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Consultants in Natural Resources and the Environment

Source Area Remedial Action Work Plan
Thornton Shopping Center
East 88th Avenue and Washington Street
Thornton, Colorado

EPA ID COR000212639
Compliance Order on Consent Number: 24-02-01-01

Prepared for—

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1.0 Introduction

This Source Area Remedial Action Work Plan (SA-RAWP) is submitted on behalf of the Thornton Development Authority (TDA), consistent with ERO's May 2024 Remedial Investigation and Corrective Measures Work Plan (Work Plan) (ERO 2024a), approved by the Colorado Department of Public Health and Environment (CDPHE) through the Hazardous Materials and Waste Management Division (Division) on July 3, 2024 (CDPHE 2024). The submittal of this report is consistent with Paragraph 23 of the Compliance Order on Consent (Consent Order) Number 24-02-01-01 between the TDA and the Division. The Consent Order outlines the compliance and schedule requirements for the remediation of the 15.86-acre Thornton Shopping Center, located at the northeast corner of East 88th Avenue and Washington Street in Thornton, Colorado. Within this report, "TSC Property" refers to the Thornton Shopping Center real property as shown on the attached figures, whereas "Site" refers to the extent of known impacts to the TSC Property as well as off-site areas associated with the historical release of tetrachloroethene (PCE) on the TSC Property. The TSC Property is shown on Figure 1.

The purpose of this SA-RAWP is to outline the source area remedial actions proposed to address shallow source area soil contamination. The most recent supplemental source area characterization conducted in the fall-winter 2024-2025 was presented in the Supplemental Source Area Characterization Plan – Implementation Report (SSACP-IR) prepared by ERO and submitted to the Department on February 14, 2025 (ERO 2025a) and approved by CDPHE on March 28, 2025 (CDPHE 2025). The SSACP-IR detailed additional characterization conducted in areas that were previously inaccessible within and adjacent to the primary source area at 8866 North Washington Street, as well as a suspected secondary PCE release area at the former dry cleaners at 8946 North Washington Street. In addition, areas of the sanitary sewer system on and off the TSC Property were evaluated for potential release points.

1.1 Location and Physical Setting

The TSC Property is located at the northeast corner of East 88th Avenue and North Washington Street in Thornton, Colorado, generally in the SW 1/4 of Section 23, Township 2 South, Range 68 West of the 6th Principal Meridian. The TSC Property elevation is approximately 5,300 feet above mean sea level (AMSL) at the former shopping center building location. The land area is generally flat within the on-site areas of the TSC Property, with the off-site areas having a topographic slope downward to the northeast, north of the former shopping center building, and to the southeast, south of the former shopping center building.

The TSC Property is zoned for commercial land use. The building demolition was completed by July 2024; the original asphalt parking lot and concrete building foundations remain. The TSC Property is bounded on the north by commercial development; to the east by Corona Street followed by single and multi-family residential development; to the south by East 88th Avenue and commercial development, with multi-family and single-family development to the southeast – within unincorporated areas of Adams County; and by North Washington Street and commercial development to the west.

Historical records indicate the TSC Property was primarily used for agricultural land use until it was first developed with a commercial shopping center. The TSC Property buildings were constructed between 1955 and 1979 and were used for retail businesses, including multiple dry cleaners, an automotive parts and repair facility, a laundromat, a gasoline station, restaurants, and other retail stores until vacated in 2023. Historical records indicate three dry cleaners are known to have operated on the TSC Property since the 1960s at the addresses of 8866, 8876, and 8946 North Washington Street (ERO 2022). No dry cleaners currently operate on the TSC Property, and all buildings have been removed.

1.2 Supplemental Source Area Characterization

Previous site characterization identified areas of significant PCE contaminant mass within the footprint of the former dry cleaner facility at 8866 North Washington Street as well as in the southern rear of the facility, coincident with the sanitary sewer system that formerly served the shopping center. The details of the supplemental characterization are presented in ERO's SSACP-IR (ERO 2025a) and a brief summary that supports further remedial actions is presented below.

1.2.1 2024 Shallow Soil Characterization

In 2024, ERO installed 52 shallow soil borings using direct-push technology (DPT) to drill to bedrock refusal, generally encountered between 18 and 24 feet below ground surface (bgs), as described in the SSACP-IR (Figure 2; ERO 2025a). The SSACP-IR detailed perimeter borings that defined the lateral extent of shallow soil PCE contamination to the north, east and west. Deeper soil contamination, at the depths of mechanical refusal to DTP, was documented along the south and southeasterly portions of the investigation area and are consistent with deep contaminant concentrations previously reported southeast of the investigation area (LTE 2017). The SSACP-IR confirmed two general source areas associated with the 8866 North Washington Street unit – one within the central portion of the former dry cleaner (Boring C+2, Figure 2) with PCE concentrations in composite soil samples up to 348 milligrams per kilogram (mg/kg); and a second beneath the former sanitary sewer lines south of the facility (borings F-6, Figure 2), where PCE concentrations were detected up to 460 mg/kg at 11 feet bgs, below the invert elevation of the sewer lines. Waste characterization samples collected during the investigation identified the source area soils within the footprint of the former dry cleaner at 8866 North Washington as likely being hazardous for PCE, with soils from 15 to 20 feet bgs failing the Toxicity Characteristic Leaching Procedure (TCLP) for PCE. The remaining soils sampled for waste characterization purposes did not exceed TCLP limits or did not exceed work plan screening levels that would have triggered further TCLP testing.

1.2.2 Deep Soil Borings

Additional assessment to further delineate the deep PCE source mass for evaluation and design of treatment alternatives was conducted around the perimeter of the source area, as presented in the SSACP-IR (ERO 2025a). Because of the significant PCE soil concentrations within the shallow source area discussed above, ERO and TDA proposed delaying the deeper, vertical delineation of source area PCE soils until after the removal of the overlying soils to limit the potential for vertical cross-contamination of shallow PCE into deeper bedrock zones. Three perimeter deep soil borings were completed as part of the SSACP, delaying the two deeper borings. CDPHE approved this approach and the deep borings are anticipated to be conducted upon completion of the source area excavation detailed in this plan.

1.3 8946 North Washington Street Assessment

A dry cleaner operated at 8946 North Washington Street since at least 1980 (ERO 2022). To assess the subsurface conditions at this location and as part of the SSACP, ERO installed six soil borings within the footprint of the building (borings 8946-1 through 8946-7), one outside the rear door of the facility (boring 8946-8) and two borings along the sanitary sewer line as it exits the building and joins the main line (borings 8946-9 and 8946-10) (Figure 5). Two borings (8946-2 and 8946-6) were completed as groundwater monitoring wells and incorporated into the site-wide groundwater monitoring. The results of the assessment are detailed in the SSACP-IR (ERO 2025) and identified PCE soil contamination beneath the building in the location of the former dry cleaning machine.

In general, PCE soil concentrations within the 8946 North Washington Street unit ranged from below detection limits to a maximum of 0.14 mg/kg at a depth of 13 feet bgs. None of the soil borings from the exterior or along the sanitary sewer line from the facility (8946-8 through 8946-10) contained detectable PCE in soils. Groundwater results indicate that the former dry cleaner is a source of localized PCE groundwater contamination with PCE concentrations of 1.38 milligrams per Liter (mg/L) in 8946-2 and 0.502 mg/L in 8946-6 in 2025 (ERO 2025b).

Based on results of the assessment, the SSACP-IR concluded that a release from this unit, separate from the release identified at the 8866 North Washington Street unit, resulted in detectable concentrations of PCE in soils and groundwater contamination above current standards. The soil characterization data did not appear to indicate the release was to the sanitary sewer or was influenced by the sanitary sewer utility corridor. Current and historical groundwater data indicates the groundwater contamination remains defined to the north and south by existing wells, but the easterly extent remains undefined by the current groundwater monitoring well network (ERO 2025b).

1.4 Geology

1.4.1 Shallow Geology

Site geology is summarized from the numerous site investigations that have occurred since 2006. In general, subsurface lithology consists of a 5- to 10-foot thick layer of clay to sandy clay overlying heavily weathered claystone and siltstone bedrock with interbeds of siltstone and sandstone (referred to as the “Denver Formation”). The heavily weathered Denver Formation bedrock ranges from 15 to 20 feet thick and transitions to zones of more competent, less weathered claystones and siltstones at depths of about 23 to 30 feet bgs.

1.4.2 Deep Geology

In general, deep geology beneath the heavily weathered Denver Formation claystones and siltstones consists of less-weathered, competent claystone with interbeds of siltstone and sandstone. A sandstone lens appears to be located at 30-40 feet in the central area of the site with limited lateral extents. A grey to blue-grey, unweathered Denver Formation ("Denver Blue") siltstone has been encountered at depths of 55 to 60 feet beneath the site (ERO 2025a).

1.5 Conceptual Site Model

Releases of the chlorinated dry cleaning solvent PCE have occurred in the 8866 North Washington Street unit as well as potentially within the 8876 North Washington Street unit potentially as early as the early 1960s. Previous reports have calculated approximately 2,140 pounds (approximately 150 gallons) of PCE were released into the subsurface and that approximately 74% of this mass exists within the primary source area (RETTEW 2019). Upon release, free-phase PCE solvent (a dense non-aqueous phase liquid, or DNAPL) migrated downward through the 5- to 10-foot thick clayey to sandy-clayey soils and encountered the upper portions of the heavily weathered bedrock beneath. Within the primary source area, groundwater can be as shallow as 11 feet bgs and portions of the PCE solvent dissolved into the groundwater when it came in contact. The dissolved PCE then migrated to the southeast with the shallow groundwater flow, also partitioning out of solution and sorbing to the clay matrix in the aquifer. The free-phase PCE continued to migrate downward through the weathered bedrock by gravity through preferential pathways such as joints, fractures, and bedding planes. As the free-phase PCE continued to move vertically downward, it continued to dissolve in groundwater and sorbing to the clay matrix, thereby reducing the solvent mass and increasing the dissolved concentrations. Vertical PCE movement continued until either the PCE was depleted, or it encountered an impermeable layer such as competent, unweathered claystone. Based on site characterization data, the original 8866 North Washington Street unit appears to be the primary source area of release of PCE contributing to groundwater contamination.

