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Livermore Site Office, Livermore, California 94551

Lawrence Livermore National Laboratory

Lawrence Livermore National Security, LLC, Livermore, California 94551

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Addendum to Remedial Design Report No. 1 for Treatment Facility A: Arroyo Seco Pipeline Extension Lawrence Livermore National Laboratory Livermore Site

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September 2011

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Environmental Restoration Department

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Certification

I certify that the work presented in this report was performed under my supervision. To the best of my knowledge, the data contained herein are true and accurate, and the work was performed in accordance with professional standards.

Scott Bourne 10/7/11

Scott Bourne Date
Registered Professional Engineer
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Table of Contents

List of Figures

List of Tables

List of Appendices

Executive Summary

The U.S. Department of Energy and Lawrence Livermore National Laboratory (LLNL) have prepared this Addendum to the Remedial Design (RD) Report No. 1 for Treatment Facilities A and B to present changes to the remedial design for Treatment Facility A (TFA). TFA remediates contaminated ground water at the LLNL Livermore Site located in Livermore, California.

RD Report No. 1 for Treatment Facilities A and B was completed in 1993 (Boegel et al., 1993). TFA was designed to remediate ground water contaminated with volatile organic compounds (VOCs), including tetrachloroethylene (PCE), trichloroethylene (TCE), chloroform, 1,1-dichloroethylene (1,1-DCE), and carbon tetrachloride (CCl_4) using an ultraviolet light/hydrogen peroxide (UV/H_2O_2) ground water treatment unit and air stripper. TFA was designed to hydraulically control the western and southwestern offsite plumes (areas of ground water containing contamination), including the ground water contamination at well W-404. An Explanation of Significant Difference (ESD) for Treatment Facilities A and B was signed in 1997 (Berg et al., 1997a), changing UV/H_2O_2 and air stripping ground water treatment to air stripping only at TFA and TFB. TFA currently receives ground water with VOCs from 16 extraction wells and treats the water using a shallow-tray air stripper and granular activated carbon treatment of the stripper air discharge.

TFA and its associated wellfield began operating in September 1989 and has remediated much of the offsite plume to below clean up standards and stopped downgradient migration of the plume at well W-404. PCE concentrations at well W-404 remain stable and have fluctuated between about 9 micrograms per liter (µg/L) and 11 µg/L since early 2008. PCE has never been detected above the reporting limit in all four downgradient monitor wells located west of well W-404 during 26 years of monitoring.

In 2006, an analysis of hydraulic and chemical data indicated that the leading edge of the offsite PCE plume, located in the well W-404 area, was immobilized within a hydraulic stagnation zone. While the leading edge of the plume was not moving further to the west, it was unlikely to be drawn effectively into the existing remedial wellfield for treatment. This Addendum presents changes to TFA's design to address this stagnation.

An underground pipeline will be constructed to connect extraction well W-404 to the existing offsite Arroyo Seco pipeline. New extraction and monitoring equipment will be installed in extraction well W-404, which will then be added to the existing control and data acquisition system at TFA. After connection of extraction well W-404, extraction well flow rates at TFA will be adjusted in accordance with the extraction wellfield design to optimize hydraulic capture and VOC removal. Treated water from TFA is discharged to both Arroyo Seco and the west perimeter channel which flows into Arroyo Las Positas.

Construction is scheduled for the summer of 2012 with extraction beginning at well W-404 by September 30, 2012. The detached PCE ground water plume at well W-404 is estimated to be cleaned up to below the Maximum Contaminant Level (MCL) of 5 micrograms per liter (µg/L) within a period of 5 and 15 years.

This RD Addendum contains the Title II Design Drawings (Appendix A), Design Calculations (Appendix B), Construction Quality Assurance/Quality Control Plan (Appendix C), Construction Health and Safety Plan (Appendix D), Field Sampling Plan (Appendix E), and Dust Control and Air Monitoring Plan (Appendix F).

1. Introduction

This Addendum to the Remedial Design Report No. 1 for Treatment Facilities A and B presents changes to the Remedial Design (RD) for Treatment Facility A (TFA) at the Livermore National Laboratory (LLNL) Livermore Site. The LLNL Livermore Site is located in Livermore about 40 miles east of San Francisco, California (Figure 1).

The LLNL Livermore Site was placed on the United States (U. S.) Environmental Protection Agency's (EPA) National Priorities List in 1987. In November 1988, the U.S. Department of Energy (DOE), U.S. EPA, the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB) – San Francisco Bay Region, signed a Federal Facilities Agreement (FFA) to facilitate compliance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended. On August 5, 1992, the Record of Decision (ROD) (U.S. DOE, 1992) was signed, documenting the final cleanup plan for the LLNL Livermore Site. As part of the CERCLA process, RD Report No. 1 for Treatment Facilities A and B was completed in 1993 (Boegel et al., 1993). TFA, located on the southwest corner of the Livermore Site (Figure 2), was designed to remediate ground water contaminated with volatile organic compounds (VOCs) using an ultraviolet light/hydrogen peroxide (UV/H_2O_2) ground water treatment unit and air stripper. TFA was designed to hydraulically control the western and southwestern offsite plumes (areas of ground water containing contamination), including the ground water contamination at well W-404 (Figure 2). An Explanation of Significant Difference (ESD) for Treatment Facilities A and B was signed in 1997 (Berg et al., 1997a), changing UV/H_2O_2 and air stripping ground water treatment to air stripping only at TFA and TFB.

TFA and its associated wellfield began operating in September 1989 and has remediated much of the offsite plume to below clean up standards and stopped downgradient migration of the plume at well W-404. However, the ground water plume around well W-404 is in a hydraulic stagnation zone creating a detached portion of the plume that is not being remediated effectively. This Addendum presents changes to the TFA's design to address this stagnation.

The scope and format of this Addendum are consistent with EPA guidance documents (EPA, 1989; 1999). Section 1 of this Addendum describes the location of TFA, site characterization, previous remediation, and regulatory history. Section 2 presents a summary of the geology and hydrogeology. Section 3 is a summary of contaminant distribution. Section 4 presents the remedial design. Section 5 contains the Remedial Action Work Plan including Quality Assurance/Quality Control (QA/QC) and Health and Safety Plans for construction and operation and maintenance (O&M), monitoring and reporting requirements, waste handling, and the requirements for project closeout.

The following appendices are also included:

Appendix A. Title II Design Drawings

Appendix B. Design Calculations

Appendix C. Construction Quality Assurance/Quality Control Plan

Appendix D. Construction Health and Safety Plan

Appendix E. Field Sampling Plan

Appendix F. Dust Control and Air Monitoring Plan

DOE is the lead agency for cleanup at LLNL Livermore Site with regulatory oversight by the U.S. EPA, the DTSC, and the RWQCB.

1.1. Location and Physical Setting

TFA is a ground water extraction and treatment facility located just north of Arroyo Seco near Vasco Road in the southwest part of LLNL Livermore Site (Figure 2). The 800-acre LLNL Livermore Site is a research and development facility owned by the U.S. DOE and operated by the Lawrence Livermore National Security Limited Liability Corporation. The Livermore Site comprises approximately 800 acres.

The ground surface slopes gently across the site, changing in elevation from 670 feet (ft) above mean sea level (MSL) in the southeast corner to 570 ft above MSL in the northwest corner. Two intermittent streams, Arroyo Seco and Arroyo Las Positas, traverse the area. Climate is semiarid with annual precipitation about 14 inches/year.

Land north and south of the site is zoned for industrial use, west of the site is medium to high-density residential areas, and east of the site is primarily agricultural land.

Currently, about 10,000 people use ground water blended from several downtown Livermore municipal supply wells as their primary drinking water supply. Contaminants from LLNL are currently about 1.6 miles from these supply wells. Ground water south and west of the site is used for agricultural irrigation.

1.2. Site History and Characterization

The LLNL site was converted from agricultural and cattle ranch land by the U.S. Navy in 1942. The Navy used the site until 1946 as a flight-training base and for aircraft assembly, repair, and overhaul. Solvents, paints, and degreasers were routinely used during this period. Between 1946 and 1950, the Navy housed the Reserve Training Command at the site. In 1950, the Navy allowed occupation of the site by the Atomic Energy Commission (AEC), which formally received transfer of the property in 1951. Under the AEC, the site became a weapons design and basic physics research laboratory. In 1952, the site was established as a separate part of the University of California Radiation Laboratory. Responsibility for the site was transferred from AEC to the Energy, Research, and Development Administration in 1975. In 1977, responsibility for LLNL was transferred to the DOE, which is currently responsible for the site. In addition to weapons research, LLNL programs have been established in biomedicine, energy, lasers, magnetic fusion energy, and environmental sciences.

Initial hazardous materials releases occurred at the Livermore Site in the mid- to late-1940s when the site was the Livermore Naval Air Station. There is also evidence that localized spills, unlined landfills, and leaking tanks and impoundments contributed VOCs, fuel hydrocarbons (FHCs), metals, and tritium to the ground water and unsaturated sediments in the post-Navy era.

In 1983, VOCs were detected by LLNL in domestic water-supply wells west of the site. A regulatory order to investigate ground water quality was issued by the State in 1984. By 1987, results of the investigation indicated that a plume of VOCs had migrated offsite about 2,200 ft west of the current LLNL property.

In May 1990, LLNL issued the CERCLA Remedial Investigations (RI) Report for the LLNL Livermore Site (Thorpe et al., 1990). Additional details of the site history, the use, storage and disposal of hazardous materials, and site characterization are presented in the RI.

1.3. Previous Remediation

As described in Remedial Design Report No. 1 (RD-1), the primary design document for TFA, the facility began operation in 1989 as an EPA-approved pilot study for the southwest corner/offsite area, and was converted to Remedial Action status in 1992 (Boegel et al., 1993). Originally designed as an UV/H_2O_2 ground water treatment unit and air-stripper system, TFA was converted to a large-capacity air-stripping system in June 1997. The effluent air from the shallow-tray air stripper is passed through granular activated carbon (GAC) to remove VOCs. Treated effluent air is then vented to the atmosphere.

The original remedial objectives of TFA and its associated remedial wellfield included: 1) to hydraulically contain, isolate, and treat the TFA VOC source area and 2) to hydraulically contain and treat the distal VOC plume emanating from this source area, including the offsite area ground water contaminant plume located to the west of TFA. The primary contaminant of concern is tetrachloroethylene (PCE), with lessor amounts of trichloroethylene (TCE), chloroform, 1,1-dichloroethylene (1,1-DCE), and carbon tetrachloride (CCl_4) also present.

The TFA remedial wellfield consists of four pipelines and associated extraction wells: the east pipeline, the south pipeline, the Arroyo Seco pipeline, and the north pipeline (Figure 6). Ground water extraction along the east pipeline (W-415) began in 1989. Ground water extraction along the south and Arroyo Seco pipelines began in 1994 and along the north pipeline in 1995. In 1999, TFA East (TFA-E), with treatment using solar treatment unit 6 (STU06), was activated. As of December 2010, over 1.7 billion gallons of water had been treated in the TFA area, with over 202 kilograms of VOCs having been removed from ground water. Total VOC concentrations in the TFA source area have declined from over 2,700 micrograms per liter (μg/L) (W-1107, 1996) to below 150 μg/L (W-1217, 2010). In the offsite area west of Vasco Road, concentrations have declined from over 200 μg/L to under 20 μg/L in all offsite monitor wells. Concentrations from third quarter 2010 are shown on Figures 3 and 4.

In 2006, an analysis of hydraulic and chemical data indicated that the leading edge of the offsite PCE plume, located in the well W-404 area, was immobilized within a hydraulic stagnation zone of the Arroyo Seco pipeline remedial wellfield. While the leading edge of the plume was not moving further to the west, it was unlikely to be drawn effectively into the existing remedial wellfield for treatment. Concentrations at the leading edge of the plume would therefore decline only through natural attenuation due to dispersion, dilution, and adsorption, not through active remediation. Accordingly, in 2007, a treatability test was conducted using monitor well W-404 as an extraction well. The objectives of the treatability test were to determine whether full hydraulic capture of the contaminant plume would be achieved through pumping at this location, and to evaluate the resulting reduction in PCE ground water concentrations. During the test, the ground water was filtered and discharged into the sanitary sewer for treatment at the Livermore Water Reclamation Plant (LWRP). The results of the treatability test and a subsequent rebound test are summarized in Noyes et al., 2009, and in Section 4.2.11 of this document. Although originally proposed as an alternative technology for

cleaning up this portion of the offsite plume, the U.S. EPA expressed concerns regarding the efficacy of the VOC treatment by the LWRP, and the test was discontinued in January 2008.

1.4. Regulatory History

The LLNL Livermore Site environmental cleanup regulatory history began in the early 1980s. The major events are listed chronologically:

1982-1983 Four former pits in the Taxi Strip Area in eastern LLNL were excavated and backfilled in the winter of 1982-1983 under the oversight of the RWQCB.

1984 The California Department of Health Services (DHS) (now the Department of Toxic Substances Control of the California Environmental Protection Agency) issued a compliance order in 1984. This order required LLNL to investigate ground water quality and to supply bottled water to local residents whose domestic wells had been affected by solvents migrating in ground water from LLNL. At the time this order was issued, the ground water investigation was already underway and bottled water had been supplied to those local residents since December 1983. In addition, a former landfill was excavated and backfilled with oversight by the DHS.

1985-1991 Between 1985 and 1987, the RWQCB was the lead regulatory agency for the LLNL ground water investigation. In 1985, the RWQCB issued Waste Discharge Requirements to define the vertical and lateral extent of ground water contamination, and to allow discharge of ground water during the investigation. All private wells affected by VOCs were permanently sealed by LLNL between 1985 and 1989. Between 1986 and 1991, the RWQCB issued four Waste Discharge Orders and two Site Cleanup Orders for the LLNL site.

In 1987, LLNL was added to the National Priorities List. In November 1988, the U.S. DOE, U.S. EPA, DTSC, and RWQCB signed a FFA, which named DOE as the overall lead agency and the U.S. EPA as the lead regulatory agency.

TFA began operating in September 1989 as an EPA-approved pilot study for the Southwest Corner/Offsite Area.

In May 1990, LLNL issued the CERCLA Remedial Investigations Report for the LLNL Livermore Site (Thorpe et al., 1990). In December 1990, the CERCLA Feasibility Study for the LLNL Livermore Site (Isherwood et al., 1990) was issued. In October 1991, the Proposed Remedial Action Plan for the LLNL Livermore Site (Dresen et al., 1991) was submitted.

1992 On August 5, 1992, the ROD was signed, documenting the final cleanup plan for the LLNL Livermore Site. TFA was converted from pilot study to Remedial Action status.

1993 RD Report No. 1 for Treatment Facilities A and B was completed in 1993.

1997 An ESD for Treatment Facilities A and B was signed in 1997, changing UV/H_2O_2 and air stripping ground water treatment to air stripping only at TFA and TFB (Berg et al., 1997a).

2007-2008 LLNL conducted a treatability test at offsite monitor well W-404 from January 2007 to January 2008. Ground water was extracted from well W-404, filtered and discharged into the sanitary sewer for treatment at the LWRP. Since this treatment technology differed significantly from the remedy proposed in the LLNL Livermore Site ROD, LLNL submitted a draft ESD (Berg et al., 2007) to the regulatory agencies on November 13, 2007. At the December 14, 2007 Remedial Project Manager's (RPM) meeting, the U.S. EPA stated that the current method of pumping and discharging to the LWRP does not satisfy EPA's preference for treatment and would require a ROD amendment not an ESD. It was also concluded that the cleanup time was going to be much longer than originally predicted, making this option economically unfeasible. DOE sent a letter to the regulators on December 20, 2007, withdrawing the ESD.

2009 A Treatability Study Summary and Proposed Cleanup Alternatives for the TFA West Area (Noyes et al., 2009) report was submitted to meet a March 2009 Consensus Statement FFA milestone. This report summarized the treatability test and the rebound test, and presented treatment alternatives for the well W-404 area.

2010 At the January 13, 2010 RPM meeting, it was agreed that LLNL would submit an RD addendum to document the remedial plan for well W-404 (TFA West). The RD addendum was added to the FFA Consensus Statement. At the February 25, 2010 RPM meeting, it was agreed that the remedial option of building a pipeline extension from well W-404 to TFA would be presented to the community. Extracting from well W-404 and piping the ground water to TFA for treatment falls under the selected remedy documented in the ROD, therefore no ROD amendments or formal public meetings are required. A public workshop was held on October 7, 2010 at the Arroyo Seco Elementary School in Livermore to inform the community of the pipeline construction scheduled for completion in September 2012.

2. Geology and Hydrogeology

This section discusses the geology (Section 2.1) and hydrogeology (Section 2.2) of the TFA area.

2.1. Geology

As previously mentioned, site characterization, including the geology of the Livermore Site is discussed in detail in the RI (Thorpe et al., 1990). In the TFA area, the uppermost sediments are composed of Quaternary-age alluvial terrace and alluvial fan deposits consisting of sands and gravels set within a sequence of silts and clays. These deposits are underlain by the Plio-Pleistocene-age Livermore Formation fluvial and lacustrine sediments consisting of inter-bedded silts and clays, and channelized sand and gravels that are interpreted to be more laterally-continuous than on the eastern side of the Livermore Site.

2.2. Hydrogeology

At the Livermore Site, the depositional sequence has been subdivided into nine hydrostratigraphic units (HSUs) based on detailed analyses of chemical, geological, geophysical, and hydraulic data (Blake et al., 1995). HSUs are defined as sedimentary sequences whose permeable layers show evidence of hydraulic communication. Hydraulic communication between HSUs is limited across HSU boundaries. In the TFA area, VOCs above their respective Maximum Contaminant Levels (MCLs) are present only in the three shallowest saturated HSUs: 1B, 2, and 3A. Although a low-concentration PCE plume has historically been present in HSU 5 monitor wells south of East Avenue, concentrations there have remained consistently below the 5 µg/L MCL since 2002.

HSU 1A, the uppermost HSU, is unsaturated in the on-site portion of the TFA area and varies in thickness from approximately 50 ft in the east to about 70 ft in the west. Onsite, HSU 1A consists primarily of clayey silt to silty clay with sand and gravel interbeds. Offsite, the upper portion of HSU 1A is dominated by finer-grained sediments while a large, laterally continuous gravel zone is present at the base of the unit. HSU 1B is approximately 50 ft thick and is the first saturated HSU in the on-site TFA area. HSU 1B is predominantly composed of finer-grained sediments, mostly clayey to sandy silts and silty clays, with occasional sands and gravels typically making up less than one third of the unit. HSU 2 is 55 ft to 70 ft thick, and is largely composed of finer-grained sediments, primarily clayey to sandy silts, with interbedded sands and occasional gravels. Offsite, a laterally-continuous high-permeability sandy gravel to gravelly sand sequence is present in the middle of the unit. All offsite HSU 2 extraction wells, including well W-404, are screened across this sequence. HSU 2 and clean up of the offsite PCE ground water plume residing within it are the main focus of this document. HSU 3A varies in thickness from about 35 to about 50 ft. HSU 3A consists of a very heterogeneous sequence of thinly-bedded (less than 5 ft thick) clayey to sandy silts, silty sands, and occasional sands and gravels that appear to be thicker to the west (up to 10 ft thick).

3. Contaminant Concentrations and Distribution

Figure 3 presents the distribution of PCE in HSU 1B in the TFA area during the third quarter of 2010. As shown, concentrations remain relatively high in the TFA source area, where PCE concentrations in monitor well W-1217 were 140 µg/L (November 2010). In the offsite area, concentrations are above the PCE MCL (5 µg/L) at only one well, W-1425, where concentrations were 7.8 µg/L (October 2010). The concentrations of all other VOCs in HSU 1B in the TFA area are below their respective MCLs.

Figure 4 presents the distribution of PCE in HSU 2 in the TFA area during the third quarter of 2010. As in HSU 1B, ground water concentrations continue to decline in HSU 2 in response to active pumping and treatment using TFA and its remedial well field. As shown, PCE concentrations across TFA, including the offsite area, are now below 20 µg/L in all monitor wells. In the westernmost, detached portion of the offsite plume, PCE concentrations at well W-404 remain stable, and have fluctuated between about 9 µg/L and 11 µg/L since the end the treatability test in early 2008 (10 µg/L, December 2010). PCE has never been detected above the reporting limit in all four downgradient monitor wells located west of well W-404 during

26 years of monitoring. As in HSU 1B, concentrations of all other VOCs present in HSU 2 are below their respective MCLs.

Figure 5 presents the third quarter 2010 carbon tetrachloride concentration in HSU 3A. Carbon tetrachloride, the only VOC above its MCL (0.5 µg/L) in HSU 3A, is present in two monitor wells, W-267 and W-616, where concentrations were 1.1 µg/L (July 2010) and 2.4 µg/L (June 2009), respectively. Concentration in well W-712, the HSU 3A extraction well hydraulically containing and treating the carbon tetrachloride plume, was 3.3 µg/L (January 2011).

4. Remedial Design

This section presents the engineering design for extension of the TFA Arroyo Seco pipeline. Section 4.1 summarizes the overall project design. Design specifications are presented in Section 4.2, the project schedule and cost estimate are presented in Section 4.3 and contingency plans are summarized in Section 4.4.

4.1. Design Summary

TFA currently receives ground water with VOCs from 16 extraction wells and treats the water using a shallow-tray air stripper and GAC treatment of the stripper air discharge. For this RD addendum, an underground pipeline will be constructed to connect extraction well W-404 to the existing Arroyo Seco pipeline (Figure 6). New extraction and monitoring equipment will be installed in extraction well W-404, which will then be added to the existing control and data acquisition system at TFA. Extraction well flow rates at TFA will be adjusted in accordance with the extraction wellfield design to optimize hydraulic capture and VOC removal. Treated water from TFA is discharged to both Arroyo Seco and the west perimeter channel, which flows into Arroyo Las Positas.

4.2. Design Specifications

This section describes the TFA Arroyo Seco pipeline design specifications including:

- Extraction well field specifications based on a treatability test, hydraulic test analysis, ground water capture zone analysis, and post-treatability test optimization.
- Conveyance, treatment, and discharge specifications, including design standards and calculations, wellhead and control cabinet improvements, conveyance and conduit systems, power, instrumentation and controls, and ground water treatment and discharge.
- Performance standards and monitoring for the ground water extraction and treatment system.
- Controls and safeguard specifications to prevent a discharge of untreated water during emergency, process upset, or other unanticipated shutdown.

Each of these elements are described in the following sections.

4.2.1. Extraction Wellfield

This section describes the design of the ground water extraction wellfield based on treatability testing; hydraulic test analysis; ground water capture zone analysis; and post-treatability test optimization. This section also presents an estimate of the time to achieve ground water cleanup based on this extraction wellfield design.

4.2.1.1. Treatability Testing

A year-long treatability test was conducted from 2007 to 2008 to determine whether full hydraulic capture of the VOC-contaminant plume in the well W-404 area would be achieved through pumping at this location and evaluate the resulting change in PCE ground water concentrations (Noyes et al., 2009). In February 2007, a three-month-long step flow rate test commenced to evaluate capture zones under different flow rates and to quantify well efficiency and sustainable yield. The well W-404 extraction flow rates for each step were determined based on available drawdown and consisted of 25 gallons per minute (gpm), 38 gpm, and 43 gpm. During the test, continuous water level and flow rate data from well W-404 were collected by the well W-404 data acquisition system (DAS). Two observation wells (W-120 and W-1701) located upgradient (to the east) of well W-404 (Figure 7) were instrumented with water level transducers and data loggers to continuously record water level data. Additionally, monthly water levels were measured in all surrounding TFA HSU 2 monitor wells to define the HSU 2 potentiometric surface in the TFA area for the three different flow rates of the step test. To evaluate changes in VOC concentrations during the test, ground water samples from well W-404 were collected for VOC analysis on the first, third, and seventh day of pumping, then once a week for the first month, monthly for the first quarter, and quarterly thereafter for the duration of the treatability test.

Between January 2007 and January 2008, about 19.0 million gallons of ground water were extracted from well W-404. During this time, PCE concentrations in well W-404 rapidly declined from about 19 µg/L at the start of the test (January 2007) to about 7 µg/L in July 2007, where concentration levels remained until the end of the test (January 2008). During the year long treatability test, an estimated 0.9 kilograms of VOCs were removed from ground water.

Although PCE concentrations appeared to decline rapidly between January and July 2007, whether this represented an actual decrease in the TFA West area contaminant plume concentrations due to pumping could not be resolved based on the data collected during the test. As the monitor wells adjacent to well W-404 contain much lower levels of PCE (Figure 7), at least some portion of the decline is likely due to dilution as cleaner water was drawn into the well screen from areas to the east, south, and north. In addition, well W-404 is screened such that it captures the entire thickness of HSU 2. Accordingly, because only a portion of HSU 2 contains PCE, vertical dilution by cleaner water is also thought to occur in well W-404.

During the treatability test, effective hydraulic capture was achieved and PCE concentrations declined. However, concerns were expressed by the U.S. EPA regarding the efficacy of VOC treatment by the LWRP, and whether this was an acceptable alternative to ground water treatment by LLNL remedial infrastructure. Also, the fees for discharging water to the LWRP made this treatment method economically unfeasible. Accordingly, the treatability test was terminated on January 14, 2008.

4.2.1.2. Hydraulic Test Analysis

The hydraulic analyses performed on data collected during the treatability test for well W-404 included:

- Water level response of the two observation wells.
- Hydraulic test analysis of extraction and observation well continuous flow rate and water level data.
- Well efficiency analysis using the three step flow rate data.

During each flow rate step, a significant water level response was observed in both wells W-120 and W-1701, given the 300 to 400 foot distance between the pumping and observation wells. Over the three flow rate steps, a range of 1 to 4 feet of drawdown was recorded in the observation wells. This response indicates good hydraulic communication between the pumping and observation wells.

Using the AQTESOLV hydraulic test analysis software, the HSU 2 hydraulic conductivity within the vicinity of well W-404 was calculated. The calculations were performed using both the pumping well continuous flow rate and water level data and the observation well continuous water level data. The calculated hydraulic conductivity for these data range from 285 to 552 square feet per day (ft^2/day). These results, along with the good hydraulic response in the observation wells, indicate that a confined homogenous isotropic aquifer is a reasonable conceptual model for evaluating the HSU 2 ground water system in the well W-404 area. The well W-404 hydraulic conductivities are similar to those from other wells in the well W-404 area, hence the results were used in the subsequent capture zone analysis.

A well efficiency analysis was conducted using the Hantush-Bierschenk method. The result of the analysis indicates any well losses due to well inefficiencies are negligible.

4.2.1.3. Ground water Capture Zone Analysis

Water levels in HSU 2 monitor and extraction wells in the TFA area were measured contemporaneously during each of the three flow rate steps. These data were contoured to produce three maps of the steady-state potentiometric surface. From the potentiometric surfaces, capture zones that honor the field conditions were interpreted for well W-404 for each flow rate step to determine optimal extraction flow rate for hydraulic capture. The potentiometric surface and estimated capture zone for the final (April 2007) flow rate step of 43 gpm is shown on Figure 7.

The observation well data, potentiometric surfaces, and calculated hydraulic conductivities were also used as calibration data for the development of an analytical element model of HSU 2 in the TFA area using the WINFLOW software package. Reverse particle tracking was implemented in the model to simulate capture zone geometry under various pumping scenarios, including worst-case conditions. The simulated worst-case conditions included an increase in ground water gradient due to potential agricultural pumping down gradient and cross gradient of the TFA West area. Results of this capture zone analysis suggested that a continuous pumping rate of at least 32 gpm from well W-404 would meet the treatability test objective.

Accordingly, for the subsequent nine months of the test (from April 2007 to January 2008), well W-404 was pumped at flow rates exceeding the identified minimum flow rate of 32 gpm. Figure 7 shows the HSU 2 ground water elevation contour map for April 2007. The estimated

hydraulic capture area fully contains the extent of the well W-404 detached plume and is consistent with the simulated capture zone analysis discussed above.

4.2.1.4. Post-Treatability Test Optimization

Following the treatability test in 2008, a hydrogeologic analysis was conducted to ensure the western portion of the TFA area PCE ground water plume would be immobilized within the stagnation zone downgradient of the TFA remedial well field hydraulic capture area. Accordingly, the calibrated WINFLOW ground water flow model was used to simulate ground water extraction and resulting capture zones along the TFA Arroyo Seco pipeline. Modeling was performed to define the optimal pumping rates needed to maintain hydraulic containment of the TFA HSU 2 plume and to ensure that the western portion of the TFA PCE plume would continue to reside within the stagnation zone. At the conclusion of the treatability test these optimal flow rates were implemented.

At TFA in 2009, mechanical and electronic upgrades were performed as part of the Remediation Evaluation (REVAL) process, a process to systematically evaluate treatment facility and extraction wellfield performance to ensure the system operates in a safe and optimal manner to remove and treat contaminated ground water. These upgrades increased data accuracy and reliability and improved treatment facility operations. During REVAL, wells along the Arroyo Seco pipeline were brought on-line in a two-step procedure, whereby wells were first started at one-half the target flow then later increased to the total target flow, which proved beneficial in maintaining stable operational flow rates. Data recorded using the automated data acquisition system allowed for effective optimization of hydraulic capture (particularly of the detached offsite plume) and cleanup.

In 2010, flow rates in extraction wells along the Arroyo Seco pipeline were adjusted to further evaluate the hydraulic influence of these wells on offsite HSU 2 well W-404. Water levels were measured in all surrounding TFA HSU 2 monitor wells before and after each flow rate change in the Arroyo Seco pipeline wells to define the HSU 2 potentiometric surface in the TFA area for each flow regime. The monitor well data was then used to refine the previously calibrated TFA area HSU 2 WINFLOW ground water flow model based on current well flow rates and recharge conditions. Particle tracking was implemented in the model to simulate capture zone geometry. The simulated hydraulic capture area fully contains the extent of the well W-404 detached plume while maximizing mass removal and minimizing the pumping of clean water.

4.2.1.5. Extraction Wellfield Configuration

The Arroyo Seco pipeline extension wellfield design includes five HSU 2 extraction wells (W-109, W-404, W-457, W-903, and W-904) and one HSU 1B extraction well (W-408). Extraction well locations are shown on Figure 6 and the optimal ground water extraction flow rates are indicated in Table 1. This extraction wellfield design is based on the capture zone analysis using both field measurements during treatability testing and conservative ground water flow modeling. The predicted ground water capture zones based on the flow rates proposed in Table 1 are shown in Figure 8.

4.2.1.6. Ground Water Cleanup Time Estimate

Results from the 2008 treatability test suggested that PCE concentrations in well W-404 might drop below the MCL with 2 to 5 years of continuous ground water extraction. However, owing to the slight rebound of concentrations observed in this well following the treatability test (from 7 µg/L to about 11 µg/L PCE), it is now expected to take more than 5 years to achieve the PCE MCL in HSU 2 in this area.

To estimate the time to cleanup HSU 2 in the TFA West Area, an analytical mixed-tank model was developed based on the modeling approach presented in Appendix C of the CERCLA Feasibility Study for the LLNL Livermore Site (Thorpe et al., 1990). The modeling results indicate that the detached HSU 2 PCE plume in the vicinity of well W-404 will be cleaned up to below MCL levels between 5 and 15 years. The uncertainty in time-to-cleanup is related with the amount of residual PCE that currently exists in lower permeability sediments within HSU 2. The concentration trends observed in well W-404 during and after the treatability test suggest that the amount of residual PCE is not significant. However, longer cleanup time estimates were conservatively used in the design of the Arroyo Seco pipeline extension.

4.2.2. Conveyance, Treatment and Discharge

A new underground pipe will be installed between extraction well W-404 and the west pipeline vault at the end of the existing Arroyo Seco pipeline so that extracted ground water from well W-404 can be treated at TFA. The new pipeline alignment is shown in Figure 6. The design detail is shown in the Title II design drawings, presented in Appendix A, and is described in the following subsections. Table 3 summarizes the design specification for pipeline extension components.

4.2.2.1. Design Standards and Calculations

The pipeline installation will conform to requirements from the City of Livermore Engineering Division and the Alameda County Water Conservation and Flood Control District, Zone 7 (Zone 7). All work to construct the Arroyo Seco pipeline will be conducted on property within the jurisdiction of these agencies. The design and construction will conform to the 2010 California:

- Building Code (International Code Council, 2009) and
- Electrical Code (National Fire Protection Association, 2008).

The new pipeline, conduit, bridge crossing, vaults, and other ancillary equipment that cannot be easily accessed or maintained are designed for an operating life of 50 years, or two to three times the expected time to cleanup of ground water in the extraction well W-404 area. Project elements that are readily accessible, such as pumps, electronics, and instrumentation are designed for a minimum operating life specified by the manufacturer but not less than 5 years.

Calculation of the anticipated total pressure loss in the Arroyo Seco pipeline extension and existing Arroyo Seco pipeline due to friction, minor, and elevation losses are presented in Appendix B. The total pressure loss was then used to determine the appropriate pump size at extraction well W-404 and to evaluate the suitability of existing pumps in extraction wells supplying water to the Arroyo Seco pipeline. Friction losses along the straight sections of pipeline were calculated with the Hazen-Williams formula (Brater et al., 1996). Minor losses due to components such as valves, fittings, and pipe transitions were calculated from velocity

head using K-factor coefficients (Brater et al., 1996). Elevation losses were determined by adding the estimated depth to water in the well to the change in topography along the Arroyo Seco pipeline.

Appendix B also contains structural calculations performed to determine design loads for exposed portions of the Arroyo Seco pipeline extension where it will be attached the bridge. Appropriate criteria specific to the project type and location from the 2009 International Building Code were use to estimate seismic loads. Static loads were estimated according to *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010). Estimated loads were used to specify anchor bolts and the hanger configuration for the pipe section that is attached to the Charlotte Way bridge.

4.2.2.2. Wellhead and Cabinet Improvements

Elements of extraction well W-404 will be retained or upgraded to standards consistent with other wells supplying water to TFA. In the well itself, the existing pump will be replaced with a new Grundfos type 40S50-15 pump capable of delivering 35 gpm at up to 250 feet of head, which is sufficient pressure to pump the water the full distance to TFA while minimizing interference to pumping at other wells. Existing piping at the extraction well W-404 wellhead will be upgraded to provide double containment and leak detection. The existing pump control cabinet will be used and will contain new pump motor controls, piping and flow control valves, and leak detection. The existing sampling ports that were installed and used for the 2007 treatability study will also remain.

The pump control cabinet and vault for extraction well W-404 will remain secured such that only authorized personnel will have access. The vault will allow access for manual water level measurements, and for water sample collection using the extraction pump and a sampling port at the wellhead. Equipment in the well and vault are not expected to generate noise that will be a nuisance to the surrounding community.

4.2.2.3. Conveyance and Conduit Systems

The new pipeline and conduit will be routed to avoid, where possible, existing underground utilities, reduce likelihood of future disturbance during utility installation or improvements, facilitate maintenance, and minimally impact the community during construction. Driveways will be avoided where feasible. The pipeline alignment is within a City of Livermore right-of-way and follows Charlotte Way from the extraction well W-404 wellhead to Susan Lane, then follows Susan Lane to just beyond the cul-de-sac at the end of Susan Lane where it enters the western pipeline vault that contains the western end of the Arroyo Seco pipeline (Figure 6). Portions of the pipe at Arroyo Seco and near the western pipeline vault are within properties owned by Zone 7 Water.

The new pipeline and conduit will be installed underground for their entire length except for the 40-foot segment at the Charlotte Way bridge where they cross Arroyo Seco (Figure 6). At the Charlotte Way bridge, the exposed pipe and conduit will be firmly supported and bolted to the side of the bridge, out of the flood control channel, meeting requirements from Zone 7 and the City of Livermore. For the underground portions, required horizontal and vertical clearances will be maintained from existing gas and electric installations owned by Pacific Gas and Electric, telephone installations owned by American Telephone and Telegraph, and water, sewer and storm drains owned by the City of Livermore. The underground segment on Charlotte Way will

be installed below the street. The Susan Lane segment will be installed below the sidewalk near the intersection with Charlotte Way and in the lawn adjacent to the sidewalk for most of the length of Susan Lane. Utility trenches will be constructed in accordance with City of Livermore standards and will generally consist of placement of pipe and conduit atop 6 inches of rock bedding and beneath a minimum 3 ft of fill. Trenching in concrete or asphalt areas will be finished to match existing conditions, which are anticipated to be from bottom to top a minimum of 6 inches compacted fill material, 9 inches aggregate base rock, and 3 inches asphalt concrete or cement concrete, as appropriate.

The Arroyo Seco pipeline extension will be double-contained along its entire length. Underground portions of the pipe will consist of an inner 2-inch inner diameter (ID) carrier pipe enclosed in an outer 4-inch ID containment pipe, both of Schedule 80 polyvinyl chloride (PVC). The inner pipe will be centered in the outer pipe with pipe centralizers at the joint and midway in pipe runs, which are typically 20-feet in length. The exposed portion of the pipe at Arroyo Seco will consist of 2-inch ID Schedule 80 PVC within a 4-inch metal containment pipe. The exposed containment pipe portion will be constructed of ductile iron that is coated and lined to resist harsh environmental factors including seismic activity, tampering/vandalism, corrosion, ultraviolet rays, dust, rain, floods and flood-entrained debris, and extreme temperatures. The maximum operating pressure for extraction well W-404 and the pipeline will conform to limits for the materials of construction.

The double-contained pipe will be equipped with a leak detection system, which will consist of buoyancy sensors at the well head, the well cabinet, and low points along the pipeline near the intersection of Charlotte Way and Susan Lane, and at the western pipeline vault. The leak detection sensors will be connected to a radio transmitter at the well W-404 cabinet with fiber optic cable run in the signal conduit parallel to the pipeline. The signal conduit will contain low voltage power wire for sensors and fiber optic cable for data. Where fiber optic cable is used, junction boxes will be located at approximate 200 foot intervals, which will facilitate access for wire and cable installation and maintenance.

4.2.2.4. Power, Instrumentation and Controls

The existing extraction well W-404 power supply will be used with minor upgrade to facilitate a larger pump motor. A pressure transducer and flow meter will be installed to measure water level and flow rate, respectively. This instrumentation will be installed within the well and the existing cabinet at the sidewalk adjacent to extraction well W-404. Extraction well W-404 will be incorporated into the existing TFA control system, which is designed to be fail-safe. The TFA control system includes a controller, human-machine interface display, data communications link, and well and treatment equipment interlocks. Wireless radio frequency transmitters will be used to send data from the well W-404 cabinet to TFA. Water levels, pumping hours, flow rates, and well flow totals will be transmitted and recorded by the Treatment Facility Real Time (TFRT) database.

4.2.2.5. Ground Water Treatment and Discharge

Ground water extracted from well W-404 will be treated at TFA, located just north of Arroyo Seco near Vasco Road in the southwestern portion of the LLNL Site (Figure 2). TFA removes VOCs from ground water pumped from extraction wells to the north, east, south and west. TFA began operating in April 1989, treating ground water from extraction well W-415 through the

east pipeline. Additional wells were connected to TFA by the south, Arroyo Seco, and north pipelines (Figure 6). Table 1 lists the wells connected to the Arroyo Seco pipeline with respective HSU, pump specifications, pumping rates, and well construction details. Each well is equipped with a pump, power and communication control, pressure transducer for measuring water levels, sample port, flow meter, and isolation valve, either located at the wellhead or in a nearby vault. The additional flow from well W-404, when added to flow from other wells, will not exceed the operating capacity of TFA. Table 2 lists existing TFA component specifications.

