Project Name:
Garden Creek Remediation

From:

Date:
November 9, 2018

To:

DRAFT

t, MD 6-1
T

cc:

Memo

Subject: Design Basis for Site-Wide Soil Vapor Extraction – 30% Design Milestone
Garden Creek Natural Gas Condensate Release

This document updates the basis for the design of a site-wide soil vapor extraction (SVE) system for remediation of a subsurface release of natural gas condensate at ONEOK's Garden Creek Facility (Facility) in McKenzie County, North Dakota. The original, draft Design Basis Memo (DBM), dated August 31, 2018, is provided for reference as Attachment 1. The contents of this memo comprise the 30 percent (%) design deliverable, which includes information and decisions from a pre-design meeting with ONEOK on September 27, 2018. Notes from this meeting conducted at the Garden Creek Plant are included as Attachment 2.

The purpose of the 30% design milestone is to identify and manage changes to the design basis, and to verify that the initial work products reflect ONEOK's expectations before investing extensive time and money in completing the design to a nearly-final level. The 30% design includes the following components:

- Conceptual Design
  - Preliminary System Layout
  - Process Flow Diagram
  - Preliminary Material Balances
  - List of Major Equipment
  - Site Plan with Remediation Areas
  - Preliminary Well Head Concept
- Discussion of newly-identified engineering alternatives
- List of Specifications
- List of Drawings
- Preliminary Schedule

Conceptual Design

General Description

The proposed site-wide Garden Creek Soil Vapor Extraction system is being designed to reduce source mass to the "extent practicable", with specific light non-aqueous phase liquid (LNAPL) performance criteria of: (1) nearly complete (e.g. greater than 90%) coverage of the LNAPL body, and (2) SVE-enhanced source reduction rates 2 to 4 times greater than estimated natural source zone depletion (NSZD) rates. Additional soil gas performance criteria include: (1) prevent employee exposure above OSHA limits - concentrations of volatile organic compounds (VOCs) and especially benzene in Operations areas

around the SVE discharge locations shall not be elevated beyond health-based action limits by SVE system operation; and (2) mitigate soil gas impacts - the SVE system will prevent lower-explosive-limit (LEL) conditions from occurring in enclosed process areas and neighboring properties where soil gas impacts have the potential to present a risk to operations or human health.

To meet the general performance criteria, the major design inputs include:

- SVE well construction: vertical wells with surface completions (with exceptions as noted below)
- Design hydrocarbon removal: up to 5,500,000 gallons based upon an ORM estimate of approximately 11 million gallons released*
- Operation lifetime: approximately 15 years
- Maximum flow rate per well: 20 standard cubic feet per minute (scfm)
- Minimum flow rate per well: 10 scfm
- Estimated minimum vacuum applied at the well heads based on friction loss calculations: 15 inches of water column
- Calculated Radius of Influence (ROI) for SVE wells: 125 – 150 feet.
- Proposed number of extraction wells: 35 (existing and new)
- Total process flow rate: 680 scfm
- Soil gas composition: refer to the draft process flow diagram provided in Appendix A
- Range of heating values from extracted soil gas: 0 to 450 British thermal unit (Btu)/scf

*The design hydrocarbon removal is based on concurrent LNAPL depletion by enhanced source zone attenuation followed by conjunctive natural source zone depletion, with an active treatment time of approximately 15 years and passive treatment time of approximately 20 additional years. Uncertainty in the volume of the original release and the rates of active and passive removal make a guarantee of the volume of condensate recovered infeasible to provide.

Based on input from the pre-design meeting with ONEOK, conceptual design for achieving the project objectives with the given inputs consists of installing a network of vertical SVE wells to provide ROI coverage of the LNAPL body in the Train 1 area of the Garden Creek Plant. Vapor extraction and treatment equipment will be located in a new compound area located outside of the designated process areas (i.e. fence lines) to minimize or eliminate daily work permitting for system operations and maintenance (O&M) activities. SVE wells will be connected to the extraction equipment via vacuum piping installed above grade, without heat tracing or insulation. Manual management of the condensation in the extraction piping will be required. Pipe routes will use existing pipe racks and fences where practical, and will extend overland using low pipe stands where required, following the example of the existing liquid recovery piping. Extraction equipment will include a blower to extract soil vapors and to pump the vapor discharge through the treatment system. Treatment options include VOC destruction using a vapor combustor or similar technology or recovery using a refrigeration process.

The following sections provide a more detailed description of the 30% conceptual design for review by ONEOK.

System Layout

The consensus reached at the pre-design meeting was to install vertical SVE wells of the same general design and construction as existing SVE, liquid recovery, and monitoring wells installed at the plant. Preliminary system layouts provided in Appendix B show an SVE well network made up of:

- 21 new or existing SVE wells, including well SVE-3 installed in October of 2018.
- 13 existing liquid recovery wells that will be repurposed as SVE wells.
- 12 air induction wells, including seven (7) new wells and five (5) existing recovery or monitoring wells repurposed as induction wells. Air induction wells will be constructed like SVE wells but open to the atmosphere to passively allow air to enter the subsurface, improving air flow and oxygenation in the vadose zone. Movement of air into these wells will be driven by the subsurface vacuum applied the other SVE well locations. Air induction wells have been added to promote remediation in areas that are not well covered by idealized zones of influence due to layout constraints.