The former sanitary sewer service laterals for the 8866 North Washington Street unit and adjacent units exit out the south/rear of the facility and connect to the facility sanitary main at one of several manholes south of the facility (Figure 2). The sanitary sewer flowed easterly behind the building, then north, beneath the building and then easterly off-site to connections in Corona Street. Based on the distribution of PCE in groundwater and site characterization data, there is no indication that the sanitary sewer main acted as preferential migration pathway to areas north of the dry cleaning unit. Site characterization data indicates soils within the area of the sewer laterals contain elevated PCE concentrations at depths of 11 feet bgs and deeper, indicating that the laterals appear to have acted as significant, secondary source of PCE releases at the facility.

If not removed, residual PCE mass in the source areas will continue to dissolve into groundwater and contribute to long-term groundwater impact on and off the TSC property.

2.0 Source Area Remedial Action Plan

Based on the elevated PCE concentrations in source area soils, the lack of significant contaminant degradation from previous remedial actions, and the removal of the former shopping center building, source area remediation will be the primary mechanism to reduce contaminant mass and off-site contaminant migration. This section describes the alternatives evaluated to conduct source area remedial actions and presents the conceptual work plans for the preferred alternatives. In general, the proposed source area remedial action work plan consists of the following principal corrective action measures:

1. Downgradient Control
2. Source Removal (8866 North Washington Street)
3. Secondary Source Removal (8946 North Washington Street)
4. Sanitary Sewer Removal
5. Performance Monitoring

2.1 Downgradient Control

The purpose of downgradient control is to minimize the off-site migration of contaminants in groundwater during and after source area remedial activities.

Three primary alternatives were identified that could provide downgradient control:

Biobarrier Wall – Construction of a mulch or similar barrier wall around the perimeter of the downgradient facility boundary through which contaminated groundwater would flow and be subject to treatment.

In-situ Injection Barrier – Install a series of injection wells and actively inject a carbon substrate into the geologic formation to create a similar treatment barrier through which contaminated groundwater would flow and be subject to treatment by enhanced reductive dechlorination (ERD).

E-Redox Mesh Network – Install a network of E-Redox® wells to create a network of low-voltage electrodes to establish a treatment zone through which contaminated groundwater would flow and be subject to treatment.

2.1.1 Barrier Treatment Wall

2.1.1.1 Overview

A barrier treatment wall system would provide the long term, continual passive treatment of site groundwater leaving the property. The wall would intercept groundwater within the natural flow path and treat groundwater within a permeable biological treatment zone. The depth of a treatment wall would be limited to accessible depths and is generally considered to be similar to the depth of shallow soil injections, or about 23 feet bgs.

2.1.1.2 Conceptual Design

The conceptual design of a barrier wall, for remedial action evaluation purposes, would consist of the following:

- 500 foot length along the south and easterly sides of the TSC property with a 3-foot wide footprint.
- Depth of excavation would be between 20 and 23 feet initially within the footprint of the wall, depending on technology for installation.
- Replaced soils below 12 feet bgs would consist of a mix of organic material and sand/glass cullet with structural fill placed on top.
- Permanent injection wells would be installed within the footprint of the wall for injection of treatment solution/amendment.

2.1.1.3 Operations and Maintenance

Once installed, operation and maintenance of a barrier bio-wall is anticipated to be negligible. Long-term maintenance is anticipated to consist of periodic injections of treatment solutions and/or amendments based on performance well results.

2.1.1.4 Pros and Cons

Based on ERO's knowledge of the technology and the site, ERO identified the following benefits and challenges with this technology:

Benefits:

- Passive treatment of groundwater without significant surface infrastructure;
- Low operation and maintenance once installed;
- Able to target full saturated zone, regardless of preferential pathways;
- Minimal permitting constraints.

Challenges:

- Require substantial utility clearances.
- Likely to require additional engineering to establish depth of trenching or excavation.
- Reductive dechlorination has the potential to form degradation products and/or methane as a byproduct of contaminant destruction.
- Significant alteration of subsurface geochemistry.
- No mechanism to "turn-off" remedial technology until geochemical components have been expended over time, greatly extending the time needed for regulatory closure.
- Waste generation and management.
- Highest expected cost of three alternatives.

2.1.2 E-Redox®

2.1.2.1 Overview

The E-Redox® system is a proprietary technology of Advanced Environmental Technologies LLC (AET) that uses a system of electrodes installed in groundwater wells to establish a low-intensity electrical field within the contaminated groundwater/soils. The resulting electrolysis degrades the PCE and associated degradation products without the production of daughter products or generation of vapors or gases such as methane. The redox conditions are manipulated by periodically switching the polarity of the electrodes which promotes contaminant degradation.

2.1.2.2 Conceptual Design

Based on consultation with AET regarding site conditions, a conceptual system would consist of a network of groundwater wells along the south and southeast boundaries of the site that would be outfitted with electrodes to operate the E-Redox® system. The network of wells would be placed 25 to 30-feet apart in a triangular fashion to create a mesh network for installation of E-Redox® electrodes inserted into well pairs. Each pair of electrodes would be connected to a DC power source, presumably from the current water kiosk building remaining on the site. Minor trenching between the wells and the electrical source would connect all infrastructure beneath the current grade to an electrical switch box to access the polarity switches. It is anticipated that minor electrical permitting with the City of Thornton would be required for this installation and, as a low-voltage system, no additional power drop would be required. Once installed, the electrical switch box would be the only surface expression of the system.

2.1.2.3 Operation and Maintenance

O&M would consist of monthly checks on the system, periodic (monthly to bi-monthly) switching of polarity, and performance sampling.

2.1.2.4 E-Redox Pros and Cons:

Based on ERO's experience with the technology, the site, and correspondence with AET, ERO identified the following benefits and challenges with this technology.

Benefits:

- Does not form degradation products or methane as byproduct of contaminant destruction.
- Able to target large, saturated zone within heavily weathered claystone and siltstones.
- Low profile and surface expression of infrastructure.
- No significant alteration of subsurface geochemistry.
- Minimal permitting constraints.
- Technology is scalable to implement at depths to treat deep groundwater plume, as necessary.
- Technology can be "turned-off" to evaluate site conditions without active treatment.
- Well infrastructure can be converted to injection points to serve similar purpose should site data indicate sub-optimal performance.

- Anticipated similar cost to in-situ treatment.

Challenges:

- Newer technology within the Colorado Front Range.
- The system requires continued electrical connection for effective use as barrier technology, long-term.

2.1.3 In-Situ Injection

2.1.3.1 Injection Overview

In-situ injection consists of the injection of a treatment solution into the subsurface within a network of wells to create a "treatment wall" along the downgradient edge of the site that would treat PCE contaminated groundwater as it flows off the facility property. The purpose of the treatment wall would be to emplace a treatment solution to indirectly treat contaminated groundwater via ERD. Several proprietary solutions are available for this style of treatment with minor differentiating distinctions between products, however for the purposes of this evaluation, performance is presumed to be similar across products.

Any injection technology relies heavily on the ability to inject into the aquifer, which primarily consists of weathered claystone and siltstone. Most injection contractors rely heavily on direct-push drilling technology (DPT) that is able to hammer an injection probe into the ground and pressure inject at specific intervals to target specific zones of interest. As previous investigations on the TSC property have shown, DPT is capable of penetrating the weathered claystone to depths of about 20 to 23 feet bgs and it is presumed that any long-term injection treatment wall installation would require the use of pre-drilled injection wells to get product deeper than the known limits of DPT technology.

2.1.3.2 Injection Conceptual Design

A conceptual injection program would consist of the initial drilling of an injection network of points in the similar general area as the E-Redox® mesh network discussed above. For evaluation purposes, it is presumed that similar locations will be used, however injection points would be installed using DPT at the locations, instead of hollow-stem auger drilling. An injection rig would then connect to the wells and pressure inject treatment solution into the boring and out into the formation. Downgradient wells MW-2 and MW-13 through MW-15 would serve as performance monitoring and sentry wells because the wells have a long history of VOC data and geochemical parameter records. No surface infrastructure from the injection would remain aside from typical monitoring wellhead manholes. Permitting of this common approach is minimal, generally limited to obtaining U.S. EPA authorization for the injectant and associated well permitting.

The choice of remedial injectant would require pilot testing, bench scale testing, and evaluation of conditions posed by treatment injectants. Typical ERD approaches commonly use carbohydrate substrate such as emulsified vegetable oil, molasses, or other proprietary compounds to promote the anaerobic degradation of the PCE and associated daughter products. The reducing conditions needed to promote ERD however, typically coincide with the formation of methane gas and potentially more toxic daughter products during the PCE dichlorination process.

2.1.3.3 Injection Operation and Maintenance

O&M activities would be negligible aside from performance monitoring.

2.1.3.4 Injection Pros and Cons

Based on ERO's experience with the technology and the site, ERO identified the following benefits and challenges with this technology.

Benefits:

- Proven remedial technology with readily available equipment.
- Minimal long-term surface infrastructure or disruption.
- Differing proprietary chemicals can be adjusted to site-specific groundwater chemistry.
- Passive in-situ technology with minimal O&M.
- Limited waste generation.
- Anticipated similar cost to E-Redox system.

Challenges:

- Proprietary product sourcing.
- Potential to create secondary compounds potentially more toxic than PCE.
- Potential for methane gas generation as a byproduct of biological degradation of PCE.
- Limited depth of DPT would be treating only the upper portions of the aquifer without installation of dedicated injection wells.
- Significant alteration of subsurface geochemistry.
- No mechanism to "turn-off" remedial technology until geochemical components have been expended.

2.1.4 Preferred Alternative – E-Redox®

Based on the evaluation presented above and the anticipated timeline of source area remedial actions, the preferred option for the downgradient control of contaminated groundwater during the remedial actions within this report is the implementation of the E-Redox® system. This technology is newer along the Colorado Front Range; however, based on results at other sites, the layout of the TSC, and the innovative approach to remedial action presented, E-Redox® provides the opportunity for downgradient control, while maintaining the established groundwater chemistry and opportunity for expansion to deeper contaminated zones, if needed. In addition, the groundwater wells housing the electrodes would provide discrete lateral definition to the groundwater plume and, should the approach provide sub-optimal results, would serve the dual purpose of providing future injection points for an alternative treatment technology.