Figure 9 shows the process flow at TFA. Untreated ground water influent is first filtered by a stainless steel filter canister with disposable filter cartridges to remove solids. A sequestering agent is then added to reduce calcium carbonate scaling. The water then passes through a shallow-tray air stripper consisting of a sump tank, three aeration trays placed in succession above it, and a lid at the top. The bottom of each aeration tray has holes that pass air from a variable-speed centrifugal blower. The treated effluent water is pumped through a steel pipeline and discharged to the Arroyo Seco near TFA or to the Western Drainage Ditch along the western LLNL perimeter, near Vasco Road (Figure 6). Vapor carrying VOCs from the TFA air stripper is vented to a knockout tank where condensed moisture is removed from the air stream. Vapor then passes through two GAC canisters, each containing 1,500 pounds of GAC to adsorb the VOCs. The clean vapor is vented to the atmosphere and is periodically monitored by an organic vapor analyzer.

4.2.3. Performance Standards and Monitoring for Ground Water Extraction and Treatment System

Performance standards for the remediation program at the Livermore Site are outlined in the LLNL Livermore Site Compliance Monitoring Plan (Nichols, 1996) and include remediation performance standards to evaluate the effectiveness of the remedy in achieving cleanup goals.

4.2.3.1. Subsurface Remediation Performance

After the Arroyo Seco pipeline extension project is completed, the system will be activated according to a facility start-up plan that will allow collection of both hydraulic (water levels and flow rates) and chemistry data. Following the completion of the facility start-up plan, routine water level measurements and ground water sampling will resume based on the existing monitoring program for TFA.

The data obtained during the facility start-up and subsequent monitoring will be used to assess the performance of subsurface remediation of the detached HSU 2 PCE plume. The concentration trends combined with the water level measurement data will be used to optimize the ground water extraction flow rates in all TFA Arroyo Seco pipeline extraction wells.

As described in RD Report No. 1 (Boegel et al., 1993) and the Compliance Monitoring Plan (Nichols et al., 1996), once MCLs have been achieved for all contaminants of concern in extraction well W-404 and in monitor wells within its capture zone, pumping of well W-404 will be stopped. Contaminant concentrations will then be monitored quarterly for a period of 2-years. If concentrations rise above MCLs, extraction will resume at well W-404 until MCLs are again achieved. Several cycles of pumping may be needed to achieve the remediation standards. As stated in RD-1, “Cleanup will be considered complete when contaminant concentrations remain below the remediation standards for 2 years. Cleanup completion will be determined in conjunction with the regulatory agencies.”

4.2.3.2. Treatment System Performance

Monitoring of extraction and treatment of ground water from extraction well W-404 will be performed as part of the existing self-monitoring program for TFA. Influent and effluent concentrations at TFA will continue to be measured to monitor the treatment facility effectiveness and efficiency, and to meet discharge limit requirements (DOE, 1992; Berg et al., 1997b). Treated water sampling and monitoring at TFA follows the site's ground water treatment system self-monitoring requirements (Chou, 1999).

Air stripper off gas from TFA is passed through GAC and then discharged to the air under Permit No. 21142 from the Bay Area Air Quality Management District.

4.2.4. Controls and Safeguards

Once connected to TFA, extraction well W-404 will be controlled by TFA's control system. TFA is designed to be fail-safe, i.e., the failure of any key component will cause the system to shut down safely, including the extraction wells. The control system notifies the system operator with an alarm on the process control display and a low-flow rate indicator for TFA on the TFRT webpage. The system can only be restarted after an operator identifies and corrects the problem.

Any of the following conditions will shut down the facility:

- Low water flow rate (e.g., pipe break);
- High water flow rate;
- Leak detected in containment pipe;
- High water level in the air stripper;
- Air supply blower failure;
- Pressure loss in the aeration system supply air;
- Activation of the manual emergency shutdown;
- Air stripper low pressure;
- Air stripper high pressure;
- The process control computer going off-line; or
- Power failure.

4.3. Schedule and Cost Estimates

The Arroyo Seco pipeline extension design will be complete after addressing regulatory and community comments. The schedule for implementation and startup for the project, as well as the schedule for addressing comments on this report are presented in Table 4. Upon completion of construction, a construction implementation report consisting of as-built documentation will be submitted to the City of Livermore.

Cost estimates for construction, startup and operation of extraction well W-404 and the Arroyo Seco pipeline extension are summarized in Table 5. Extraction well W-404 will be part of the operation and maintenance (O&M) program for TFA.

4.4. Contingency Planning

DOE/LLNL has prepared a Contingency Plan (McKereghan, 1996), which describes how DOE/LLNL and the regulatory agencies plan to address foreseeable problems that may arise during environmental remediation at the Livermore Site. That document also describes plans for modifying remediation systems as the site cleanup progresses and additional information is collected. Contingency Plan requirements that could be implemented, if needed for extraction well W-404, TFA and the Arroyo Seco pipeline include:

- Insufficient hydraulic containment: Adjust extraction flow rates and/or number/location of extraction wells.
- Increasing chemical concentration: Adjust extraction flow rates and/or number/location of wells. Conduct additional source investigations, if necessary.
- Remedial action affects non-LLNL, offsite plume(s): Adjust extraction flow rates, employ ground water barriers (e.g., reinjection, slurry walls), and/or apply innovative technologies.
- Uncontrolled events impact remediation efforts: Assess damage to infrastructure and, if appropriate, modify, replace or decommission remediation system(s).
- Personnel changes: A phase-in/phase-out period will be employed, if appropriate, to ensure smooth transitions during personnel changes. Review project documentation at transitions and learn current positions on site-related issues that have major impacts.
- Insufficient funding affects planned remediation: Established Livermore Site remediation priority list will be followed. If necessary, milestones dates will be revised through coordination with the regulatory agencies.
- Regulation changes: DOE/LLNL, regulators, and the community will be included in the process to determine if and how regulatory changes affect the Livermore Site cleanup.
- Changes to the mission and operation of LLNL: Future mission and operation of LLNL will include CERCLA compliance and cleanup implementation as specified in the Federal Facility Agreement and ROD documents.

5. Remedial Action Work Plan

The Remedial Action Work Plan is described below for construction of the Arroyo Seco pipeline extension project described in Section 5, and includes the following major components:

- Quality Assurance/Quality Control Plan (Section 5.1);
- Health and Safety Plan (Section 5.2);
- Field Sampling Plan (Section 5.3);
- Dust Control and Air Monitoring Plan (Section 5.4);
- Noise Controls (Section 5.5);
- Traffic Controls (Section 5.6);
- Monitoring and Reporting Programs (Section 5.7);
- Waste Handling (Section 5.8); and

- Requirements for Closure (Section 5.9).

Each is described in the following sections.

5.1. Quality Assurance/Quality Control Plan

The Quality Assurance and Quality Control (QA/QC) Plan for construction is presented in Appendix C of this document. It defines the quality objectives for the construction. After construction is complete, the existing QA/QC Plan for the O&M of TFA will govern operation of extraction well W-404. Operation and Maintenance Volume 1: Treatment Facility Quality Assurance and Documentation (LLNL, 2004) and Volume II: Treatment Facility A (Kawaguchi and Iyer, 2003) describe the organizational structure, responsibilities and authority for O&M QA/QC, and the objectives, quality goals, and QA elements.

5.2. Health and Safety Plan

The Health and Safety Plan (HSP) for construction is presented in Appendix D of this document. It defines the responsibilities for health and safety during construction activities and references existing LLNL Health and Safety documents that address construction health and safety issues. Because construction of the Arroyo Seco pipeline extension will be performed by a construction contractor, the contractor will be required to comply with the applicable LLNL safety requirements in their plan.

After construction is complete, the existing HSP for O&M of TFA provided in RD-1 (Boegel et al., 1993) will govern operation of extraction well W-404. The HSP for O&M of TFA presents: (1) organizational structure and responsibilities, (2) hazard analyses and control measures, (3) training requirements for performing O&M, and (4) emergency safety procedures. Safety procedures for O&M work performed by LLNL staff and contractors are detailed in Integration Work Sheets which are prepared as part of LLNL's Integrated Safety Management System.

5.3. Field Sampling Plan

The Field Sampling Plan (FSP) for construction is presented in Appendix E. The FSP for preconstruction soil testing that will be performed at locations along the proposed pipeline alignment to search for previously unidentified underground utilities that may be present and to collect soil samples for laboratory analysis. Approximately one shallow boring will be installed every 100 linear feet along the alignment; in each boring, soil samples will be collected at a depth of between 2 and 3 ft below ground surface except in the boring near the leak detection vault where the soil sample will be collected at 5 ft below ground surface. Asphalt or concrete will be cored as necessary and an air knife and hand auger will be used to remove soil to near the target depth. Soil samples will be collected according to LLNL Standard Operating Procedures (Goodrich and Lorega, 2009) and analyzed at an offsite laboratory for VOCs by U.S. EPA Method 8260b, total metals listed in Title 22 of the California Code of Regulations (CCR) by U.S. EPA Method 6010, for pesticides by U.S. EPA Method 8081a, and for radiological parameters (i.e., gross alpha and beta) by U. S. EPA Method 9310.

5.4. Dust Control and Air Monitoring Plan

The Dust Control and Air Monitoring Plan for construction is presented in Appendix F. Dust control measures and ambient air monitoring will be performed during all excavation and backfilling activities in areas within and around the construction zone. Dust control measures detailed in Appendix F include but are not limited to minimizing disturbed areas, controlling construction vehicle traffic and using clean water for dust suppression. An LLNL employee will be designated to liaison with community members on issues related to dust control. Contact information for the dust control liaison will be provided to the community and he or she will respond to dust complaints and prepare documentation.

The air monitoring program will include collection and analysis of air samples during trenching. Air monitoring will be conducted upwind and downwind along the pipe alignment. No hazardous materials or environmental contamination are expected to be encountered during construction activities. Dust monitoring will begin prior to the start of excavation activities to establish background concentrations. Continuous data logging during work hours will be used.

5.5. Noise Controls

LLNL will implement noise control measures to minimize disturbance to community members and to provide for the health and safety of employees, contractors and visitors. Construction activities will comply with the City of Livermore Noise Ordinance outlined in Chapter 9.36 of the Livermore Municipal Code (City of Livermore, 1997). The following minimum measures will be implemented:

- Work that generates noise will only be performed between 7:00 am and 6:00 pm Monday through Saturday.
- A decibel meter will be used to monitor noise levels.
- Construction equipment will utilize noise control techniques that may include damping materials, mufflers or enclosures.
- Equipment staging and parking areas will be located as far as feasible from residences.
- Temporary sound barriers will be erected if noise levels exceed 85 decibels (dBA) at an eight-hour time-weighted average during construction activities.
- A DOE/LLNL employee will be designated to liaison with community members on issues related to noise. Contact information for the noise liaison will be provided to the community and he or she will respond to noise complaints and prepare documentation.

5.6. Traffic Control Plan

Temporary traffic controls will be employed during all phases of construction to ensure safe and efficient movement of road users through or around the project area while reasonably protecting workers, responders to traffic incidents, and equipment. Drawing C-2 in Appendix A is a Traffic Control Plan that shows the location of flagmen and traffic controls including signage, cones, and temporary lane closures. The Traffic Control Plan was developed in accordance with City of Livermore Requirements (City of Livermore, 2005) based on the

California Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways (Caltrans, 2010) as maintained by the State of California, Business, Transportation and Housing Agency, Department of Transportation.

5.7. Monitoring and Reporting Programs

Monitoring requirements for VOCs in extraction well W-404 and performance of TFA are presented in Operation and Maintenance Manual Volumes 1 and 2. Monitoring results and TFA performance information will be reported in the Quarterly Self-Monitoring Reports and the Annual Ground Water Project reports, starting with the 2012 annual report. The monitoring programs for VOCs in ground water and TFA performance are summarized in Sections 5.6.1 and 5.6.2, respectively.

5.7.1. Monitoring of VOC Attenuation in Ground Water

Sampling requirements for the ground water monitoring and extraction wells for the remediation program at the Livermore Site are outlined in the LLNL Livermore Site Compliance Monitoring Plan (Nichols, 1996). The addition of extraction well W-404 to TFA does not change the current sampling and monitoring plan for the TFA Area.

5.7.2. Ground Water Extraction and Treatment System Influent and Effluent

The self-monitoring requirements and procedures for TFA are outlined in the Operation and Maintenance Manual Volumes 1 and 2. Chemical analyses will be performed according to EPA Methods. Results will be evaluated according to QA/QC procedures contained in the program-wide Quality Assurance Project Plan (QAPP) (Dibley, 1999). Quarterly treatment facility influent and monthly effluent monitoring will be conducted and the results used to evaluate facility performance and to verify that discharge requirements are met. The self-monitoring program sampling frequency and required analyses for TFA are summarized in Table 6.

5.8. Waste Handling

The only anticipated hazardous waste that will be generated by the Arroyo Seco pipeline extension project is the spent GAC and cartridge filters from TFA. These wastes will be characterized and shipped offsite by LLNL Radioactive and Hazardous Waste personnel for disposal according to the established LLNL procedures. If any potentially hazardous materials are encountered in the pipeline excavation, as identified by ambient air monitoring and visual examination, the composition and extent of the material will be characterized. If the material is confirmed as hazardous, it will be removed, transported under hazardous waste manifest and properly disposed at a licensed facility. Shipment and disposal will be in accordance with Department of Transportation 49 Code of Federal Regulations (CFR) and EPA 40 CFR. Additionally, waste shipments will be made according to CCR, Title 22 Section 66260.1 requirements. The waste will be packaged and labeled for shipment by the LLNL Radioactive and Hazardous Waste Management personnel.

Non-hazardous materials excavated from the trench that are not replaced as backfill such as asphaltic concrete pavement, concrete sidewalks and curbs, and native soil not suitable for re-compaction or backfill into the trench, will be transported offsite for reuse or recycling. The

disposal of these materials will be overseen by the LLNL Radioactive and Hazardous Waste Management personnel.

5.9. Requirements for Closure

TFA, extraction well W-404, and the Arroyo Seco pipeline extension will be decommissioned when ground water cleanup is complete as described in the ROD. Cleanup will be considered complete in the area when VOC concentrations in ground water remain below the cleanup standards for two years and after concurrence with the regulatory agencies that remediation is complete.

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U.S. EPA (1989), *Interim Final Guidance on Preparing Superfund Decision Documents: The Proposed Plan, The Record of Decision, Explanation of Significant Difference, and The Record of Decision Amendment*, Office of Solid Waste and Emergency Response (OSWER), Directive 9335.3-02.

U.S. EPA (1999), *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents" (July 1999)* U.S. Environmental Protection Agency, Washington, D.C. OSWER 9200.1-23P, (EPA 540/R-98/031).

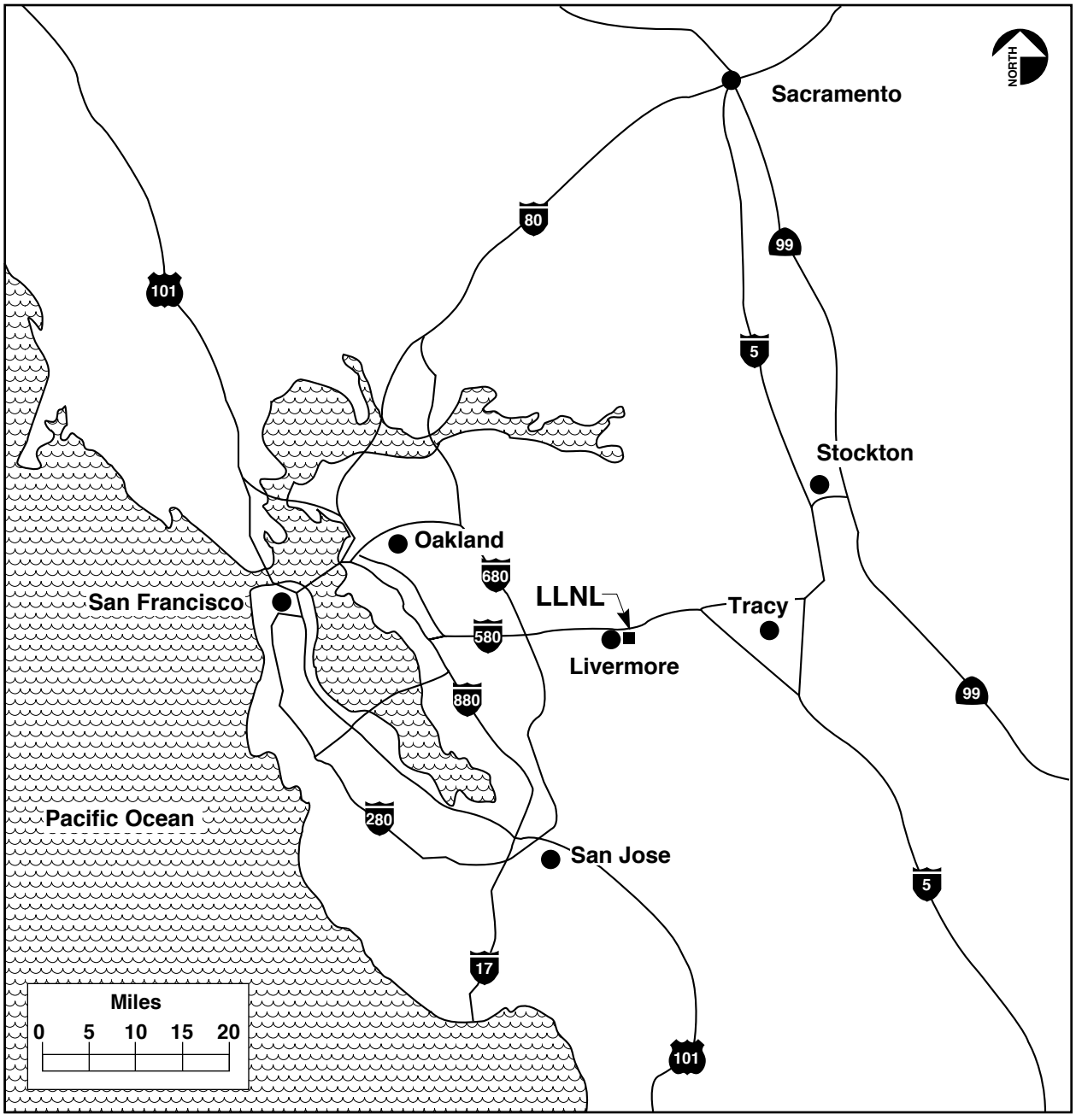
7. Acronyms and Abbreviations

AEC	Atomic Energy Commission
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCl_4	Carbon tetrachloride
CCR	California Code of Regulations
CFR	Code of Federal Regulations
DAS	Data acquisition system
dBA	Decibels
1,1-DCE	1,1-Dichloroethene
DHS	California Department of Health Services
DOE	Department of Energy
DTSC	California Department of Toxic Substances Control
EPA	Environmental Protection Agency
ESD	Explanation of Significant Difference
FFA	Federal Facilities Agreement
FHCs	Fuel hydrocarbons
FSP	Field Sampling Plan
ft	Feet
ft^2/day	Square feet per day
GAC	Granular activated carbon
gpm	Gallons per minute
HSP	Health and Safety Plan
HSU	Hydrostratigraphic unit
ID	Inner diameter
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
MCL	Maximum Contaminant Level
MSL	Mean sea level
O&M	Operation and Maintenance
PCE	Perchloroethylene, also called tetrachloroethylene or tetrachloroethene
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
REVAL	Remediation Evaluation
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RWQCB	California Regional Water Quality Control Board
STU	Solar Treatment Unit
TCE	Trichloroethene
TFA	Treatment Facility A
TFA-E	Treatment Facility A East

TFRT	Treatment Facility Real Time
U. S.	United States
UV/H_2O_2	Ultraviolet light/hydrogen peroxide
VOCs	Volatile Organic Compounds
µg/L	Micrograms per liter
Zone 7	City of Livermore Engineering Division and the Alameda County Water Conservation and Flood Control District, Zone 7

Figures

List of Figures



ERD-LSR-06-0055

Figure 1. Location of the LLNL Livermore Site.

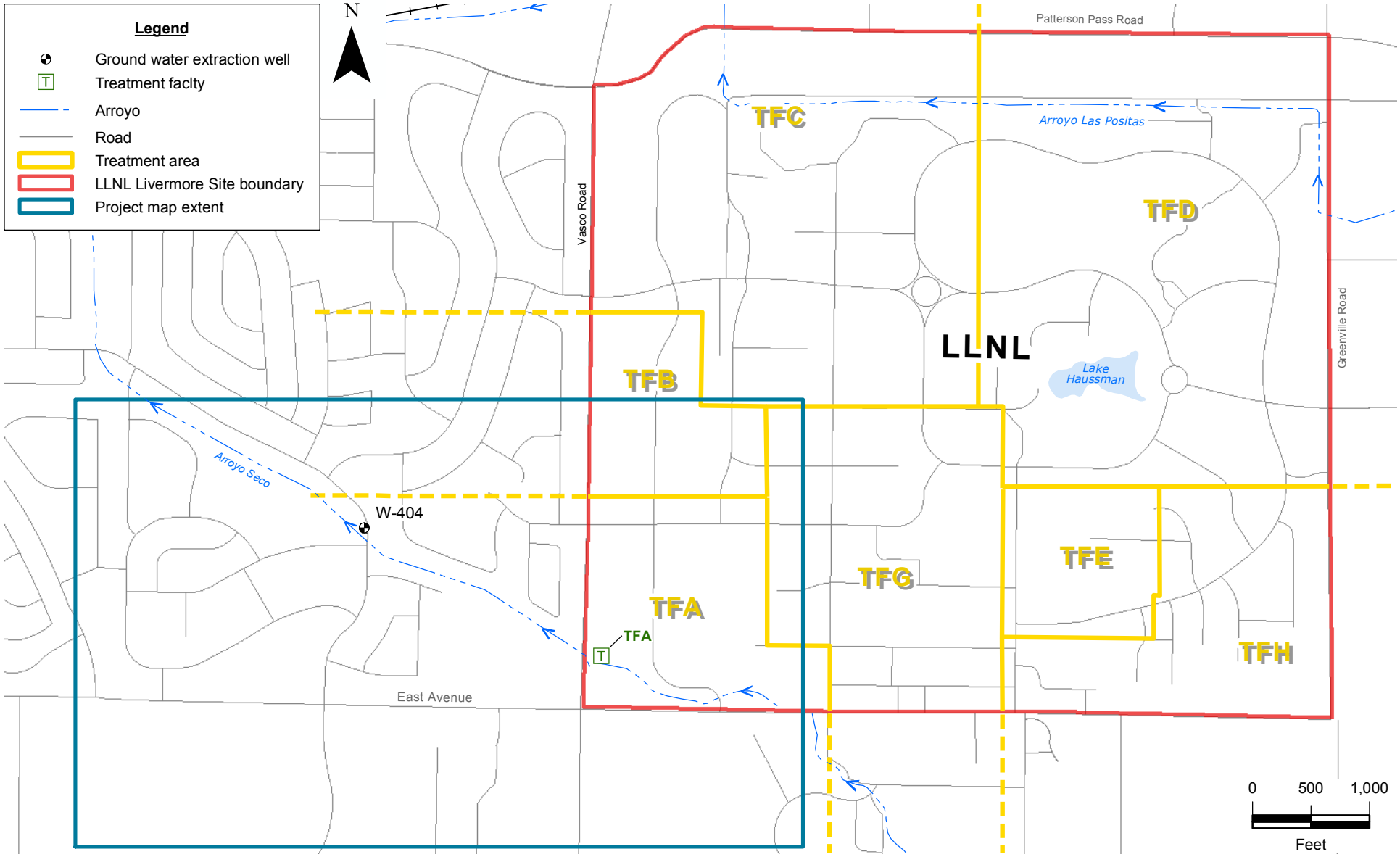


Figure 2. Location of extraction well W-404 and the TFA area at and near the LLNL Livermore Site.

Figure 3. Isoconcentration contour map of PCE within HSU 1B in the TFA area, third quarter 2010.

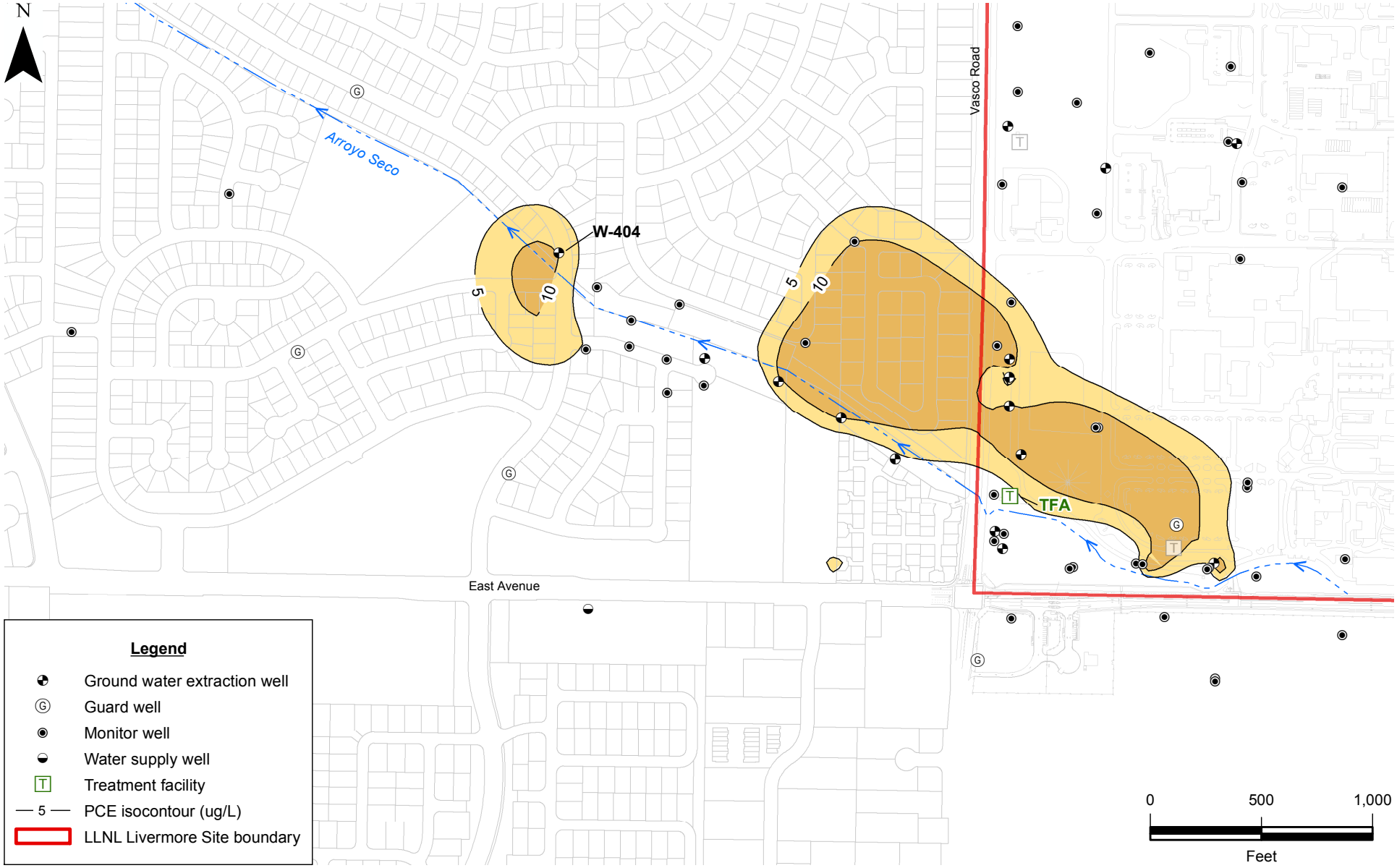


Figure 4. Isoconcentration contour map of PCE within HSU 2 in the TFA area, third quarter 2010.

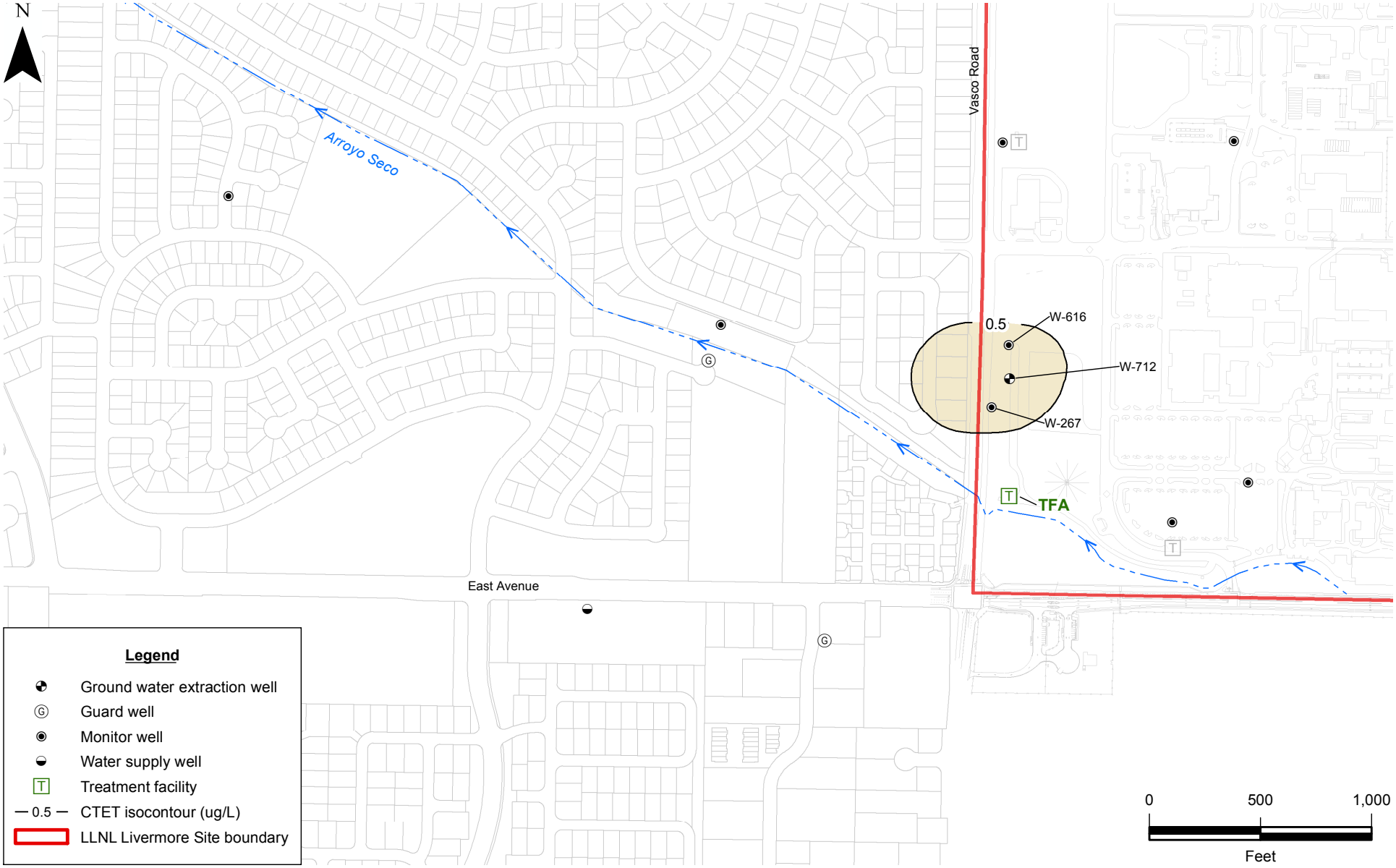


Figure 5. Isoconcentration contour map of carbon tetrachloride within HSU 3A in the TFA area, third quarter 2010.

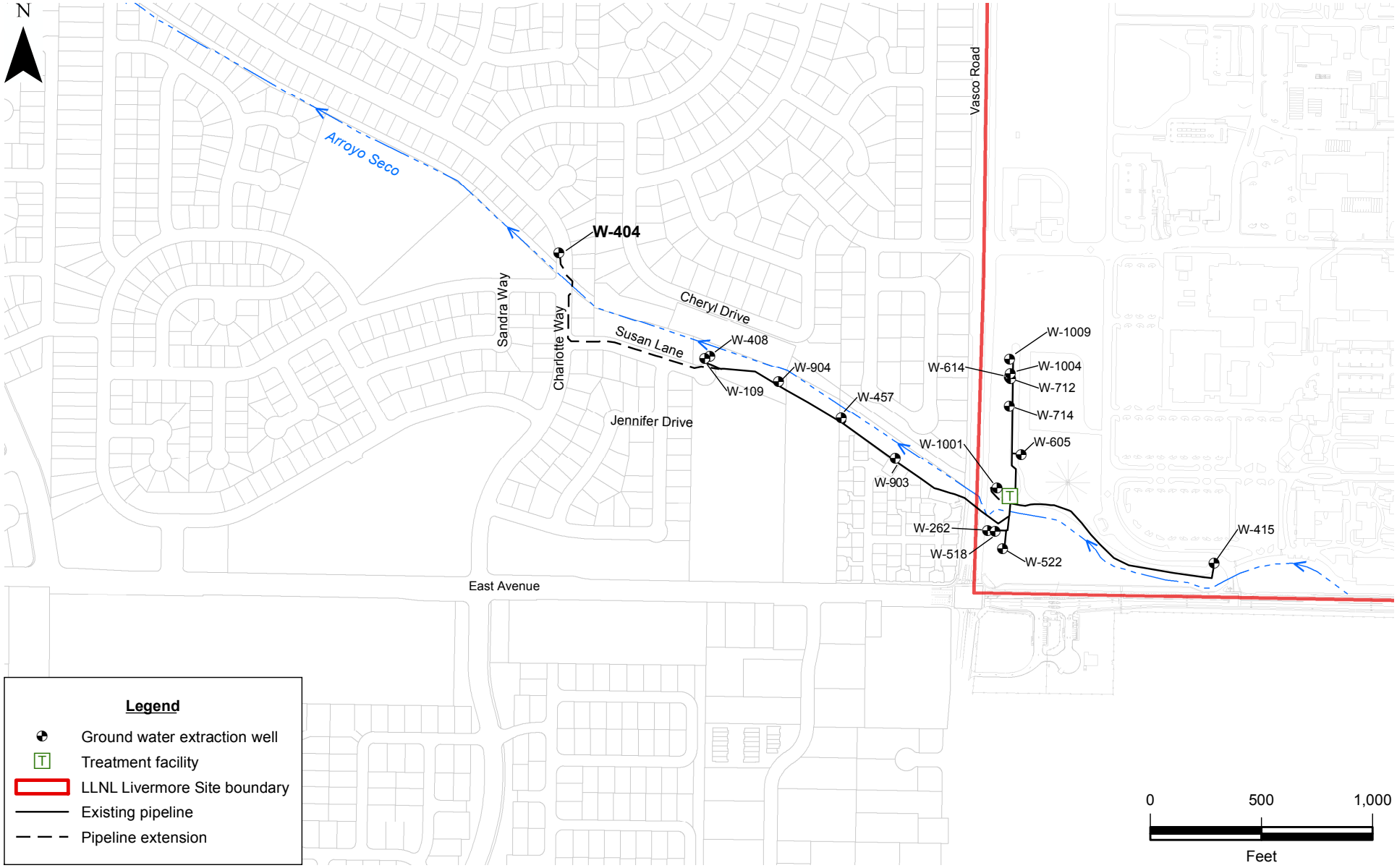


Figure 6. TFA existing pipeline routes, Arroyo Seco pipeline extension route, and ground water extraction wells.

Figure 7. Isoconcentration contour map of PCE within HSU 2 and estimated hydraulic capture areas in the TFA area, second quarter 2007 treatability test.

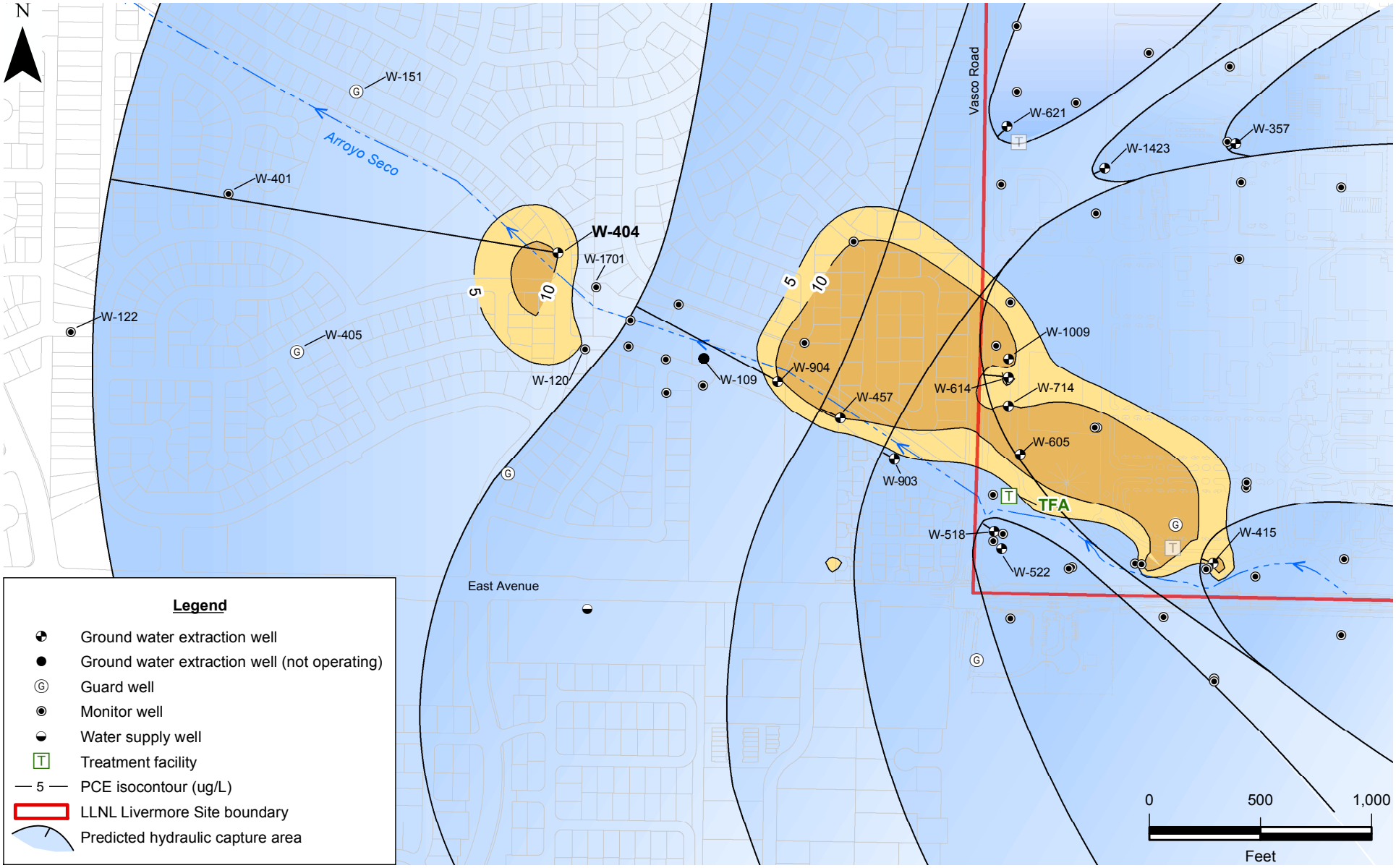


Figure 8. Isoconcentration contour map of PCE within HSU 2 (third quarter 2010) showing predicted hydraulic capture areas in the TFA area for the planned extraction wellfield flow rates.

