>34</td>
<td>30</td>
</tr>
<tr>
<td>T1-5</td>
<td>3.92</td>
<td>4.0</td>
<td>25.8</td>
<td>8.5</td>
<td>4.5</td>
<td>18</td>
<td>48</td>
<td>34</td>
</tr>
<tr>
<td>T1-6</td>
<td>2.22</td>
<td>1.2</td>
<td>9.0</td>
<td>10.0</td>
<td>0.3</td>
<td>10</td>
<td>38</td>
<td>52</td>
</tr>
<tr>
<td>T1-7</td>
<td>1.55</td>
<td>1.9</td>
<td>34.0</td>
<td>10.1</td>
<td>9.7</td>
<td>18</td>
<td>48</td>
<td>34</td>
</tr>
<tr>
<td>T1-8</td>
<td>1.17</td>
<td>1.8</td>
<td>28.1</td>
<td>13.9</td>
<td>0.6</td>
<td>22</td>
<td>46</td>
<td>32</td>
</tr>
<tr>
<td>T1-9</td>
<td>3.04</td>
<td>26.9</td>
<td>41.8</td>
<td>15.4</td>
<td>30.5</td>
<td>40</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>T1-10</td>
<td>7.71</td>
<td>5.5</td>
<td>141.3</td>
<td>113.1</td>
<td>14.6</td>
<td>18</td>
<td>50</td>
<td>32</td>
</tr>
<tr>
<td>T1-11</td>
<td>3.05</td>
<td>1.4</td>
<td>23.7</td>
<td>9.2</td>
<td>0.6</td>
<td>14</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>T1-12</td>
<td>1.76</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.1</td>
<td>46</td>
<td>44</td>
<td>10</td>
</tr>
<tr>
<td>T1-13</td>
<td>2.75</td>
<td>2.1</td>
<td>38.3</td>
<td>15.9</td>
<td>0.6</td>
<td>12</td>
<td>42</td>
<td>46</td>
</tr>
<tr>
<td>T1-14</td>
<td>2.37</td>
<td>5.4</td>
<td>37.1</td>
<td>5.3</td>
<td>7.1</td>
<td>18</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>T1-15</td>
<td>3.43</td>
<td>29.1</td>
<td>43.6</td>
<td>7.1</td>
<td>18.6</td>
<td>30</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>T1-16</td>
<td>3.21</td>
<td>6.2</td>
<td>22.1</td>
<td>3.8</td>
<td>2.6</td>
<td>28</td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>T1-17</td>
<td>2.50</td>
<td>1.5</td>
<td>12.2</td>
<td>5.7</td>
<td>0.5</td>
<td>14</td>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>T1-18</td>
<td>1.47</td>
<td>4.8</td>
<td>20.3</td>
<td>3.8</td>
<td>2.3</td>
<td>48</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td>T1-19</td>
<td>1.42</td>
<td>5.5</td>
<td>45.9</td>
<td>8.3</td>
<td>11.6</td>
<td>70</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>T1-20</td>
<td>2.77</td>
<td>5.5</td>
<td>25.4</td>
<td>7.9</td>
<td>1.2</td>
<td>16</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>T1-21</td>
<td>2.86</td>
<td>1.8</td>
<td>44.8</td>
<td>9.3</td>
<td>1.2</td>
<td>14</td>
<td>50</td>
<td>36</td>
</tr>
<tr>
<td>T1-22</td>
<td>2.56</td>
<td>2.0</td>
<td>21.5</td>
<td>3.9</td>
<td>0.0</td>
<td>16</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>T1-23</td>
<td>3.41</td>
<td>3.3</td>
<td>113.1</td>
<td>27.4</td>
<td>3.0</td>
<td>24</td>
<td>42</td>
<td>34</td>
</tr>
<tr>
<td>T1-24</td>
<td>2.78</td>
<td>0.5</td>
<td>52.0</td>
<td>34.2</td>
<td>1.6</td>
<td>26</td>
<td>42</td>
<td>32</td>
</tr>
<tr>
<td>T2-1</td>
<td>5.79</td>
<td>28.5</td>
<td>43.2</td>
<td>5.3</td>
<td>17.2</td>
<td>26</td>
<td>42</td>
<td>32</td>
</tr>
<tr>
<td>T2-2</td>
<td>5.10</td>
<td>47.9</td>
<td>73.8</td>
<td>6.2</td>
<td>40.4</td>
<td>26</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>T2-3</td>
<td>5.40</td>
<td>53.2</td>
<td>33.9</td>
<td>4.6</td>
<td>11.3</td>
<td>26</td>
<td>42</td>
<td>32</td>
</tr>
<tr>
<td>T2-4</td>
<td>2.68</td>
<td>2.2</td>
<td>39.8</td>
<td>16.7</td>
<td>0.6</td>
<td>15</td>
<td>42</td>
<td>46</td>
</tr>
<tr>
<td>T2-5</td>
<td>5.74</td>
<td>29.7</td>
<td>45.3</td>
<td>6.0</td>
<td>17.9</td>
<td>26</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>T2-6</td>
<td>1.65</td>
<td>1.5</td>
<td>21.5</td>
<td>3.9</td>
<td>1.0</td>
<td>16</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>T2-7</td>
<td>2.59</td>
<td>0.5</td>
<td>47.1</td>
<td>32.0</td>
<td>1.5</td>
<td>48</td>
<td>42</td>
<td>10</td>
</tr>
<tr>
<td>T2-8</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
</tbody>
</table>