2.1.4.1 Preferred Alternative –Conceptual Design

As shown on Figure 3, the conceptual, full-scale, design would consist of an estimated 38 groundwater wells installed using a hollow-stem auger to drill and complete 2-inch wells to a depth of 30 feet bgs with 15-feet of well screen. The wells would be installed along the 450-foot length of the proposed treatment zone and be screened across the entire water table, historically encountered between 17 and 20 feet bgs. Deeper groundwater contamination has been documented in this area at the MW-23D cluster, adjacent to MW-13, however as shown below on Table 1, PCE concentrations drop by an order of magnitude or more in wells screened below 30 feet bgs compared to shallow contamination within MW-13, which is only screened to 25 feet bgs. For this reason, the E-Redox treatment zone is proposed to initially target the shallow zone that contains the majority of the PCE mass leaving the site.

Table 1. MW-13/MW-23D average groundwater PCE concentrations.

Well	Screen Interval (feet bgs)	Average PCE Concentration 2023-2024 (µg/L)
MW-13	10-25	7,344
MW-23D 31-33.5'	31-33.5	198
MW-23D 47-52'	47-52	154
MW-23D 56.5-61.5'	56.5-61.5	173

Downgradient wells MW-2 and MW-13 through MW-15 would serve as performance monitoring and sentry wells because the wells have a long history of VOC data and geochemical parameter records.

2.1.4.2 Preferred Alternative – Timing

Boundary control performance monitoring wells (MW-2 and MW-13 through MW-15) are about 30 to 40 feet downgradient of the proposed treatment zone. Using previously calculated groundwater velocities of between 2 and 40 feet per year (Freedom 2006; Quantum 2022), performance indicators of the treatment zone are anticipated to be seen in the boundary control wells within the first one to two years from startup and can be used to evaluate efficacy and adjust as necessary. As discussed in Section 6.1, the E-Redox® system is anticipated to remain operational until the upgradient wells within the treatment zone meet yet to be established cleanup target levels and the need for further downgradient control can be re-evaluated.

2.1.4.3 Preferred Alternative –Pilot Testing

Pilot testing of the chosen technology will be conducted throughout the first year of remedial activities to establish viability, scalability, and longevity of the downgradient control solution. The pilot testing will consist of the following:

- Install of nine groundwater wells across the central line of the groundwater plume upgradient of well MW-13, generally well locations 8 through 16 on Figure 3. Complete wells to depth of 30 feet bgs with 15 feet of well screen. Should the ultimate excavation design deem the southwest, deep portion of the proposed excavation shown on Figure 4 reasonably feasible, the pilot test network may be extended westerly toward well location number 1 (Figure 3) to accommodate potential downgradient impacts from the excavation.

- Deploy of a Regenesis Flux Tracer mapping tool within three of the wells (e.g., wells 8, 12, and 16, Figure 3) to evaluate contaminant flux at the approximate site boundary.

- Install and deploy three E-Redox units and install wiring/setup system within the nine E-Redox wells after the flux test is completed.
- Monitor contaminant concentrations monthly for a period of 6-months after installation for success criteria of PCE mass reduction and decrease in oxidation/reduction potential (ORP).
- Should success criteria indicate practical viability, upscale the E-Redox system to that conceptually presented within Figure 3.
- Should success criteria not be met, are determined unlikely to be met, or the full upscaling of the system deemed impracticable, incorporate the data from Flux Tracer information to design an injection program to supplement or replace the E-Redox® system, consistent with that discussed above in Section 2.1.3.

Results of the pilot testing will be submitted to CDPHE for review and include proposed actions for larger-scale implementation.

2.2 Source Area Remediation

As presented in the SSACP-IR and discussed in previous reports, two former dry cleaner sources were located on the TSC Property – the primary source area generally associated with the former dry cleaner at the 8866 North Washington Street unit and associated sanitary sewer lines south of the unit; and a secondary source at the former 8946 North Washington Street unit. Past reports submitted to CDPHE have estimated that up to 1,500 pounds of PCE, representing an estimated 74% of the total PCE mass (including the downgradient PCE groundwater plume) is likely located within the primary shallow source area (Rettew 2019). Although these estimates by others have not been updated with current data, there is no reason to suspect they are an inaccurate representation of contaminant mass distribution across the site.

Three primary alternatives were identified that could provide source area mass reduction and are listed below with a summary of the evaluation presented in the following sections:

In-Situ Treatment – Injection of a treatment solution into the subsurface that would actively treat contaminants in-situ.

Soil Mixing – Using soil mixing equipment and technology, such as caisson drilling, to add treatment amendment(s) directly to treat the contaminated soils in-situ or with minimal removal.

Excavation – Excavate and dispose areas of contaminated soils in accordance with an excavation and waste management plan.

Other technologies that were evaluated at a discussion level, but not carried further, include the following, with the primary reasons for discontinuation of the evaluation noted:

In-situ thermal treatment – Estimated infrastructure and operational costs (electricity) far exceed any other alternative total costs for implementation;

Soil-vapor extraction – Thickness and depth of source area soil contamination and presence within a fine-grain, weathered bedrock formation would require significant infrastructure installation and present challenges to provide substantial airflow through contaminated formation. The continued presence and operations of the treatment infrastructure also presents a limitation on future redevelopment of the property.

Natural Attenuation – Timeframe for natural degradation of the contamination is unrealistic and unacceptable with continued off-site groundwater migration.

2.2.1 In-Situ Treatment

2.2.1.1 Overview

In-situ treatment consists of the direct injection of a treatment solution into the subgrade to treat contaminated soils. The treatment solution is typically injected using DPT and can target specific intervals for injection. This technology was previously conducted on the site in 2008, 2009, and 2014 and consisted of direct injection of a carbon substrate solution (BOS 100®) into the primary source area and portions of the adjacent buildings and paved areas. All previous injections were conducted when the original building was still standing. Previous injections were conducted on 5-foot centers and were able to inject to depths of up to 22 feet bgs (Quantum 2022).

2.2.1.2 Conceptual Design

The conceptual design of an in-situ treatment would consist of the following:

- Conduct bench-scale evaluation of reagents.
- Obtain EPA UIC authorization for injection.
- Establish treatment grid on 5-foot centers within approximate treatment area 120 feet by 200 feet (up to an estimated 1,000 injection points).
- Pressure-inject chosen reagent from the base of the formation to the surface.
- Conduct confirmation sampling within footprint of treatment area at a scale consistent with the SSACP to confirm treatment of site soils.

2.2.1.3 Operation and Maintenance

Design considerations for the site operations are critical in determining the depth of treatment, reagent injection rate, and reagent amendment mixes. Once injection is complete, little to no long-term maintenance is expected.

2.2.1.4 Pros and Cons

Benefits:

- No dewatering required.
- Minimal waste generated.
- Limited soil removal/generation.
- Current surface (asphalt/concrete) does not require removal – limiting stormwater concerns.

- Able to target areas identified during SSACP-IR for treatment.

Challenges:

- Technology previously used within the primary source area with minimal impact.
- Introduces significant reagent mass to groundwater system with uncertain downgradient effects.
- Relies on native soil pathways for subsurface reagent distribution leading to incomplete treatment.
- DPT depth limitations limit deep treatment.
- Surfacing and/or preferential pathways may limit effectiveness of treatment application.
- Complete treatment between injection points across the entire depth of treatment cannot be confirmed without additional drilling.
- Least reliable determination of success for the cost.

2.2.2 Soil Mixing

2.2.2.1 Overview

Soil mixing consists of the mixing of a reagent with soils that would oxidize the PCE contamination in-situ. The technology relies upon physically mixing soils with a reagent using a caisson drill rig or hydraulic powered drill with large-diameter augers capable of reaching the prescribed depths.

2.2.2.2 Conceptual Design

For evaluation purposes, a conceptual design of a soil mixing remedial option consists of the following activities:

- Removal of source area concrete and asphalt surfacing.
- Excavate and remove sanitary sewer manholes and water utility infrastructure that could hinder or damage drilling equipment.
- Pilot testing of drilling large diameter auger within the formation to ensure depths can be achieved.
- Concurrently with pilot testing of drilling technology, conduct bench-scale testing of reagents to confirm application rates.
- Obtain EPA UIC authorization for reagent injections.
- Mobilize equipment, product, water source, and mixing facilities.
- Drill numerous holes within the source area footprint while conducting mixing activity with reagent additions (actual number of holes contingent on diameter of equipment used).
- Conduct confirmation sampling within footprint of treatment area at a scale consistent with the SSACP to confirm treatment of site soils.

2.2.2.3 Operation and Maintenance

Design considerations for the site operations are critical in determining the depth of treatment, reagent application rate, and mixing parameters. Once mixing is complete, little to no long-term maintenance is anticipated.

2.2.2.4 Pros and Cons

Benefits:

- Minimizes the need for groundwater dewatering, treatment, and disposal.
- Minimizes waste disposal costs.
- Potential for deep soil treatment, depending on results of pilot testing.

Challenges:

- Uncertain geotechnical and/or geochemical conditions would remain in the treated soils presenting redevelopment uncertainties.
- Relies on direct contact between reagent and contamination at prescribed application rates.
- The size of treatment area is likely to exceed cost efficiency with the number of holes required for complete coverage.
- Soil stabilization after mixing may preclude accessing deeper soils.
- Health and safety considerations associated with various reagents.

2.2.3 Excavation

2.2.3.1 Overview

Excavation of the source area provides the greatest degree of remedial certainty because the accessible contamination is removed. Although total contaminant removal by excavation at this site is infeasible given the documented depths, it is reasonable to presume that a substantial percentage of the mass contributing to the dissolved groundwater plume that flows off-site can be accessed and feasibly removed.

The conceptual source area excavation is anticipated to be substantially similar to the source area excavation proposed within the RETTEW June 7, 2019 Draft Corrective Action Plan (RETTEW 2019) and by Quantum in 2022 (Quantum 2022) with the exception of the extent of building removed. Excavation would remove the greatest amount of PCE-contaminated soils as practicable, given the remaining constraints – anticipated to be site bedrock geology which is expected to limit the excavation to about 22 to 23 feet. Once contaminated soils are removed, soil treatment amendment can be added directly to the base of the excavation and an in-situ groundwater treatment system can be installed to provide direct access to remaining PCE mass entrained in bedrock below the excavation for treatment. In addition, once such an excavation is backfilled, the deep source area groundwater assessment discussed in the SSACP and postponed in the SSACP-IR can be completed with a significantly reduced risk of cross-contaminating deeper groundwater bearing zones.

2.2.3.2 Conceptual Design

The conceptual excavation design consists of the following:

- Removal of presumed clean shallow soils that would be excavated, characterized, and staged on-site for ultimate reuse on the site.