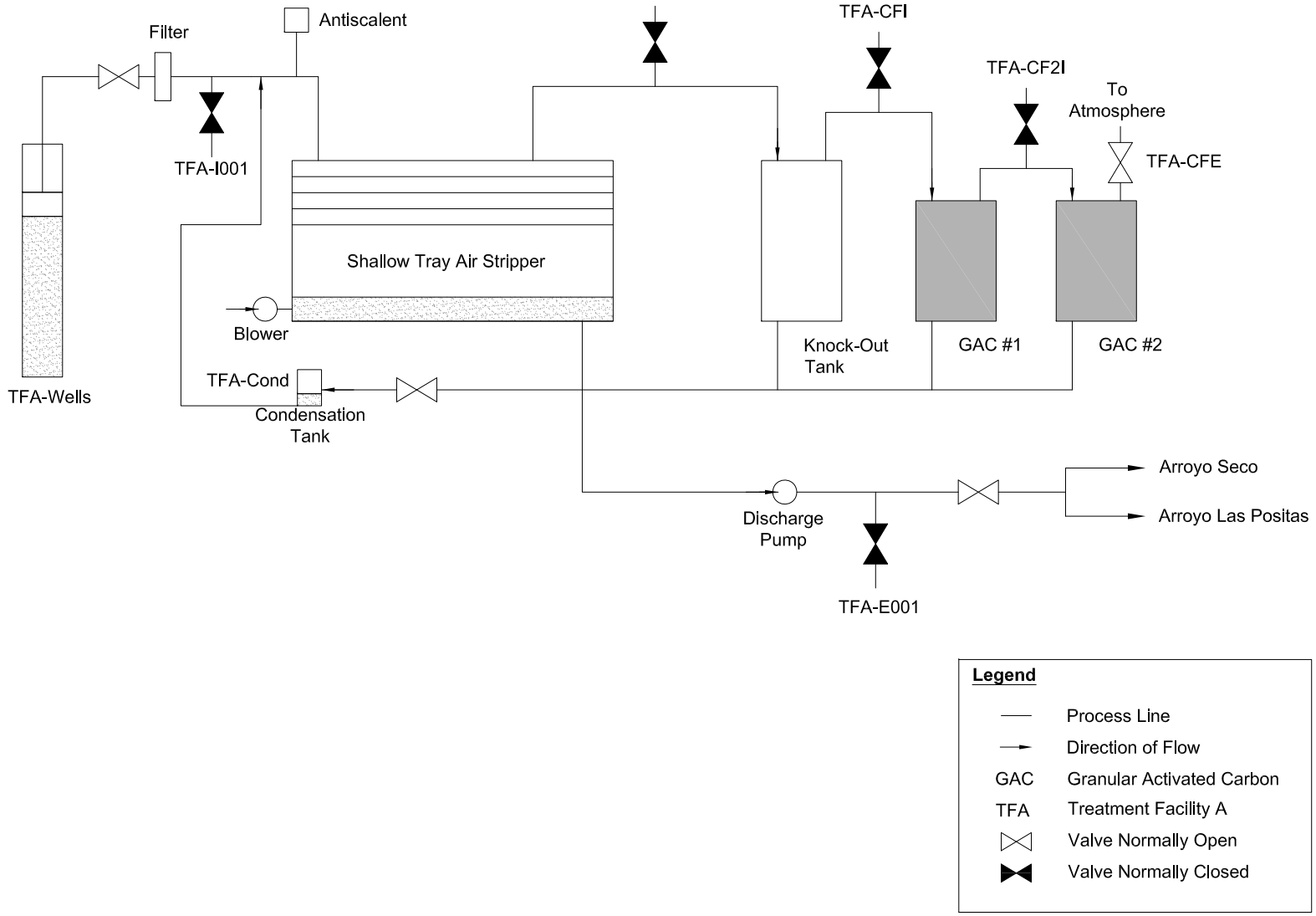


Figure 9. Process Flow Diagram for TFA.

Tables

List of Tables

Table 1. Planned ground water extraction well flow rates for the Arroyo Seco pipeline.

Well	HSU	Pump Type	Flow Rate (gpm)	Casing Diameter (in)	Casing Depth (ft-bgs)	Screen Interval (ft-bgs)
W-404	2	Submersible	32	4.5	158	150-158
W-408	1B	Submersible	25	4.5	122.5	103-122.5
W-109	2	Submersible	0	4.5	147	137-147
W-904	2,2	Submersible	37	6	154	121-133 140-149
W-457	2	Submersible	25	4.5	149.5	130-149.5
W-903	2	Submersible	25	6	145	132-140

Notes:

ft-bgs = Feet below ground surface.
gpm = Gallons per minute.
HSU = Hydrostratigraphic unit.
in = Inches.

Table 2. Current component specifications for TFA.

Item	Description
TFA Building (B-011)	**Butler Building, 25-ft x 25-ft x 12-ft**
Building foundation	**10-in-thick, 3,000 psi concrete with rebar (at previous location of UV/oxidation reactor). 4-in-thick 3,000 psi concrete pad reinforced with rebar throughout the rest of the building**
Extraction well pumps	**Grudfos Submersible, 0.5 hp to 5 hp**
Filter canister	**Cuno, 12DC3, Five Canisters, 12 Filter Cartridges per canister**
Filter cartridges	**Honeycomb Parker Hannifin Corporation, M23R29-4A, 15 gpm at 0-2 psi pressure drop**
Control system	**OPTO-22/Paragon TNT Control Unit / Control Software**
Sequestering agent	**Belsperse 161**
Air stripper	**North-East Environmental Products, Shallow Tray Air Stripper, Model 41231**
Supply air blower	**20 hp variable speed, 2,400 cfm at 25 in water, 4,800 cfm maximum**
Carbon filter	**Two, 1,500-lb granular activated carbon**
Level control system	**Rosemount – Level Sensor** **Yokogawa – PID Controller** **Toshiba – Variable Frequency Drive**
Discharge pump	**Bell and Gossett, 1510 3E, 15 hp variable speed**
Leak detection system	**Low level sump float**

Notes:

psi = Pounds per square inch.
hp = Horsepower.
gpm = Gallons per minute.
cfm = Cubic feet per minute.
lb = Pound.
PID = Proportional integral derivative.

Table 3. Design specification summary for Arroyo Seco pipeline extension components.

Item	Description
Capabilities	**Addition of ground water extraction and underground conveyance from extraction well W-404 to TFA** **Underground installation of pipe and use of steel pipe in exposed portions to protect conveyance** **Construction and operation mitigations to minimize impacts to neighborhood**
Anticipated maximum flow rate	**Extraction well W-404: 32 gpm** **Arroyo Pipe: 144 gpm** **TFA: 284 gpm**
TFA Extraction wells	**West Pipeline: W-404, W-408, W-109, W-904, W-457, W-903** **East Pipeline: W-415** **North Pipeline: W-1009, W-1004, W-614, W-712, W-714, W-605, W-1001** **South Pipeline: W-522, W-518, W-262**
Extraction well pump type	**Extraction well W-404: Grundfos 40S50-15**
Water flow meter	**Rosemount 8732 flow tube and transmitter**
Sensor - water level	**Instrumentation North West PS9800**
Sensor - leak detection	**Flowline 6907.100 level switch, buoyancy**
Water conveyance line	**Schedule 80 PVC, 2-inch**
Containment pipe	**Schedule 80 PVC, 4-inch**
Containment pipe - bridge crossing	**Schedule 40, ductile iron, 4-inch, Coated**

Table 4. Arroyo Seco pipeline extension construction and document schedule.

Activity	Completion Date
Submit Draft Addendum to Remedial Design Report No. 1 (RD1) for Treatment Facility A to regulatory agencies and the Technical Assistance Grant group	5-1-11
Receive regulatory comments on Draft Addendum to RD1	7-1-11
Submit Draft Final Addendum to Remedial Design Report No. 1 for Treatment Facility A to regulatory agencies	8-31-11
Submit Final Addendum to Remedial Design Report No. 1 for Treatment Facility A to regulatory agencies	9-30-11[a]
Preconstruction pot-holing and soil testing	11-15-11
Begin ground water extraction at well W-404	9-30-12[a]
Submit as-built documentation	11-30-12

Notes:

[a] **These dates can be met only if there are few or no comments on the Draft Final Addendum.**

Table 5. LLNL Project Cost Estimate Summary.

Item #	Item Description		Materials	Direct Labor	Equipment	Total	Annual Operation
Pipeline Construction							
1	Mobilization		$0	$0	$0	$15,000	$0
2	Demolition and Site Preparation		$0	$1,600	$1,300	$2,900	$0
3	Erosion Control		$400	$6,100	$200	$6,700	$0
4	Pipe Installation		$37,800	$28,800	$14,800	$81,400	$0
5	Manhole and Leak Detection Installation		$1,600	$2,600	$1,800	$6,000	$0
6	Materials Handling and Disposal		$0	$6,800	$10,200	$17,100	$0
7	Health and Safety Training / Plan		$0	$10,000	$0	$10,000	$0
8	Traffic Control		$0	$11,200	$2,000	$13,200	$0
9	Electrical & Electronic		$3,500	$5,900	$0	$9,400	$0
10	Wellhead & Cabinet Improvements		$8,800	$3,500	$0	$12,300	$0
11	Arroyo Pipe Connection		$1,800	$6,000	$0	$7,800	$0
12	Air Monitoring		$0	$18,000	$7,500	$25,500	$0
13	Construction Oversight		$0	$72,000	$0	$72,000	$0
14	Well W-404 Start up and Testing		$500	$8,400	$500	$9,400	$0
Operation and Maintenance for W-404							
17	Wellhead maintenance		$0	$0	$0	$0	$5,000
18	Well W-404 Sampling		$0	$0	$0	$0	$2,800
Contract Administrations							
19	Bonds	2%	$0	$0	$0	$3,000	$0
20	Tax on Material	9.75%	$0	$0	$0	$3,900	$0
21	Overhead and Profit	15%	$0	$0	$0	$22,800	$0
22	General Terms	10%	$0	$0	$0	$15,200	$0
23	Permits	10%	$0	$0	$0	$15,200	$0
24	Contractor Contingency	30%	$0	$0	$0	$63,700	$0
				TOTAL ESTIMATED PROJECT COST		$412,500	$7,800

Table 6. Summary of Sampling Frequency and Required Analyses for the Self-Monitoring Program at TFA.

Sampling Frequency	Required Analyses	
	Influent (TFA-I001)	Effluent (TFA-E001)
Daily	Operational Status	—
Monthly	VOCs (E601) pH	VOCs (E601) pH Temperature Total Volume
Semi-Annually	Total Chromium (E218.2) [a]	Total Chromium (E218.2) [a,b] Fish toxicity (FISHTOX1P)
Annually	Purgeable Organics (E602) [c] Semivolatile Organics (E625) [c]	Purgeable Organics (E602) [c] Semivolatile Organics (E625) [c] Metals (NPDESMET2) [a] Gross Alpha and Beta (E900) [a] Tritium (E906) Turbidity (E180.1) Chloride (GENMIN: CL)

Notes:

TFA = Treatment Facility A.

VOCs = Volatile organic compounds.

TFA treated water discharges to the West Perimeter Drainage Channel or Arroyo Seco receiving waters, TFB-R002 or TFG-ASW, respectively are covered in the self-monitoring of facilities TFB and TFG-1.

[a] Influent, effluent, and radiological samples (except tritium [E906] shall be analyzed for dissolved (filtered) constituents.

[b] Sample monthly for E218.2 only if the influent concentration is >22 micrograms per liter (µg/L); semi-annually if the influent concentration is <22 µg/L.

[c] Sample if known to be present in the influent.

Appendices

List of Appendices

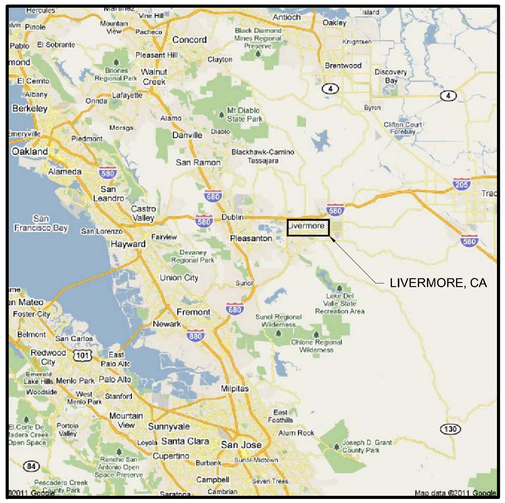
Appendix A

Title II Design Drawings

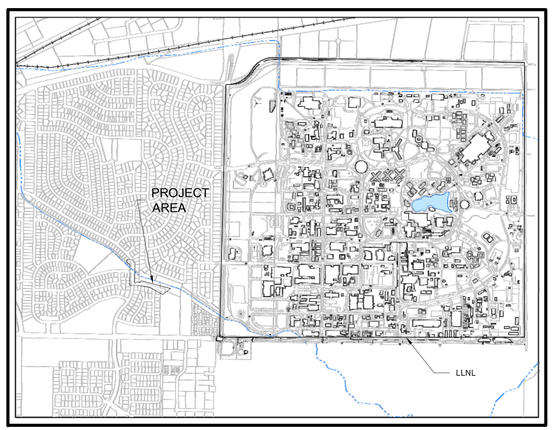
REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE

ARROYO SECO PIPELINE EXTENSION PROJECT

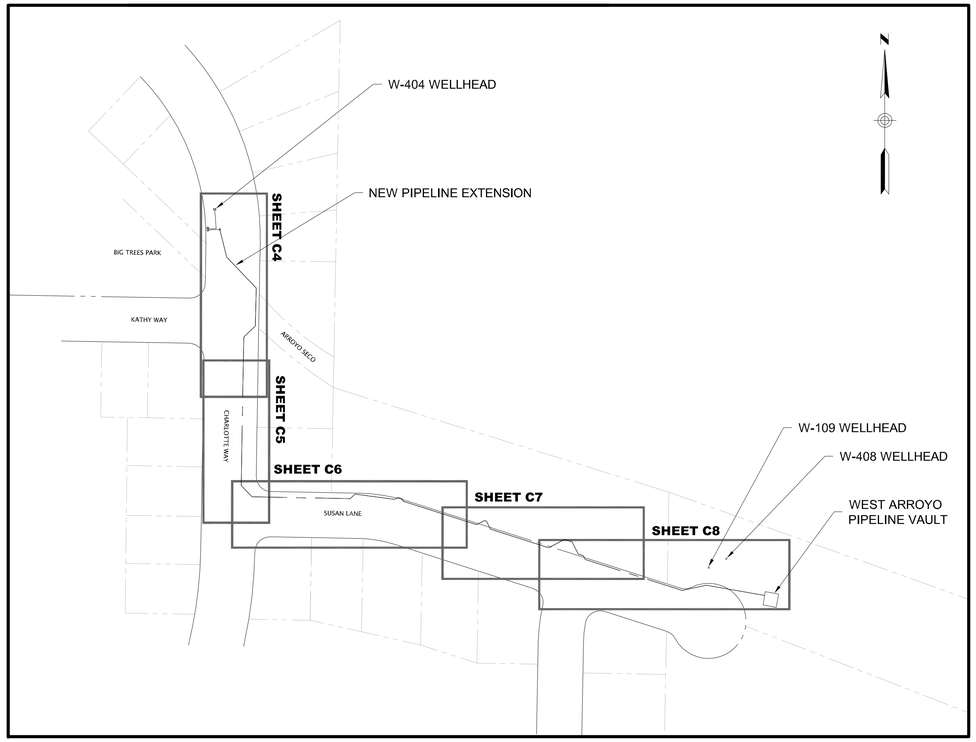
LAWRENCE LIVERMORE NATIONAL LABORATORY SECURITY, LLC
ENVIRONMENTAL RESTORATION DEPARTMENT



REGIONAL MAP
NTS



NEIGHBORHOOD MAP
NTS



SITE MAP
NTS

INDEX OF DRAWINGS

INDEX NO.	TITLE
G1	TITLE SHEET
G2	NOTES
C1	EXISTING CONDITIONS
C2	TRAFFIC CONTROL PLAN
C3	DEMOLITION & EROSION CONTROL PLAN
C4	PIPELINE LAYOUT PLAN
C5	PLAN AND PROFILE (STA 0+00-2+25)
C6	PLAN AND PROFILE (STA 2+25-4+00)
C7	PLAN AND PROFILE (STA 4+00-6+50)
C8	PLAN AND PROFILE (STA 6+50-9+00)
C9	PLAN AND PROFILE (STA 9+00-11+13.04)
C10	SURFACE REPAIR DETAILS
C11	PIPELINE DETAILS
C12	BRIDGE CROSSING DETAILS
C13	VAULT, WELLHEAD AND CABINET DETAILS
E1	ELECTRICAL PLAN
E2	ELECTRICAL DETAILS

RELEASED FOR CONSTRUCTION	
PE DEPT. HEAD:	DATE:

APPROVED BY	
CLIENT:	DATE:
PROJ. MANAGER:	DATE:
DESIGN:	DATE:

REVIEWED BY	
M & O:	DATE:
HAZ. CTRL:	DATE:
SECURITY:	DATE:
S & S P:	DATE:

DRAWING NUMBER: TFA-05-11-AA REV: 1 SHT: 1

CLASSIFICATION: UNCLASSIFIED

REGISTERED PROFESSIONAL ENGINEER
SCOTT A. BOURNE
C72817
EXP 6/30/12
CIVIL
STATE OF CALIFORNIA

UNLIMITED DISTRIBUTION

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APPLICATIONS

CONTRACT NO.

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

INDEX NO. G1

LAWRENCE LIVERMORE NATIONAL LABORATORY

TITLE
TITLE SHEET
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE NTS SHEET 1 OF 17

DRAWING: G1, G2-Title Sheet & Notes.dwg MODEL: ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE

GENERAL NOTES

1. THE OVERALL PROJECT PURPOSE IS TO FACILITATE EXTRACTION AND TREATMENT OF GROUND WATER WHICH CONTAINS CHLORINATED SOLVENTS THAT INCLUDE PERCHLOROETHENE, TRICHLOROETHENE, AND OTHERS, THE WORK IS BEING DONE AT THE DIRECTION OF THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY IN ACCORDANCE WITH THE COMPREHENSIVE ENVIRONMENTAL COMPENSATION AND LIABILITY ACT OF 1990 (CERCLA).
2. ALL WORK SHALL BE CONDUCTED IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL CODES, ORDINANCE, REGULATIONS, AND LAWS. CONSTRUCTION MATERIAL AND METHODS SHALL COMPLY WITH THE LATEST CITY OF LIVERMORE STANDARD SPECIFICATIONS AND DETAILS, THE STATE OF CALIFORNIA (CALTRANS) STANDARD SPECIFICATIONS, LATEST EDITION, CALIFORNIA CODE OF REGULATIONS (CCR) TITLE 24, AND LIVERMORE-AMADOR VALLEY ZONE 7 WATER AGENCY
3. ALL NECESSARY PERMITS AND APPROVALS FROM AGENCIES GOVERNING THIS WORK SHALL BE SECURED PRIOR TO BEGINNING CONSTRUCTION.
4. WRITTEN SPECIFICATIONS ARE AN INTEGRAL PART OF THE PROJECT PLANS. THE CONTRACT DOCUMENTS INCLUDE AND ARE NOT COMPLETE WITHOUT THE PROJECT SPECIFICATIONS SEPARATE FROM THESE PLANS.
5. CONTRACTOR AGREES THAT HE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY, AND FOR ALL NECESSARY ENGINEERING REVIEWS THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS, AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE OWNER AND THE ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPTING FOR LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE OWNER OR THE ENGINEER.
6. CONTRACTOR SHALL LEAVE AN EMERGENCY PHONE NUMBER WITH THE POLICE AND FIRE DEPARTMENTS AND KEEP THEM INFORMED REGARDING DETOURS.
7. CONTRACTOR SHALL POST ON THE SITE, EMERGENCY TELEPHONE NUMBERS FOR PUBLIC WORKS, AMBULANCE, POLICE, AND FIRE DEPARTMENTS.
8. CONTRACTOR SHALL NOTIFY ALL PUBLIC OR PRIVATE UTILITY OWNERS 48 HOURS PRIOR TO COMMENCEMENT OF WORK ADJACENT TO THE UTILITY UNLESS AN EXCAVATION PERMIT SPECIFIES OTHERWISE.
9. CONTRACTOR TO CONTACT UNDERGROUND SERVICE ALERT U.S.A. 800-227-2600 FORTY-EIGHT (48) HOURS PRIOR TO BEGINNING WORK TO HAVE THE LOCATION OF EXISTING UNDERGROUND UTILITIES MARKED. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO IDENTIFY, LOCATE, AND PROTECT ALL UNDERGROUND FACILITIES.
10. CONTRACTOR SHALL NOTIFY THE PROGRAM MANAGER AT LEAST TWO WORKING DAYS PRIOR TO COMMENCEMENT OF WORK OR IF WORK HAS BEEN SUSPENDED FOR A PERIOD OF MORE THAN THREE DAYS. ALL PROJECT OWNERS, CONTRACTORS AND/OR DEVELOPERS ARE REQUIRED TO CALL FOR INSPECTIONS A MINIMUM OF TWO (2) WORKING DAYS IN ADVANCE OF THE REQUIRED INSPECTION TIME.
11. ALL MATERIAL SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR UNLESS OTHERWISE NOTED.
12. CONSTRUCTION HOURS SHALL BE 7AM-5PM MONDAY (M) -FRIDAY (F). CONSTRUCTION HOURS ARE 9AM -3PM M-F FOR ANY WORK REQUIRING LANE OBSTRUCTION.
13. THE CONTRACTOR SHALL PROVIDE ALL LIGHTS, SIGNS, BARRICADES, FLAGMEN OR OTHER DEVICES NECESSARY TO PROVIDE FOR PUBLIC SAFETY AND IN ACCORDANCE WITH FEDERAL HIGHWAY ADMINISTRATION (FHWA), CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS), AND PER MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), LATEST EDITION
14. UTILITIES AND UNDERGROUND FACILITIES INDICATED ARE FOR INFORMATION ONLY. THE EXISTENCE, TYPES, LOCATIONS, SIZES AND/OR DEPTHS OF EXISTING UNDERGROUND UTILITIES AS SHOWN ON THIS TOPOGRAPHIC SURVEY ARE APPROXIMATE AND WERE OBTAINED FROM SOURCES OF VARYING RELIABILITY. ONLY ACTUAL EXCAVATION (POT-HOLING) WILL REVEAL THE TYPES, EXTENT, SIZES, LOCATIONS, AND DEPTHS OF SUCH UNDERGROUND UTILITIES. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE LOCATION AND DEPTH WITH THE APPROPRIATE AGENCIES PRIOR TO COMMENCEMENT OF CONSTRUCTION. NEITHER THE OWNER NOR THE CITY NOR THE ENGINEER ASSUMES RESPONSIBILITY THAT THE UTILITIES AND UNDERGROUND FACILITIES INDICATED WILL BE THE UTILITIES AND UNDERGROUND FACILITIES ENCOUNTERED.
15. THE CONTRACTOR SHALL HIRE A STREET CLEANING CONTRACTOR THROUGHOUT ALL PHASES OF CONSTRUCTION, INCLUDING SUSPENSION OF WORK, UNTIL FINAL ACCEPTANCE OF THE PROJECT. IT IS THE CONTRACTOR'S RESPONSIBILITY TO KEEP THE WORK SITE (CITY STREETS AND PARKS) CLEAN AND FREE FROM RUBBISH AND DEBRIS THAT ARE ATTRIBUTABLE TO THE CONSTRUCTION ACTIVITIES.
16. CONTRACTOR SHALL PROTECT ALL EXISTING FACILITIES DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE TO REPAIR OR REPLACE ANY EXISTING IMPROVEMENTS OF UNDERGROUND FACILITIES DAMAGED BY HIM, HIS SUBCONTRACTORS OR HIS MATERIAL SUPPLIERS.
17. ALL EXISTING FACILITIES SHALL BE MAINTAINED IN-PLACE BY THE CONTRACTOR UNLESS OTHERWISE SHOWN OR DIRECTED, THE CONTRACTOR SHALL TAKE ALL PRECAUTIONS NECESSARY TO SUPPORT, MAINTAIN, OR OTHERWISE PROTECT EXISTING UTILITIES AND OTHER FACILITIES AT ALL TIMES DURING CONSTRUCTION. THE CONTRACTOR SHALL LEAVE EXISTING FACILITIES IN AN EQUAL OR BETTER-THAN-ORIGINAL CONDITION AND TO THE SATISFACTION OF THE CONTROLLING AGENCIES.
18. CONTRACTOR SHALL OBTAIN INSPECTION OF ALL WORK BY THE CONTROLLING AGENCIES. ANY INSPECTION BY THE CONTROLLING AGENCIES OR ENGINEERS SHALL NOT, IN ANY WAY, RELIEVE THE CONTRACTOR FROM ANY OBLIGATION TO PERFORM THE WORK IN STRICT COMPLIANCE WITH THE APPLICABLE CODES AND AGENCY REQUIREMENTS.
19. IN ADDITION TO TESTS REQUIRED TO BE PERFORMED BY CONTRACTOR PER THE SPECIFICATIONS, OWNER, AT IT'S OWN DISCRETION, SHALL PERFORM ANY APPLICABLE TESTS FOR COMPACTION AND CONCRETE QUALITY FOR VERIFICATION OF CONTRACTOR'S TEST RESULTS. THE TESTS PERFORMED BY THE OWNER SHALL NOT, IN ANY WAY, RELIEVE THE CONTRACTOR FROM ANY OBLIGATION TO PERFORM THE WORK IN STRICT COMPLIANCE WITH THE APPLICABLE CODES AND AGENCY REQUIREMENTS.
20. THE CONTRACTOR SHALL LOCATE AND MARK ALL EXISTING PROPERTY AND STREET MONUMENTS PRIOR TO CONSTRUCTION. ANY MONUMENTS DISTURBED DURING CONSTRUCTION OF THE PROJECT SHALL BE REPLACED BY A REGISTERED LAND SURVEYOR AT THE CONTRACTOR'S EXPENSE.
21. THE CONTRACTOR SHALL PROVIDE FOR INGRESS AND EGRESS FOR PRIVATE PROPERTY ADJACENT TO THE WORK THROUGHOUT THE PERIOD OF CONSTRUCTION.
22. ALL DEMOLITION, TRENCHING, AND GRADING OR OTHER DUST GENERATING ACTIONS SHALL BE PERFORMED IN SUCH A MANNER AS TO COMPLY WITH THE STANDARDS ESTABLISHED BY THE AIR QUALITY MANAGEMENT DISTRICT FOR AIRBORNE PARTICULATES (DUST). THE CONTRACTOR SHALL PROVIDE WATER FOR DUST CONTROL AND EARTH COMPACTION. THE CONTRACTOR WILL BE RESPONSIBLE FOR ANY DAMAGE OR COMPLAINTS DUE TO DUST CAUSED BY HIS OPERATIONS.
23. CONTRACTOR SHALL NOT INTERRUPT EXISTING UTILITIES WITHOUT APPROVAL FROM THE AUTHORITY HAVING JURISDICTION.
24. CONCRETE SHALL BE CALTRANS CLASS 2 WITH A 28 DAY, STRENGTH OF 3000 PSI UNLESS OTHERWISE NOTED.
25. RECORD DRAWINGS. AT THE COMPLETION OF CONSTRUCTION, CONTRACTOR SHALL SUBMIT TO THE OWNER RECORD DRAWINGS CONSISTING OF RED-LINE MARKUPS OF THE 24"x36" DRAWING SET USED FOR CONSTRUCTION, .
26. CONTRACTOR SHALL GUARANTEE ALL MATERIALS AND WORKMANSHIP ON ITEMS INSTALLED TO BE FREE FROM DEFECTIVE INSTALLATION INCLUDING, BUT NOT LIMITED TO THE LOCAL CODES AND MANUFACTURER'S INSTALLATION REQUIREMENTS FOR UP TO FOUR YEARS AFTER THE COMPLETION OF CONSTRUCTION.
27. THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR, OR LIABLE FOR, UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES TO THE PLANS MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THE PLANS.

GRADING NOTES

1. ALL GRADING AND PAVING SHALL MATCH EXISTING GRADE AND BE SPACED TO PROMOTE POSTING DRAINAGE TO NEAREST EXISTING STORM SYSTEM.
2. ALL GRADING AND PAVING SHALL CONFORM TO CITY OF LIVERMORE STANDARD SPECIFICATIONS AND CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS) STANDARD SPECIFICATIONS, LATEST EDITION.
3. ANY IMPORTED FILL MATERIAL SHALL BE APPROVED BY THE ENGINEER PRIOR TO BEING DELIVERED TO THE SITE.
4. CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING ACTUAL EARTH QUANTITIES TO HIS SATISFACTION.

UTILITY NOTES

1. ALL PIPED UTILITIES ABANDONED IN PLACE SHALL HAVE ALL OPENINGS CLOSED WITH CONCRETE PLUGS WITH A MINIMUM LENGTH EQUAL TO TWO TIMES THE DIAMETER OF THE ABANDONED PIPE UNLESS OTHERWISE NOTED.
2. TRACER WIRE. ALL NON-METALLIC PIPING SHALL HAVE AN ELECTRICALLY CONDUCTIVE INSULATED 12 GAUGE COPPER TRACER WIRE THE FULL LENGTH OF THE INSTALLED PIPE. TRACER WIRE SHALL BE EXTENDED UP INTO ALL VALVE BOXES.
3. WARNING TAPE. DETECTABLE OR NON-DETECTABLE ACID AND ALKALI RESISTANT SAFETY WARNING TAPE SHALL BE PROVIDED ALONG THE FULL LENGTH OF ALL PIPING NOT LOCATED UNDER SIDEWALKS OR PAVED PORTIONS OF PUBLIC STREETS, UNDERGROUND WARNING TAPE SHALL BE CONTINUOUS THE ENTIRE LENGTH OF SERVICE LATERALS.
4. NO TRENCHES IN ROADS OR DRIVEWAYS SHALL BE LEFT IN AN OPEN CONDITION OVERNIGHT. ALL SUCH TRENCHES SHALL BE BACKFILLED OR COVERED BY STEEL PLATES BEFORE THE END OF EACH WORK DAY AND NORMAL TRAFFIC FLOWS RESTORED.
5. ALL PIPE FITTING SHALL BE SLIP FITTING. PIPE LENGTHS TO BE GLUED WITH PVC SOLVENT GLUE ONTO UNION FITTINGS PER OWNER'S SPECIFICATIONS UNLESS OTHERWISE NOTED.

SURVEY NOTE

THE BACKGROUND TOPOGRAPHIC INFORMATION SHOWN ON THESE PLANS IS A TOPOGRAPHIC SURVEY PERFORMED BY KIER AND WRIGHT, DEC 2010 .

BENCHMARK

LLNL CONTROL POINT NO. 133; BRASS DISK IN MONUMENT WELL AT THE INTERSECTION OF PATTERSON PASS ROAD AND SHANNON COURT AS SHOWN ON THE LLNL CONTROL MAP.
ELEVATION=574.48.

BOUNDARY NOTE

NO BOUNDARY INFORMATION IS SHOWN ON THESE PLANS. RIGHT OF WAY LINES AND PROPERTY LINES SHOWN HEREON ARE DERIVED FROM RECORD DATA AS DISCLOSED BY THE CURRENT ASSESSORS MAPS AND THE SUBDIVISION MAPS REFERECED HEREON. EASEMENT IF ANY ARE NOT SHOWN HEREON.

DISCREPANCIES

IF THERE ARE ANY DISCREPANCIES BETWEEN DIMENSIONS IN DRAWINGS AND EXISTING CONDITIONS WHICH WILL AFFECT THE WORK, THE CONTRACTOR SHALL BRING SUCH DISCREPANCIES TO THE ATTENTION OF THE ENGINEER FOR ADJUSTMENT BEFORE PROCEEDING WITH THE WORK. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROPER FITTING OF ALL WORK AND FOR THE COORDINATION OF ALL TRADES, SUBCONTRACTORS, AND PERSONS ENGAGED UPON THIS CONTRACT.

PROJECT DESCRIPTION

THE ARROYO SECO PIPELINE EXTENSION PROJECT SCOPE IS TO INSTALL AN UNDERGROUND PIPELINE TO CONNECT EXTRACTION WELL W-404 TO THE EXISTING ARROYO SECO PIPELINE AT A LOCATION IN THE WESTERN ARROYO PIPELINE VAULT. THE PROJECT INVOLVES UPGRADES TO THE EXISTING GROUNDWATER EXTRACTION SYSTEM AND MONITORING SYSTEM, INSTALLATION OF DOUBLE CONTAINED PLASTIC PRESSURE PIPE, A LEAK DETECTION SYSTEM, AND A CONNECTION TO THE EXISTING CONTROL AND DATA ACQUISITION SYSTEM AT THE TREATMENT FACILITY A AT LAWRENCE LIVERMORE NATIONAL LABORATORY.

REFERENCES

1. LLNL (2006), WELL 404 CONNECTION CHARLOTTE WAY AS-BUILTS, JUNE.
2. LLNL (1990), LLNL GROUNDWATER PUMPING STATION AND PIPELINE AS-BUILTS & GENERAL IMPLEMENTATION PLANS, AUGUST.
3. CITY OF LIVERMORE (2009), UTILITY AS-BUILTS, NOVEMBER.
4. KIER & WRIGHT (2010), TOPOGRAPHIC SURVEY OF SUSAN LANE AND CHARLOTTE WAY FOR LLNL,DECEMBER.
5. CITY OF LIVERMORE (2005), CITY OF LIVERMORE STANDARD SPECIFICATIONS, MAY.
6. PG&E (2010), ELECTRIC AND GAS SERVICE REQUIREMENTS (GREEN BOOK), APRIL.

ABBREVIATIONS

AB	AGGREGATE BASE
ADA	AMERICAN DISABILITY ACT
ACFC & WCD	ALAMEDA COUNTY FLOOD DISTRICT & WATER CONSERVATION DISTRICT
BP	BEGIN PIPELINE
BFPD	BACKFLOW PREVENTIVE DEVICE
CLR	CLEARANCE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
DI	DUCTILE IRON
EP	END PIPELINE
EPDM	ETHYLENE PROPYLENE DIENE MONOMER
ELEV	ELEVATION
LF	LINEAR FEET
LAR & PD	LIVERMORE AREA RECREATION & PARKS DISTRICT
MIN	MINIMUM
MAX	MAXIMUM
MFG	MANUFACTURER
NTS	NOT TO SCALE
O.C.	ON CENTER
POB	POINT OF BEGINNING
PG&E	PACIFIC GAS & ELECTRIC COMPANY
PI	POINT OF INTERSECTION
PVC	POLYVINYL CHLORIDE
PCC	PORTLAND CEMENT CONCRETE
PSI	POUNDS PER SQUARE INCH
PVI	POINT OF VERTICAL INTERSECTION
REQ'D	REQUIRED
R	RADIUS
REL	RELATIVE
SCH80	SCHEDULE 80
SF	SQUARE FEET
STI	STEEL
STA	STATION
STD'S	STANDARDS
SW	SIDEWALK
TYP	TYPICAL
(E)	EXISTING
(N)	NEW

LEGEND

- ASPHALT BERM
- CONCRETE/BLOCK/RETAINING WALL
- CONCRETE CURB
- CONCRETE CURB & GUTTER
- DRIVEWAY
- EDGE OF PAVEMENT
- ELECTRIC LINE
- FENCE LINE
- GAS LINE-VALVE & METER
- JOINT TRENCH
- LOT LINE
- MONUMENT/MONUMENT LINE
- PROPERTY LINE
- SANITARY SEWER-MANHOLE & CLEANOUT
- SIDEWALK
- SPOT ELEVATION
- STORM DRAIN-MANHOLE & CATCH BASIN
- TELEPHONE LINE
- TRAFFIC SIGN (EXISTING)
- WATER LINE & VALVE
- BACKFLOW PREVENTION DEVICE
- ELECTROLIER
- FIRE DEPARTMENT CONNECTION
- FIRE HYDRANT
- TREE
- UTILITY BOX
- TRAFFIC CONES
- TRAFFIC SIGN (NEW)
- TRAFFIC FLAGGER
- WORKSPACE FOR TRAFFIC CONTROL PURPOSES
- CENTERLINE
- DRAINAGE INLET PROTECTION
- TREE PROTECTION
- AB
- ASPHALT CONCRETE
- BACKFILL
- TRENCH LIMITS

811 Know what's below. Call before you dig.

REGISTERED PROFESSIONAL ENGINEER — SCOTT A. BOURNE — C72817 — EXP. 6/30/12 — CIVIL — STATE OF CALIFORNIA

UNLIMITED DISTRIBUTION

FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE:
DECIMALS ± ANGLES ±
DO NOT SCALE THIS DRAWING

NEXT ASSY | USED ON
APPLICATIONS

INDEX NO. G2

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
NOTES
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

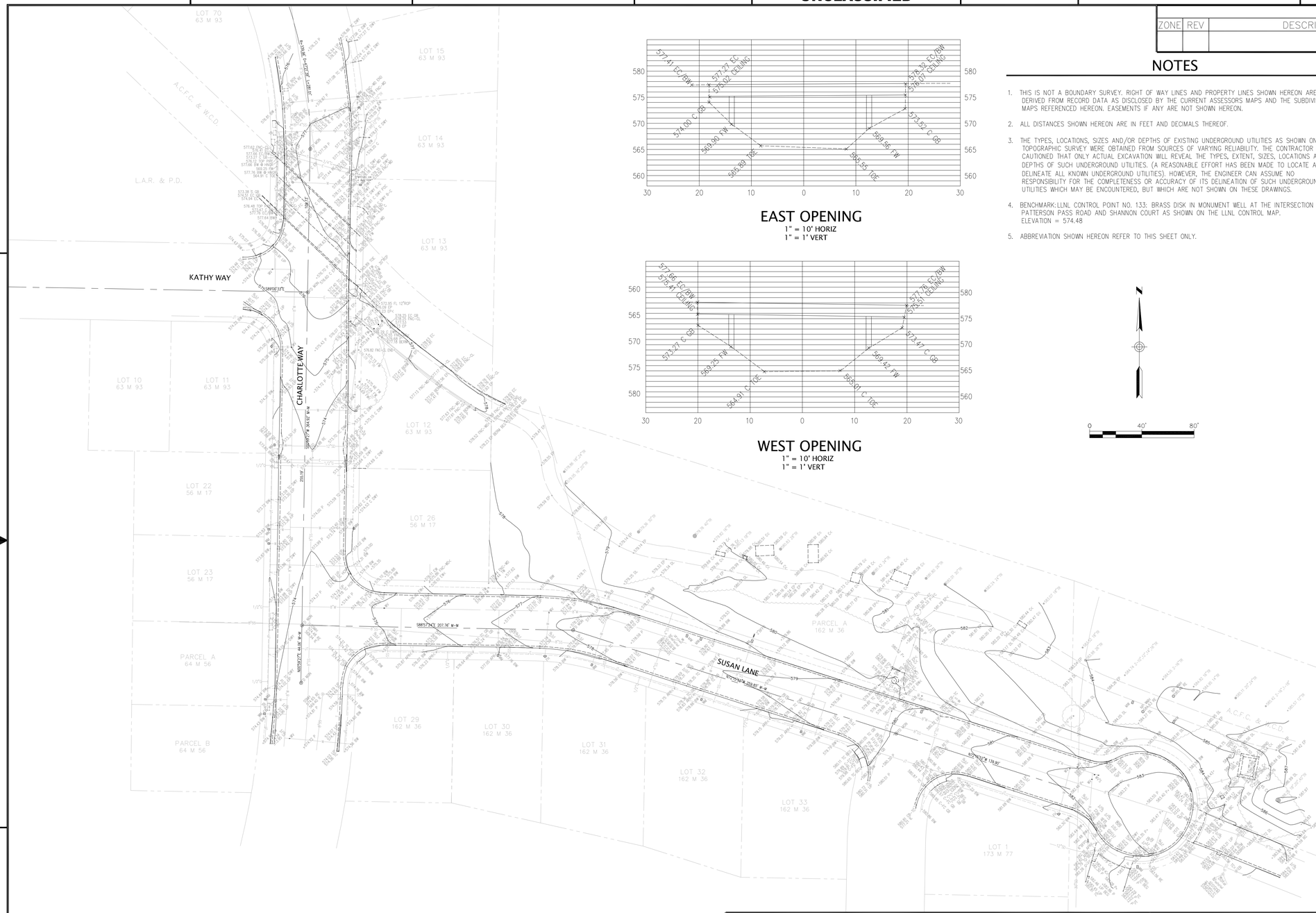
SCALE NTS | SHEET 2 OF 17

DRAWING NUMBER: TFA-05-11-AA | REV: | SHT: 2

CLASSIFICATION: UNCLASSIFIED

DRAWING: G1, G2-Title Sheet & Notes.dwg MODEL: | ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



EAST OPENING
1" = 10' HORIZ
1" = 1' VERT

WEST OPENING
1" = 10' HORIZ
1" = 1' VERT

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. RIGHT OF WAY LINES AND PROPERTY LINES SHOWN HEREON ARE DERIVED FROM RECORD DATA AS DISCLOSED BY THE CURRENT ASSESSORS MAPS AND THE SUBDIVISION MAPS REFERENCED HEREON. EASEMENTS IF ANY ARE NOT SHOWN HEREON.
2. ALL DISTANCES SHOWN HEREON ARE IN FEET AND DECIMALS THEREOF.
3. THE TYPES, LOCATIONS, SIZES AND/OR DEPTHS OF EXISTING UNDERGROUND UTILITIES AS SHOWN ON THIS TOPOGRAPHIC SURVEY WERE OBTAINED FROM SOURCES OF VARYING RELIABILITY. THE CONTRACTOR IS CAUTIONED THAT ONLY ACTUAL EXCAVATION WILL REVEAL THE TYPES, EXTENT, SIZES, LOCATIONS AND DEPTHS OF SUCH UNDERGROUND UTILITIES. (A REASONABLE EFFORT HAS BEEN MADE TO LOCATE AND DELINEATE ALL KNOWN UNDERGROUND UTILITIES). HOWEVER, THE ENGINEER CAN ASSUME NO RESPONSIBILITY FOR THE COMPLETENESS OR ACCURACY OF ITS DELINEATION OF SUCH UNDERGROUND UTILITIES WHICH MAY BE ENCOUNTERED, BUT WHICH ARE NOT SHOWN ON THESE DRAWINGS.
4. BENCHMARK:LLNL CONTROL POINT NO. 133; BRASS DISK IN MONUMENT WELL AT THE INTERSECTION OF PATTERSON PASS ROAD AND SHANNON COURT AS SHOWN ON THE LLNL CONTROL MAP. ELEVATION = 574.48
5. ABBREVIATION SHOWN HEREON REFER TO THIS SHEET ONLY.