- Removal of presumed PCE-contaminated soils from beneath the primary source area dry cleaner and sanitary sewer lines. These soils would be characterized, treated on-site to reduce contaminant concentrations if needed, and disposed of as non-hazardous waste at a permitted disposal facility.
- Removal of contaminated deeper soils and bedrock to 22 to 23 feet bgs. Because bedrock is generally about 10 feet bgs, limited layback/sloping would be required. These soils would be treated on-site to reduce contaminant concentrations if needed, confirmed to meet treatment standards, and loaded for transport and off-site disposal as non-hazardous wastes.
- Confirmation floor soil sampling of the excavation floor would be conducted and along excavation walls in areas that have not been delineated within the SSACP.
- The excavation would require dewatering of the excavation area. Dewatered groundwater would require either treatment (under a Treatment by Rule authorization) to reduce contaminant concentrations prior to any discharge under appropriate CDPHE Water Quality Control Division (WQCD) permitting or full characterization and disposal in accordance with the Colorado Hazardous Waste Regulations (CHWR).
- Injection piping could be installed within the base of the excavation to facilitate future remedial injections within the excavation footprint.

2.2.3.3 Operation and Maintenance

Excavation activities would completely remove all source areas soils such that additional long-term O&M would not be required for the primary source area contamination.

2.2.3.4 Pros and Cons

Benefits:

- Complete removal of accessible PCE mass from the accessible areas of excavation reduces mass available for off-site migration.
- Removal of aquifer matrix removes sorbed PCE mass from the site.
- Defined timeline of source area treatment actions.
- Installation of treatment infrastructure for deeper soil remedial actions.
- Insight into subsurface lithology that can be translated to other areas of the site.

Challenges:

- Trenching and slope stabilization safety.
- Potential for air emissions compliance.
- Highest trucking and waste disposal costs of all alternatives.
- Increased land area required for on-site treatment or storage of soils.
- Large volume of waste generated requiring management and disposal.
- Potential for episodic increase in RCRA Hazardous Waste Generator status.
- Significant permitting requirements for stormwater, dewatering, and waste management in addition to typical construction permitting.

2.2.4 Preferred Source Area Remedy – Excavation

Based on the evaluation presented above, source area excavation affords the benefit of the complete removal of the source area mass and can facilitate future redevelopment. The following provides greater detail to the conceptual excavation plan described above with Figure 4 presenting an illustration of the proposed excavation.

2.3 Conceptual Excavation Design

2.3.1 Pre-Excavation Activities

2.3.1.1 Health and Safety Plan Development

A site-specific health and safety plan (HASP) will be developed for the project and excavation activities.

2.3.1.2 Contractor Solicitation

Project specifications will be developed to permit the competitive bidding process of selecting qualified contractor(s) for the implementation of the excavation activity.

2.3.1.3 Dewatering Design and Permitting

Groundwater is as shallow as 11 and 14 feet bgs within the proposed excavation area, necessitating the dewatering of the proposed excavation prior to and/or during the excavation activities. Dewatering prior to the excavation would require additional, dewatering well installation and pumping equipment. Dewatering during excavation is expected to use dewatering pumps placed directly within the excavation. The inlet of the pumps would have filtering mechanisms and pump groundwater to a frac tank for on-site treatment and storage prior to either discharge under a CDPHE WQCD Short Term Dewatering Discharge General Permit (General Permit COG31700) or disposal in accordance with the CHWR. In addition to dewatering permit, the treatment of dewatering waters is anticipated to require a Treatment by Rule authorization under the CHWR for the treatment of the hazardous waste (PCE) within the groundwater.

Details of water management will be developed and presented in a Dewatering Plan, if applicable, that will be integral to the Waste Management Plan (WMP).

2.3.1.4 Buried Utility Management

Potable water service lines are the only remaining subsurface utilities within the area of the proposed excavation. The utilities will be required to be abandoned prior to excavation activities.

2.3.1.5 Foundation Removal

As shown on Figure 4, the proposed excavation will require the removal of portions of the remaining building foundation. The asphalt, concrete and foundations within the work area will be removed prior to or at the appropriate times during excavation activities to facilitate the project. Foundation and hardscape removal will be minimized to facilitate stormwater control.

2.3.1.6 Well Abandonments

Groundwater monitoring wells within the proposed excavation area will be abandoned in accordance with Colorado Division of Water Resources Water Well Construction Rules prior to excavation activities. Wells anticipated for abandonment include MW-6, MW-9, MW-11, MW-12R, and the MW-22D cluster. Deep wells within the MW-22D cluster (MW-22 30-35', MW-22 35-40', MW-22 41-46', MW-22 48-53', MW-22 55-60', and MW-22 72.5-75') are completed with bentonite ground annular spacing to depths well below the base of the proposed excavation. These wells will be abandoned by filling the well casing with bentonite grout in accordance with the rules. Performance monitoring wells will be established within and downgradient of the excavation and installed as described in the 2024 Long Term Groundwater Monitoring Plan (ERO 2024a).

2.3.1.7 Soil Stockpiling Areas

Temporary facilities will include soil stockpile areas in the west and/or north portions of the TSC property for staging of soils as part of the WMP, generally described in Section 5.2. Stockpile areas are anticipated to include areas for the stockpiling of clean overburden; soils staged for reuse or disposal pending characterization and waste management approvals; and finally those that have the potential to be considered hazardous for PCE and may require treatment prior to disposal. Stockpiles may be located within the excavation area itself, if practicable, or constructed within the land area of the TSC Property. Those constructed outside of the excavation would consist of 20-mil liners with a 1-foot berm covering an area sufficient to stage the soils excavated plus an additional 25 percent. The ultimate design and locations of the stockpile areas will be outlined within the Excavation Plan and/or WMP.

2.3.1.8 Stormwater Controls

The ultimate excavation contractor will be tasked with developing and implementing an appropriate Stormwater Management Plan (SWMP) and obtain appropriate permitting from CDPHE and the City of Thornton. Stormwater controls will be placed in accordance with the SWMP, maintained, and inspected by the contractor and TDA.

2.3.1.9 Decontamination Areas

Appropriate equipment and personnel decontamination areas will be constructed and maintained for the duration of the excavation activity.

2.3.2 Excavation

The preliminary work plan for the primary source area excavation is presented below. Specifics of the work plan may change based on contractor input and/or additional site-specific design considerations to be outlined in the Excavation Plan.

- Concrete foundation and asphalt will be removed from the excavation area and recycled or disposed at a permitted facility.
- Soils from the source area (Area 1, Figure 4) between the surface and 10 feet bgs will be spot-excavated and transported to the hazardous waste staging area for characterization and management according to the WMP.

- Soil excavated from the ground surface to 10 feet bgs in the main excavation area will be considered clean and transported to the clean soil stockpile for potential on-site reuse, pending confirmation according to the WMP.
- Soils along the sanitary sewer corridor within the excavation area will be spot excavated with the soils above the utility considered clean and transported to the clean soil stockpile for on-site reuse, pending confirmation and in accordance with the WMP. Soils within the sanitary line elevation and beneath will be considered potentially contaminated, removed and transported to the appropriate stockpile for characterization and management per the WMP.
- Once the overall excavation reaches 10 feet bgs, soils within Area 1 and those within the sewer-line source area (Area 2, Figure 4) will be spot-excavated between 10 and 20 feet if equipment is able to do so. These soils will be considered hazardous and transported to the hazardous waste staging area for characterization and management according to the WMP.
- Soils within the remainder of the primary excavation will then be excavated from 10 to 18 feet bgs and considered potentially contaminated, removed and transported to the appropriate stockpile for characterization and management according to the WMP.
- Soil excavated from the ground surface to 18 feet bgs in the southern overburden area (Figure 4) will be considered clean and transported to the clean soil stockpile for on-site reuse, pending confirmation according to the WMP.
- Soil excavated from 18 to 23 feet bgs (or as deep as efficiently and mechanically accessible) throughout the footprint of the excavation will be considered potentially contaminated, removed and transported to the appropriate stockpile for characterization and disposal per the WMP.
- Confirmation floor soil sampling will occur within the floor area of the excavation at intervals matching the SSACP.
- The excavation limits shown on Figure 4 are delineated by SSACP boring data such that no additional wall samples north of the "South Soils" area shown on the figure will be collected. Confirmation wall samples will be collected from the area noted as "South Soils".
- Constructing a dewatering treatment system to containerize, treat and reduce contaminant concentrations within construction dewatered waters to below hazardous levels for either disposal or discharge.
- Obtaining appropriate CDPHE permits and/or authorizations for dewatering, treatment, and disposal or discharge of groundwater from the excavation.
- Management and disposal of treatment media used in any dewatering treatment facilities.
- Placing of soil amendments and a gravel drainage layer in the base of the excavation at the final depth with injection piping installed to facilitate future remedial treatments.
- Backfilling the excavation with a combination of excavated clean soils and imported fill with amendments.

2.3.2.1 Air Emission Control

Perimeter air monitoring stations will be established to monitor air quality during the excavation in accordance with the HASP. Should excavation activities be identified as a source of increased VOCs with the potential to migrate off-Site in accordance with action levels established in the health and safety plan (HASP), the appropriate action will be followed including, but not limited to stopping work or application of water or surfactants.

2.3.2.2 Fugitive Dust

Fugitive dust will not be permitted and will be monitored during excavation activities. The excavation contractor will be required to maintain a water truck on-site during excavation activities. If dry conditions necessitate dust control or air quality or odor concerns are present, a water truck will be used to spray clean water within the excavation on an as needed basis.

2.3.2.3 Decontamination

Decontamination procedures will be established for trucks, personnel, and equipment within the site, depending on the stage of excavation, and those hauling soil and equipment off the site and outside of access control. Decontamination soil and wash waters will be managed in accordance with the WMP.

2.3.2.4 Soil Management

Soil characterization will be conducted in accordance with Section 5.2 of this Plan and the WMP prior to final handling and disposition.

2.3.2.5 Excavation Soil Sampling

Confirmation soil sampling will be outlined within a Sampling and Analysis Plan (SAP) to be developed prior to site activities. In general, because the limits of the excavation were designed based on data from the SSACP, additional soil sampling along the walls of the excavation are not planned for areas within the footprint of the SSACP activities (Figure 4). Soil samples from the floor of the excavation will be collected similar to the frequency of the SSACP sampling.

Floor and excavation wall samples from the area outside of the SSACP activities will be collected provided conditions present safe conditions for collection. Best efforts will be employed to obtain samples at an interval of one sample every 50 linear feet of excavation wall and on 50-foot centers from the excavation floor. Wall samples will be collected from about 1-foot above the base of the excavation and from the mid-depth of the excavation, as accessible. The purpose of the wall samples in this area is to document conditions of the soil left in place outside of the excavation perimeter prior to implementing the other remedial actions.

2.3.2.1 Backfill Amendment

Prior to backfilling the excavation, a carbon substrate treatment solution will be placed at the base of the excavation and mixed, as feasible, into backfilled soils to the top of the water table at about 13 feet bgs. The carbon substrate is anticipated to consist of a lactic, organic, and/or fatty acid product to enhance the reductive dechlorination of PCE and its degradation products. Placement within the base of the excavation and within the saturated zone is intended to create a biological treatment zone both vertically and laterally outside of the area of excavation treatment to enhance the biodegradation of the PCE. The choice of the substrate will be dependent on treatability testing and consultation with vendors and be detailed in the Excavation Plan.

2.3.2.2 In-Situ Treatment Gallery

An in-situ treatment gallery will be installed in the base of the excavation prior to backfilling to facilitate the treatment of deep groundwater and bedrock beneath the excavation, if warranted. An approximate 6-inch-thick gravel drainage layer will be constructed across as much of the floor as feasible. A geotextile fabric will be placed over the layer to minimize intrusion of fine material. Perforated horizontal PVC drain pipe will be installed within the base of the gravel layer, plumbed to a solid vertical standpipe at each end. The tops of the PVC riser will be housed within a flush-mounted, traffic-weighted well vault or similar surface completion once backfilling is complete. The remainder of the excavation will be backfilled as generally described below.

2.3.2.3 Backfilling

The excavation area will be completed with a combination of imported clean backfill as needed and clean soil from the shallow portion of the excavation. The clean excavated soil used for backfilling will only be placed in the upper 10 feet of the excavation consistent with the depth from which it was removed. Backfilling is anticipated to consist of the following steps, to be refined through final designs:

- Backfill from the top of the gravel treatment gallery layer to 13 feet bgs with imported fill material mixed on-site with the amendment described above in Section 2.3.2.1;
- Backfill the area from 13 feet bgs to ground surface by placing the reuse soil directly in the excavation. Compaction specifications have yet to be determined, but will be incorporated into the final contractor specifications.

At this time, the surface completion of the excavation area is anticipated to consist of gravel.

2.3.2.4 Survey Control

Site survey control has already been established on the TSC property by a licensed Colorado Professional Land Surveyor. Prior to and during the excavation activities, survey control will document the extents of excavation, depths and topography within the excavation, and completion elevations of components. Because the proposed excavation will remove almost 10 feet or more of soils beneath the existing utilities, none of the existing utilities (e.g., sewer lines) within the excavation area are planned to be surveyed beyond what is currently known.

3.0 Secondary Source Area Removal – 8946 North Washington Street

Because of the limited contamination at the 8946 North Washington Street unit, the alternatives analysis for the primary source area described above was used to informally review alternatives for this site. Based on the limited area, direct excavation, and off-site disposal of contaminated soils consistent with the work plan described above was identified as the most efficient alternative. Although smaller in scale, the proposed excavation activity will occur in tandem with the larger excavation activity described above for planning, equipment, personnel, and cost efficiencies. Details specific to the proposed excavation in this area are presented below.

3.1 Excavation Preparation

Because all excavation activities will occur in tandem with the larger excavation described in Section 2.3, most of the excavation preparation activities will be the same and/or utilize the same facilities, equipment, and plans.

3.2 Excavation

As noted above, with the exception of the excavation area, the excavation infrastructure, processes, and procedures for the larger source area excavation described in Section 2.2.4 will apply to this area. Specifics related directly to this area are presented below.

3.2.1 Excavation Area

The extent of the proposed excavation in this area is shown on Figure 5, delineated by the existing soil borings described in the SSACP-IR (ERO 2025a). The excavation will extend at least to the top of groundwater at a depth of 13 feet bgs. If feasible, additional deeper soils will be removed.

3.2.2 Confirmation Sampling

Because of the limited soil samples defining the limits of this excavation, confirmation soil samples will be collected from the walls and floor of the excavation. Wall samples will be collected from the following depths, at lateral intervals of no less than 25 linear feet along the walls of the excavation:

- One sample between the surface and the water table;
- One sample at the water table
- One sample at the base of the wall.

Floor samples will be collected at a rate of one per 400 square feet of excavation, or at least one from each quadrant, if safely accessible. If not safely accessible, an excavator will be used to collect soil from the base and a soil sample will be collected from the bucket as representative of that location.

3.2.3 Soil Management

Soil management will follow the procedures outlined in Section 5.0 and the WMP.

3.2.4 Backfilling

Backfilling of the excavation will be conducted in a similar manner as the larger excavation. Because of the smaller size, the lateral pipe may be substituted with a singular vertical injection pipe to allow access to the base gravel layer.

4.0 Sanitary Sewer Line Removal

The SSACP-IR documented the likely presence of PCE-contaminated soils along portions of the sanitary sewer lines within the TSC property (See Section 5.0 of the SSACP-IR; ERO 2025a). Although the extent of PCE-impacted soils did not appear to extend north of the former main building, a detailed assessment of the entire sewer line was not conducted because the sanitary line is proposed for removal as part of this remedial action plan.

Prior to building demolition and after all water to the TSC Property had been turned off, the sanitary sewer line for the TSC property was cut and abandoned west of manhole G06018 within the driveway off Corona Street (Figure 6). No active sewer remains for the TSC Property.

4.1 Sewer Line Removal

The sanitary sewer line between manholes G06009 and G06018 (Figure 6) will be excavated, removed, the sewer line trench inspected and evaluated for releases and backfilled with documented clean fill as part of this work plan.

The sanitary sewer line will be excavated using heavy equipment, anticipated to consist of an excavator with a 24-inch to 36-inch wide bucket. The process will generally consist of the following:

- Surface asphalt and concrete within the path of the sanitary line will be removed for recycling/disposal.
- The excavator will generally remove the overburden soils to the top of the sanitary line and cast to one side or transport to clean soils pile, subject to the waste management plan in the following general manner:
    - Soils north of the former north wall of the TSC building will be considered clean and transported to the clean soil stockpile for on-Site reuse or placed back in the trench upon completion.
    - Soils south of the former north wall of the TSC building will be managed similar to the overall excavation described in Section 2.3.2 and subject to the WMP.
- The length of the existing sanitary line and a minimum of 6-inches of soils beneath the line will be excavated. Soils at and beneath the line will be considered potentially contaminated, transported to the appropriate staging pile for characterization and likely off-site disposal as described in Section 5.0 and the WMP.
- Soils within the utility trench will be screened with a PID at approximately 10-foot intervals using soils collected from the excavator as personnel will not be permitted within the utility trench. Should elevated PID readings be encountered, additional soil may be removed based on field conditions.
- One soil sample will be collected from the base of the trench (effectively beneath the original sewer line elevation) using the excavator to obtain a representative sample at 20-foot intervals along the length of the sewer line corridor outside the proposed source area excavation area. Areas that the sewer line overlaps with proposed source area excavations will not be sampled.
- Sample locations will be noted and identified for professional surveying to the site datum.

- Because an open trench of this depth presents a significant safety hazard on the site, the trench will be backfilled daily or a trench plate placed to cover it upon collection of trench-base samples. The sewer line excavation will be backfilled with overburden soils that fit unrestricted use categories based on screening protocols or documented clean imported fill material.

5.0 Waste Management

Several waste streams are anticipated to be generated during the course of the implementation of this plan. A project-specific Waste Management Plan (WMP) will be developed and submitted for approval that will outline specific waste characterization strategies, management details, sample frequency, and is anticipated to include requests for waste determinations (e.g., Contained-Out determinations) for specific areas based on existing data or streamlined process for obtaining such based on new data. In general, waste streams are anticipated to include:

Solid Waste Debris – Concrete and asphalt across the current existing surface as well as various utility remnants such as piping, manholes, and rebar.

Excavated Soils – Excavated soils will be categorized into different classifications that will be managed on-site and/or shipped off-site for disposal. These categories include known clean overburden soils, potentially contaminated soils, and potentially hazardous soils. Identification and management of each of these is summarized below and will be detailed in the WMP.

Liquid Waste – This waste stream includes decontamination water, groundwater, dewatering waters, and collected precipitation.

5.1 Solid Waste Debris

Solid waste debris will be visually inspected for indications of potential contamination and evaluated accordingly should contamination be identified. In general, solid waste debris will be containerized or directly loaded into trucks and disposed or recycled at a permitted facility.

5.2 Excavated Soils

To maximize the efficiency of any excavation, excavated soils are proposed for segregation based on results of the SSACP into groups to facilitate regulatory and waste management approvals through the WMP. Three categories of soils are expected to be encountered and the screening of which is summarized below.

Clean overburden – This category consists primarily of soils known to be clean based on past laboratory data or those with no reasonable expectation to have been in contact with dry cleaning solvents from historical activities. These soils include those within the primary excavation between the surface and 10 feet bgs and those within the southern portion of the primary excavation to depths of 18 feet bgs. Historical data show these soils are located outside of the identified source areas and have non-detect or PCE concentrations below the current EPA Regional Screening Levels (RSLs) for unrestricted residential land use and risk-based screening level concentrations that are protective of groundwater (PGW), currently 0.0051 mg/kg (EPA 2024). Confirmation sampling of these soils will be conducted at a rate of one sample per 1,000 CY removed to confirm the viability of reuse of these soils. Reuse of these soils is restricted to areas between the surface and 13 feet bgs to ensure these remain above the groundwater table.

Potentially Contaminated Soils – Soils from below the water table that have historically contained PCE concentrations exceeding the EPA PGW RSLs, but below residential land use RSLs and are anticipated to be disposed off-site pending characterization and waste management approvals. These soils are generally between 10 feet and 20 feet bgs in the primary excavation, or between 18 and 22 feet bgs in the southern portion of the primary excavation; within the sanitary sewer excavation areas; and within the 8946 North Washington Street excavation area. Waste characterization of these soils will be conducted at appropriate intervals, anticipated to be 500 CY, and in conformance with the WMP. Some soil from this interval may be wet and will be placed in a location for water to drain from the soil for subsequent water collection.