LEGEND

	ASPHALT BERM
	CONCRETE/BLOCK/RETAINING WALL
	CONCRETE CURB
	CONCRETE CURB & GUTTER
	DRIVEWAY
	EDGE OF PAVEMENT
E	ELECTRIC LINE
X	FENCE LINE
G GM	GAS LINE–VALVE & METER
JT	JOINT TRENCH
	LOT LINE
	MONUMENT/MONUMENT LINE
	PROPERTY LINE
SS SC	SANITARY SEWER–MANHOLE & CLEANOUT
	SIDEWALK
• 300.00	SPOT ELEVATION
SD	STORM DRAIN–MANHOLE & CATCH BASIN
T	TELEPHONE LINE
W	WATER LINE & VALVE
	BACKFLOW PREVENTION DEVICE
	ELECTROLIER
	FIRE DEPARTMENT CONNECTION
	FIRE HYDRANT
	TRAFFIC SIGN
	TREE
	UTILITY BOX
	ANGLE POINT
A.C.F.C. & W.C.D.	ALAMEDA COUNTY FLOOD DISTRICT & WATER CONSERVATION DISTRICT
APR	CONCRETE APRON
BEG	BEGIN
BFPD	BACK FLOW PREVENTION DEVICE
BTM	BOTTOM
BW	BACK OF WALK
△CNTRL	SURVEY CONTROL POINT
CTVB	CABLE TELEVISION BOX
CB	CATCH BASIN
C	CONCRETE
CO	CLEAN OUT
DL	DRIP LINE
DWY	DRIVEWAY
EB	ELECTRIC BOX
EC	EDGE OF CONCRETE
EGR	EDGE OF GRAVEL ROAD
EM	ELECTRIC METER
EP	EDGE OF PAVEMENT
EV	ELECTRIC VAULT
EW	EDGE OF WALK
FB	FACE OF ASPHALT BERM
FC	FACE OF CURB
FD MON	FOUND MONUMENT
FH	FIRE HYDRANT
FL	FLOW LINE
FNC	FENCE
FW	FACE OF WALL
GB	GRADE BREAK
HCR	HANDICAP RAMP
HNGR	HANGER
IE	INVERT ELEVATION
L.A.R. & P.D.	LIVERMORE AREA RECREATION & PARKS DISTRICT
LT	LIGHT
LIP	LIP OF GUTTER
M–M	MONUMENT TO MONUMENT
NP WMH	NON POTABLE WATER MANHOLE
P	PAVEMENT
RE	RIM ELEVATION
SDMH	STORM DRAIN MANHOLE
SL	STREET LIGHT
SLB	STREET LIGHT BOX
SSMH	SANITARY SEWER MANHOLE
TB	TELEPHONE BOX
TC	TOP OF CURB
TMH	TELEPHONE MANHOLE
TR	TREE
TW	TOP OF WALL
WB	WATER BOX
WM	WATER METER
WV	WATER VALVE

CLASSIFICATION: UNCLASSIFIED

FEET
THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE:
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APPLICATIONS

INDEX NO. C1

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR ruiz5	12/10
DRAWN KIER & WRIGHT	12/10
CHECKED	
APPROVED KIER & WRIGHT	12/10
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
EXISTING CONDITIONS
ARROYO SECO PIPELINE EXT.

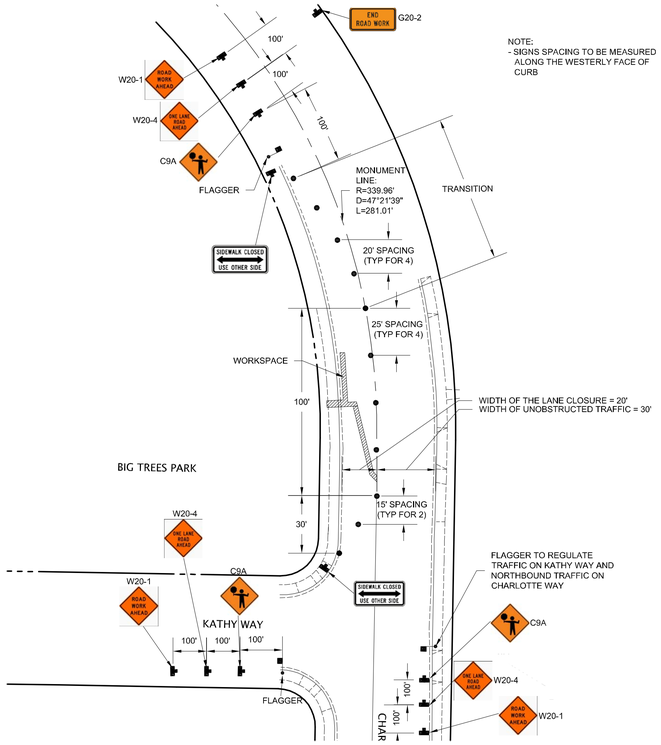
SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA–05–11–AA	

SCALE NTS | SHEET 3 OF 17

DRAWING NUMBER: TFA–05–11–AA | REV. | SHT 3

DRAWING: C1–EXISTING CONDITIONS | MODEL: | ACAD Civil3D 2011

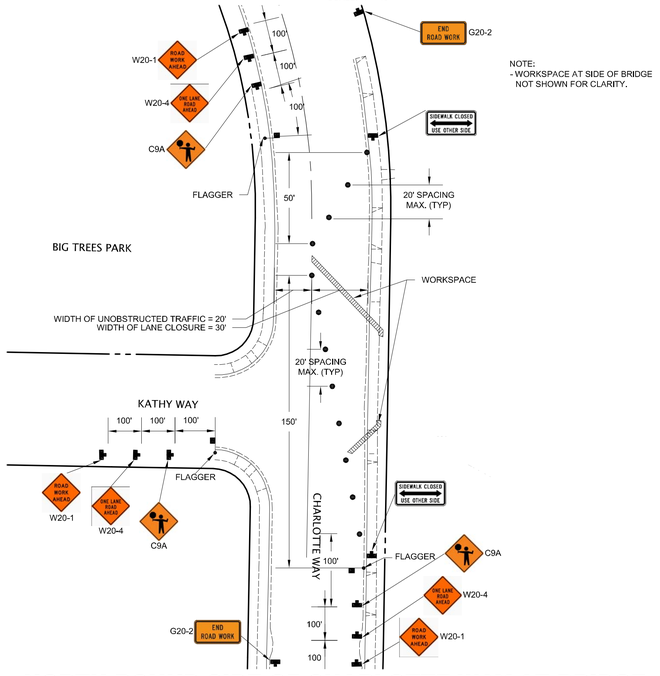
REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



NOTE:
- SIGNS SPACING TO BE MEASURED ALONG THE WESTERLY FACE OF CURB

SOUTH BOUND SIDE OF CHARLOTTE WAY

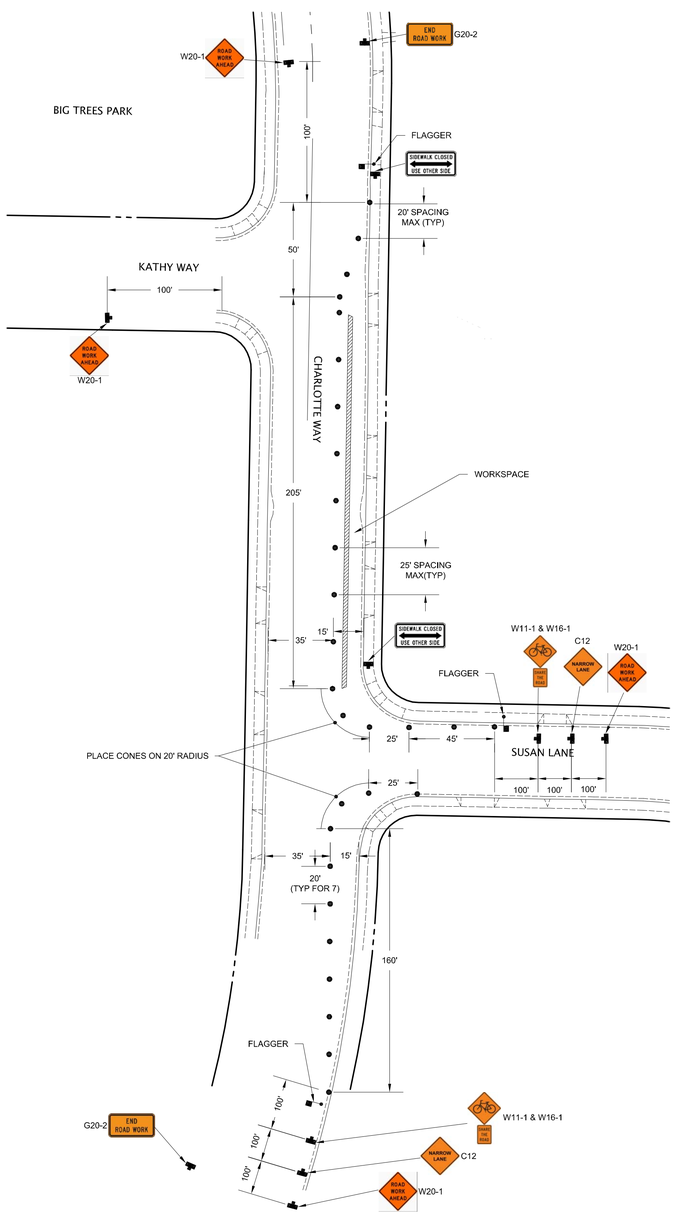
SCALE: 1" = 40'



NOTE:
- WORKSPACE AT SIDE OF BRIDGE NOT SHOWN FOR CLARITY.

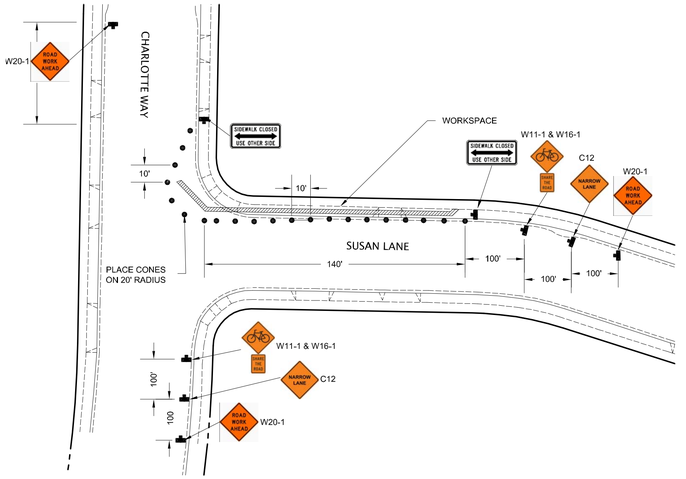
NORTH BOUND SIDE OF CHARLOTTE WAY AT BRIDGE

SCALE: 1" = 40'



NORTH BOUND SIDE OF CHARLOTTE WAY SOUTH OF BRIDGE

SCALE: 1" = 40'

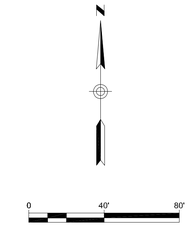


SUSAN LANE

SCALE: 1" = 40'

LEGEND:
- CHANNELIZING DEVICE
- SIGN (SHOWN TAGING LEFT)
- FLAGGER

NOTES:
1. TRAFFIC CONTROL SIGNAGE, BARRICADES, FLAGGER, AND GENERAL METHODS PER CALTRANS AND MUTCD (LATEST EDITION) AND ANY REQUIREMENTS DEEMED NECESSARY BY THE CITY ENGINEER.
2. TRAFFIC CONTROL TO SHOW INTENT OF WORKSPACE PROTECTION IN FULL. CONTRACTOR SHALL PROVIDE TRAFFIC CONTROL MEASURES FOR WORKSPACE BASED ONLY ON DAILY WORK PROGRESS. SEE GENERAL NOTE 18, SHEET G2
3. FLAGGERS TO COORDINATE AND ENFORCE ONE-WAY TRAFFIC ON CHARLOTTE WAY, TAKING TRAFFIC TURNING ONTO CHARLOTTE WAY FROM SUSAN LANE AND KATHY WAY INTO ACCOUNT
4. FLAGGERS TO ASSIST PEDESTRIANS CROSSING THE STREET. PEDESTRIANS WILL BE ESCORTED THROUGH THE CONSTRUCTION AREA, IF NECESSARY
5. WHERE PARKING IS TO BE PROHIBITED, NOTIFY PROPERTY OWNERS, AND TEMPORARY "NO PARKING" SIGNS SHALL BE POSTED 72 HOURS IN ADVANCE
6. ALL WORK SHALL BE COMPLETED BETWEEN THE HOURS OF 9AM-3PM



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FEET
THIRD ANGLE PROJECTION

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APPLICATIONS

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN RN	03/27/11
CHECKED bourne2	10/06/11
APPROVED	
ENGINEERING GROUP	DRAWING LEVEL:

INDEX NO. C2

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY
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TITLE
TRAFFIC CONTROL PLAN
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

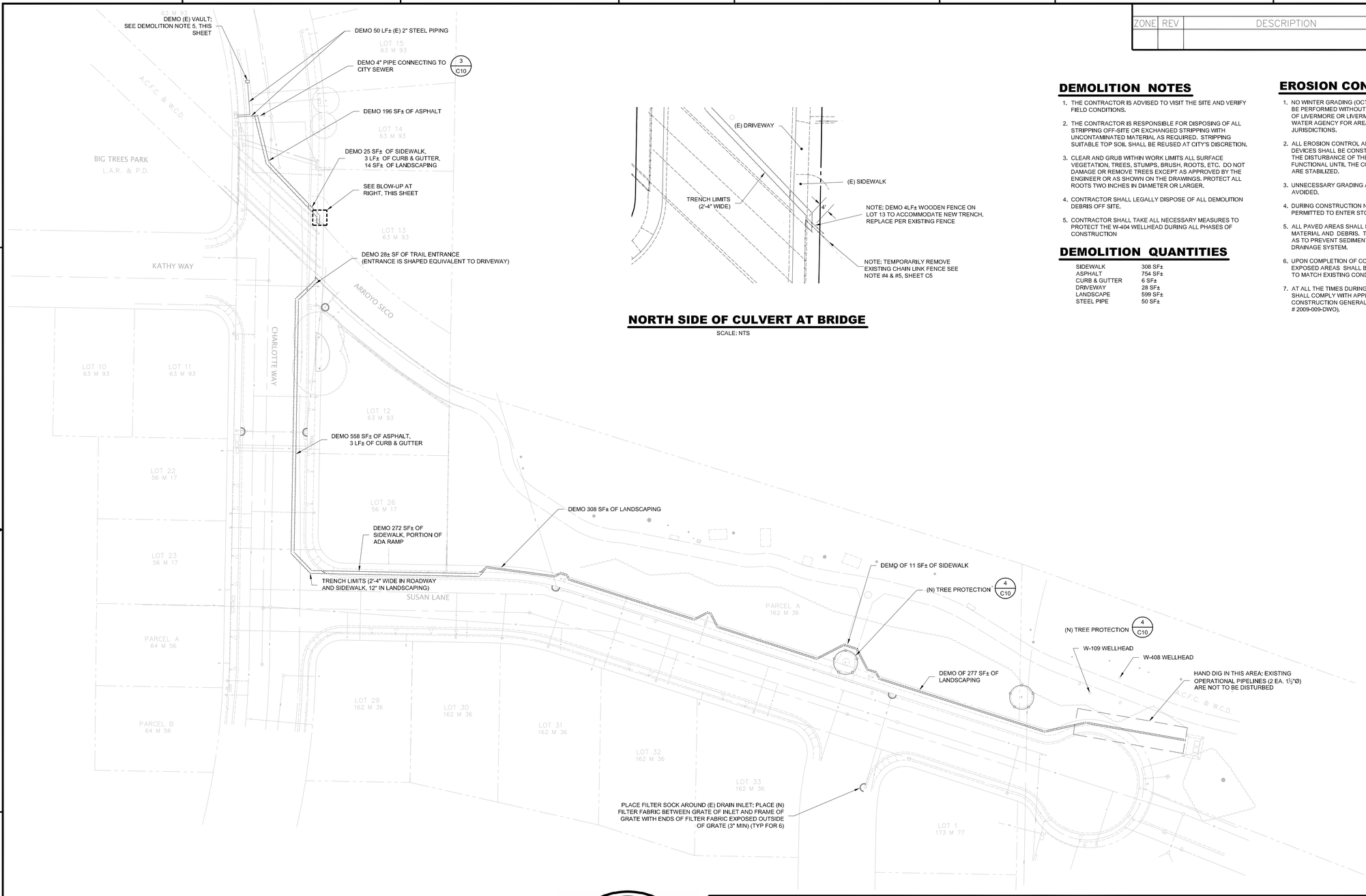
SCALE 1" = 40' | SHEET 4 OF 17

DRAWING NUMBER: TFA-05-11-AA | REV: | SHT: 4

CLASSIFICATION: UNCLASSIFIED

DRAWING: C2- Traffic Control Plan.dwg | MODEL: | ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



NORTH SIDE OF CULVERT AT BRIDGE

SCALE: NTS

DEMOLITION NOTES

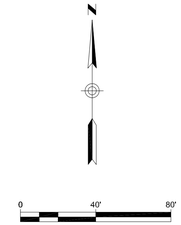
1. THE CONTRACTOR IS ADVISED TO VISIT THE SITE AND VERIFY FIELD CONDITIONS.
2. THE CONTRACTOR IS RESPONSIBLE FOR DISPOSING OF ALL STRIPPING OFF-SITE OR EXCHANGED STRIPPING WITH UNCONTAMINATED MATERIAL AS REQUIRED. STRIPPING SUITABLE TOP SOIL SHALL BE REUSED AT CITY'S DISCRETION.
3. CLEAR AND GRUB WITHIN WORK LIMITS ALL SURFACE VEGETATION, TREES, STUMPS, BRUSH, ROOTS, ETC. DO NOT DAMAGE OR REMOVE TREES EXCEPT AS APPROVED BY THE ENGINEER OR AS SHOWN ON THE DRAWINGS. PROTECT ALL ROOTS TWO INCHES IN DIAMETER OR LARGER.
4. CONTRACTOR SHALL LEGALLY DISPOSE OF ALL DEMOLITION DEBRIS OFF SITE.
5. CONTRACTOR SHALL TAKE ALL NECESSARY MEASURES TO PROTECT THE W-404 WELLHEAD DURING ALL PHASES OF CONSTRUCTION

DEMOLITION QUANTITIES

SIDEWALK	308 SF±
ASPHALT	754 SF±
CURB & GUTTER	6 SF±
DRIVEWAY	28 SF±
LANDSCAPE	599 SF±
STEEL PIPE	50 SF±

EROSION CONTROL NOTES

1. NO WINTER GRADING (OCT. 15TH THROUGH APR 15TH) CAN BE PERFORMED WITHOUT PRIOR APPROVAL FROM THE CITY OF LIVERMORE OR LIVERMORE-AMADOR VALLEY ZONE 7 WATER AGENCY FOR AREAS SUBJECT TO THEIR RESPECTIVE JURISDICTIONS.
2. ALL EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE CONSTRUCTED SIMULTANEOUSLY WITH THE DISTURBANCE OF THE LAND AND SHALL REMAIN FUNCTIONAL UNTIL THE CONTRIBUTING DISTURBED AREAS ARE STABILIZED.
3. UNNECESSARY GRADING AND DISTURBING OF SOIL SHALL BE AVOIDED.
4. DURING CONSTRUCTION NO TURBID SITE WATER SHALL BE PERMITTED TO ENTER STORM DRAIN SYSTEMS.
5. ALL PAVED AREAS SHALL BE KEPT CLEAR OF EARTH MATERIAL AND DEBRIS. THE SITE SHALL BE MAINTAINED SO AS TO PREVENT SEDIMENT LADEN RUNOFF TO ANY STORM DRAINAGE SYSTEM.
6. UPON COMPLETION OF CONSTRUCTION, ALL REMAINING EXPOSED AREAS SHALL BE PERMANENTLY REVEGETATED, TO MATCH EXISTING CONDITIONS.
7. AT ALL THE TIMES DURING CONSTRUCTION, CONTRACTOR SHALL COMPLY WITH APPLICABLE PROVISIONS OF THE CONSTRUCTION GENERAL PERMIT FOR STORM WATER (WDR # 2009-009-DWO).



REGISTERED PROFESSIONAL ENGINEER
SCOTT A. BOURNE
C72817
EXP. 6/30/12
CIVIL
STATE OF CALIFORNIA

CLASSIFICATION: UNCLASSIFIED

FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
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APPLICATIONS

CONTRACT NO.

INDEX NO. C3

LAWRENCE LIVERMORE NATIONAL LABORATORY
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APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN RN	03/09/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
DEMOLITION & EROSION CONTROL PLAN
ARROYO SECO PIPELINE EXT.

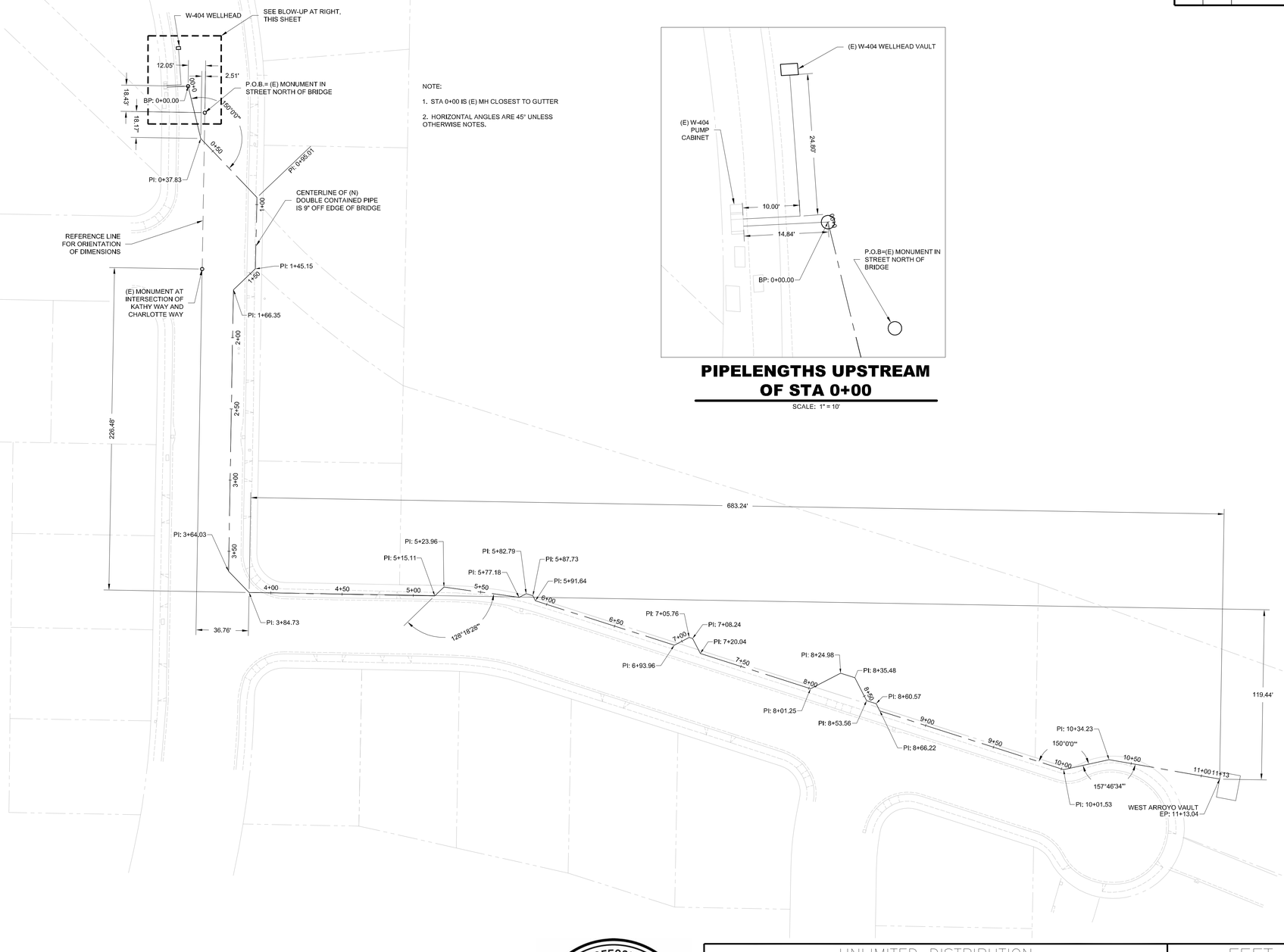
SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE 1" = 40' SHEET 5 OF 17

DRAWING NUMBER: TFA-05-11-AA REV. SH 5

DRAWING: C3-Demo & Ero. Contr. Plan.dwg MODEL: ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE

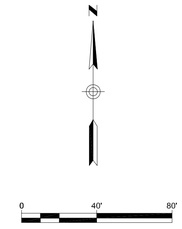


NOTE:

1. STA 0+00 IS (E) MH CLOSEST TO GUTTER
2. HORIZONTAL ANGLES ARE 45° UNLESS OTHERWISE NOTES.

PIPELENGTHS UPSTREAM OF STA 0+00

SCALE: 1" = 10'



CLASSIFICATION: UNCLASSIFIED

DRAWING NUMBER: TFA-05-11-AA | REV. | SHT: 6

REGISTERED PROFESSIONAL ENGINEER
SCOTT A. BOURNE
C72817
EXP. 6/30/12
CIVIL
STATE OF CALIFORNIA

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FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE:
DECIMALS ANGLES
±
DO NOT SCALE THIS DRAWING

NEXT ASSY	USED ON
APPLICATIONS	

CONTRACT NO.

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

INDEX NO. C4

LAWRENCE LIVERMORE NATIONAL LABORATORY

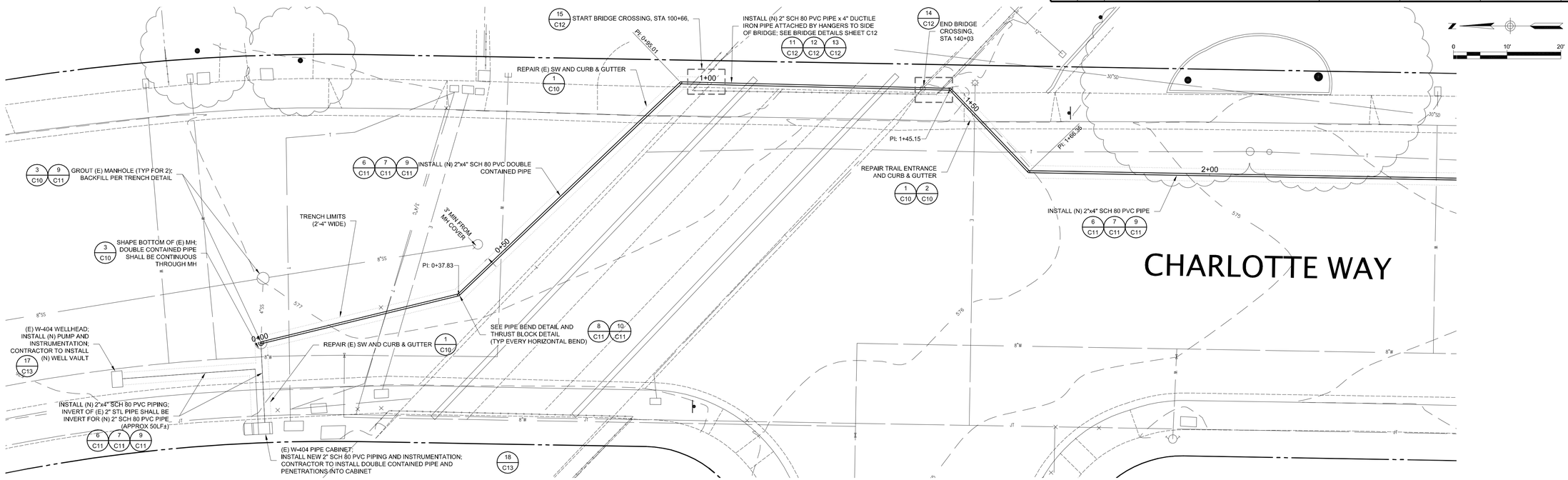
TITLE
PIPELINE LAYOUT PLAN
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

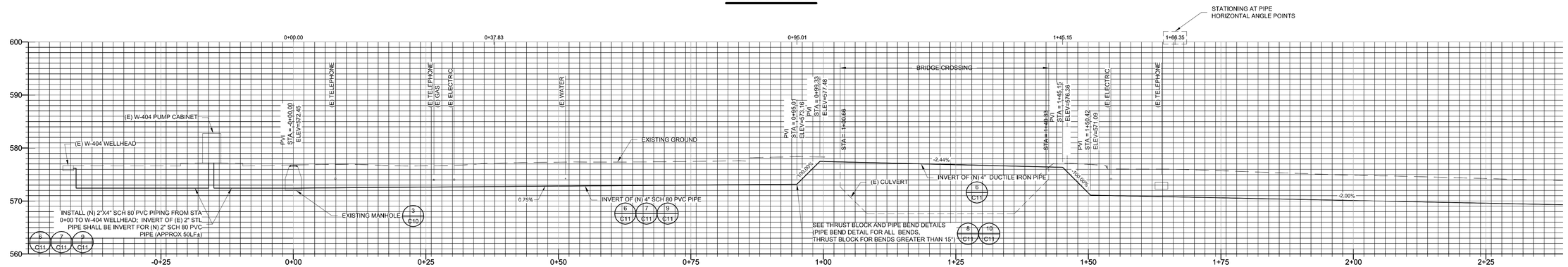
SCALE 1" = 40' SHEET 6 OF 17

DRAWING: C4 – Pipeline Layout Plan.DWG MODEL: ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



PLAN VIEW



PROFILE

SHEET NOTES

1. EXISTING UTILITIES TO BE SUPPORTED DURING TRENCHING OPERATIONS.

2. CONTRACTOR SHALL AVOID WORK IN THE ARROYO SECO CULVERT AREA INCLUDING THE USE OF MOTORIZED EQUIPMENT. CONTRACTOR SHALL OBTAIN APPROVAL OF ENGINEER AND OWNER BEFORE BEGINNING WORK IN THIS AREA. CONTRACTOR ALSO SHALL REASONABLY PROTECT LOCAL PLANTS AND WILDLIFE IN THE ARROYO SECO CULVERT WHILE WORKING IN THIS AREA.

3. RESHAPE ASPHALT SURFACE AT TRAIL NEAR SOUTH CULVERT PENETRATION TO PROVIDE POSITIVE DRAINAGE TO NEAREST STORM DRAIN.

4. EXISTING CHAIN LINK FENCING AT BRIDGE CROSSING SHALL BE TEMPORARILY REMOVED IN ORDER TO ALLOW CONSTRUCTION IN THAT AREA. EXISTING FENCE POSTS SHALL NOT BE DISTURBED. EXISTING CHAIN LINK FENCING TO BE REATTACHED AFTER CONSTRUCTION AT BRIDGE CROSSING IS COMPLETE.

5. CONTRACTOR SHALL ASSUME RESPONSIBILITY FOR PUBLIC SAFETY THROUGH BARRICADING AND OTHER MEANS AT ALL TIMES WHILE CHAIN LINK FENCING IS TEMPORARILY REMOVED. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

6. 2"x4" SCH 80 PVC PIPE REFERS TO A DOUBLE CONTAINED PIPE WHERE A 2" PVC PIPE IS INSIDE OF A 4" PVC PIPE USING PIPE SPACERS. SIMILARLY FOR 2" SCH 80 PVC PIPE x 4" DUCTILE IRON PIPE AT BRIDGE CROSSING, FOR OUTER PIPE, 4" DUCTILE IRON PIPING IS USED AT BRIDGE CROSSING; OTHERWISE USE 4" SCH 80 PVC PIPING SEE PIPELINE DETAILS, SHEET C11, AND BRIDGE CROSSING DETAILS, SHEET C12.

7. PIPE LOCATION AND ELEVATIONS SHOWN ARE BASED ON BEST AVAILABLE UTILITY INFORMATION. CONTRACTOR TO COORDINATE WITH ENGINEER ONCE UTILITIES ARE PHYSICALLY UNEARTHED TO ENSURE UTILITY CLEARANCE AND PROPER PATH FOR PIPELINE IS ESTABLISHED.

8. USE OF "OFF THE SHELF" ELBOWS AND FITTINGS IS INCORPORATED INTO THE DESIGN AS BEST AS POSSIBLE. CERTAIN BENDS (HORIZONTAL, VERTICAL AND COMBINED) WILL REQUIRE FITTINGS FABRICATED AT CUSTOM ANGLES. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ORDER THESE FITTINGS CORRECTLY BASED ON THE ACTUAL PIPELINE PATH. NEITHER THE ENGINEER, NOR OWNER, SHALL BE RESPONSIBLE FOR COSTS ACCRUED (MATERIAL, LABOR AND/OR "LOST" CONSTRUCTION TIME) BY ORDERING INCORRECT CUSTOM FITTINGS BASED SOLELY ON DRAWING SET.

9. NO TRENCHES SHALL BE LEFT IN AN OPEN CONDITION OVERNIGHT. ALL SUCH TRENCHES SHALL BE BACKFILLED OR COVERED BY STEEL PLATE BEFORE THE END OF EACH WORK DAY AND NORMAL TRAFFIC FLOWS RESTORED.

REGISTERED PROFESSIONAL ENGINEER
SCOTT A. BOURNE
C72817
EXP. 6/30/12
CIVIL
STATE OF CALIFORNIA

UNLIMITED DISTRIBUTION

FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE: DECIMALS ± ANGLES ±
DO NOT SCALE THIS DRAWING

NEXT ASSY | USED ON
APPLICATIONS

CONTRACT NO.

INDEX NO. C5

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
PLAN & PROFILE
STA: 0+00 – 2+25
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE 1" = 10' SHEET 7 OF 17

DRAWING: C5-C9 – Plan & Profile.dwg MODEL: ACAD Civil3D 2011

DRAWING NUMBER TFA-05-11-AA REV. SHT 7

CLASSIFICATION: UNCLASSIFIED

REVISIONS						
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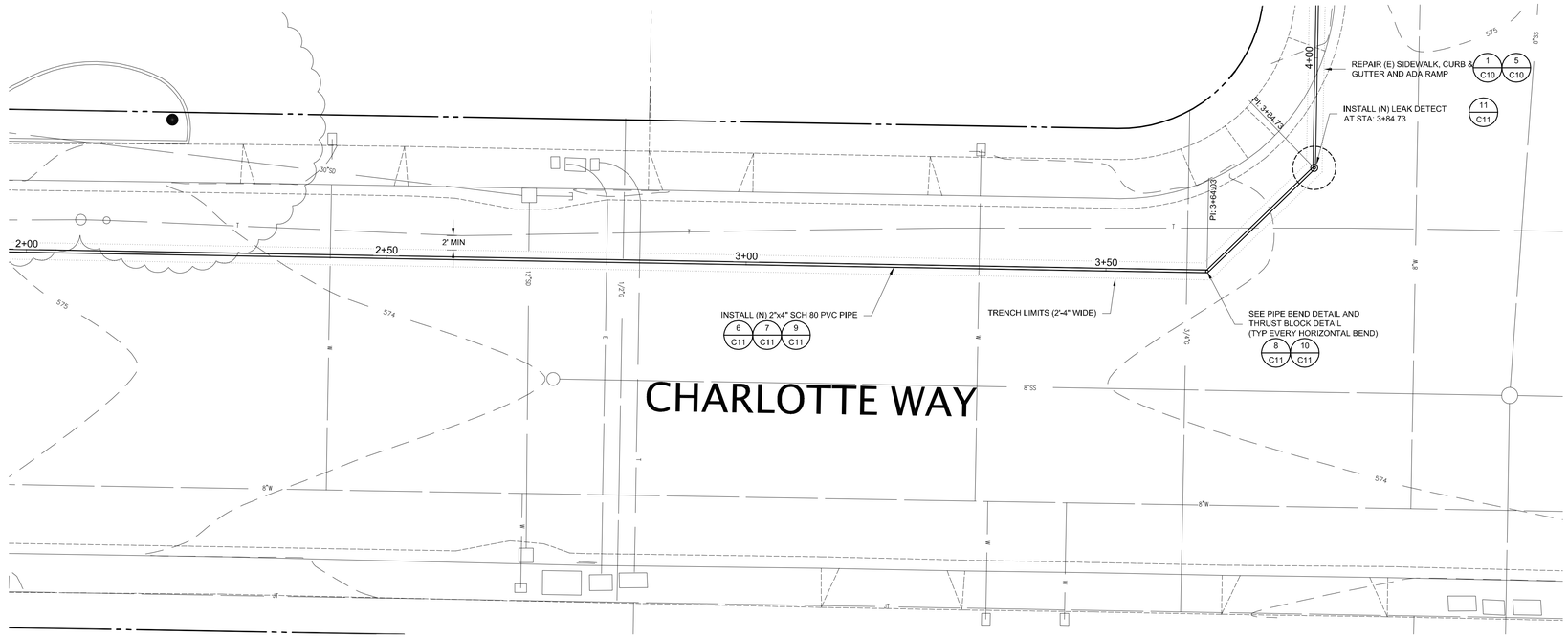
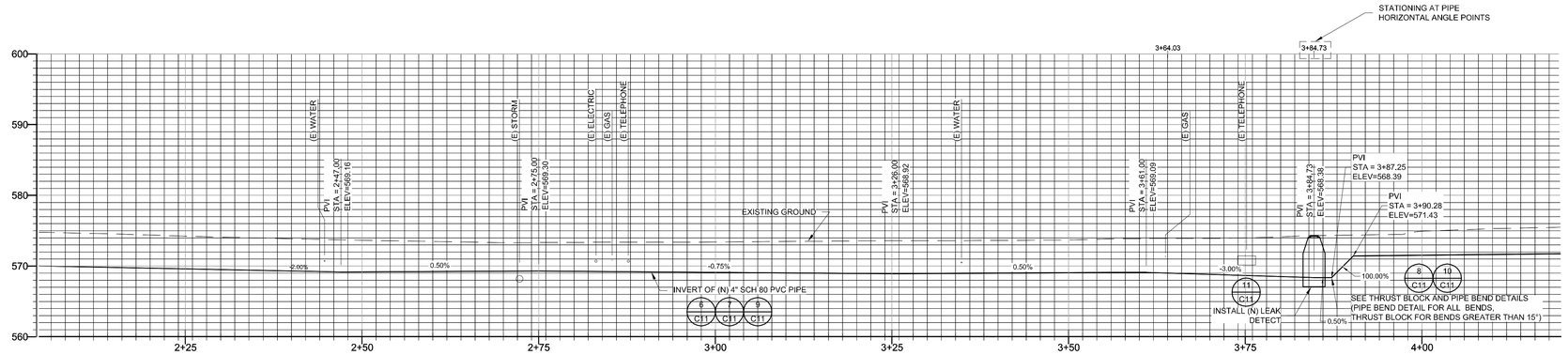


PLAN VIEW



PROFILE

SHEET NOTES

1. EXISTING UTILITIES TO BE SUPPORTED DURING TRENCHING OPERATIONS

2. 2"x4" SCH 80 PVC PIPE REFERS TO A DOUBLE CONTAINED PIPE WHERE A 2" PVC PIPE IS INSIDE OF A 4" PVC PIPE USING PIPE SPACERS, SIMILARLY FOR 2" SCH 80 PVC PIPE x 4" DUCTILE IRON PIPE AT BRIDGE CROSSING. SEE PIPELINE DETAILS SHEET SHEET C11

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REGISTERED PROFESSIONAL ENGINEER
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STATE OF CALIFORNIA

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FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE:
DECIMALS ± ANGLES ±
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APPLICATIONS

APPROVALS		DATE
ORIGINATOR	mckeregahan1	01/11
DRAWN	CAT	03/08/11
CHECKED	bourne2	04/06/11
APPROVED	dohoney1	04/06/11
ENGINEERING GROUP		DRAWING LEVEL:

INDEX NO. C6

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

TITLE
PLAN & PROFILE
STA: 2+25 – 4+00
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE 1" = 10' SHEET 8 OF 17

DRAWING: C5-C9 – Plan & Profile.dwg MODEL: ACAD Civil3D 2011

CLASSIFICATION: UNCLASSIFIED

DRAWING NUMBER TFA-05-11-AA REV. SHT 8

REVISIONS						
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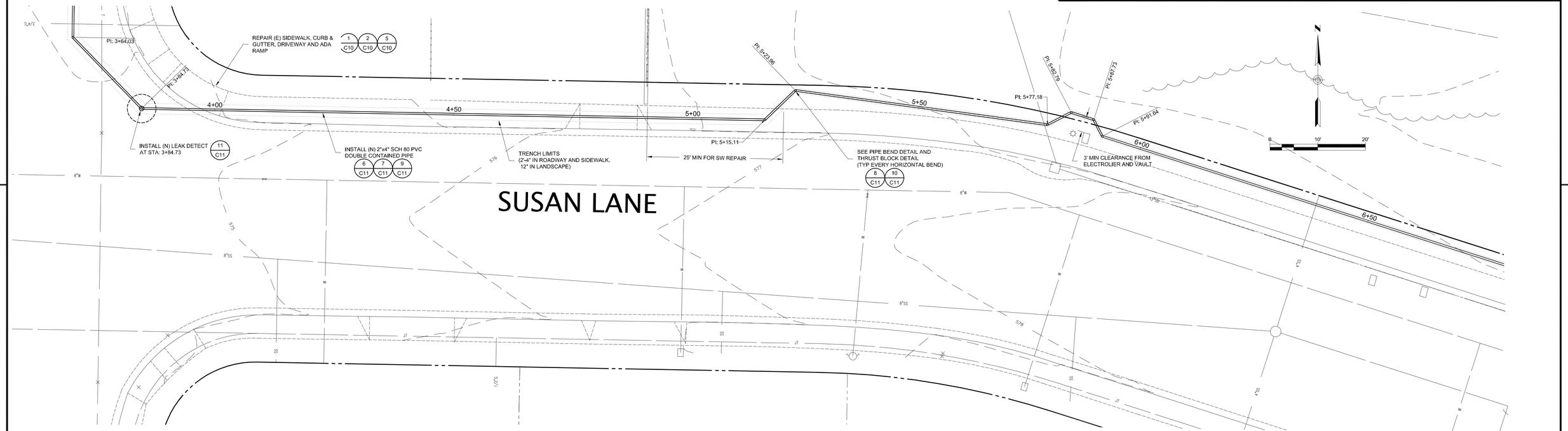
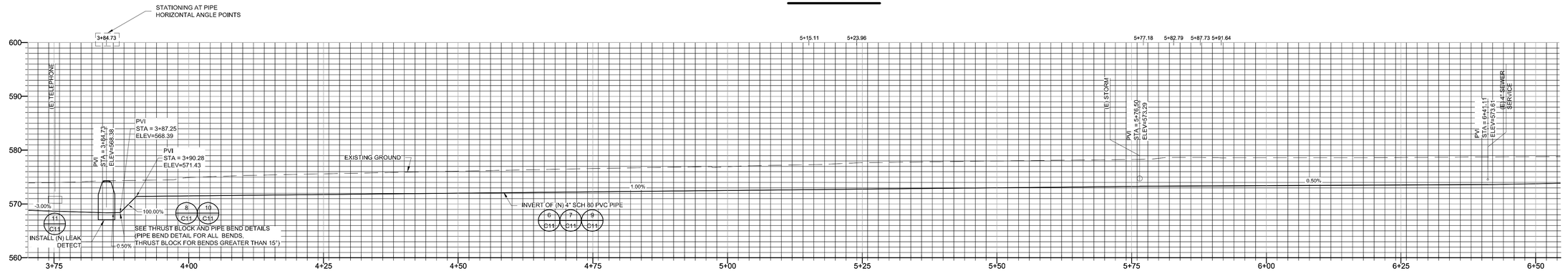


PLAN VIEW



PROFILE

SHEET NOTES

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2. 2"x4" SCH 80 PVC PIPE REFERS TO A DOUBLE CONTAINED PIPE WHERE A 2" PVC PIPE IS INSIDE OF A 4" PVC PIPE USING PIPE SPACERS. SEE PIPELINE DETAILS SHEET C11

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5. REPLACE LANDSCAPE IN KIND FROM STA: 5+18± TO STA: 11+13.04

6. CONTRACTOR TO REPAIR IRRIGATION SYSTEM IN KIND FROM STA:5+18± TO STA: 11+13.04 AS NECESSARY

7. NO TRENCHES SHALL BE LEFT IN AN OPEN CONDITION OVERNIGHT. ALL SUCH TRENCHES SHALL BE BACKFILLED OR COVERED BY STEEL PLATE BEFORE THE END OF EACH WORK DAY AND NORMAL TRAFFIC FLOWS RESTORED

REGISTERED PROFESSIONAL ENGINEER
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STATE OF CALIFORNIA

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FEET

THIRD ANGLE PROJECTION

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APPLICATIONS

CLASSIFICATION: UNCLASSIFIED

INDEX NO. C7

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
PLAN & PROFILE
STA: 4+00 – 6+50
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE 1" = 10' SHEET 9 OF 17

DRAWING NUMBER TFA-05-11-AA REV. SHT 9

DRAWING: C5-C9 – Plan & Profile.dwg MODEL: ACAD Civil3D 2011

REVISIONS						
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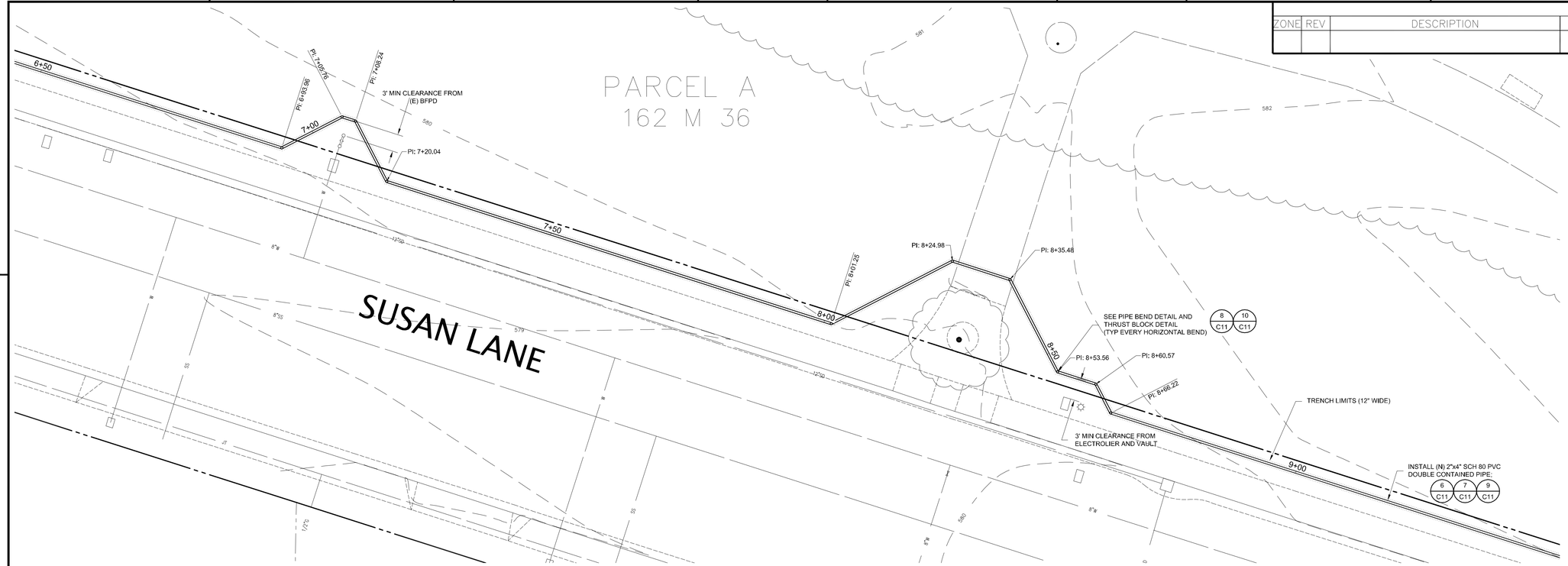
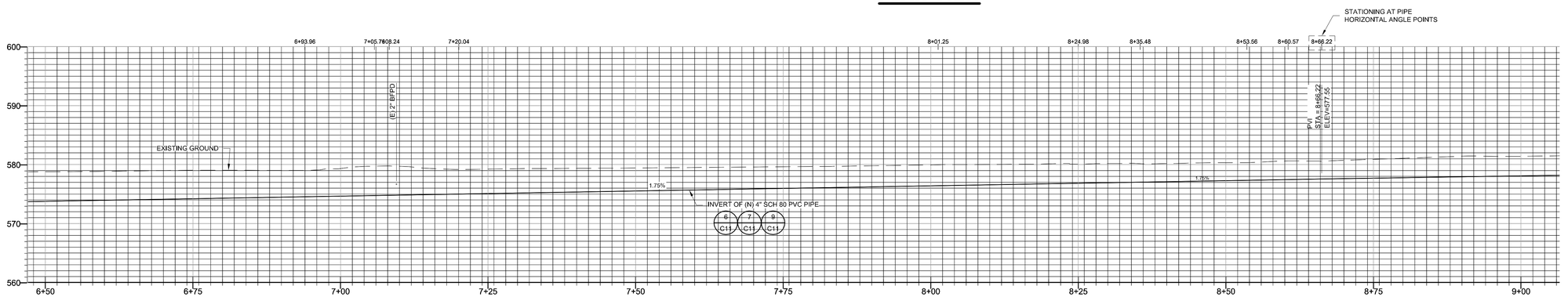


PLAN VIEW



PROFILE

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APPLICATIONS

CLASSIFICATION: UNCLASSIFIED

INDEX NO. C8

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
PLAN & PROFILE
STA: 6+50 – 9+00
ARROYO SECO PIPELINE EXT.

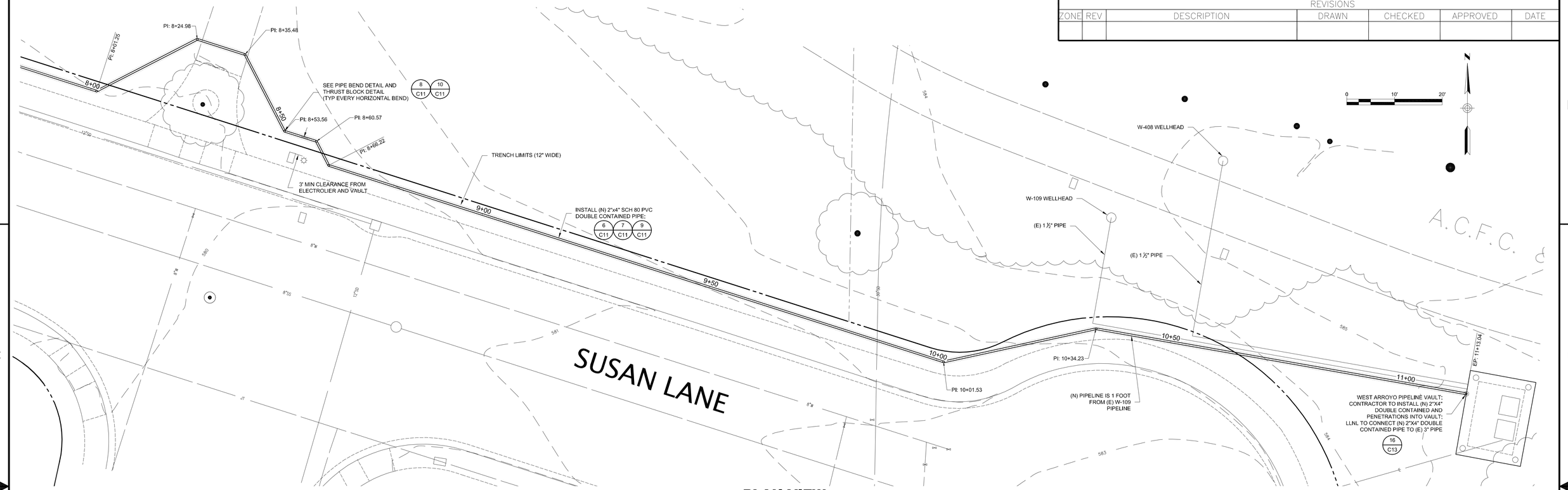
SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE 1" = 10' SHEET 10 OF 17

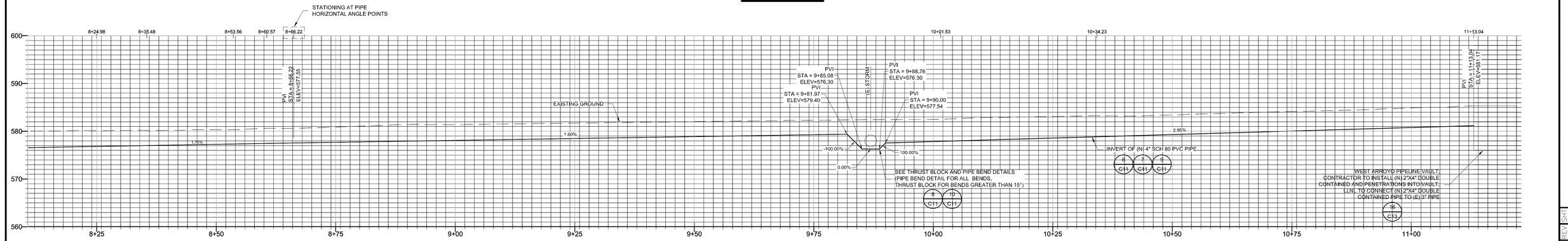
DRAWING NUMBER: TFA-05-11-AA REV: SHT 10

DRAWING: C5-C9 – Plan & Profile.dwg MODEL: ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



PLAN VIEW



PROFILE

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REGISTERED PROFESSIONAL ENGINEER
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C72817
EXP. 6/30/12
CIVIL
STATE OF CALIFORNIA

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FEET

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APPLICATIONS

CONTRACT NO.

INDEX NO. C9

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
PLAN & PROFILE
STA: 9+00 – 11+13.04
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

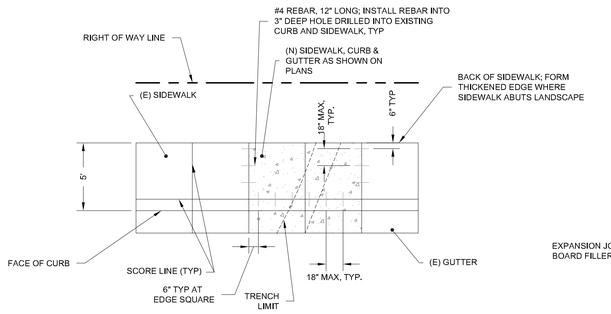
SCALE 1" = 10' SHEET 11 OF 17

DRAWING: C5-C9 – Plan & Profile.dwg MODEL: ACAD Civil3D 2011

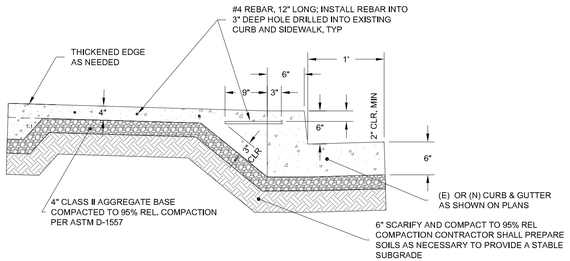
DRAWING NUMBER: TFA-05-11-AA REV: SHT: 11

CLASSIFICATION: UNCLASSIFIED

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



PLAN VIEW



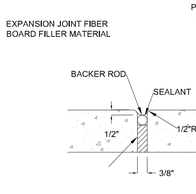
ELEVATION VIEW

1 SIDEWALK AND CURB & GUTTER REPAIR DETAIL

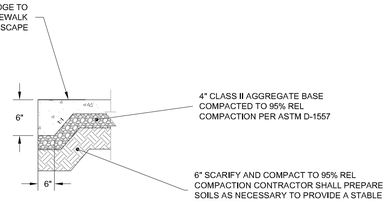
SCALE: NTS

NOTE:

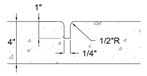
1. USE REBAR AT ONLY AT EXTENTS OF REPAIR AS SHOWN.
2. MATCH WIDTH AND SCORING PATTERN WITH ADJACENT SIDEWALK.
3. ALL EXPOSED CORNERS TO HAVE ½" RADIUS.
4. SAWCUT EXISTING SIDEWALK AT SCORE LINE OR DEEP JOINS PAST TRENCH LIMIT TO CONFORM TO EXISTING SIDEWALK.
5. THE CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 3000 PSI. LAMPBLACK SHALL BE ADDED AT A RATE OF ¾ POUND/PINT OF CUBIC YARD OF CONCRETE.
6. ALTERNATE BETWEEN EXPANSION AND WEAKENED PLANE JOINTS AT 5' O.C., TYPICAL ALONG SIDEWALKS.
7. SUBGRADE SOILS SHALL BE MOISTURE CONDITIONED TO 3 TO 5 PERCENT ABOVE OPTIMUM MOISTURE.



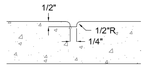
EXPANSION JOINT



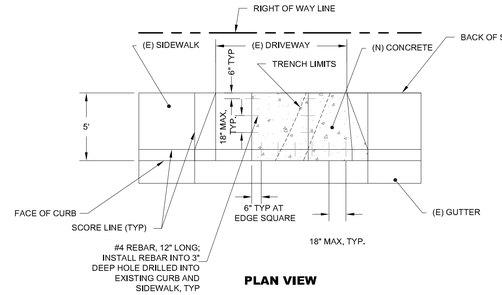
THICKENED EDGE



WEAKENED PLANE JOINT



SCORE MARK



NOTE:

1. TOP OF FLARE TO BE MIN OF:
   4' FROM CENTER OF FIRE HYDRANT
   4' FROM CENTER OF STREET LIGHT
   4' FROM PROPERTY LINE
   10' FROM BEGINNING OF CURB RTURN
   8' FROM CENTER OF STREET TREE
   4' FROM TOP OF FLARE OF OTHER DRIVEWAY
2. USE REBAR AT ONLY AT EXTENTS OF REPAIR AS SHOWN.
3. MATCH WIDTH AND SCORING PATTERN WITH ADJACENT SIDEWALK.
4. ALL EXPOSED CORNERS TO HAVE ½" RADIUS.
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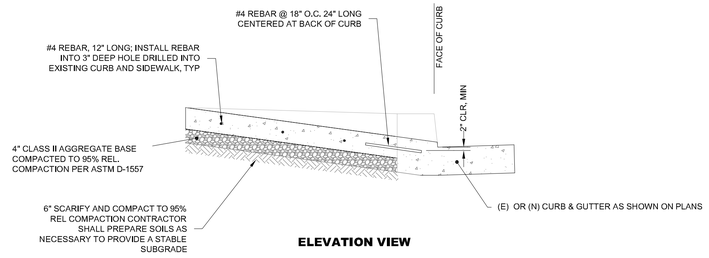
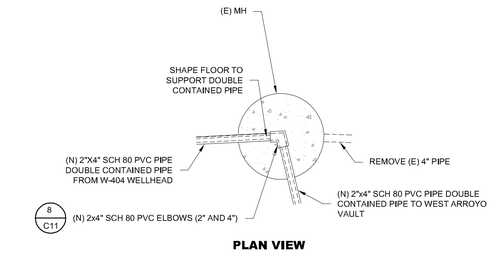
PLAN VIEW



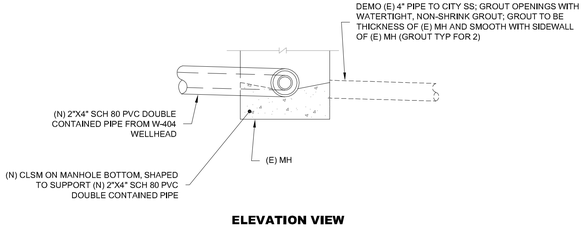
ELEVATION VIEW

2 DRIVEWAY REPAIR DETAIL

SCALE: NTS



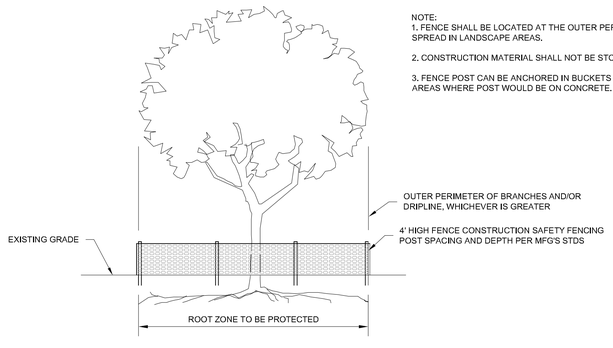
PLAN VIEW



ELEVATION VIEW

3 EXISTING MANHOLE DETAIL - STA 0+00

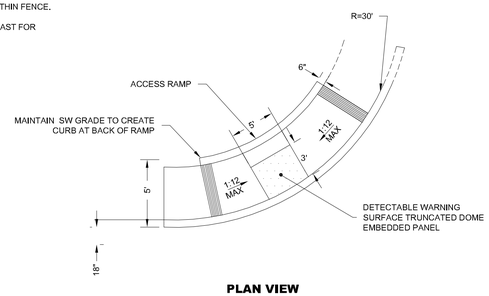
SCALE: NTS



NOTE:
1. FENCE SHALL BE LOCATED AT THE OUTER PERIMETER OF DRIP LINE SPREAD IN LANDSCAPE AREAS.
2. CONSTRUCTION MATERIAL SHALL NOT BE STORED WITHIN FENCE.
3. FENCE POST CAN BE ANCHORED IN BUCKETS W/ BALLAST FOR AREAS WHERE POST WOULD BE ON CONCRETE.

4 TREE PROTECTION DETAIL

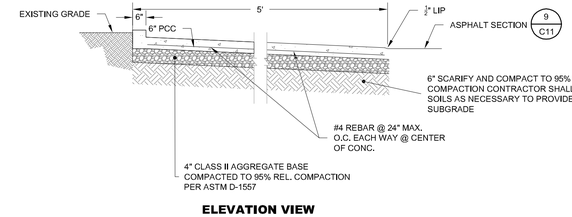
SCALE: NTS



PLAN VIEW

NOTE:

1. USE REBAR AT ONLY AT EXTENTS OF REPAIR AS SHOWN.
2. MATCH WIDTH AND SCORING PATTERN WITH ADJACENT SIDEWALK.
3. ALL EXPOSED CORNERS TO HAVE ½" RADIUS.
4. SAWCUT EXISTINGADA RAMP AT SCORE LINE OR DEEP JOINS PAST TRENCH LIMIT TO CONFORM TO EXISTING SIDEWALK.
5. THE CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 3000 PSI. LAMPBLACK SHALL BE ADDED AT A RATE OF ¾ POUND/PINT OF CUBIC YARD OF CONCRETE.
6. SUBGRADE SOILS SHALL BE MOISTURE CONDITIONED TO 3 TO 5 PERCENT ABOVE OPTIMUM MOISTURE.
7. SEE CALTRANS CURB RAMP DETAILS FOR ADDITIONAL DETAILS AND REQUIREMENTS.



ELEVATION VIEW

5 ADA RAMP REPAIR DETAIL

SCALE: NTS

CLASSIFICATION: UNCLASSIFIED

DRAWING NUMBER: TFA-05-11-AA REV: 1.2

REGISTERED PROFESSIONAL ENGINEER
SCOTT A. BOURNE
C72817
EXP 6/30/12
CIVIL
STATE OF CALIFORNIA

UNLIMITED DISTRIBUTION

FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE:
DECIMALS ± ANGLES ±
DO NOT SCALE THIS DRAWING

NEXT ASSY | USED ON
APPLICATIONS

INDEX NO. C10

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

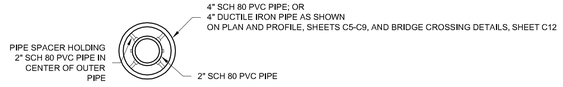
TITLE: SURFACE REPAIR DETAILS ARROYO SECO PIPELINE EXT.

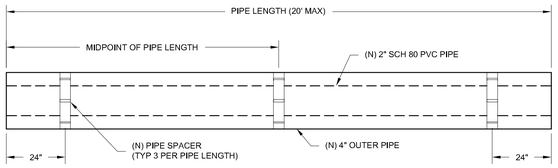
SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE: NTS | SHEET 12 OF 17

DRAWING: C10-C13 Details.dwg | MODEL: | ACAD Civil3D 2011

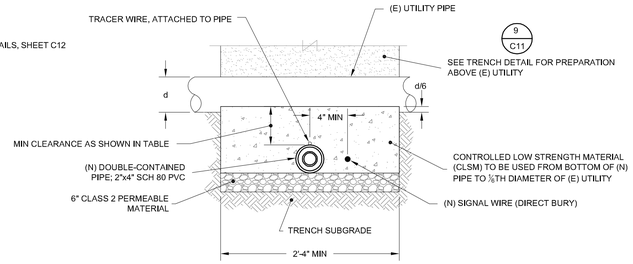
REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE





6 DOUBLE CONTAINED PIPE DETAIL

SCALE: NTS

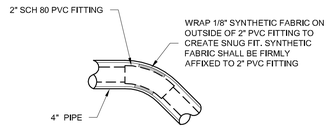


ELEVATION VIEW

7 UTILITY CROSSING DETAIL

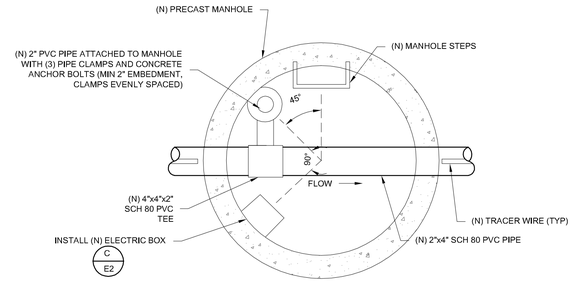
SCALE: NTS

MINIMUM CLEARANCE FROM UTILITY	
STORM	0'-6"
SEWER	0'-6"
WATER	1'-0"
ELECTRIC	1'-0"
GAS	0'-6"
COMMUNICATION	0'-6"



8 PIPE BEND DETAIL

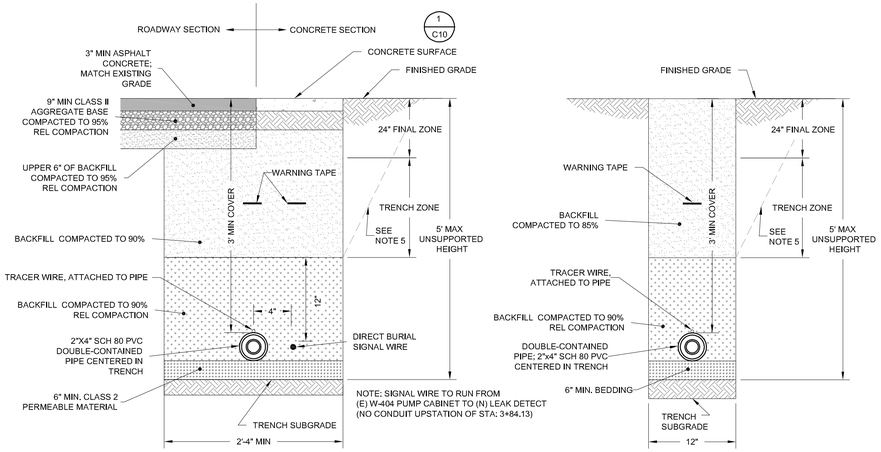
SCALE: NTS



PLAN VIEW

TRENCH DETAIL NOTES

1. TRENCHING SHALL CONFORM TO THE "CONSTRUCTION SAFETY ORDERS OF THE STATE OF CALIFORNIA" AND SECTION 6705 OF THE CALIFORNIA LABOR CODE
2. IN EXISTING STREETS, THE TOTAL ASPHALT CONCRETE THICKNESS REPLACED SHALL NOT BE LESS THAN 6" (3" IN RESIDENTIAL STREETS), OR MATCH THE EXISTING ASPHALT CONCRETE SECTION, WHICHEVER IS GREATER.
3. IN EXISTING STREETS THE ASPHALT CONCRETE BOTTOM LIFT SHALL NOT BE LESS THAN 4" (2" IN RESIDENTIAL STREETS), AND THE ASPHALT CONCRETE TOP LIFT SHALL NOT BE LESS THAN 2".
4. WHERE ADEQUATE COMPACTION CANNOT BE ACHIEVED DUE TO OBSTRUCTION OR OTHER CONDITIONS, REPLACE PIPE ZONE AND/OR TRENCH ZONE FILL WITH CONTROLLED LOW STRENGTH MATERIAL (CLSM) AS DIRECTED BY THE ENGINEER
5. SLOPING TRENCH SECTIONS, ABOVE PIPE ZONE, CAN ONLY BE USED WHERE STABLE COMPACTED SOIL CONDITIONS EXIST, WHERE APPROVED BY THE ENGINEER, OR WHERE SHOWN ON THE DRAWING OR SPECIFICATIONS. SLOPE TRENCH SECTIONS WILL NOT BE ALLOWED IN EXISTING STREETS
6. PRIOR TO TRENCHING, CONTACT USA 1-800-227-2600
7. BEFORE PAVEMENT SECTION IS REPLACED, THE EXISTING PAVEMENT SHALL BE SAWCUT AT LEAST 12 INCHES BACK FROM TRENCH EXCAVATION ALONG NEAT, STRAIGHT PARALLEL LINES. WHERE THE EXISTING ASPHALT CONCRETE IS 6" OR MORE IN THICKNESS OR WHERE REPAVING IS LESS THAT 15 SQUARE FEET IN AREA, SAWCUT MAY BE THE EDGE OF THE TRENCH EXCAVATION. WHERE WALL OF TRENCH EXCAVATION IS WITHIN 18" OF THE LIP OF GUTTER, REPLACE AC FROM TRENCH WALL TO LIP OF GUTTER
8. IN EXISTING STREETS, THE TOTAL AGGREGATE BASE SHALL BE THE GREATER OF THE EXISTING STREET AGGREGATE BASE SECTION OR 9" AB MIN.
9. CONTRACTOR TO PROVIDE 1" CONDUIT WITH PULLWIRE FROM W-404 WELLHEAD TO W-404 PUMP CABINET (35LF±)
10. SEE THE "UTILITY EARTHWORK" SECTION OF THE CITY STANDARD SPECIFICATIONS FOR ADDITIONAL INFORMATION

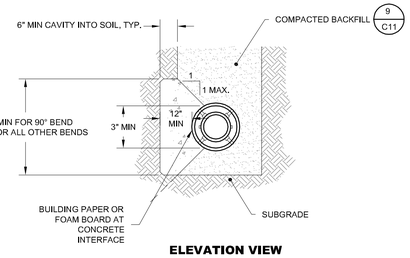


ASPHALT & CONCRETE **LANDSCAPE**

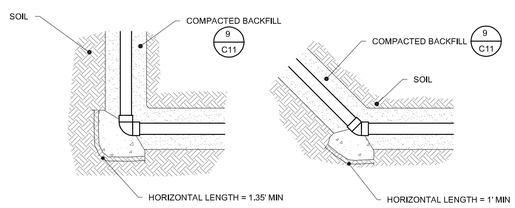
9 TRENCH DETAIL

SCALE: NTS

NOTE: THRUST BLOCK NOT NEEDED
FOR ANGLES UNDER 15°



ELEVATION VIEW

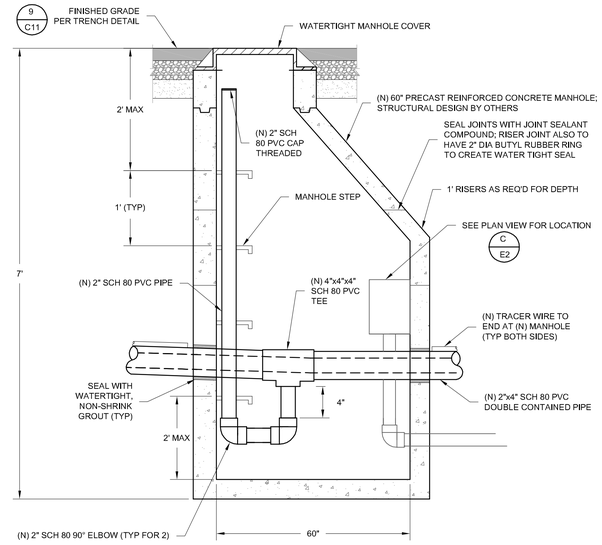


90° BEND **45° BEND & SHALLOWER**

PLAN VIEW

10 THRUST BLOCK DETAIL

SCALE: NTS



ELEVATION VIEW

11 LEAK DETECT DETAIL- STA 3+84.73

SCALE: NTS

DRAWING NUMBER: TFA-05-11-AA | REV: D | SHT: 13

CLASSIFICATION: UNCLASSIFIED

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FEET

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN FEET
TOLERANCES ARE:
DECIMALS ANGLES
± ±
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NEXT ASSY | USED ON | APPLICATIONS

CONTRACT NO.

APPROVALS	DATE
ORIGINATOR mckeeghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

INDEX NO. C11

LAWRENCE LIVERMORE NATIONAL LABORATORY
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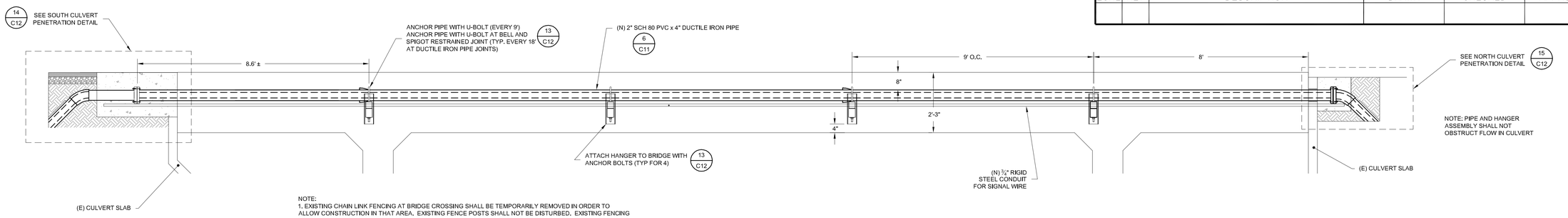
TITLE
PIPELINE DETAILS
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE NTS | SHEET 13 OF 17

DRAWING: C10-C13 Details.dwg | MODEL: | ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



NOTE:
1. EXISTING CHAIN LINK FENCING AT BRIDGE CROSSING SHALL BE TEMPORARILY REMOVED IN ORDER TO ALLOW CONSTRUCTION IN THAT AREA. EXISTING FENCE POSTS SHALL NOT BE DISTURBED. EXISTING FENCING TO BE REATTACHED AFTER CONSTRUCTION AT BRIDGE CROSSING IS COMPLETE.