Potentially Hazardous Soils – These soils are expected to consist of the soils within the two identified source areas of the primary excavation – those surrounding the C+2 boring from the surface to 20 feet bgs (Area 1, Figure 4) and soils below 10 feet within the sanitary sewer source area in the southern portion of the excavation (Area 2, Figure 4). In addition, soils along the excavation floor below 20 to 22 feet bgs in the primary excavation may be included within this category. Waste characterization of these soils will be conducted at approximately 200 CY intervals and in conformance with the WMP.

A beneficial reuse or waste management decision will be made based on the soil sampling results and are expected to result in the following waste determinations (to be detailed in the WMP):

- ***Non-Impacted/Unrestricted Site Reuse:*** Clean overburden soils with confirmed VOC concentrations at or below the applicable EPA RSL for PGW and unrestricted land use may be reused anywhere within the Site.
- ***Impacted - No Site Reuse:*** Potentially-contaminated soils with VOC concentrations that meet Option II of Restricted Use in Table A2-1 of the CDPHE Contained-Out Determination Procedure for Environmental Media Contaminated with a RCRA Hazardous Waste (CDPHE 2002) will be considered restricted solid waste. Excavated soils that meet this criteria will be transported and disposed at a Subtitle D Disposal Facility that is suitably lined, has a leachate collection system, is monitored, and will be capped, maintained, and monitored upon closure, pending CDPHE and waste disposal facility approvals.
- ***Potentially Hazardous Soils No Reuse:*** Soils with VOC concentrations that exceed CDPHE Contained-Out criteria (CDPHE 2002) will be staged for either treatment or will be hauled off-Site for disposal. Any on-site treatment will be conducted under a Treatment by Rule authorization, approved by CDPHE prior to any on-site treatment. All treated soils will be managed and disposed off-site at an appropriate, permitted disposal facility. Temporarily staged soils within this category will be managed in accordance with CHWR and the WMP.

5.3 Liquid IDW

Groundwater, accumulated precipitation, and decontamination water generated during the implementation of this work plan will be collected and containerized as liquid IDW and placed in appropriate containers for management, treatment if applicable, and disposal or discharge. Specific methods will be detailed in the WMP.

5.4 Waste Tracking

All drums, containers, trucks, or roll-offs used for waste storage and disposal will be tracked within the site database, used to track waste characterization and disposal records.

6.0 Performance Monitoring

Performance monitoring of site activities will consist of the following activities to monitor the success of the activities implemented as well as evaluate if additional measures are needed or might be anticipated.

6.1 Downgradient Control

Groundwater monitoring wells MW-2 and MW-13 through MW-16 will be monitored for water quality parameters (pH, DO, ORP, and temperature) bi-monthly during the course of the E-Redox® operations, switching to monthly during the course of excavation operations. Once operational, the E-Redox® operational monitoring will consist of an initial sampling of all wells for VOCs, chloride, ethene, ethane, methane, and acetylene to obtain a pre-system, baseline snapshot of groundwater conditions. Monthly to bi-monthly electrode inspection, grab samples from treatment-zone wells for VOCs, and polarity switching according AET recommendations will generally occur on a schedule of every 8 weeks. Continued quarterly monitoring of wells downgradient of the E-Redox® system will provide performance monitoring of the system.

Upon completion of the excavation activities, the E-Redox® system will remain operational until upgradient wells within the network meet yet to be established target levels and/or the need for further downgradient control evaluation can be completed.

6.2 Source Area Excavation

Upon completion of the excavation, four shallow groundwater wells will be installed – two within the backfill of the site, along the approximate axis of the excavation, and two between the limits of excavation and the E-Redox® downgradient control area. The wells will be installed in the same manner as those described in the 2024 Long Term Groundwater Monitoring Plan (LLTGMP) (ERO 2024) and sampled bi-monthly for a period of 6 months following excavation completion, after which they will be incorporated into the overall LTGMP for quarterly sampling. The wells will be sampled for VOCs, TOC, and monitored for groundwater quality parameters.

As noted above, deep soil borings outlined in the SSACP will be installed once backfilling is completed. In addition, replacement wells for the deep MW-22D cluster will be installed at a location to be determined upon completion of the excavation and in consultation with CDPHE.

6.3 8946 North Washington Street

Performance monitoring of this excavation will consist of the continued monitoring of the downgradient monitoring wells MW-3, MW-4, and MW-8 on a quarterly basis, but will include TOC and chloride. Should PCE concentrations in the downgradient wells show sustained elevated PCE concentrations, the injection gallery installed within the excavation may be utilized to enhance remediation under work plan addendum.

6.4 Sanitary Sewer Line

Performance monitoring of sanitary sewer line removal will consist of the previously discussed soil sampling during the removal. No additional performance monitoring is planned for this component.

7.0 Schedule

The following presents the best assessment of a schedule at this time. The majority of the tasks associated with this project have yet to be subjected to the contractor bidding process and, based on the resultant schedules from solicitations, this schedule may require adjustments. As the timeline gets refined, updates will be provided to CDPHE in monthly reports.

Estimated Timeline	Anticipated Tasks
June 2025	Specification development, utility locating
July 2025	Contractor prequalification, solicitation, permitting
July-December 2025	Award, well abandonment, downgradient control installation, excavation, waste disposal, backfilling
December 2025	Excavation demobilization, performance well installation
March 2026	Completion report submittal

8.0 Reporting

8.1 Pre-Activity Reports

Based on the proposed activities outlined herein, the following project-specific workplans are anticipated to be prepared for submittal to the Division (and/or other division as appropriate within CDPHE) prior to implementation:

Waste Management Plan (WMP) – This plan will be developed to describe specific waste handling, management and disposal activities during the implementation of site remediation. Portions of this plan may be supplemented or amended as necessary upon consultation and coordination with site contractors and waste disposal facilities. The plan is anticipated to include requests for waste determinations (e.g., Contained-Out determinations) for specific areas based on existing data and a streamlined process for obtaining such based on new data. In addition, as necessary, this plan will include requests for generator treatment permit by rule authorization to treat PCE-contaminated media on-site in accordance with Colorado Hazardous Waste Regulations (CHWR) §100.21(d) to reduce contaminant concentrations prior to disposal. Should dewatering be deemed necessary, this plan will reference and be integrated with the Dewatering Plan.

Dewatering Plan – Dewatering is anticipated to be required in some form for the implementation of this overall plan. The Dewatering Plan will describe the proposed method(s) for dewatering and management of the media associated with the dewatering. Because dewatering is expected to remove contaminated environmental media, this plan will be integrated into the WMP as applicable for waste management purposes. Any discharge permitting requirements will be incorporated into the dewatering plan as appropriate.

Excavation Plan – This plan will consist of expanded details of the conceptual plan presented in the conceptual plans outlined in Sections 2.3 for the primary source area, Section 3.2 for the source area at 8946 Washington Street, and Section 4.0 for the sanitary sewer line removal. The plan is anticipated to include proposed excavation drawings, specifications, on-site soil management, traffic patterns, confirmation sampling protocols, in-situ treatment specifications, backfilling specifications, and safety and security protocols.

Stormwater Management Plan – This plan is anticipated to be required for construction activities and will be the basis for construction stormwater permitting under the CDPHE Water Quality Control Division (WQCD) Construction Stormwater Discharge Permit COR400000.

Sample and Analysis Plan – This plan will describe the means and methods for media sampling during the course of the implementation of the various remedies. At a minimum, the plan will include sample types, frequencies, collection methods, locations, decontamination procedures, quality control and quality assurance procedures, data management, sample naming convention, and location documentation/surveying procedures.

8.2 Completion Reports

Monthly Progress Reports – Monthly progress reports will continue to update site progress.

Pilot Test Completion - Results of the pilot testing will be submitted to CDPHE for review and include proposed actions for larger-scale implementation. This report is anticipated to be submitted within 30 day of completion of the 6-month pilot test period.

Source Area Remedial Excavation - Within 90 days of completion of the excavation and performance well installation activities, including the disposal or management of all excavated soils, a completion report will be submitted. The report will include a narrative description of site activities, sampling details, sample results, deviations, maps, waste disposal correspondence, and an evaluation of the remedial actions taken. All waste manifests will be included within the final implementation report.

9.0 References

Colorado Department of Public Health and Environment (CDPHE), Hazardous Materials and Waste Management Division (HMWMD). 2002. Appendix 2 – Contained-Out Determination procedure for Environmental Media Contaminated with RCRA Hazardous Waste. May.