2. CONTRACTOR SHALL ASSUME RESPONSIBILITY FOR PUBLIC SAFETY THROUGH BARRICADING AND OTHER MEANS AT ALL TIMES WHILE CHAIN LINK FENCING IS TEMPORARILY REMOVED. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS.

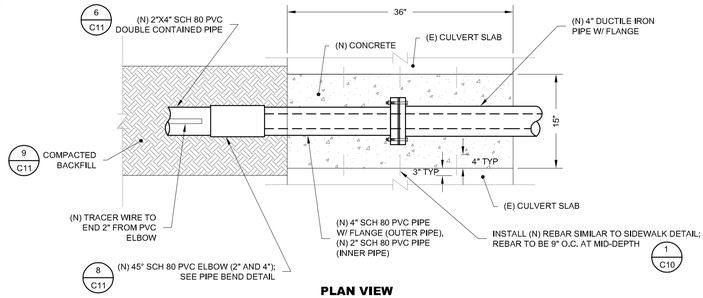
3. SLOPE OF PIPELINE TO MATCH SLOPE OF BRIDGE

4. USE RESTRAINED JOINTS AT BELL AND SPIGOT CONNECTIONS FOR DUCTILE IRON PIPE

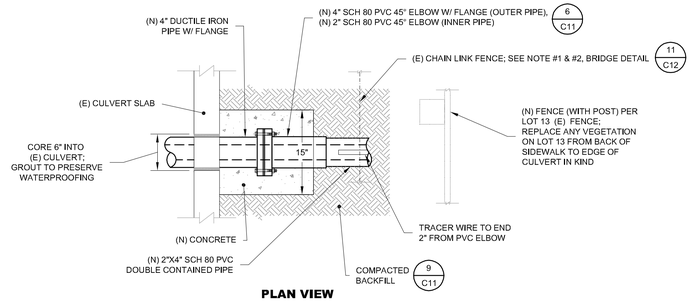
5. CONTRACTOR SHALL PREVENT DUST, DEBRIS AND OTHER MATERIALS FROM ENTERING ARROYO SECO CULVERT AREA, FROM NORTHERLY TOP OF BANK TO SOUTHERLY TOP OF BANK

11 BRIDGE DETAIL

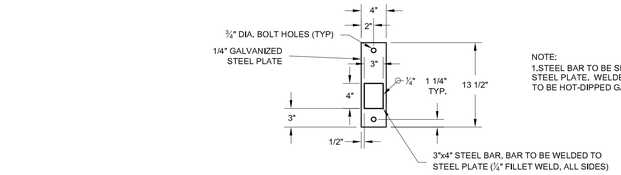
SCALE: NTS



PLAN VIEW



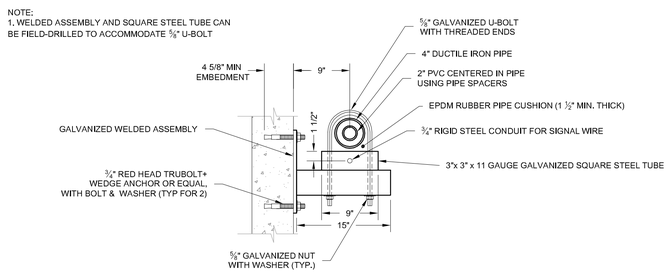
PLAN VIEW



NOTE:
1.STEEL BAR TO BE SHOP-WELDED TO ¼" STEEL PLATE. WELDED ASSEMBLY THEN TO BE HOT-DIPPED GALVANIZED.

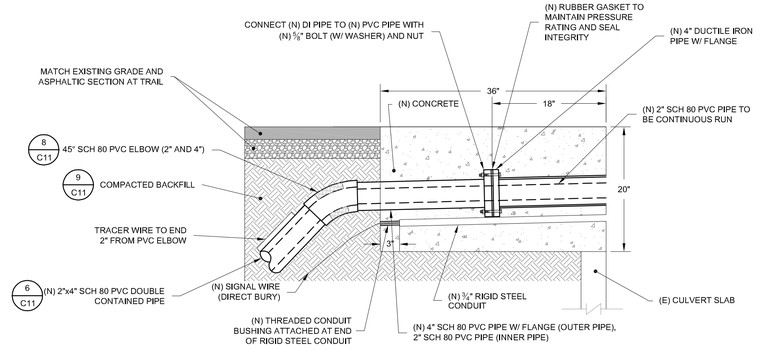
12 STEEL PLATE DETAIL

SCALE: NTS



13 HANGER DETAIL

SCALE: NTS

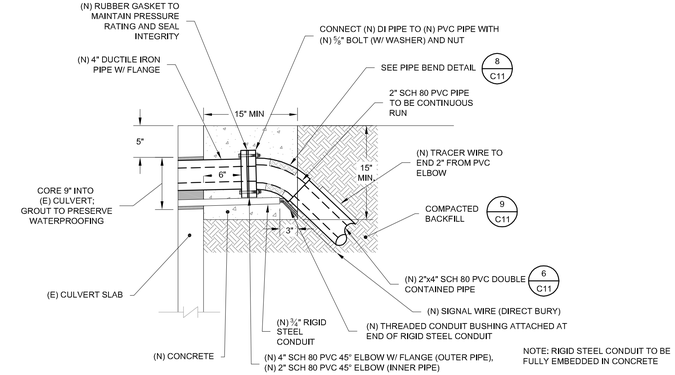


ELEVATION VIEW

NOTE: RIGID STEEL CONDUIT TO BE FULLY EMBEDDED IN CONCRETE

14 SOUTH CULVERT PENETRATION DETAIL

SCALE: NTS



ELEVATION VIEW

NOTE: RIGID STEEL CONDUIT TO BE FULLY EMBEDDED IN CONCRETE

15 NORTH CULVERT PENETRATION DETAIL

SCALE: NTS

CLASSIFICATION: UNCLASSIFIED

DRAWING NUMBER: TFA-05-11-AA | REV: 1 | SHT

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INCHES

THIRD ANGLE PROJECTION

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TOLERANCES ARE:
DECIMALS ANGLES
± ±
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APPLICATIONS

CONTRACT NO.

APPROVALS	DATE
ORIGINATOR mckeeghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

INDEX NO. C12

LAWRENCE LIVERMORE NATIONAL LABORATORY

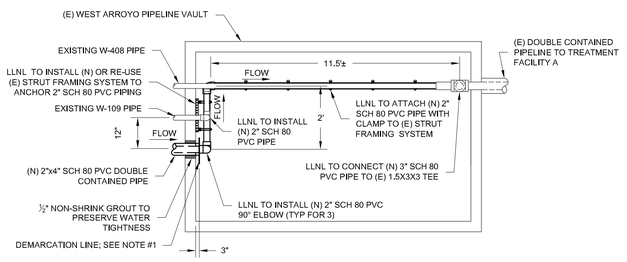
TITLE
BRIDGE CROSSING DETAILS
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

SCALE NTS | SHEET 14 OF 17

DRAWING: C10-C13 Details.dwg | MODEL: | ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE



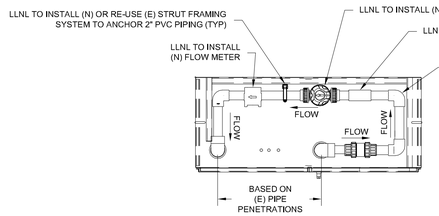
PLAN VIEW- MECHANICAL VAULT

NOTE:

1. DEMARCATION LINE IS THE LINE ESTABLISHING RESPONSIBILITY OF WORK BETWEEN CONTRACTOR AND LLNL. CONTRACTOR TO FURNISH AND INSTALL (N) 4" SCH 80 PVC TO THE DEMARCATION LINE; CONTRACTOR TO FURNISH AND INSTALL (N) 2" SCH 80 PVC PIPE 12" PAST THE DEMARCATION LINE; LLNL SHALL FURNISH AND INSTALL ALL REMAINING PIPE AND FITTINGS DOWNSTREAM OF THE DEMARCATION LINE.

2. UNLESS OTHERWISE NOTED, CONTRACTOR TO FURNISH AND INSTALL MATERIALS SHOWN IN THIS DETAIL

3. WORK TO BE PERFORMED IN MECHANICAL PORTION OF VAULT ONLY



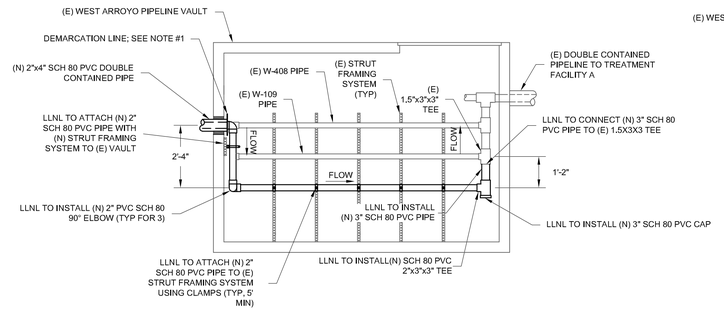
PLAN VIEW

NOTE:

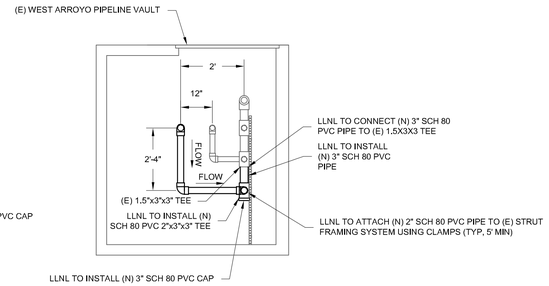
1. DEMARCATION LINE IS THE LINE ESTABLISHING RESPONSIBILITY OF WORK BETWEEN CONTRACTOR AND LLNL. CONTRACTOR TO FURNISH AND INSTALL (N) 4" SCH 80 PVC TO THE DEMARCATION LINE; CONTRACTOR TO FURNISH AND INSTALL (N) 2" SCH 80 PVC PIPE 6" ABOVE THE DEMARCATION LINE; LLNL SHALL FURNISH AND INSTALL ALL REMAINING PIPE AND FITTINGS ABOVE OF THE DEMARCATION LINE.

2. UNLESS OTHERWISE NOTED, CONTRACTOR TO FURNISH AND INSTALL MATERIALS SHOWN IN THIS DETAIL

3. ALL INSTRUMENTATION SHOWN IN ELEVATION VIEW, SOME INSTRUMENTATION NOT SHOWN IN OTHER VIEWS FOR CLARITY



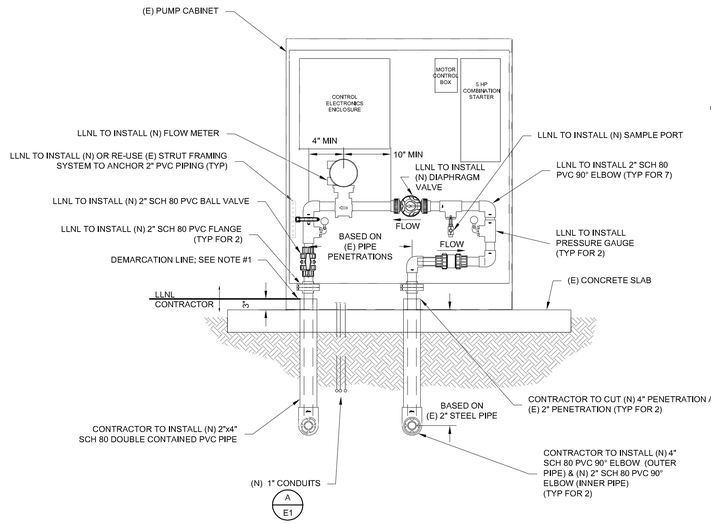
ELEVATION VIEW



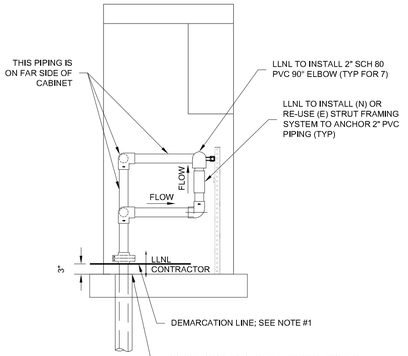
SIDE VIEW

16 WEST ARROYO VAULT DETAIL

SCALE: NTS



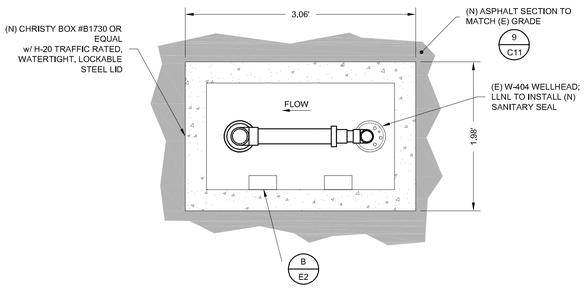
ELEVATION VIEW



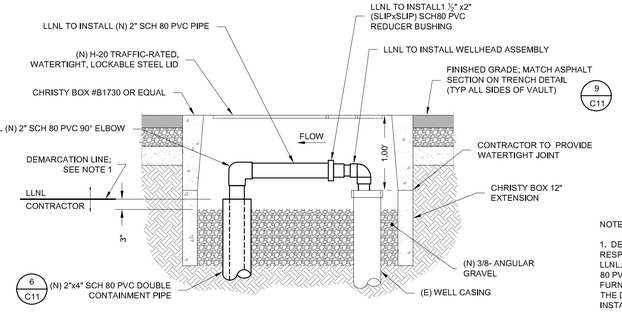
SIDE VIEW

18 W-404 PUMP CABINET DETAIL

SCALE: NTS



PLAN VIEW



ELEVATION VIEW

NOTE:

1. DEMARCATION LINE IS THE LINE ESTABLISHING RESPONSIBILITY OF WORK BETWEEN CONTRACTOR AND LLNL. CONTRACTOR TO FURNISH AND INSTALL (N) 4" SCH 80 PVC TO THE DEMARCATION LINE; CONTRACTOR TO FURNISH AND INSTALL (N) 2" SCH 80 PVC PIPE 6" ABOVE THE DEMARCATION LINE; LLNL SHALL FURNISH AND INSTALL ALL REMAINING PIPE AND FITTINGS UPSTREAM OF THE DEMARCATION LINE.

2. UNLESS OTHERWISE NOTED, CONTRACTOR TO FURNISH AND INSTALL MATERIALS SHOWN IN THIS DETAIL

3. CONTRACTOR TO PROVIDE SEAL TO PREVENT WATER ENTERING VAULT FROM ROADWAY

17 WELLHEAD DETAIL

SCALE: NTS

DRAWING_NUMBER: TFA-05-11-AA | REV: | SHT: 15

CLASSIFICATION: UNCLASSIFIED

REGISTERED PROFESSIONAL ENGINEER
SCOTT A. BOURNE
C72817
EXP. 6/30/12
CIVIL
STATE OF CALIFORNIA

FEET
THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN FEET
TOLERANCES ARE:
DECIMALS ± ANGLES ±
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APPLICATIONS

INDEX NO. C13

CONTRACT NO.

LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR mckereghan1	01/11
DRAWN CAT	03/08/11
CHECKED bourne2	04/06/11
APPROVED dohoney1	04/06/11
ENGINEERING GROUP	DRAWING LEVEL:

TITLE
VAULT AND CABINET DETAILS
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	

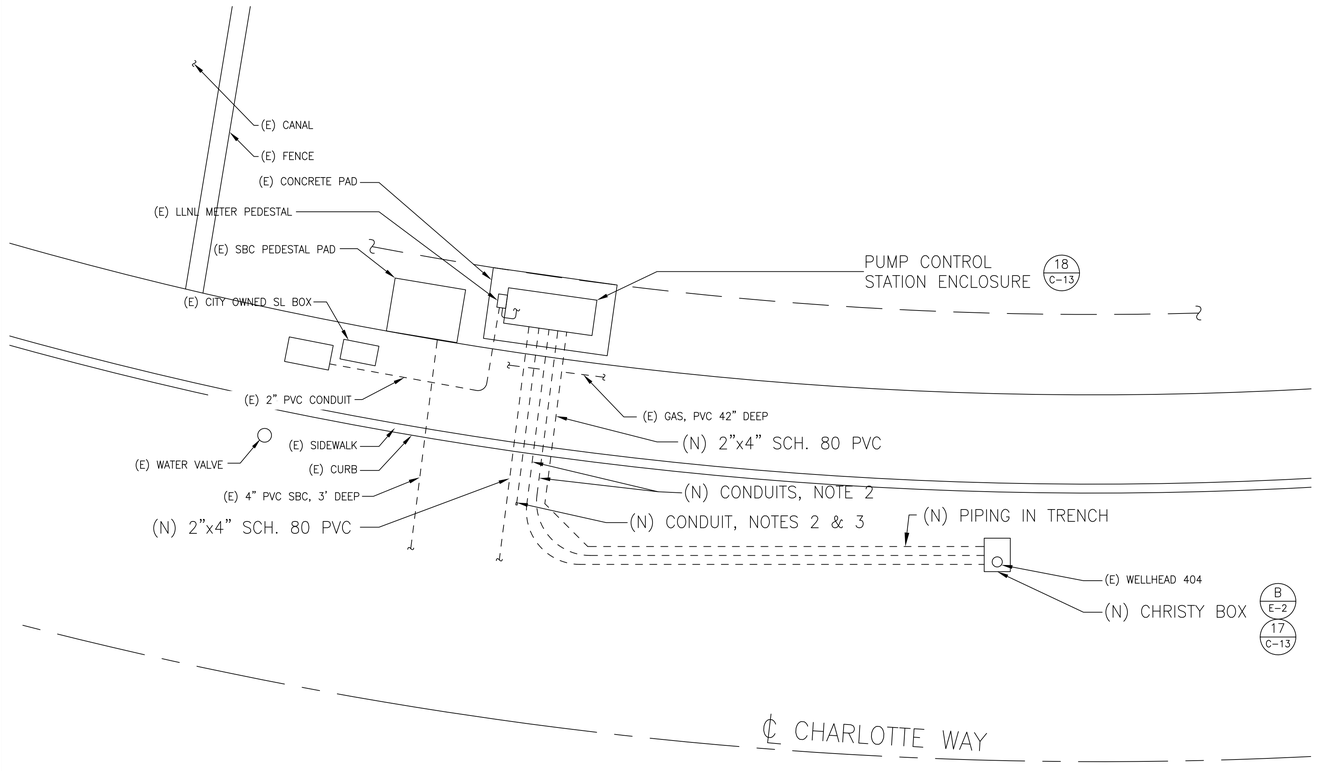
SCALE NTS | SHEET 15OF 17

DRAWING: C10-C13 Details.dwg | MODEL: | ACAD Civil3D 2011

REVISIONS						
ZONE	REV	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
			NONE			

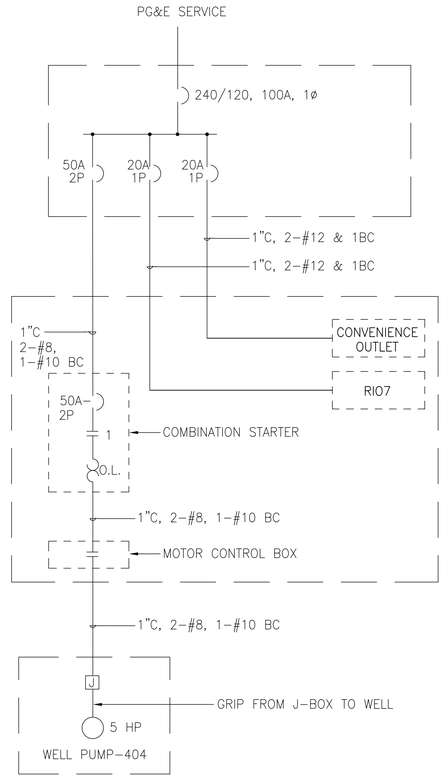
GENERAL NOTES:

1. UNDERGROUND PIPE ROUTING SHOWN ON DRAWING IS FOR REFERENCE ONLY. FINAL ROUTING TO BE DETERMINED BY THE CITY OF LIVERMORE AND CONTRACTOR.
2. UNDERGROUND RACEWAYS SHALL BE 1" PVC CONDUIT (INCLUDING PULL ROPE) WITH TWO LAYERS OF HALF-LAP WRAPPED 0.010" THICK VIRGIN POLYETHYLENE TAPE, BURIED WITH 24" MIN. COVER AND HAVE PLASTIC CAUTION TAPE ABOVE ITS ENTIRE LENGTH.
3. CONDUIT END FOR BURIED CABLE (MULTI-CONDUCTOR SIGNAL CABLE, DETAIL "C", E-2), COIL 20 FEET IN PUMP CABINET.
4. ELECTRICAL INSTALLATION SHALL CONFORM WITH NATIONAL ELECTRICAL CODE (NFPA 70) AND APPLICABLE CODES AND STANDARDS.



A WELL 404 CONNECTION PLAN
SCALE: NONE

N



SINGLE LINE POWER DIAGRAM
REFERENCE ONLY

DRAWING NUMBER TFA-05-11-AA REV SHT 16

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INDEX NO. E1
CONTRACT NO.
LAWRENCE LIVERMORE NATIONAL LABORATORY

APPROVALS	DATE
ORIGINATOR schwartz1	3/2011
DRAWN schwartz1	3/2011
CHECKED soto3	4/5/11
APPROVED dohoney1	4/6/11
ENGINEERING GROUP ERD	DRAWING LEVEL:

TITLE
ELECTRICAL PLAN AND SINGLE LINE POWER DIAGRAM, ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA-05-11-AA	
SCALE NONE		SHEET 16 OF 17	

DRAWING: TFA-05-11-AA.dwg MODEL:

REVISIONS						
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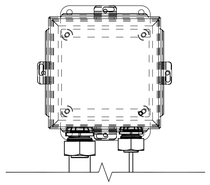
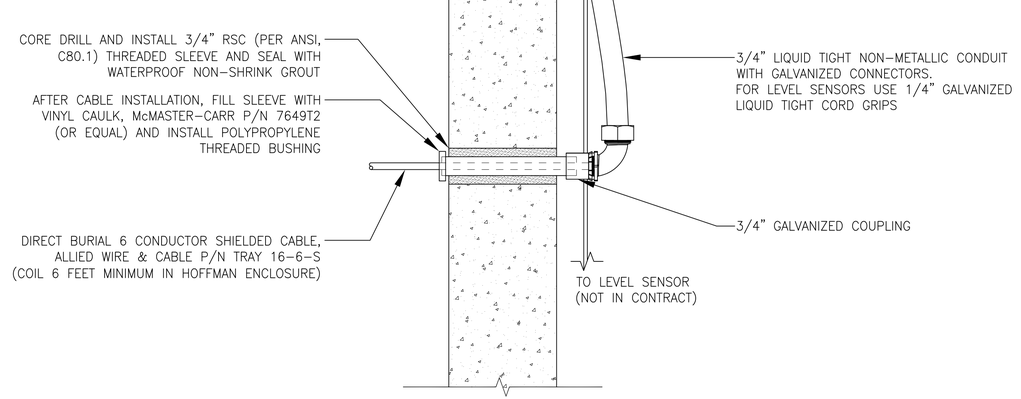
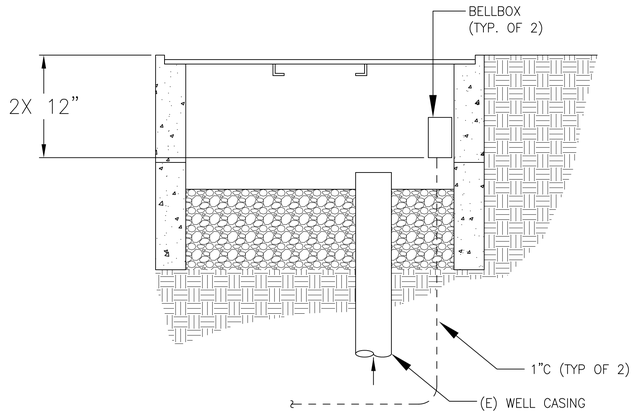


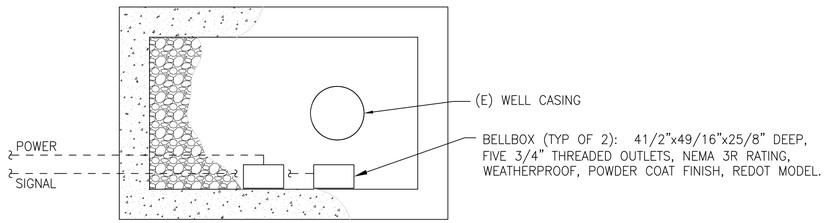
ENCLOSURE FRONT VIEW



C MANHOLE BURIED CABLE PENETRATION DETAIL
SCALE: SCALE



WELLHEAD CHRISTY BOX ELEVATION



B WELLHEAD CHRISTY BOX PLAN
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APPROVED dohoney1	4/6/11
ENGINEERING GROUP ERD	DRAWING LEVEL:

TITLE
ELECTRICAL DETAILS
ARROYO SECO PIPELINE EXT.

SIZE	CAGE CODE	DWG NO.	REV.
D	14067	TFA–05–11–AA	

SCALE NONE | SHEET 17OF 17

DRAWING: TFA–05–11–AA.dwg MODEL:

Appendix B

Design Calculations

APPENDIX B-1

Weiss Associates
Engineering Calculation Lead Sheet

Weiss Associates Project Number	010-2013-32565-83225
Client	Environmental Restoration Department Lawrence Livermore National Laboratory Roberto Ruiz
Project Title	Arroyo Seco Pipeline Extension Project
Purpose	Calculate pressure losses (elevation, friction and minor) for addition extraction well W-404 to TFA via a new underground pipe to determine size of new W-404 pumps and suitability of existing pumps along the Arroyo Seco pipe
Design Data Input	Flow rates provided by ERD hyrogeologists in Operational Hydrogeologic Review (OHGR); Details on existing Arroyo Seco pipe and wells from "Groundwater Pumping Station and Pipeline" as-built drawings from September 24, 1990
Applicable Codes and Standards	NA
Formula and Procedures	See assumptions
Assumptions	See assumptions
Number of Sheets	10
Originator	Chris Taylor
Checker	Scott Bourne
Data Checking Complete	4/4/2011 (rev October 7, 2011)

Notes: NA

Assumptions

Flow rates determined from hydrogeologic analysis and results for nominal flow scenarios.
Depth to water assumed to be depth to low level set point in well or anticipated depth to water under anticipated pumping conditions based on the 2007 treatability test at extraction well W-404 and continuous water level measurements at other TFA extraction wells.
Calculations assume pressure at intake to Cuno filter near TFA will be 15 psi.
Friction losses calculated from Hazen Williams Equation.
Minor losses calculated from velocity head using K-factor coefficients.
Hazen Williams "C" Value based on the 2004 version of “Recommended Standards for Wastewater Facilities” (Ten States Standards) stated under Section 49.6 Design Friction Losses (sub-section 49.61 Friction Coefficient), “…for other smooth pipe materials such as pvc, polyethylene, lined ductile iron, etc. a higher “C” value not to exceed 120 may be allowed for design.”
Coefficients for friction and minor losses from "Civil Engineering Reference Manual", Eighth Edition, M. Lindeburg (table shown below)
The energy loss calculations include upgrades to the W-404 well cabinet to reduce energy losses.
Stationing used in spreadsheet based on "TFA-Main & W-404 Plant Engineering Documentation" drawing set. Area upstream of MCV (where W-109 and W-408 join the Arroyo Pipe) shown as negative.
Elevations based on "TFA-Main & W-404 Plant Engineering Documentation" drawing set datum, not Kier Wright Topo datum.
Elevation at Cuno Filter is assumed to be 605.00'.
Pipe routing, valving and fittings for W-904, W-457, W-903 based on "process and instrumentation Diagram, Control System 25, Treatment facility-A" drawing set.
Neglect frictions from pump intake to top of groundater and fitting losses for angles under 15 degrees.

Hazen-Williams Equation:

HLoss=10.44*L*F^1.85 / (C^1.85*d^4.8655)

- L=Length (feet)
- F=Flow (gpm)
- C=Hazen-Williams roughness coefficient
- d=Pipe Diameter (inches)

For Fittings Losses:

HLoss = K*(v^2)/2g

- v=Velocity (fps)
- g= gravitational constant (32.2ft/sec^2)
- K = Minor Loss Coefficient

Minor Loss Coefficient Table

Fitting	K
0	0
15 deg	0.076
30 deg	0.152
90 deg	1.500
45 deg	0.400
2-90 deg	3.000
Ball	0.050
Check	2.300
Gate	0.150
Globe	10.000
Tee-Line	0.900
Tee-Branch	2.000
AxB Expansion	(1-(Area of Smaller Pipe/Area of Larger Pipe))^2
AxB Reducer	1/2*(1-(Area of Smaller Pipe/Area of Larger Pipe))^2

Summary
Nominal Flow Scenario

						Pipe Network Energy Losses			Pump Requirements	
ID	**Station**	**Cum. Flow Rate in Arroyo Pipe**	**Depth to Water**	**Pipe Dia**	**Velocity**	**Fitting**	**Friction**	**Elevation**	**TDH**	**Pump rate**
	ft	**gpm**	**ft**	**in**	**ft/s**	**ft**	**ft**	**ft**	**ft**	**gpm**
W404	-1187.00	32	**64**	2	3.27	25.6	122.2	98.9	247	**32**
W408	-112.35	25	**57**	1.5	4.54	18.8	93.5	79.5	192	**25**
W109	-116.67	0	**83**	1.5	0.00	0.0	0.0	0.0	0	**0**
WPV **Connect**	-5.00	57	**--**	3.0	2.59	13.0	78.0	23.3	114	**--**
W904	291.55	94	**111**	1.5	6.72	22.2	91.6	131.1	245	**37**
W457	618.74	119	**88**	1.5	4.54	14.7	69.7	105.0	189	**25**
W903	924.11	144	**102**	1.5	4.54	13.7	55.6	116.8	186	**25**
Filter	1592.79	144	**--**	3.0	6.54	0.0	0.0	0.0	0	

Assumptions and calculations detailed in separate tab
* Pump is required to operate at top of curve.

Well W-404 and the Arroyo Seco Pipeline Extension

Extension Pipe Station (-)	Invert of Casing Pipe based on Survey Datum	Invert of Casing Pipe (adjusted to as-built datum)	As- Built Stationing	Description	Fitting (Downstream)	Pipe Dia. (inches)	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
				Top of Groundwater		2.00	0.00	0.00	512.64	32	0.07	0.02	3.27	120	0.000	0.00	0.00	0.00	0.00	0.00	121.77
				Up from wellhead	90 deg	2.00	64.00	64.00	576.64	32	0.07	0.02	3.27	120	1.500	0.25	1.99	64.00	66.24	28.67	121.77
				Horizontal Pipe	90 deg	2.00	91.50	155.50	576.64	32	0.07	0.02	3.27	120	1.500	0.25	2.84	0.00	69.33	30.00	93.10
				Down to trench	90 deg	2.00	1.00	156.50	573.64	32	0.07	0.02	3.27	120	1.500	0.25	0.03	-3.00	66.61	28.83	91.77
				Edge of box		2.00	3.00	159.50	573.64	32	0.07	0.02	3.27	120	0.000	0.00	0.09	0.00	66.70	28.87	92.94
				Out of Box	90 deg	2.00	0.75	160.25	573.64	32	0.07	0.02	3.27	120	1.500	0.25	0.02	0.00	66.97	28.98	92.90
				90 deg to Cabinet	90 deg	2.00	24.80	185.05	574.13	32	0.07	0.02	3.27	120	1.500	0.25	0.77	0.49	68.48	29.64	92.79
				Up to Cabinet	90 deg	2.00	10.50	195.55	574.55	32	0.07	0.02	3.27	120	1.500	0.25	0.33	0.42	69.47	30.07	92.13
				Into bottom edge of Cabinet	90 deg	2.00	3.00	198.55	577.55	32	0.07	0.02	3.27	120	1.500	0.25	0.09	3.00	72.82	31.51	91.70
				90 to center of inflow pipe	90 deg	2.00	0.50	199.05	577.75	32	0.07	0.02	3.27	120	1.500	0.25	0.02	0.20	73.28	31.71	90.26
				90 to front of cabinet	90 deg	2.00	1.00	200.05	577.75	32	0.07	0.02	3.27	120	1.500	0.25	0.03	0.00	73.56	31.84	90.05
				90 to door of cabinet	90 deg	2.00	1.50	201.55	577.75	32	0.07	0.02	3.27	120	1.500	0.00	0.05	0.00	73.61	31.86	89.93
				Pipe into flow meter		2.00	3.00	204.55	580.75	32	0.07	0.02	3.27	120	0.000	0.00	0.09	3.00	76.70	33.19	89.91
				Flow Meter	90 deg	2.00	1.00	205.55	580.75	32	0.07	0.02	3.27	120	1.500	0.25	0.03	0.00	76.98	33.32	88.57
				Unistrut Anchor	90 deg	2.00	2.00	207.55	580.75	32	0.07	0.02	3.27	120	1.500	0.25	0.06	0.00	77.29	33.45	88.45
				90 at back of cabinet	90 deg	2.00	3.00	210.55	577.75	32	0.07	0.02	3.27	120	1.500	0.25	0.09	-3.00	74.63	32.30	88.32
				Out of Cabinet		2.00	1.50	212.05	577.75	32	0.07	0.02	3.27	120	0.000	0.00	0.05	0.00	74.68	32.32	89.47
				Down to Trench	90 deg	2.00	0.50	212.55	574.75	32	0.07	0.02	3.27	120	1.500	0.25	0.02	-3.00	71.94	31.14	89.45
				Into Manhole		2.00	3.00	215.55	573.11	32	0.07	0.02	3.27	120	0.000	0.00	0.09	-1.64	70.40	30.47	90.63
0.00	572.45	572.95		Out of Manhole		2.00	15.34	230.89	573.11	32	0.07	0.02	3.27	120	0.000	0.00	0.48	0.00	70.87	30.67	91.30
37.43	572.73	573.23		Horizontal Bend	30 deg	2.00	37.43	268.32	573.39	32	0.07	0.02	3.27	120	0.152	0.03	1.16	0.28	72.34	31.31	91.10
94.96	573.16	573.66		Combined Bend	45 deg	2.00	57.53	325.85	573.82	32	0.07	0.02	3.27	120	0.400	0.07	1.79	0.43	74.62	32.30	90.46
99.80	577.99	578.49		Bridge Crossing	45 deg	2.00	6.84	332.69	578.65	32	0.07	0.02	3.27	120	0.400	0.07	0.21	4.83	79.73	34.51	89.47
145.13	576.92	577.42		Bridge Crossing	45 deg	2.00	45.34	378.03	577.58	32	0.07	0.02	3.27	120	0.400	0.07	1.41	-1.07	80.14	34.68	87.26
155.54	568.59	569.09		Vertical Bend	45 deg	2.00	13.33	391.37	569.25	32	0.07	0.02	3.27	120	0.400	0.07	0.41	-8.33	72.29	31.28	87.09
166.33	571.83	572.33		Combined Bend	45 deg	2.00	11.27	402.63	572.49	32	0.07	0.02	3.27	120	0.400	0.07	0.35	3.24	75.94	32.87	90.48
247.00	569.14	569.64		Vertical Bend		2.00	80.71	483.35	569.80	32	0.07	0.02	3.27	120	0.000	0.00	2.51	-2.69	75.76	32.79	88.90
275.00	569.28	569.78		Vertical Bend		2.00	28.00	511.35	569.94	32	0.07	0.02	3.27	120	0.000	0.00	0.87	0.14	76.77	33.22	88.98
326.00	569.90	570.40		Vertical Bend		2.00	51.00	562.35	570.56	32	0.07	0.02	3.27	120	0.000	0.00	1.58	0.62	78.97	34.18	88.55
361.00	569.07	569.57		Vertical Bend		2.00	35.01	597.36	569.73	32	0.07	0.02	3.27	120	0.000	0.00	1.09	-0.83	79.23	34.29	87.59
364.01	568.98	569.48		Horizontal Bend	45 deg	2.00	3.01	600.37	569.64	32	0.07	0.02	3.27	120	0.400	0.07	0.09	-0.09	79.30	34.32	87.48
376.00	568.62	569.12		Vertical Bend	15 deg	2.00	12.00	612.37	569.28	32	0.07	0.02	3.27	120	0.076	0.01	0.37	-0.36	79.32	34.33	87.45
384.71	570.10	570.60		Combined Bend	45 deg	2.00	8.83	621.20	570.76	32	0.07	0.02	3.27	120	0.400	0.07	0.27	1.48	81.14	35.12	87.44
515.09	572.71	573.21		Horizontal Bend	45 deg	2.00	130.41	751.61	573.37	32	0.07	0.02	3.27	120	0.400	0.07	4.05	2.61	87.87	38.03	86.65
523.94	572.88	573.38		Horizontal Bend	45 deg	2.00	8.85	760.46	573.54	32	0.07	0.02	3.27	120	0.400	0.07	0.27	2.78	90.99	39.38	83.74
570.50	573.82	574.32		Vertical Bend		2.00	46.57	807.03	574.48	32	0.07	0.02	3.27	120	0.000	0.00	1.45	0.94	93.38	40.41	82.39
577.17	573.82	574.32		Horizontal Bend	45 deg	2.00	6.67	813.70	574.48	32	0.07	0.02	3.27	120	0.400	0.07	0.21	0.00	93.65	40.53	81.36
582.77	573.82	574.32		Horizontal Bend	45 deg	2.00	5.60	819.30	574.48	32	0.07	0.02	3.27	120	0.400	0.07	0.17	0.00	93.89	40.63	81.24
587.72	573.82	574.32		Horizontal Bend	45 deg	2.00	4.95	824.25	574.48	32	0.07	0.02	3.27	120	0.400	0.07	0.15	3.92	98.03	42.43	81.13
591.63	573.82	574.32		Horizontal Bend	45 deg	2.00	3.91	828.16	574.48	32	0.07	0.02	3.27	120	0.400	0.07	0.12	0.00	98.22	42.51	79.34
625.00	573.82	574.32		Vertical Bend		2.00	33.37	861.53	574.48	32	0.07	0.02	3.27	120	0.000	0.00	1.04	0.00	99.25	42.96	79.26
641.00	573.50	574.00		Vertical Bend		2.00	16.00	877.53	574.16	32	0.07	0.02	3.27	120	0.000	0.00	0.50	-0.32	99.43	43.03	78.81
693.94	574.56	575.06		Horizontal Bend	45 deg	2.00	52.95	930.48	575.22	32	0.07	0.02	3.27	120	0.400	0.07	1.64	1.06	102.20	44.23	78.74
705.74	574.79	575.29		Horizontal Bend	45 deg	2.00	11.80	942.29	575.45	32	0.07	0.02	3.27	120	0.400	0.07	0.37	0.23	102.87	44.52	77.54
708.23	574.84	575.34		Horizontal Bend	45 deg	2.00	2.49	944.78	575.50	32	0.07	0.02	3.27	120	0.400	0.07	0.08	0.05	103.06	44.60	77.25
710.00	574.88	575.38		Vertical Bend		2.00	1.77	946.55	575.54	32	0.07	0.02	3.27	120	0.000	0.00	0.05	0.04	103.15	44.64	77.17
720.02	575.06	575.56		Horizontal Bend	45 deg	2.00	10.02	956.57	575.72	32	0.07	0.02	3.27	120	0.400	0.07	0.31	0.18	103.71	44.88	77.13
801.23	576.48	576.98		Horizontal Bend	45 deg	2.00	81.22	1037.79	577.14	32	0.07	0.02	3.27	120	0.400	0.07	2.52	1.42	107.72	46.62	76.88
824.97	576.89	577.39		Horizontal Bend	45 deg	2.00	23.74	1061.53	577.55	32	0.07	0.02	3.27	120	0.400	0.07	0.74	0.41	108.93	47.14	75.15
835.46	577.08	577.58		Horizontal Bend	45 deg	2.00	10.49	1072.03	577.74	32	0.07	0.02	3.27	120	0.400	0.07	0.33	0.19	109.52	47.40	74.62
853.54	577.39	577.89		Horizontal Bend	45 deg	2.00	18.08	1090.11	578.05	32	0.07	0.02	3.27	120	0.400	0.07	0.56	0.31	110.45	47.80	74.37
860.55	577.51	578.01		Horizontal Bend	45 deg	2.00	7.01	1097.12	578.17	32	0.07	0.02	3.27	120	0.400	0.07	0.22	0.12	110.86	47.98	73.97
866.21	577.61	578.11		Combined Bend	45 deg	2.00	5.66	1102.78	578.27	32	0.07	0.02	3.27	120	0.400	0.07	0.18	0.10	111.20	48.13	73.79
986.58	577.61	578.11		Vertical Bend	45 deg	2.00	120.37	1223.15	578.27	32	0.07	0.02	3.27	120	0.400	0.07	3.74	0.00	115.00	49.77	73.64
987.90	576.30	576.80		Vertical Bend	45 deg	2.00	1.86	1225.01	576.96	32	0.07	0.02	3.27	120	0.400	0.07	0.06	-1.31	113.82	49.26	72.00
991.58	576.30	576.80		Vertical Bend	45 deg	2.00	3.68	1228.69	576.96	32	0.07	0.02	3.27	120	0.400	0.07	0.11	0.00	114.00	49.34	72.51
992.85	577.57	578.07		Vertical Bend	45 deg	2.00	1.80	1230.49	578.23	32	0.07	0.02	3.27	120	0.400	0.07	0.06	1.27	115.39	49.94	72.43
1001.52	577.83	578.33		Horizontal Bend	45 deg	2.00	8.67	1239.16	578.49	32	0.07	0.02	3.27	120	0.400	0.07	0.27	0.26	115.99	50.20	71.83
1034.22	578.81	579.31		Horizontal Bend	30 deg	2.00	32.71	1271.87	579.47	32	0.07	0.02	3.27	120	0.152	0.03	1.02	0.98	118.01	51.07	71.57