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Appendix A Figures

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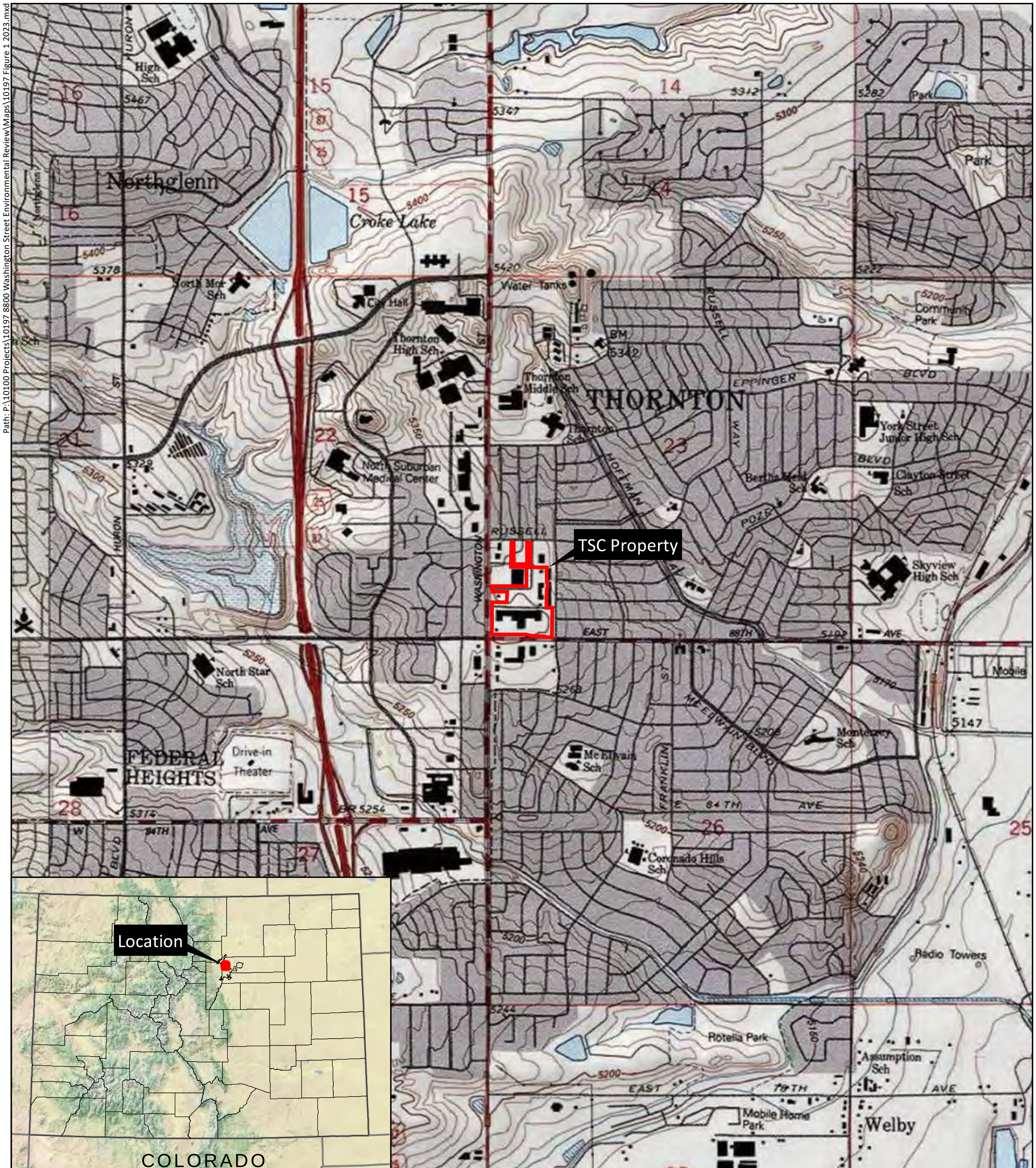


Thornton Shopping Center

Section 23, T2S, R68W; 6th PM

UTM NAD 83: Zone 13N; 502054mE, 4411959mN

Longitude 104.975982°W, Latitude 39.857657°N

USGS Commerce City, CO Quadrangle

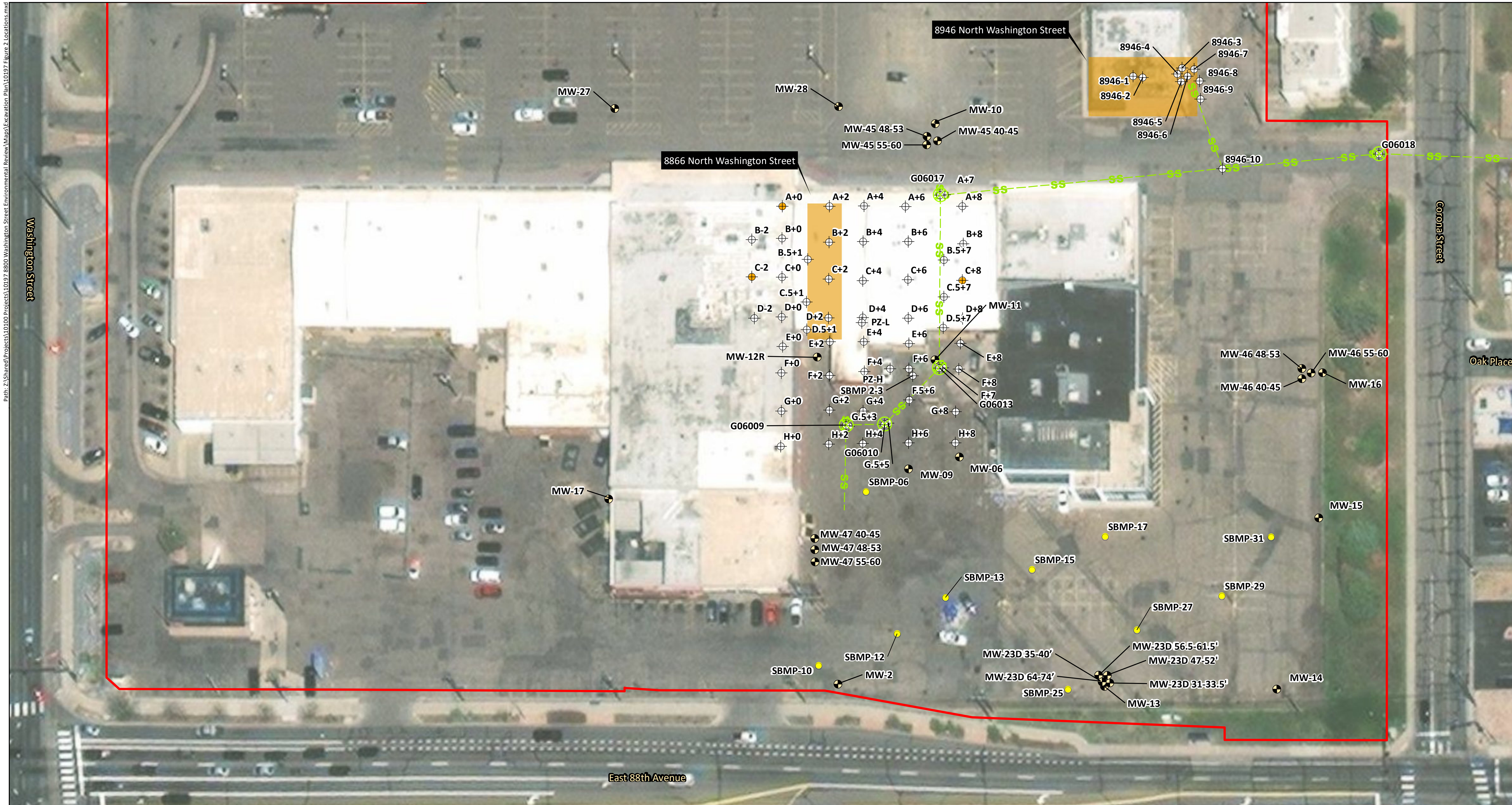
Adams County, Colorado

0 1,000 2,000 feet

N

Figure 1
Site Map

ERO
ERO Resources Corp.



Thornton Shopping Center

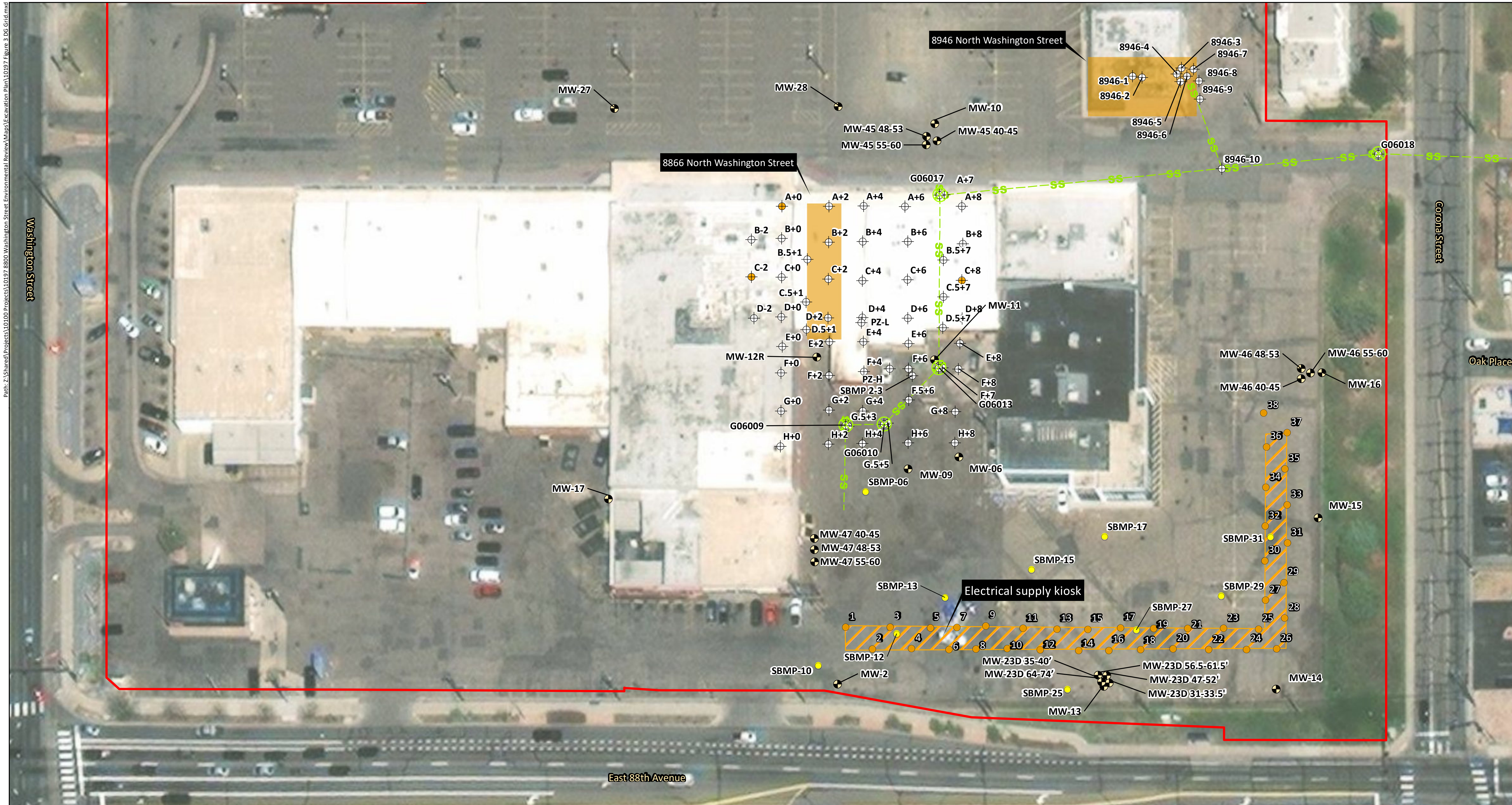
- Shallow Soil Boring Location
- Deep Soil Boring Location
- New and Existing Monitoring Wells
- Sanitary Manhole
- Former MIP Confirmation Borings (LTE 2017)
- SS Sanitary Line
- TSC Property
- Dry Cleaner Facility Footprint

Figure 2
Site Sample Locations

File: 10197 Figure 2 Locations.mxd [dlH]
June 17, 2025

ERO
ERO Resources Corp.

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community 5/5/2023



Path: Z:\Shared\Projects\10100 Projects\10197 8800 Washington Street Environmental Review\Maps\Excavation Plan\10197 Figure 3 DG Grid.mxd

Thornton Shopping Center

- Shallow Soil Boring Location
- Deep Soil Boring Location
- New and Existing Monitoring Wells
- Sanitary Manhole
- Former MIP Confirmation Borings (LTE 2017)
- SS Sanitary Line
- TSC Property
- E-Redox Well
- E-Redox Area
- Dry Cleaner Facility Footprint

0 32.5 65 feet

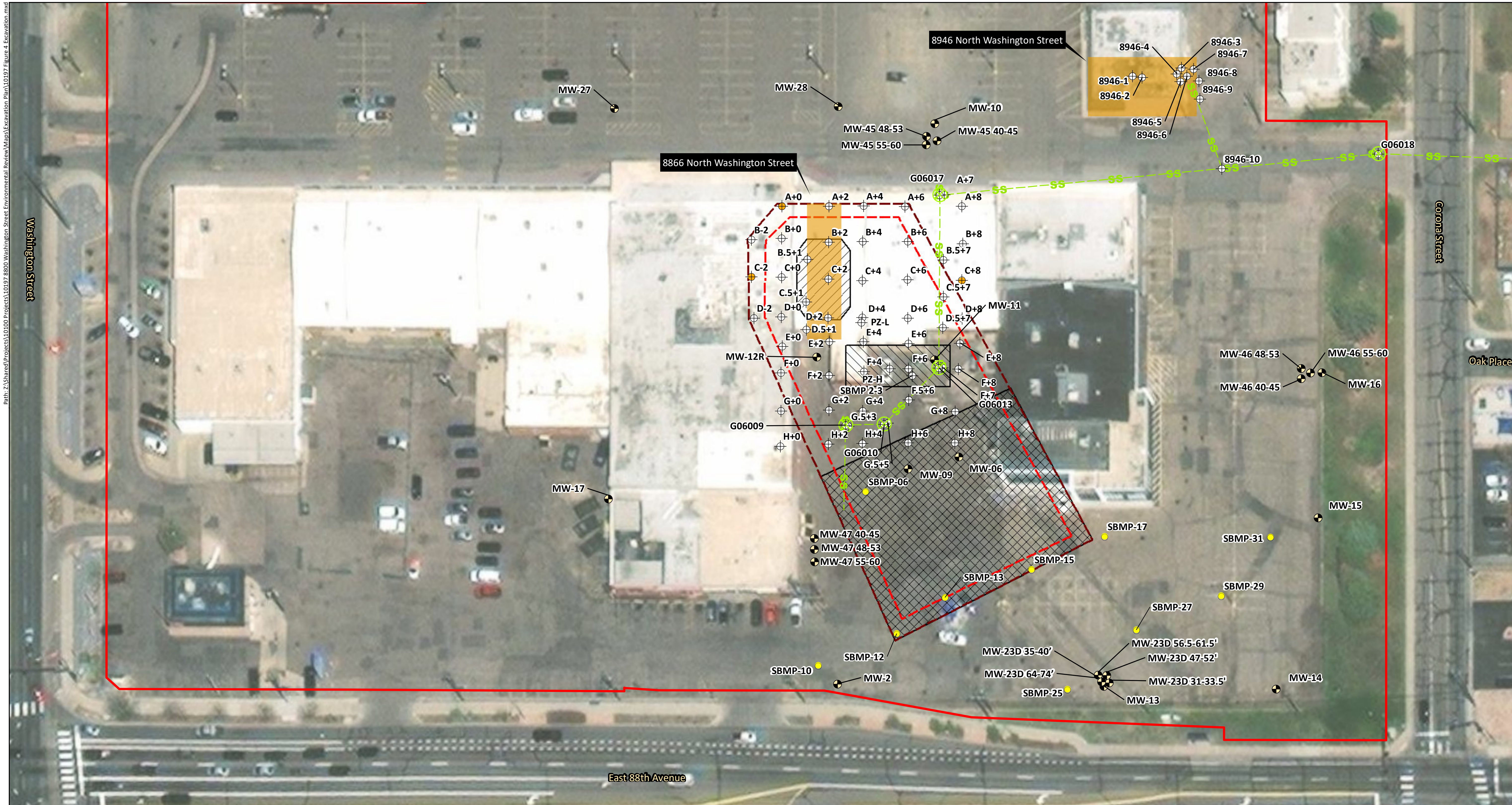
N

Figure 3
Downgradient Control

File: 10197 Figure 3 DG Grid.mxd [dlH]
June 17, 2025

ERO
ERO Resources Corp.

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community 5/5/2023



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community 5/5/2023

Thornton Shopping Center

- Shallow Soil Boring Location
- Deep Soil Boring Location
- New and Existing Monitoring Wells
- Sanitary Manhole
- Former MIP Confirmation Borings (LTE 2017)
- Sanitary Line
- TSC Property
- Dry Cleaner Facility Footprint
- Excavation Extent
- Bedrock Excavation
- Area 1 Soils from 0-20 feet bgs potentially hazardous.
- Area 2 Soils below 10 feet bgs potentially hazardous.
- South Soils - Soils from 0-18 feet bgs are clean overburden. Soils below 18 feet bgs are potentially hazardous.

0 32.5 65 feet

N

Figure 4
Excavation Extents

File: 10197 Figure 4 Excavation.mxd [dlH]
June 17, 2025

ERO Resources Corp.

Thornton Shopping Center - 8946 Washington Street Investigation

- Soil Boring Location
- Soil Boring/Monitoring Well Location
- Sanitary Sewer Manhole
- Sanitary Sewer Utility
- TSC Property
- Excavation Extent

0 10 20 feet

N

Figure 5
8946 North Washington Street
Excavation Extent

ERO Resources Corp.

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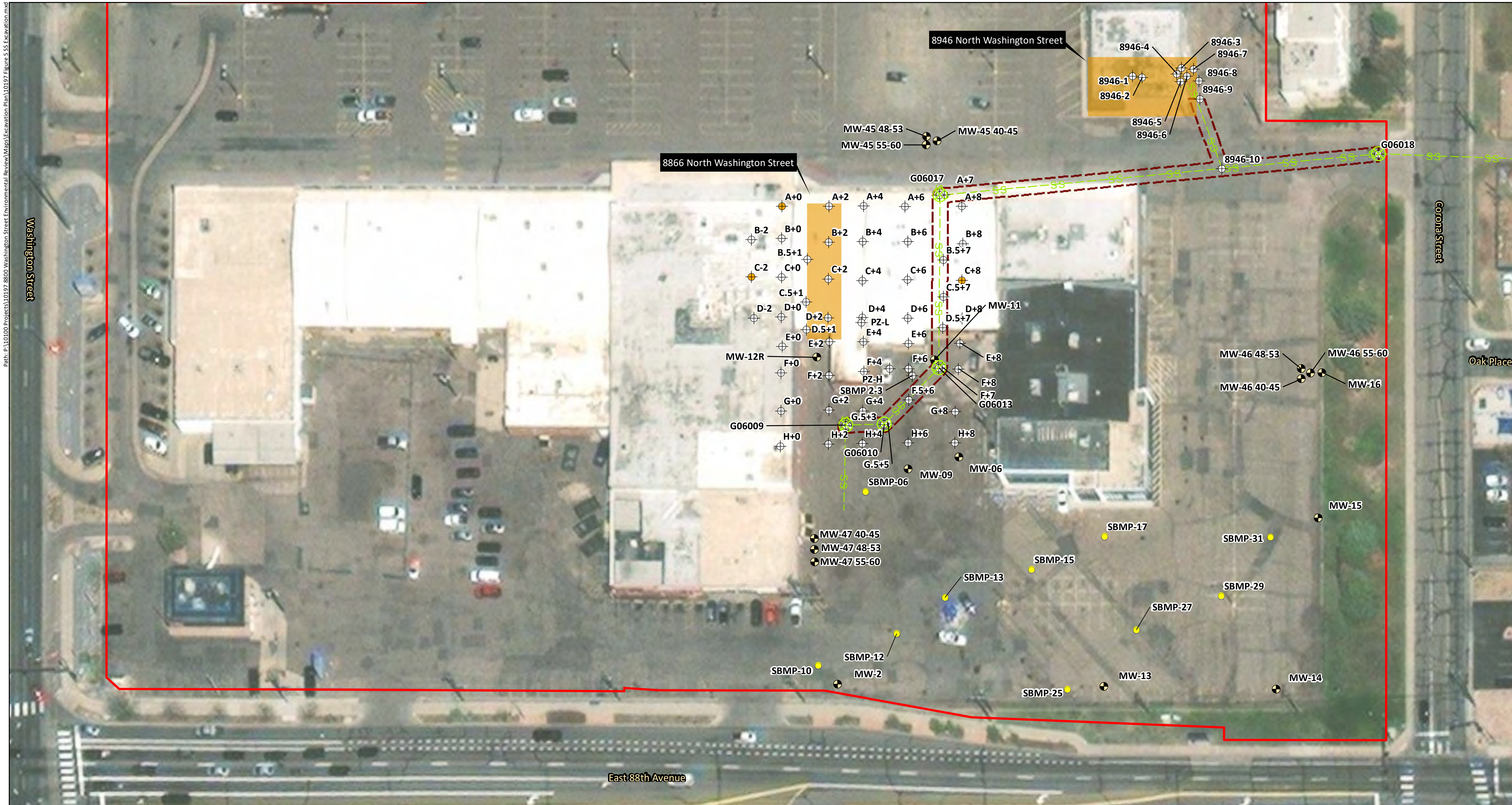

Thornton Shopping Center

- Shallow Soil Boring Location
- Deep Soil Boring Location
- Monitoring Well Location
- Sanitary Manhole
- Former MIP Confirmation Borings (LTE 2017)
- SS Sanitary Line
- TSC Property
- Building Footprint
- Sanitary Sewer Excavation Area

0 32.5 65 feet

N

Figure 6
Sanitary Sewer Excavation Area

File: 10197 Figure 5 SS Excavation.mxd [dlH]
April 11, 2025

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