Well W-404 and the Arroyo Seco Pipeline Extension

Extension Pipe Station (-)	Invert of Casing Pipe based on Survey Datum	Invert of Casing Pipe (adjusted to as-built datum)	As- Built Stationing	Description	Fitting (Downstream)	Pipe Dia. (inches)	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
1113.03	581.17	581.67	-22.50	Edge of MCV		2.00	78.85	1350.72	581.83	32	0.07	0.02	3.27	120	0.000	0.00	2.45	2.36	122.82	53.15	70.70
1114.03	581.17	581.67	-21.50		90 deg	1.50	1.00	1351.72	581.83	32	0.07	0.01	5.81	120	1.500	0.79	0.13	0.00	123.73	53.55	68.62
			-19.17		90 deg	1.50	2.33	1354.05	581.83	32	0.07	0.01	5.81	120	1.500	0.79	0.29	0.00	124.81	54.01	68.22
			-17.17		90 deg	1.50	2.00	1356.05	579.34	32	0.07	0.01	5.81	120	1.500	0.79	0.25	-2.49	123.35	53.38	67.75
					Ball	1.50	0.00	1356.05	579.34	32	0.07	0.01	5.81	120	0.050	0.03	0.00	0.00	123.38	53.40	68.38
-1187.00	total distance to wellhead				Check	1.50	0.00	1356.05	579.34	32	0.07	0.01	5.81	120	2.300	1.21	0.00	0.00	124.58	53.92	68.37
					2"x1" Reducer	1.00	0.00	1356.05	579.34	32	0.07	0.01	13.07	120	0.309	0.82	0.00	0.00	125.40	54.27	67.85
				Assembly	Flow Meter	1.00	0.00	1356.05	579.34	32	0.07	0.01	13.07	120		0.00	0.00	0.00	125.40	54.27	67.50
					1"x1.5" Expansion	1.50	0.00	1356.05	579.34	32	0.07	0.01	5.81	120	0.000	0.00	0.00	0.00	125.40	54.27	67.50
			0		Ball	1.50	0.00	1356.05	579.34	32	0.07	0.01	5.81	120	0.050	0.03	0.00	0.00	125.43	54.28	67.50
			-9.1666	Tee for W-404	Tee-Branch	1.50	8.00	1364.05	579.34	32	0.07	0.01	5.81	120	2.000	1.05	1.01	0.00	127.48	55.17	67.49
			-8	Tee for W-109	Tee-Line	1.50	1.17	1365.22	580.50	32	0.07	0.01	5.81	120	0.900	0.47	0.15	1.16	129.27	55.94	66.60
			-6.8333	Loss to W-109 tee	Tee-Line	1.50	1.17	1366.39	581.67	57	0.13	0.01	10.35	120	0.900	1.50	0.43	1.17	132.36	57.28	65.82
				Loss to Vertical Riser												13.01	78.01	23.33	246.70	106.77	64.49
															Totals:	25.61	122.20	98.89	246.70	106.77	

Well W-408

Station	Description	Fitting (downstream)	Pipe Dia. (inches)	Slope	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
-169.35	Top of Groundwater		1.50	Vertical	0.00	0.00	525.50	25	0.06	0.012	4.54	120	0.0	0.00	0.00	0.00	0.00	0.00	--
-112.35	90 deg down to pump	90 deg	1.50	0.00%	57.00	57.00	582.50	25	0.06	0.012	4.54	120	1.5	0.48	4.54	57.00	62.02	26.84	98.03
-110.85	Wellhead		1.50	-0.87%	1.50	58.50	582.50	25	0.06	0.012	4.54	120	0.0	0.00	0.12	0.00	62.14	26.89	71.19
-82.26	90deg turn	90 deg	1.50	-0.87%	28.59	87.09	582.25	25	0.06	0.012	4.54	120	1.5	0.48	2.28	-0.25	64.65	27.98	71.14
-15.83	Edge of MCV		1.50	0.00	66.43	153.52	581.67	25	0.06	0.012	4.54	120	0.0	0.00	5.30	-0.58	69.37	30.02	70.05
		Ball	1.50	0.00	0.00	153.52	581.67	25	0.06	0.012	4.54	120	0.1	0.02	0.00	0.00	69.39	30.03	68.01
		Check	1.50	0.00	0.00	153.52	581.67	25	0.06	0.012	4.54	120	2.3	0.74	0.00	0.00	70.12	30.35	68.00
	Assembly	1.5"x1" Reducer	1.00	0.00	0.00	153.52	581.67	25	0.06	0.005	10.21	120	0.3	0.50	0.00	0.00	70.62	30.56	67.68
		Flow Meter	1.00	0.00	0.00	153.52	581.67	25	0.06	0.005	10.21	120		0.00	0.00	0.00	70.62	30.56	67.47
		1"x1.5" Expansion	1.00	0.00	0.00	153.52	581.67	25	0.06	0.005	10.21	120	0.2	0.25	0.00	0.00	70.87	30.67	67.47
		Ball	1.50	0.00	0.00	153.52	581.67	25	0.06	0.012	4.54	120	0.1	0.02	0.00	0.00	70.89	30.68	67.36
-6.83	Tee From W-109	Tee-Branch	1.50	0.00	9.00	162.52	581.67	57	0.13	0.012	10.35	120	2.0	3.33	3.30	0.00	77.51	33.54	67.35
1592.79	Loss to Vertical Riser													13.01	78.01	23.33	191.85	83.03	64.49
													Totals:	**18.81**	**93.55**	**79.50**	**191.85**	**83.03**	

Well W-109

Station	Description	Fitting (downstream)	Pipe Dia. (inches)	Slope	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
-199.67	Top of Groundwater		1.50	Vertical	0.00	0.00	499.50	0	0.00	0.012	0.00	120	0.0	0.00	0.00	0.00	0.00	0.00	--
-116.67	90 deg down to pump	90 deg	1.50	0.00	83.00	83.00	582.50	0	0.00	0.012	0.00	120	1.5	0.00	0.00	83.00	83.00	35.92	101.85
-115.17	Wellhead		1.50	0.00	1.50	84.50	582.50	0	0.00	0.012	0.00	120	0.0	0.00	0.00	0.00	83.00	35.92	65.93
-104.17	90deg turn	90 deg	1.50	-0.01	11.00	95.50	582.40	0	0.00	0.012	0.00	120	1.5	0.00	0.00	-0.10	82.90	35.88	65.93
-19.16	Edge of MCV		1.50	-0.01	85.01	180.51	581.67	0	0.00	0.012	0.00	120	0.0	0.00	0.00	-0.73	82.17	35.56	65.97
-18.16		90 deg	1.50	-0.01	1.00	181.51	581.67	0	0.00	0.012	0.00	120	1.5	0.00	0.00	0.00	82.17	35.56	66.28
-17		90 deg	1.50	0.00	1.16	182.67	581.67	0	0.00	0.012	0.00	120	1.5	0.00	0.00	0.00	82.17	35.56	66.28
-16		90 deg	1.50	0.00	1.00	183.67	580.50	0	0.00	0.012	0.00	120	1.5	0.00	0.00	-1.17	81.00	35.06	66.28
		Ball	1.50	0.00	0.00	183.67	580.50	0	0.00	0.012	0.00	120	0.1	0.00	0.00	0.00	81.00	35.06	66.79
		Check	1.50	0.00	0.00	183.67	580.50	0	0.00	0.012	0.00	120	2.3	0.00	0.00	0.00	81.00	35.06	66.79
		1.5"x1" Reducer	1.50	0.00	0.00	183.67	580.50	0	0.00	0.012	0.00	120	0.3	0.00	0.00	0.00	81.00	35.06	66.79
	Assembly	Flow Meter	1.00	0.00	0.00	183.67	580.50	0	0.00	0.005	0.00	120		0.00	0.00	0.00	81.00	35.06	66.79
		1"x1.5" Expansion	1.00	0.00	0.00	183.67	580.50	0	0.00	0.005	0.00	120	0.2	0.00	0.00	0.00	81.00	35.06	66.79
		Ball	1.50	0.00	0.00	183.67	580.50	0	0.00	0.012	0.00	120	0.1	0.00	0.00	0.00	81.00	35.06	66.79
-8	W-404 and W-109 combine	Tee-Branch	1.50	0.00	8.00	191.67	580.50	32	0.07	0.012	5.81	120	2.0	1.05	1.01	0.00	83.06	35.94	66.79
-6.8333	Tee For W-408	Tee-Line	1.50	0.00	1.65	193.33	581.67	57	0.13	0.012	10.35	120	0.9	1.50	0.61	1.17	86.33	37.36	65.90
1592.79	Loss to Vertical Riser													13.01	78.01	23.33	200.67	86.85	64.49
													Totals:				**0.00**	**0.00**	

No Flow

Existing Arroyo Seco Pipe

Station	Description	Fitting (Downstream)	Pipe Dia. (inches)	Slope	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
-6.83	W-408 and W-109 Combine		1.50	Vertical	0.00	0.00	581.67	57.00	0.13	0.012	10.35	120	0.0	0.00	0.00	0.00	0.00	0.00	64.49
-6.00	90deg down	90 deg	1.50	0.00%	0.83	0.83	582.50	57.00	0.13	0.012	10.35	120	1.5	2.49	0.30	0.83	3.63	1.57	62.92
-5.00	Vault	1.5" to 3" Reducer	1.50	0.00%	1.00	1.83	582.50	57.00	0.13	0.012	10.35	120	0.3	0.47	0.37	0.00	4.46	1.93	62.55
0.00	8.933deg Horizontal Bend		3.00	0.00%	5.00	6.83	582.50	57.00	0.13	0.049	2.59	120	0.0	0.00	0.06	0.00	4.53	1.96	62.53
186.87	30deg Horizontal Bend	30 deg	3.00	0.60%	186.87	193.70	583.62	57.00	0.13	0.049	2.59	120	0.0	0.00	2.35	1.12	7.99	3.46	61.03
200.00	0.4deg Vertical Bend		3.00	0.60%	13.13	206.83	583.70	57.00	0.13	0.049	2.59	120	0.0	0.00	0.16	0.08	8.24	3.57	60.92
240.35	Stub for Well A	Tee-Line	3.00	1.29%	40.35	247.19	584.22	57.00	0.13	0.049	2.59	120	0.9	0.09	0.51	0.52	9.36	4.05	60.44
246.00	Access Manhole		3.00	1.29%	5.65	252.84	584.29	57.00	0.13	0.049	2.59	120	0.0	0.00	0.07	0.07	9.50	4.11	60.37
291.55	W-904	Tee-Line	3.00	1.29%	45.55	298.39	584.88	94.00	0.21	0.049	4.27	120	0.9	0.25	1.44	0.59	11.79	5.10	59.38
351.01	0.45deg Vertical Bend		3.00	1.29%	59.46	357.86	585.65	94.00	0.21	0.049	4.27	120	0.0	0.00	1.89	0.77	14.44	6.25	58.24
471.68	7.117deg Horizontal Bend		3.00	0.50%	120.67	478.53	586.25	94.00	0.21	0.049	4.27	120	0.0	0.00	3.83	0.60	18.87	8.17	56.32
530.78	5.3deg Combined Bend		3.00	0.50%	59.10	537.63	586.55	94.00	0.21	0.049	4.27	120	0.0	0.00	1.87	0.30	21.04	9.11	55.38
598.00	Access Manhole		3.00	1.73%	67.23	604.86	587.71	94.00	0.21	0.049	4.27	120	0.0	0.00	2.13	1.16	24.33	10.53	53.95
615.00	Stub for Well B	Tee-Line	3.00	1.63%	17.00	621.86	587.99	94.00	0.21	0.049	4.27	120	0.9	0.25	0.54	0.28	25.40	10.99	53.49
618.74	Well W-457	Tee-Line	3.00	1.63%	3.74	625.60	588.05	119.00	0.27	0.049	5.40	120	0.9	0.41	0.18	0.06	26.06	11.28	53.21
655.16	1.3667deg Combined Bend		3.00	1.63%	36.42	662.03	588.64	119.00	0.27	0.049	5.40	120	0.0	0.00	1.79	0.59	28.43	12.31	52.18
830.00	Access Manhole		3.00	0.50%	174.84	836.87	589.51	119.00	0.27	0.049	5.40	120	0.0	0.00	8.57	0.87	37.88	16.39	48.09
900.00	0.57deg Combined Bend		3.00	0.50%	70.00	906.87	589.86	119.00	0.27	0.049	5.40	120	0.0	0.00	3.43	0.35	41.66	18.03	46.46
911.00	Stub for Well C	Tee-Line	3.00	1.50%	11.00	917.87	590.03	119.00	0.27	0.049	5.40	120	0.9	0.41	0.54	0.17	42.77	18.51	45.97
911.93	2.3166deg Bend		3.00	1.50%	0.93	918.80	590.04	119.00	0.27	0.049	5.40	120	0.0	0.00	0.05	0.01	42.83	18.54	45.95
924.11	W-903	Tee-Line	3.00	1.50%	12.18	930.98	590.22	144.00	0.32	0.049	6.54	120	0.9	0.60	0.85	0.18	44.46	19.24	45.24
1102.00	30 Deg Horizontal Bend	30 deg	3.00	1.50%	177.91	1108.89	592.90	144.00	0.32	0.049	6.54	120	0.2	0.10	12.42	2.68	59.65	25.82	38.67
1166.00	Access Manhole		3.00	1.50%	64.01	1172.90	593.86	144.00	0.32	0.049	6.54	120	0.0	0.00	4.47	0.96	65.08	28.17	36.32
1183.00	Stub for Future Well	Tee-Line	3.00	1.50%	17.00	1189.90	594.12	144.00	0.32	0.049	6.54	120	0.9	0.60	1.19	0.26	67.12	29.05	35.44
1214.50	30deg horizontal Bend	30 deg	3.00	1.50%	31.50	1221.40	594.59	144.00	0.32	0.049	6.54	120	0.2	0.10	2.20	0.47	69.90	30.25	34.24
1250.57	Begin Existing Casing		3.00	0.72%	36.07	1257.48	594.85	144.00	0.32	0.049	6.54	120	0.0	0.00	2.52	0.26	72.67	31.45	33.03
1420.57	End Existing Casing		3.00	1.12%	170.01	1427.49	596.75	144.00	0.32	0.049	6.54	120	0.0	0.00	11.86	1.90	86.44	37.41	27.08
1445.87	Air Valve Assembly	90 deg	3.00	1.58%	25.30	1452.79	597.15	144.00	0.32	0.049	6.54	120	1.5	0.99	1.77	0.40	89.60	38.78	25.71
1460.00	Access Manhole		3.00	-0.35%	14.13	1466.92	597.10	144.00	0.32	0.049	6.54	120	0.0	0.00	0.99	-0.05	90.54	39.18	25.30
1498.04	45 deg horizontal Bend	45 deg	3.00	-0.35%	38.04	1504.96	596.97	144.00	0.32	0.049	6.54	120	0.4	0.27	2.65	-0.13	93.32	40.39	24.10
1509.04	Connect to Existing Pipe	2-90 deg	3.00	-2.00%	11.00	1515.96	596.75	144.00	0.32	0.049	6.54	120	3.0	1.99	0.77	-0.22	95.86	41.49	23.00
1570.54	Connect to Existing Pipe	2-90 deg	3.00	-0.59%	61.50	1577.46	596.39	144.00	0.32	0.049	6.54	120	3.0	1.99	4.29	-0.36	101.78	44.05	20.44
1572.79	Vertical Riser	90 deg	3.00	0.89%	2.25	1579.71	596.41	144.00	0.32	0.049	6.54	120	1.5	0.99	0.16	0.02	102.96	44.56	19.93
1572.79	Assumed Ground Elevation		3.00	Vertical	5.84	1585.55	605.00	144.00	0.32	0.049	6.54	120	0.0	0.00	0.41	8.59	111.95	48.45	16.03
1592.79	Bldg 011 Filter	90 deg	3.00	0.00	20.00	1605.55	605.00	144.00	0.32	0.049	6.54	120	1.5	0.99	1.40	0.00	114.34	49.49	15.00
		Check	*3.00*				605.00	144.00	0.32	0.049	6.54		2.3	1.53					
													Loss Subtotal for W-903:	8.03	47.07	14.78	69.88	30.24	
													Loss Subtotal for W-457:	9.03	62.30	16.95	88.29	38.21	
													Loss Subtotal for W-904:	9.70	72.74	20.12	102.55	44.38	
													Loss Subtotal for W-109:	13.01	78.01	23.33	114.34	49.49	

Totals: 13.01 78.01 23.33 114.34 49.49

Well W-904

Station	Description	Fitting (downstream)	Pipe Dia. (inches)	Slope	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
-114.63	Top of Groundwater		1.50	Vertical	0.00	0.00	473.88	37.00	0.08	0.012	6.72	120	0.0	0.00	0.00	0.00	0.00	0.00	--
-3.63	wellhead	90 Deg	1.50	0.00	111.00	111.00	584.88	37.00	0.08	0.012	6.72	120	1.5	1.05	18.28	111.00	130.33	56.40	121.01
		Check	1.50		0.00	111.00	584.88	37.00	0.08	0.012	6.72	120	2.3	1.61	0.00	0.00	131.94	57.10	64.60
	Assembly	Globe	1.50		0.00	111.00	584.88	37.00	0.08	0.012	6.72	120	10.0	7.01	0.00	0.00	138.95	60.13	63.90
		Ball	1.50		0.00	111.00	584.88	37.00	0.08	0.012	6.72	120	0.1	0.04	0.00	0.00	138.98	60.15	60.87
		Tee-Branch	1.50		0.00	111.00	584.88	37.00	0.08	0.012	6.72	120	2.0	1.40	0.00	0.00	140.38	60.76	60.86
0	Meet Existing PipeLine	Tee-Branch	1.50	0.00	3.63	114.63	584.88	37.00	0.08	0.012	6.72	120	2.0	1.40	0.60	0.00	142.39	61.62	60.25
291.55	Loss to Vertical Riser		3.00			1281.24	585.65	94.00	0.21	0.049	4.27	120		9.70	72.74	20.12	244.94	106.01	59.38
													Totals:	22.20	91.62	131.12	244.94	106.01	

Well W-457

Station	Description	Fitting (downstream)	Pipe Dia. (inches)	Slope	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
-92.98	Top of Groundwater		1.50	Vertical	0.00	0.00	500.05	25.00	0.06	0.012	4.54	120	0.0	0.00	0.00	0.00	0.00	0.00	--
-4.98	wellhead	90 deg	1.50	0.00	88.00	88.00	588.05	25.00	0.06	0.012	4.54	120	1.5	0.48	7.02	88.00	95.50	41.33	96.97
		Check	1.50		0.00	88.00	588.05	25.00	0.06	0.012	4.54	120	2.3	0.74	0.00	0.00	96.23	41.65	55.64
	Assembly	Globe	1.50		0.00	88.00	588.05	25.00	0.06	0.012	4.54	120	10.0	3.20	0.00	0.00	99.43	43.03	55.33
		Ball	1.50		0.00	88.00	588.05	25.00	0.06	0.012	4.54	120	0.1	0.02	0.00	0.00	99.45	43.04	53.94
		Tee-Branch	1.50		0.00	88.00	588.05	25.00	0.06	0.012	4.54	120	2.0	0.64	0.00	0.00	100.09	43.32	53.93
0	Meet Existing Pipeline	Tee-Branch	1.50	0.00	4.98	92.98	588.05	25.00	0.06	0.012	4.54	120	2.0	0.64	0.40	0.00	101.12	43.76	53.66
618.74	Loss to Vertical Riser		3.00			954.05	588.64	119.00	0.27	0.049	5.40	120		9.03	62.30	16.95	189.41	81.97	53.21
													Totals:	14.74	69.72	104.95	189.41	81.97	

Well W-903

Station	Description	Fitting (downstream)	Pipe Dia. (inches)	Slope	Length Segment	Length Total	Elevation (centerline)	Rate GPM	Rate cfs	Area (sq. ft.)	Velocity fps	"C"	"K" (per fitting)	Loss Fitting	Loss Friction	Loss Elevation	Total Loss (ft)	Total Loss (psi)	PSI (in pipe)
-107.45	Top of Groundwater		1.50	Vertical	0.00	0.00	488.22	25.00	0.06	0.012	4.54	120	0.0	0.00	0.00	0.00	0.00	0.00	--
-5.45	wellhead	90 deg	1.50	0.00	102.00	102.00	590.22	25.00	0.06	0.012	4.54	120	1.5	0.48	8.13	102.00	110.61	47.87	95.57
		Check	1.50		0	102.00	590.22	25.00	0.06	0.012	4.54	120	2.3	0.74	0.00	0.00	111.35	48.19	47.70
	Assembly	Globe	1.50		0	102.00	590.22	25.00	0.06	0.012	4.54	120	10.0	3.20	0.00	0.00	114.55	49.58	47.38
		Ball	1.50		0	102.00	590.22	25.00	0.06	0.012	4.54	120	0.1	0.02	0.00	0.00	114.57	49.58	45.99
		Tee-Branch	1.50		0	102.00	590.22	25.00	0.06	0.012	4.54	120	2.0	0.64	0.00	0.00	115.21	49.86	45.99
0	Meet Existing Pipeline	Tee-Branch	1.50	0.00	5.45	107.45	590.22	25.00	0.06	0.012	4.54	120	2.0	0.64	0.43	0.00	116.29	50.33	45.71
924.11	Loss to Vertical Riser		3.00			648.68	590.22	144.00	0.32	0.049	6.54	120		8.03	47.07	14.78	186.17	80.57	45.24
													Totals:	13.74	55.64	116.79	186.17	80.57	

APPENDIX B-2

Weiss Associates
Engineering Calculation Lead Sheet

Weiss Associates Project Number	010-2013-32565-83225
Client	Environmental Restoration Department Lawrence Livermore National Laboratory Roberto Ruiz
Project Title	Arroyo Seco Pipeline Extension Project
Purpose	To determine structural design forces for the proposed Arroyo Seco pipeline extension project, with emphasis on the portion of the pipeline that will be affixed the side of the Charlotte Way Bridge.
Design Data Input	Data for calculations from March 31, 2011 Design Drawings for the Arroyo Seco Extension Project; As-built drawings for the Charlotte Way Bridge provided by the City of Livermore; Independent testing information for a representative anchor bolt; and standard material properties for ductile iron, carbon steel and concrete.
Applicable Codes and Standards	2009 International Building Code
Formula and Procedures	ASCE 7-10 Minimum Design Loads for Buildings and Other Structures; ACI 318-08 Building Code Requirements for Structural Concrete and Commentary.
Assumptions	See assumptions and notes
Number of Sheets	12
Originator	Chris Taylor
Checker	Scott Bourne
Data Checking Complete	4/4/2010 (rev October 7, 2011)

Notes: NA

Summary of Design Calculations

Load Values

W_p	187	pounds	Weight of pipe and mount per support
F_p	130	pounds	Seismic force in horizontal direction
F_v	47	pounds	Seismic force in vertical direction
Load	401	pounds	Factored vertical load, combined Case 3
R_x	108	pounds	Maximum horizontal reaction
R_y	301	pounds	Maximum vertical reaction

Anchor Strengths

N_a	2,152	pounds	Allowable strength in tension
N_{sa}	29,925	pounds	Allowable steel strength in tension
N_{cb}	2,152	pounds	Allowable concrete strength in tension
N_b	6,762	pounds	Pullout in tension
V_a	1,736	pounds	Allowable strength in shear
V_{sa}	32,370	pounds	Allowable steel strength in shear
V_{cbg}	1,736	pounds	Allowable concrete strength in shear
V_{cpg}	4,303	pounds	Allowable concrete pryout in shear

Other Check Values

Y	0.009	inches	Maximum pipe deflection
$\triangle L$	0.003	feet	Maximum thermal expansion on each side of pipe
T	666	pounds	Maximum pipe thrust
A_t	0.444	sq ft	Minimum thrust block area

SEISMIC DESIGN CALCULATIONS FOR HANGER

(Reference: ASCE 7-10, Minimum Design Loads for Buildings and Other Structures)

Seismic Force (Horizontal)

$$Fp = \frac{0.4 a_p * S_{DS} * W_p}{R / l_p} \times \left(1 + 2 * \frac{z}{h}\right)$$

Eq. 13.3-1

a_p=	Component amplification factor=	2.5		From Table 13.6-1
I_p=	Component importance factor=	1.5		From Section 13.1.3
W_p=	Component operating weight=	186.79	lbs	
R_p=	Component response modification factor=	6		From Table 13.6-1
z=	Height in structure of point of attachment of component with respect to the base=	11.41	ft.	See notes below
h=	Avg. height of structure with respect to the base=	12.77	ft.	See notes below

Notes:
1. Height for bridge will be taken as maximum height of bridge (top of sidewalk) = El. 578.32 ft.
2. Base for bridge will be taken at lowest point of culvert = El. 565.55 ft.

S_{DS}= Spectral acceleration, short period 1 Eq. 11.4-3

$$S_{DS} = \frac{2}{3} * (S_{MS})$$

S_{MS}= Mapped MCER 5% damped, spectral response acceleration parameter at short periods adjusted to site class. 1.5 Eq. 11.4-1

$$S_{MS} = F_a * S_S$$

Site Class- D

S_S=	Mapped MCER 5% damped, spectral response acceleration parameter at short periods =	1.5	Figure 22-1
F_a=	Short Period Site Coefficient=	1	Table 11.4-1

F_p= 130 lbs Note: F_p shall not be greater than 1736 lbs

Seismic Force (Vertical)

$$F_v = \pm 0.25 * S_{DS} * W_p$$

Section 13.3.1

S_{DS}=	Spectral acceleration, short period	1	
W_p=	Component operating weight	186.79 lbs	Sheet 3, Table 1

F_v= 46.7 lbs

LOAD CALCULATIONS

(Reference: ASCE 7-10, Minimum Design Loads for Buildings and Other Structures)

Dead Load Per Hanger

$$W_{ps} = W_{hanger} + (W'_{pipe} + W'_{spacer} + W'_{water}) * L_{hanger}$$

W'_{pipe} =	Weight of inner /outer pipe	12.28	lbs/ft total	
	Weight of 2" Sch80 PVC	0.98	lbs/ft	
	Weight of 4" Ductile Iron	11.3	lbs/ft	
W'_{spacer} =	Weight of spacer	0.38	lbs/ft	Note: 3 spacers every 20 feet
	Spacer weight	2.5	lbs each	
W'_{water} =	weight of water in inner pipe	1.25	lbs/ft	
	Inner Pipe ID	1.913	inches	
W_{hanger} =	weight of hanger	61.68	lbs each	Note: Includes anchor, u-bolt, pipe seat
L_{hanger} =	Length between each hanger	9	ft	
W_{ps} =	Weight per pipe support	187	lbs/support	

Factored Vertical Load

Factored load will be maximum for these three cases:

Case I:	Factored Load	=1.4D	Section 2.3.2 (#1)
Case II:	Factored Load	=1.2D+1.0E+L+0.2S	Section 2.3.2 (#5)
Case III:	Factored Load	=0.9D+1.0E	Section 2.3.2 (#7)

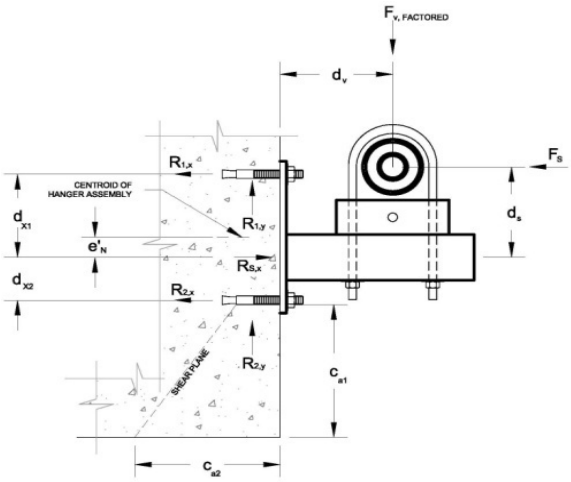
where:

D=	Dead Load=	186.79	lbs	
E(case II)=	Earthquake Load(case II)=	176.8	lbs	(12.4-1)
E(case III)=	Earthquake Load(case III)=	83.4	lbs	(12.4-2)
L=	Live Load=	0	lbs	
S=	Snow Load=	0	lbs	

Factored Load Case I=	262	lbs	
Factored Load Case II=	**401**	**lbs**	**(Vertical Factored Load)**
Factored Load Case III=	252	lbs	

Horizontal Reaction Check:

Note: Seismic force acts directly at the support



Seismic Force (F_p)=			130	lbs
Distance from center of steel pipe to mid point of steel bar (ds)=			0.66	ft.
Moment (Horizontal)=	F_s*d_s=		86	ft-lbs

$\sum F = 0$

$R_{x1}+R_{x2}$ = 130 lbs Eq (1)

$\sum M = 0$

$R_{x1}*d_{x1}+R_{x2}*d_{x2}$= 86 lbs Eq (2)

where:

R_{x1}= Reaction at anchor bolt 1

R_{x2}= Reaction at anchor bolt 2

d_{x1}= Distance from the center of steel pipe to anchor bolt 1= 0.61 ft.

d_{x2}= Distance from the center of steel pipe to anchor bolt 2= 0.31 ft.

R_{x2}= 22 lbs

R_{x1}= 108 lbs

R_x **108** **lbs** Note: R_x shall not be greater than 2152 lbs

Vertical Reaction Check:

Factored Load (F_v)= 401 lbs

Distance from bridge crossing to mid point of steel bar (d_v)= 0.75 ft.

Moment (Vertical)= F_v*d_v = 301 ft-lbs

$R_{y1}+R_{y2}$= 401 lbs Eq (1)

$R_{y1}*d_{y1}+R_{y2}*d_{y2}$= 301 lbs-ft. Eq (2)

where:

R_{y1}= Reaction at anchor bolt 1

R_{y2}= Reaction at anchor bolt 2

L= Embedment Length= 4.63 in. or 0.39 ft.

d_{y1}= Distance from edge of the bridge to midpint of L =L/2 0.19 ft.

d_{y2}= Distance from edge of the bridge to midpint of L =L/2 0.19 ft.

R_{y2}= 100 lbs

R_{y1}= 301 lbs

R_y **301** **lbs** Note: R_y shall not be greater than 1736 lbs

Check for Deflection

(Ref: Ductile Iron Pipe Research Association (DIPRA), Design of Ductile Iron Pipe on Supports, 2003)

$$Y = \frac{458.4 * w * L^4}{E * \left(D^4 - d^4\right)}$$

w=	Unit Load=	13.90	lbs/ft.	
L=	Span=	9	ft.	
E =	Modulus of elasticity=	2.4.E+07	psi	DIPRA, 2003
D=	Pipe OD=	4.80	in.	
x=	Pipe wall thickness=	0.25	in.	
d=	Pipe ID= D-(2* x)=	4.3	in.	

Y= 0.01 in. Note: Y shall not be greater than 0.5

Check for Thermal Expansion

(Ref: Ductile Iron Pipe Research Association (DIPRA), Design of Ductile Iron Pipe on Supports, 2003)

Assumption: There is negligible radial and circumferential expansion.

Linear Expansion

$\Delta_L = \alpha * L * \Delta T$

where:

α=	Thermal expansion coefficient=	0.0000062		DIPRA, 2003
L=	Length of 4" ductile iron pipe	9	ft	
Δ_T=	Temp difference=	100	degree F	

Δ_L= 0.006 ft.

Linear Expansion on each side of pipe= 0.0028 ft.

ANCHOR BOLT CALCULATIONS

(Ref: (1) ACI 318-08, Appendix D IBC 2006 Section 1912 .
(2) ICC-ES Evaluation Report, 2010, ESR-2427, ITW Red Head Carbon Steel Trubolt, Table 3 & 4).

Check for Steel Strength in Tension

$$N_{sa} = \phi * n * A_{se,N} * f_{uta}$$ Eq. D-3

where:

ø=	Strength Reduction Factor=	0.75		Table 3
n=	Number of Anchors =	2		
$A_{se,N}$=	Effective cross section area of anchor in tension=	0.266	sq. in.	Table 3
f_{uta}=	Specific ultimate tensile strength of anchor=	75,000	psi	Table 3

N_{sa}= 29925 lbs

Check for Concrete Breakout in Tension

$$N_{cbg} = \phi * \frac{A_{Nc}}{A_{Nco}} * (\psi_{ec,N} * \psi_{ed,N} * \psi_{c,N} * \psi_{cp,N} * N_b)$$ Eq. D-5

where:

ø=	Strength Reduction Factor=	0.65		Table 3
A_{Nc}=	Projected failure area of group=	244.68	sq in.	Fig RD.5.2.1(a)
A_{Nco}=	Projected failure area of one anchor=	126.6	sq in.	Eq. D-6
$\Psi_{ec,N}$=	Modification for eccentric load=	0.76		(see below for details)
$\Psi_{ed,N}$=	Modification for edge effect=	0.97		(see below for details)
$\Psi_{c,N}$=	Modification for cracking=	1.00		(see below for details)
$\Psi_{cp,N}$=	Modification for post installed anchors=	0.34		(see below for details)
N_b=	Basic concrete breakout strength=	6762	lbs	

N_{cb}= 2152 lbs

Modification for eccentric load

$$\psi_{ec,N} = \frac{1}{[1 + (2e'_N / 3h_{ef})]}$$ Eq. D-9

e'_N=	Eccentricity =	0.15	ft.	
		1.76	in.	
Effective embedment depth (h_{ef})=		3.75	in.	Table 3

$\Psi_{ec,N}$= 0.76

Modification for edge effects

If $C_{a,min} \geq 1.5h_{ef}$ then: $\Psi_{ed,N}$= 1.0

If $C_{a,min} \leq 1.5h_{ef}$ then: $\Psi_{ed,N}$= $0.7+0.3(C_{a,min}/1.5\ h_{ef})$

$C_{a,min}$= 0.43 ft

5.1 in.

h_{ef}= Effective embedment depth= 3.75 in.

$\Psi_{ed,N}$= 0.97

Modification for cracking

$\Psi_{c,N}$= 1.0 Table 3

Modification for post installed anchors

If $C_{a,min} \geq C_{ac}$ then: $\Psi_{cp,N}$= 1.0 D-12

If $C_{a,min} \leq C_{ac}$ then: $\Psi_{cp,N}$= $C_{a,min}/C_{ac}$ D-13

C_{ac}= Critical edge distance= $4\ h_{ef}$ D.8.6

$\Psi_{cp,N}$= 0.34

Basic concrete breakout strength

$$N_b = k_c * \lambda * \sqrt{f'_c} * h_{ef}^{1.5}$$ Eq. D-7

where:

k_c=	Coefficient for basic concrete breakout stength=	17	D.5.2.2
λ=	Modification factor for lightweight concrete=	1.0	Section 8.6.1
f'_c=	Concrete compressive strength=	3000 psi	From As-builts
h_{ef}=	Effective embedment depth=	3.75 in.	Table 3

N_b= 6762 lbs

Check for Pullout in Tension

$$N_{pn} = \phi * \psi_{c,p} * N_p$$ Eq. D-14

$\Psi_{c,p}$= Modification for cracking

Np= Pullout strength in tension

NOTE: Anchor pullout strength does not control anchor design. Determine steel and concrete capacities only (ICC-ES Footnote #8)

Allowable Tension Force

$N_{allowable}$ (N_A)= min (N_{sa}, N_{cb}, N_b, N_p)

N_A= 2152 lbs

Check for Steel Strength in Shear

$$V_{sa} = \phi * n * A_{se,V} * f_{uta}$$ Eq. D-19

where:

ø =	Strength Reduction Factor =	0.65		Table 4
n =	Number of Anchors=	2		
$A_{se,V}$ =	Effective cross section area of anchor in shear =	0.332	sq in.	Table 4
f_{uta} =	Specific ultimate tensile strength of anchor=	75,000		Table 4

V_{sa}= 32370 lbs

Check for Concrete Breakout in Shear

$$V_{cbg} = \phi * \frac{A_{Vc}}{A_{Vco}} * (\psi_{ec,V} * \psi_{ed,V} * \psi_{c,V} * \psi_{h,V} * V_b)$$ Eq. D-22

where:

ø=	Strength Reduction Factor	0.70		Table 4
A_{Vc}=	Projected failure area of group	55.18	sq in.	Fig RD.5.2.1(a)
A_{Vco}=	Projected failure area of one anchor	118.2	sq in.	Eq. D-23
$\Psi_{ec,V}$=	Modification for eccentric load=	1.00		(see below for details)
$\Psi_{ed,V}$=	Modification for edge effect=	1.00		(see below for details)
$\Psi_{c,V}$=	Modification for cracking=	1.00		(see below for details)
$\Psi_{h,V}$=	Modification for shear strength of anchor=	1.00		(see below for details)
V_b=	Basic concrete breakout strength in shear=	5312	lbs	

V_{cbg}= 1736 lbs

Modification for eccentric load

$$\psi_{ec,V} = \frac{1}{[1 + (2e'_V / 3C_{a1})]}$$ Eq. D-26

e'_v=	0.00 ft	
	0.00 in	Note: No eccentricity in shear.
C_{a1}=	0.43 feet	
	5.13 inches	
$\Psi_{ec,V}$=	1.00	

Modification for edge effects

If $C_{a2,} \geq 1.5C_{a1}$ then: $\Psi_{ed,V}=$ 1.0 Eq. D-27

If $C_{a2} \leq 1.5C_{a1}$ then: $\Psi_{ed,V}=$ $0.7+0.3(C_{a2}/1.5\ C_{a1})$ Eq. D-28

$C_{a1}=$ 0.43 feet
5.13 inches

$C_{a2}=$ $> 1.5C_{a1}$ feet
7.7 inches

$\Psi_{ed,V}=$ 1.00

Modification for cracking

$\Psi_{c,V}=$ 1.00 (For anchors in cracked concrete with no supplemental reinforcementor edge reinforcement smaller than a #4 bar) D.6.2.7

Modification factor for shear stength of anchors located with the concrete members with $h_a < 1.5\ C_{a1}$

$$\psi_{h,V} = \sqrt{\frac{1.5\ C_{a1}}{h_a}}$$

Eq. D-29

$C_{a1}=$ Edge distance = 0.43 feet
5.13 inches

$h_a=$ 7.7 inches

$\Psi_{h,V}=$ 1.00

V_b = Basic concrete breakout strength in shear of a single anchor in cracked concrete

$$V_b = (7 * \left(\frac{l_e}{d_a}\right)^{0.2} * \sqrt{d_a}) * \lambda * \sqrt{f'_c} * (c_{a1})^{1.5}$$

Eq. D.24

where:

l_e =	Load bearing length of anchor =	3.75	Table 4
$d_a=$	Outside diameter of anchor=	0.7482	Table 4
$\lambda=$	Adjustment for lightweight concrete=	1.0	Section 8.6.1
$f'_c=$	Concrete compressive strength=	3000	From As-builts
$C_{a1}=$	Edge distance=	5.13	

$V_{b=}$ 5312 lbs

Check for Pryout Strength in Shear

$$V_{cpg} = k_{cp} * N_{cbg}$$ Eq. D.31

where

k_{cp}= 1.0 for h_{ef}<2.5 inches

k_{cp}= 2.0 for h_{ef}≥2.5 inches

k_{cp}= 2

Nominal concrete breakout strength in tension (N_{cbg})= 2152 lbs

V_{cpg}= 4303 lbs

Allowable Shear Force

$V_{allowable}$ (V_A) = min (V_{sa}, V_{cbg}, V_b, V_{cpg})

V_A= 1736 lbs

Check for Interaction of tensile and shear forces

$$\frac{N_{ua}}{\phi N_n} + \frac{V_{ua}}{\phi V_n} \leq 1.2$$ Eq. D.32

N_a	108	lbs
V_a	301	lbs
ΦNn	2,152	lbs
ΦVn	1736	lbs
Sum	0.22	< 1.2

Check for concrete splitting

Anchor bolt spacing must be greater than 6x the outer diameter Appendix D.8.2

da=	0.75	in.	Table 4
Spacing =	11	in.	From Design Drawings
Product	4.5	inhces	< 11 inches

THRUST BLOCK DESIGN CALCULATIONS

Thrust (T):

$$T = \phi * 2 * P * A \times Sin \frac{\theta}{2}$$

	90° Fitting	45°Fitting	
Safety Factor (ø)	1.5	1.5	
Pipe Pressure (P)	100	100	psi
	14400	14400	psf
Area (A)	0.022	0.022	sq ft.
Angle (θ)	90	45	degree
Thrust (90° Fitting)=	**666.43**	**lbs**	
Thrust (45° Fitting)=	**360.67**	**lbs**	

Thrust Block Area Required (A_T):

$$A_T = \frac{T}{P_a}$$

Allowable Soil Pressure (P_a)=	1500	psf		
A_T (90° Fitting)=	0.444	sq ft.		
A_T (45° Fitting)=	0.240	sq ft.		
A_T (90° Fitting) per side (min)=	√0.444=		**0.667**	**ft.**
A_T (45° Fitting) per side (min)=	√0.240=		**0.490**	**ft.**

Appendix C

Construction Quality Assurance/ Quality Control Plan

Appendix C

Construction Quality Assurance/Quality Control Plan

C-1. Introduction

This Quality Assurance/Quality Control (QA/QC) Plan has been developed in support of the construction of Arroyo Pipeline Extension. The purpose of this plan is to define quality objectives and areas of responsibility. This plan has been developed to comply with Lawrence Livermore National Laboratory (LLNL) QA policy and to address the applicable elements of U.S. Department of Energy (DOE) Order 414.1C (DOE, 2005).

The objectives of the QA/QC plan are to:

- Assure excellence in construction design and implementation.
- Provide the QA/QC requirements to meet all programmatic and institutional needs.

This QA/QC plan defines the process for providing confidence that these QA/QC objectives will be achieved and that achievement will include due consideration for health, safety, property, and the environment.

C-2. Quality Assurance Program

The LLNL Site Environmental Restoration Project's QA Program is based on the following QA documents:

- DOE Order 414.1C, Quality Assurance (DOE, 2005).
- LLNL Environmental Restoration Project Quality Assurance Project Plan (QAPP) (Dibley, 1999).
- LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (SOPs) (Goodrich and Lorega, 2009).
- LLNL Operations and Business (O&B) Quality Assurance Plan (QAP) (LLNL, 2010)

Table D-1 shows the 10 criteria of the LLNL O&B QAP, which implements DOE Order 414.1C, and their applicability to construction related activities for the Arroyo Seco pipeline extension. The Construction QA/QC Plan follows the Environmental Restoration Project QAPP approved by the U.S. EPA.

C-2.1. Organization

This section documents the organizational structure, functional responsibilities, and lines of communication for those aspects of construction related activities for the Arroyo Seco pipeline extension that affect quality. The descriptions below generally describe the QA/QC responsibilities of those involved in carrying out the QA/QC program for the construction of the Arroyo Seco pipeline extension.

- The U.S. DOE is the Principal Responsible Party for Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA) related activities at the LLNL Site. Environmental restoration activities at Livermore Site are conducted by the LLNL Environmental Restoration Department (ERD), under the direction of the DOE Livermore Site Office (LSO) Remedial Project Manager (RPM). The DOE RPM coordinates these activities through the U.S. EPA, and California Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board (RWQCB) RPMs.
- The LLNL O&B Principal Associate Director (PAD) is responsible for the quality of directorate related activities including the Facilities and Infrastructure (F&I) Directorate where ERD resides organizationally. The primary implementing document of the QA system is the O&B QAP. The O&B Assurance and Compliance Manager has primary oversight of the QA system ensuring that it is properly integrated at the directorate level(s) by Quality Manager(s). Each Associate Director (AD) is ultimately responsible for QA, including formally planning, controlling, and verifying activities and quality management as described in the O&B QAP. The Quality Manager reports the results of quality verification to the F&I AD who, in turn, relays this information to DOE.
- The ERD Department Leader is responsible for implementing the ERD QA programs as it relates to activities in the Department and ensuring that nonconforming conditions are promptly addressed and documented. The ERD Department Leader reports to both the F&I AD and to DOE.
- The ERD Livermore Site Program Leader is responsible for ensuring that approved procedures related to QA are used during Department activities and ensuring that nonconforming conditions are promptly addressed and documented. The ERD Livermore Site Program Leader issues this construction QA/QC plan and periodically reviews its implementation. The ERD Livermore Site Program Leader reports to the ERD Department Leader on QA conformance and other QA-related issues.
- The ERD Quality Assurance Implementation Coordinator (QAIC) is responsible for the development and implementation of this construction QA/QC plan, establishment and control of the applicable QA/QC requirements, coordination with appropriate project personnel to assure compliance within groups over which the quality organization has no administrative control, and development of tracking and reporting systems to provide management visibility of implementation activities and results. The QAIC maintains direct communication and liaison with the F&I Quality Manager and has line authority through the ERD Department Leader for the implementation of the QA Program within the Department.

- The LLNL Quality Assurance Engineer (QAE) is responsible for providing direction to the Project Manager, Remediation Engineer, and Technician Supervisor in the selection and installation of the equipment and remediation systems to meet QA objectives and ensuring that construction meets design criteria specified in the design documents. The QAE reports directly to the QAIC on construction QA/QC related activities.
    - The QAIC and QAE constitute the independent quality assurance reviewers as defined in the O&B QAP. The QAP requires that adequacy of design products are verified/validated by individuals or groups other than those involved in performing the work. DOE conducts additional QA audits of ERD activities. The ERD Department Leader may assign an outside (non-LLNL), independent QA team as appropriate (i.e., when the necessary technical expertise to conduct design review is not available within the LLNL organization).
- The LLNL Remediation Engineer is responsible for writing design criteria for equipment and flow rates to treat water, as well as providing oversight for construction activities. The Remediation Engineer is the equivalent to the Remedial Design Engineer. The Remediation Engineer reports to the ERD Livermore Site Program Leader regarding facility design and construction.
- The LLNL Construction Manager is responsible for overseeing design and construction activities for the Arroyo Seco pipeline extension. The LLNL Construction Manager reports during construction activities to the ERD Livermore Site Program Leader. The LLNL Construction Manager serves as the intermediary between LLNL and the design and construction contractor. He/she is responsible for inspecting the construction to ensure that it is built as designed.
- The ERD Technician Supervisor is responsible for the supervision and oversight of day-to-day construction activities. The ERD Technician Supervisor is the equivalent to the Remedial Action Constructor. The ERD Technician Supervisor reports to the ERD Livermore Site Program Leader regarding construction-related activities.
- The Construction Contractor will be selected by a competitive bid process and is responsible for performing day-to-day construction activities. The Construction Contractor shall be responsible proper performance of the work and for job site conditions during the course of construction, including and the safety of persons and property.

C-3. Training and Qualifications

Personnel supporting ERD activities are trained to ensure that they have the skills and knowledge necessary to perform their work assignments in a safe, competent, uniform, and environmentally sound manner. LLNL and contractors performing Arroyo Seco pipeline construction activities shall comply with the LLNL Training Program as outlined in Document 40.1, LLNL Training Program Manual of the LLNL ES&H manual. In addition to regulatory-driven training such as hazardous waste operations and emergency response certification, Superfund Amendments and Reauthorization Act/Occupational Safety and Health Administration (SARA/OSHA), and the Environment, Safety, and Health courses

provided by LLNL, technicians also receive on-the-job training for their specific work tasks. All training is tracked and recorded using the Livermore Training Records and Information Network (LTRAIN).

The Construction Contractor for the Arroyo Seco pipeline extension will have satisfactorily completed recent jobs and contracts similar in type and complexity to the scope of work for the Arroyo Seco pipeline extension project. The Project Manager for the Construction Contractor will have specific experience with sequencing and coordinating work operations of projects similar in nature to the Arroyo Seco pipeline extension project. The general superintendent for the Construction Contractor will have a working knowledge of Federal and State codes, regulations, and standards and is able to implement these in the field. The general superintendent for the Construction Contractor will have a history of successfully directing similar work and will be current on OSHA 40-hour training. The Construction Contractor safety officer will have a history of preventing project safety violations and incidents, and have a thorough knowledge of the current contents of 10 Code of Federal Regulations (CFR) 1900 through 1926.

C-4. Quality Improvement

ERD technicians integrate quality improvement into all construction activities by communicating to management, per the requirements of SOP 4.12, "Quality Improvement Forms", any unsafe practice or nonconforming item or process (e.g., faulty material, malfunctioning equipment, process defects, data irregularities, and deviations from standard operating procedures) that could potentially compromise worker safety or the activity's deliverable. The technicians also identify and communicate methods to improve quality or achieve greater efficiency of the remedial systems under construction.

The design of the Arroyo Seco pipeline extension was reviewed at multiple stages by ERD technical personnel to ensure that the design would be constructible, durable, require minimal maintenance, and comply with all specifications. The design was also reviewed at 65% and 100% completion by a diverse cadre of LLNL technical professionals to further ensure that the final design and construction is of the highest quality with the best opportunity for excellent performance. Construction managers will evaluate further opportunities for quality improvement during construction.

C-5. Documents and Records

Documents and records have been developed and controlled in a manner that ensures availability to ERD managers and workers so that they can perform their assigned responsibilities safely and properly per the requirements of SOP 4.18, "ERD Document Control". Records are retained so that the basis of technical and regulatory decisions can be adequately defended per the requirements of SOP 4.10: Records Management.

C-6. Work Processes

All work must be authorized before commencing and work activities be conducted under

conditions and controls that ensure worker safety and provide assurance that quality is achieved. Work processes will be performed per approved procedures.

C-6.1. Identification and Control of Items

Upon delivery, all materials and accompanying bill of lading and product test reports for items delivered to the Arroyo Seco pipeline extension job site will be inspected to verify compliance with the approved design submittals to assure that only correct and accepted items are used or installed.

The LLNL Technician Supervisor and LLNL Construction Manager will inspect items arriving at the construction sites. Acceptance of items or materials not in conformance with the design requirements shall be approved by the QAE or the LLNL Construction Manager.

Samples, generated as part of the construction activities will be assigned unique identifiers. Documented traceability of sample identifiers is maintained throughout the handling of samples. Such documented traceability is referred to as the chain-of-custody process for samples and is described in SOP 4.2, "Sample Control and Documentation".

C-6.2. Handling, Storing, and Shipping of Items

Items associated with construction activities will be handled, stored, and shipped to prevent damage, loss, or deterioration.

Environmental samples will be handled, stored, and shipped per the requirements of SOP 4.3, "Sample Containers and Preservation" and SOP 4.4, "Guide to the Handling, Packaging and Shipping of Samples".

C-7. Design Control

If during the course of construction, design changes are necessary, these changes must be controlled in accordance with the following requirements:

- Changes to final designs, field changes, and nonconforming items dispositioned "use as is" or "repair" must be justified and must be subject to design control measures commensurate with those applied to the original design.
- Design control measures for changes must include provisions to ensure that the design analyses for the item are still valid.
- Changes must be approved by the same groups or organizations that reviewed and approved the original design documents.
- If a significant design change becomes necessary because of an incorrect original design or because conditions in the field are different from those originally anticipated, the design process and design verification methods and implementing procedures must be reviewed and modified, as appropriate. These design deficiencies must be documented according to the requirements provided using the organization's nonconformance reporting process.
- Field changes must be incorporated into the applicable design documents.

- Design changes that affect related implementing procedures or training programs must be communicated to the appropriate organizations.

C-8. Inspection and Acceptance Testing

All Arroyo Seco pipeline extension construction work is subjected to inspection. For the Arroyo Seco pipeline extension project inspections, the ERD QAIC or LLNL Construction Manager shall immediately stop work and notify the ERD Livermore Site Program Leader if the work does not meet design criteria or quality requirements. After construction, the LLNL Construction Manager shall verify the accuracy of the as-built drawings to the final constructed Arroyo Seco pipeline extension, prior to accepting and certifying the construction as complete.

The ERD Technician Supervisor and Remediation Engineer shall maintain cognizance of incoming and stored materials and items and inspect or test them for conformance to requirements, as necessary. They shall tag rejected items to ensure that they are not inadvertently used.

Lockout tags shall be tied on electrical equipment, lifts and hoists, valves, etc. where such items (1) are unsafe to use, (2) are uncertified, or (3) may pose a risk to personnel working on the system per the requirements of SOP 4.16, "ERD Lockout/Tag Program".

C-9. Assessment/Verification

C-9.1. System Check

Prior to pumping groundwater from extraction well W-404 to TFA, the following minimum requirements apply to Arroyo Seco pipeline extension check phase:

- A conformance inspection will be conducted to confirm that all wellhead improvements (pump, pressure transducer sounding tube, piping, instrumentation, and control systems for W-404) have been installed according to approved design. The manufacturer, type, and size of the wellhead improvements will be checked against the design documents. The location of all improvements will be checked against the design drawings. The installation procedures will be checked against manufacturer's recommendations and LLNL standards. Any deficiencies in the wellhead improvements will be corrected.
- A conformance inspection will be conducted to confirm that new pipeline and electrical conduits has been installed according to the approved design. The materials of construction and placement techniques will be checked against the design documents and utility trench requirements from the City of Livermore. Any deficiencies in the new pipeline and conduit installation will be corrected.
- To confirm piping integrity, a hydrostatic pressure test will be performed in accordance with City of Livermore requirements and the hydrostatic testing procedures outlined in Standard C605 – Underground Installation of Polyvinyl Chloride Pressure Pipe and Fittings for Water from American Water Works

Association to ensure the pipe is tight at pressures exceeding the design operating pressure. Any leaks will be repaired.

- The leak detection system installed in the double contained pipe and will be tested according to manufacturers specifications which shall at a minimum include manually triggering the buoyancy switches and evaluate the resulting signal and response at TFA. Any defective buoyancy switches will be repaired.
- Electrical conduit, installed parallel to the new pipeline, will be evaluated by an LLNL Building Electrical Authority Having Jurisdiction field evaluator and checked for conformance to National Fire Protection Association (NFPA) 70. Any defects will be repaired. All instrumentation, control systems, and equipment will be inspected for malfunctions. All automatic controls will be inspected for operational readiness prior to startup of that phase.
- Mechanical equipment, such as pumps and valves, required for the operation, will be cycled or operated. Any functional deficiencies will be corrected.

C-9.2. Proof-of-System Check

After the system check has been conducted and any deficiencies corrected, a proof-of-system check will be conducted to ensure that the treated ground water meets regulatory effluent discharge limits. The proof-of-system check will consist of the following elements:

- The new double contained pipeline will be tested for integrity with the leak detection system.
- Extraction well W-404 will be pumped long enough, typically less than two hours, to confirm that the ground water pumps and water level shutoff devices operate properly.
- The treated ground water at TFA will be analyzed for constituents in groundwater and in accordance with applicable discharge limitations.
- All treatment, transport, and disposal components (including pumps, valves, liquid level controllers, pipelines, flow meters, pressure gauges, etc.) will be inspected for leaks and/or malfunctions. In addition, automatic controls will be inspected for operational readiness. All mechanical equipment will be operated under load to assure proper performance. Any deficiencies will be corrected.

C-9.3. Proof-of-System Monitoring

Proof-of-system monitoring will be conducted to characterize changes to the TFA influent and effluent stream as a result of connecting new extraction well (W-404), to determine the treatment efficiencies of TFA, and to monitor the performance of the W-404.

During the proof-of-system monitoring, the following analyses or measurements will be conducted:

- Total volume of water extracted from well W-404.
- Water levels in the well W-404.

- Total volume of water treated.
- Analysis of TFA influent and effluent samples for TFA will be analyzed for constituents in groundwater and in accordance with applicable discharge limitations.

The quality of the data generated as part of the proof-of-system testing will be assessed following the data quality assessment procedures outlined in Section 3.1.3 and Section 4 (Data Validation and Usability) of the ERD QAPP.

C-9.4. Measurement and Testing Equipment Calibration and Verification

All Measurement and Test Equipment used in acceptance testing of electronic, monitoring, and interlock systems and items will be calibrated in accordance with the applicable LLNL or manufacturer's calibration manual or ERD SOP 4.8, "Calibration/Verification and Maintenance of Field Instruments Used in Measuring Parameters of Surface Water, Ground Water, and Soils", as appropriate. The individual conducting the test will be responsible for assuring that all test equipment is calibrated and within its certification period.

C-10. References

Dibley, V. (March 1999), *Environmental Restoration Division, Quality Assurance Project Plan, Livermore Site and Site 300 Environmental Restoration Projects,* Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-103160 Rev. 2).

Goodrich, R., and G. Lorega (Eds.) (2009), *LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (SOPs),* Lawrence Livermore National Laboratory Livermore, Calif. (UCRL-AM-109115 Rev. 13).

ERD (2004). *Operations and Maintenance Manual Volume 1: Treatment Facility Quality Assurance and Documentation.* Lawrence Livermore National Laboratory, Livermore, Calif.

Kawaguchi, S. and A. C. Iyer (2003), *Operations and Maintenance Manual, Volume II: Treatment Facility A (TFA)*, Lawrence Livermore National Laboratory, Livermore, Calif. November (as amended).

LLNL (2010) Operations and Business *Quality Assurance Plan, Rev. 0,* Lawrence Livermore National Laboratory, Livermore, Calif.

LLNL (2010), Construction Management and Inspection (CM&I), Facilities & Infrastructure Department.

U.S. DOE (2005), DOE Order 414.1C, Quality Assurance.

U.S. Environmental Protection Agency (2002), Guidance for Quality Assurance Project Plans (QA/G-5), EPA/240/R-02/009, Office of Research and Development.

Table C-1. Applicability of the O&B QAP criteria to the construction of Arroyo Seco Pipeline Extension.

O&B QAP Requirement	Title	Applicable?
Criterion 1	**Management/Program**	**Yes**
Criterion 2	**Management/Personnel Training and Qualification**	**Yes**
Criterion 3	**Management/Quality Improvement**	**Yes**
Criterion 4	**Management/Documents and Records**	**Yes**
Criterion 5	**Performance/Work Processes**	**Yes**
Criterion 6	**Performance/Design**	**Yes**
Criterion 7	**Performance/Procurement**	**Yes**
Criterion 8	**Performance/Inspection and Acceptance Testing**	**Yes**
Criterion 9	**Assessment/Management Assessment**	**Yes**
Criterion 10	**Assessment/Independent Assessment**	**Yes**

Notes:

O&B = Operations and Business.

QAP = Quality Assurance Plan.

Appendix D

Construction Health and Safety Plan

Appendix D

Construction Health and Safety Plan

This Appendix contains the Construction Health and Safety Plan for the Arroyo Seco pipeline extension Project.

D-1. Reason for Issue

Safety procedures are required for construction of the Arroyo Seco pipeline extension which will connect extraction well W-404 to the existing Treatment Facility A (TFA). This Health and Safety Plan serves as an administrative tool to summarize the requirements that are pertinent to the project. Potential health and safety hazards and the control of such hazards during construction are addressed in one or more of the following documents:

- Lawrence Livermore National Laboratory (LLNL) Environment, Safety, and Health Manual (LLNL, September 2010).
- LLNL Environment, Safety, and Health Manual, Document 2.5 – Managing Subcontracted Work at LLNL (LLNL, June 2011).
- Integration Work Sheets that will be prepared during procurement of the construction contractor.
- Contractors Project Specific Health and Safety Plan (to be developed).

The requirements of the LLNL Environmental Safety and Health (ES&H) Manual are based on DOE's Integrated Safety Management System (ISMS) and ES&H standards derived from statutes, regulations, DOE Orders, and national and internally developed consensus standards.

D-2. Work to be Performed and Location of Activity

D-2.1. Location of the Arroyo Seco Pipeline Extension

This project includes extension of Arroyo Pipeline to connect extraction well W-404 to the existing TFA. The alignment of the pipeline is entirely within City of Livermore right-of-way, and follows Charlotte Way from the W-404 wellhead to Susan Lane, then follows Susan Lane to just beyond the cul-de-sac at the end of Susan Lane where it enters the vault at the western end of the existing Arroyo Seco pipeline.

D-2.2. Arroyo Seco Pipeline Extension

The new pipeline will be underground for its entire length except for the 40-foot segment where it crosses Arroyo Seco. There the exposed pipe will be bolted to the side of the bridge.

The pipeline will connect well W-404 to the existing Arroyo Pipeline for treatment of volatile organic compounds (VOCs) at TFA. TFA treats ground water using an air stripper with vapor phase granular activated carbon (GAC) treatment. The treated water is discharged to Arroyo Seco and the Western Perimeter drainage channel. The proposed pipeline will be approximately 1,200 feet (ft) of double-contained (2 in inner diameter/4 in outer diameter, both of Schedule 80 polyvinyl chloride [PVC]) pipe that runs along the public right of way via Charlotte Way/Susan Lane. The inner pipe will be centered within the outer pipe, with spiders spaced every 10 ft. A leak detection system capable of detecting the location of any leak within double containment will also be installed. Pipe routing is based on existing utilities and right of ways. Pump control will be provided by the existing control system at TFA. A new pump capable of delivering up to 40 gallons per minute at sufficient pressure will be installed at well W-404 to pump the water the full distance to TFA.

D-3. Responsibilities

The Livermore Site Program Leader is responsible for the safety of Arroyo Seco pipeline extension project operation and for assuring that all work is performed in conformance with this Health and Safety Plan. The responsible individual (RI) identifies each work activity, defines the scope of work, and is responsible to verify that all workers assigned the work team are trained and qualified to perform the work for which they are assigned. In the absence of the RI, the LLNL Construction Manager shall assume these responsibilities.

The RI(s) and the LLNL Environmental Safety & Health (ES&H) team leader may approve any changes in construction activities that improve or do not significantly affect safety and environmental controls. The RI will ensure that this action is documented in a memorandum. Any changes in the operation that increase the hazards level, introduce additional hazards, or decrease safety shall not be made until a revision to this Health and Safety Plan has been reviewed and approved, consistent with the LLNL Environmental Restoration Department review and approval process.

Before starting construction activities, the RI shall verify and document that the operating personnel have read and understand the Health and Safety Plan, relevant Integration Work Sheets (IWSs), and associated LLNL ES&H Manual sections referenced in Section D-8.2.

D-4. Hazard Analysis

D-4.1. Noise Hazard

Irreversible hearing loss can occur due to long-term exposure to noise from operating heavy equipment and other construction activities. The American Conference of Industrial Hygienists has established a standard of 85 decibels (acoustic) (dBA) over an 8-hour day. Exposure to noise louder than 85 dBA is permitted as long as the average exposure for the entire day is less than 85 dBA.

D-4.2. Electrical Hazard

An existing power supply of 230 volts alternating current will be used to pump the groundwater from the existing extraction well W-404 to TFA. The control conduit of low voltage direct current will be used for leak detection system in the pipeline. Electrical shock and injury may occur if personnel come into contact with exposed energized parts during construction activities.

D-4.3. Chemical and Radiological Hazards

No radiological hazards are anticipated for the project. VOCs, consisting primarily of tetrachloroethene (PCE), trichloroethene (TCE), 1.1 dichloroethane (1,1-DCA), and 1,1-dichlorothene (1,1-DCE), and chromium are in the extracted ground water from well W-404. Concentrations of total VOCs in extracted ground water range from 15.2 micrograms per liter (µg/L) to 31.2 µg/L. Only PCE currently exceeds its Maximum Contaminant Level (MCL) of 5 µg/L at well W-404. These VOCs are listed as potential carcinogens and kidney and liver toxins that may enter the body through inhalation, skin absorption, and/or ingestion. Concentrations of total chromium are less than the MCL. Hexavalent chromium compounds are potential carcinogens that also may enter the body through inhalation, skin absorption, and/or ingestion. Both VOCs and chromium are irritating to the eyes, nose, and throat and may affect the central nervous system.

D-4.4. Confined Space Hazard

Confined space entry may be required during construction activities at Arroyo Seco pipeline western vault. A confined space is defined as an enclosed area that is large enough for an employee to enter and perform assigned work, has limited or restricted means of entry or exit, and is not designed for continuous human occupancy. If an ignition source is present in or introduced into an enclosed space that contains flammable gases, solvents, or dust, the atmosphere may burn or explode. Serious injury or death may result when the atmosphere contains even low concentrations of toxic gases.

D-4.5. Hand and Portable Power Tool Hazard

LLNL provides hand and portable tools that meet accepted national safety standards. However, these tools can still cause injury and must be properly used and maintained.

D-4.6. Working Alone Hazard

Working alone means performing any activity out of sight or communication for more than a few minutes at a time. For work on exposed energized electrical equipment, an individual is considered to be working alone if not within sight of someone else. The major danger in working alone is sustaining an illness or injury that precludes self-rescue.

D-4.7. Physical and Biological Hazards

Physical hazards associated with working at Livermore Site include extreme temperatures with temperatures often exceeding 100º Fahrenheit in the summer. High air temperatures coupled with use of semi-permeable or impermeable protective clothing and/or strenuous

physical activities have a high potential for inducing heat stress in workers. In addition, hazardous conditions may exist during lightning storms at the Livermore Site.

D-4.8. Slip/Trip/Fall Hazards

The surfaces that operators stand or work on can be hazardous if not properly designed or maintained. Injuries can result from slips, trips, or falls on work surfaces. Work along the bridge at Arroyo Seco presents a fall hazard.

D-4.9. Material Handling Hazards

The hazards associated with improper material handling include being struck by a load, losing control of a load, physical overexertion, and exceeding equipment capacities. Such accidents can lead to injuries.

Materials handling will also involve using heavy equipment such as backhoes, front-end loaders, and other trenching equipment.

D-4.10. Hazards to Eyes

During construction activities, flying particles or objects can present a hazard to worker's eyes. The use of soldering or welding equipment also poses an eye hazard.

D-4.11. Fire Hazards

Soldering or welding of pipe connections will be required. These hot-work activities present a fire hazard.

D-4.12. Trenching and Excavation Hazards

Trench excavation, together with moving equipment to the job, positioning and removal can result in injuries and property damage. The other possible losses are trench cave-ins, undetermined sidewalk, and disturbance to underground utility conduits.

D-4.13. Respiratory Hazards

During pipeline installation, undesirable dust particles can present a respiratory hazard to workers when engineering controls are not used.

D-5. Hazard Control

Controls for the hazards identified in Section D-4 are based on selected sections of LLNL ES&H Manual.

D-5.1. Noise Hazard Control

Personnel are required to wear noise protection when working within a noise hazard area. Participation in a hearing conservation program is required for all individuals exposed to noise levels that equal or exceed an 8-hour time-weighted average of 85 dBA or the peak level of

140 dBA. Noise safety precautions will be followed as outlined in the LLNL ES&H Manual, Document 18.6, "Hearing Conservation".

D-5.2. Electrical Hazard Control

D-5.2.1. Access Control

Limiting access to the breaker switches associated with the ground water treatment system prevents inadvertent contact with energized equipment. All breaker switches are contained in cabinets with keyed locks.

D-5.2.2. Electrical System Maintenance Safety Procedures

Personnel involved in electrical work required during the pipeline extension shall be trained to HS5220-W, "Electrical Safety Awareness"; HS5230-W, "High Voltage Safety"; HS5245, "Lock & Tag"; HS5250, "Working on Energized R&D Equipment"; and HS5210-W, "Capacitor Safety Orientation". All electrical systems shall be checked for grounding continuity. Ground Fault Circuit Interrupters (GFCIs) shall be used on power outlets, temporary power cords (120 volts alternative current [VAC]), generators, and all power tools. Portable generators are to be used and maintained according to the assured ground program. Generators shall not be used in the rain. When practical, mechanical barriers and interlock systems shall be used. All breaker switches are contained in cabinets with keyed locks. All electrical equipment and systems will meet LLNL electrical standards and Underwriters' Laboratories (UL) standards. All applicable controls stated in the LLNL ES&H Manual, Document 16.1, "Electrical Safety", 16.2, "Work and Design Controls for Electrical Equipment", and 16.3, "LLNL Authority Having Jurisdiction Requirements for Approving Electrical Equipment, Installations and Work" shall be followed. Only qualified electricians or electrical technicians may work on electrical systems.

D-5.3. Chemical and Radiological Hazard Control

Concentrations of contaminants in the ground water extracted from W-404 are generally several orders of magnitude lower than the recommended permissible exposure limits (PELs) or threshold limit values (TLVs) for these chemicals. Therefore, it is not anticipated that exposure levels in excess of PELs or TLVs will be encountered. However, precautions, such as use of personal protective equipment (PPE) or clothing (i.e., gloves, safety glasses) per the requirements of LLNL ES&H Manual, Document 11.1, "Personal Protective Equipment" will be taken. In addition, to prevent the ingestion of hazardous materials, workers should wash their hands prior to eating, drinking, smoking, or using restroom facilities. Additional information on the safe handling of chemicals can be found in the LLNL ES&H Manual, Document 14.1, "LLNL Chemical Safety Management Program."

D-5.4. Confined Space Hazard Control

Construction personnel and technicians should be familiar with and perform all work in confined spaces in accordance with the LLNL ES&H Manual, Document 18.7, "Working in Confined Spaces." The ES&H Team will be contacted prior to entry of any confined spaces. A Confined Space Permit is required, and only qualified personnel with recent Confined Space

Training are permitted to work in confined spaces. Personnel must follow the Two-Man Rule when working in confined spaces.

D-5.5. Hand and Portable Tool Hazard Control

Technicians and construction personnel are responsible for selecting and using the proper tools for the job assigned and for wearing the appropriate personal protective equipment (i.e., safety glasses, etc.) when working with hand and portable tools. All hand and portable tools should be inspected prior to use to make sure they are not damaged and are in good-working condition. Any tool that is damaged or unfit for use should be immediately removed from service. Personnel are responsible for following the work safety standards outlined in LLNL ES&H Manual, Document 11.2, "Hazards—General and Miscellaneous" Chapter 5.0, *Hand and Portable Power Tools* and Document 19.1, "LLNL Ergonomics Program". Personnel are responsible for wearing the appropriate PPE such as safety glasses, gloves, and steel toed boots, as appropriate.

D-5.6. Working Alone Hazard Control

When working alone on a non-hazardous activity, facility technicians and construction personnel will advise a co-worker or supervisor that they will be working alone and when they expect to return. For potentially hazardous activities, technicians will: (1) exercise prudent judgment whether or not to perform the activity alone, and (2) obtain prior authorization from work supervisor before beginning planned hazardous-work-alone operations to ensure that all hazards have been thoroughly evaluated from the perspective of working alone. Work supervisors are responsible for ensuring an IWS is prepared for activities classified as hazardous for working alone. Personnel are responsible for following the work safety standards outlined in LLNL ES&H Manual, Document 11.2, "Hazards—General and Miscellaneous" Section 11.0, *Working Alone* and the Environmental Restoration Division Working Alone Guidelines (in ERD Operations and Maintenance [O&M] Manual, Appendix L) for all work-alone activities.

D-5.7. Physical and Biological Hazard Control

During late spring and summer months, technicians and construction personnel should ingest fluids and evaluate their physical conditions regularly and break when necessary to avoid overheating. Work should be conducted in accordance with the LLNL ES&H Manual, Document 11.2, "Hazards—General and Miscellaneous" Section 14.0, *Heat Stress* and 17.0 *Working Outdoors*.

D-5.8. Slip/Trip/Fall Hazard Control

Work surfaces should be properly maintained at all times to prevent slips, trips, and falls. Maintenance includes assuring all spills and foreign materials (i.e., tools, excess equipment, etc.) are promptly removed, installing rubber or slip resistant mats at locations that may accumulate water, and ensuring that floor openings are equipped with adequate covers when worker exposure is possible. Any access to elevated locations or work at heights requires guardrails, an administrative control system, or fall protection devices. Personnel are responsible for following the work safety standards outlined in LLNL ES&H Manual, Document 11.1, "Personal Protective Equipment", Document 11.2, "Hazards – General and Miscellaneous Section 2.0 -

Housekeeping", Section 15.0, "Walking and Working Surfaces", and Document 15.6, "Fall Protection".

D-5.9. Material Handling Hazard Control

Technicians and construction personnel should use methods that ensure personal safety and safety of the material being handled when lifting or handling materials manually. Objects that are too heavy or bulky to handle safely should be moved using more than one person or mechanical lifting device. All material lifting or handling should be performed in accordance with the safety standards and procedures for lifting contained in the LLNL ES&H Manual, Document 15.2, "Manual and Mechanical Material Handling" and Document 21.3 "Vehicle Operation and Traffic."

D-5.10. Mechanical Motion Hazard Control

Any machine part, function, or process, which may cause injury shall either be guarded (physical barriers which prevent access to danger areas) or safeguarded (provided with devices which inhibit machine operation, to mitigate or eliminate danger areas).

Machine operators shall be trained in the proper use of equipment and associated guards/safeguards to protect themselves and others from machine-related hazards. Machine operators shall wear protective clothing or personal protective equipment as necessary whenever engineering controls are not available or are not fully capable of protecting personnel. At a minimum, all personnel operating or working within close proximity of heavy machinery or equipment shall wear safety shoes and safety glasses. When there is a potential for head injury, hard hats shall be worn. Additional details for personal protective equipment are contained in the LLNL ES&H Manual, Document 11.1.

D-5.11. Eye Hazard Control

Eye protection shall be provided and worn by technicians where flying particles or objects present a hazard. The minimum type of eye protection is a pair of safety glasses. Increased protection against flying particles is provided when safety glasses have side shields; side shields should be used in most cases. Special eye protection is required when operations such as welding or metal cutting with a torch or arc are performed.

Generally, the technician supervisor will select the eye protection that is appropriate for the type of work being conducted by the technician. Additional details for eye protection are contained in the LLNL ES&H Manual, Document 11.1.

D-5.12. Fire Hazard Control

As part of the LLNL program to control fire hazards, permits are required for welding, soldering, and other hot-work operations with a high fire potential. The permits are obtained from the LLNL Fire Department. Construction areas shall be maintained in a fire-safe condition, including ensuring that the construction site is accessible to the Fire Department. Technicians will obtain fire permits for all soldering or welding work with a high fire potential. This work will be also be conducted in accordance with the requirements of the LLNL ES&H Manual, Document 22.5, "Fire", LLNL Fire Protection Program Manual, and National Fire Protection

Association (NFPA) 51 (Standard for Fire Prevention During Welding, Cutting, or Other Hot Work).

D-5.13. Trenching and Excavation Hazard Control

Construction personnel and technicians should be familiar with and perform all work in trench excavation area in accordance with the LLNL ES&H Manual and the integration work sheet. Public and workers protection should be provided by barricade and warning devices. Workers, who enter excavation five feet deep or more should be protected with a system of shoring, sloping, benching, or equivalent alternative methods. Workers should not be allowed to work in or near the excavation until a qualified person has determined that no hazard to workers exists from possible moving ground. Underground utility survey should be conducted before any excavation work.

D-5.14. Respiratory Hazard Control

Engineering controls will be implemented to limit dust generation. Appropriate personal protective equipment (i.e., respiratory protection) shall be used during construction when determined appropriate by the ES&H personnel. Respiratory protection may include dust masks or other respiratory protection based on site conditions and in accordance with the LLNL ES&H Manual. Dust level levels will be monitored during construction to evaluate the effectiveness of engineering controls and required respiratory protection.

D-6. Stop Work Procedures

LLNL's stop-work procedure applies to all work done at the Laboratory. Activities that are imminently dangerous to workers, the public, or the environment shall be stopped immediately by any Laboratory employee, supplemental labor employee, or contractor. Each worker is empowered to stop work if there is a perceived unsafe or unapproved condition. "Stopping work" includes stabilizing an imminent danger situation to the extent that it can be left unattended for a prolonged period of time until the issue is resolved. The person requesting the work stoppage shall notify manager responsible for the work. The manager shall notify the area ES&H Team and the Directorate ES&H Assurance Manager as soon as possible of this action. Informal stop work interventions to correct minor conditions (e.g., to remind workers to put on their hard hats, safety glasses etc.) do not require formal notification. Details of the Stop Work Process are included in the LLNL ES&H Manual, Document 2.1, "General LLNL Worker ES&H Responsibilities."

D-7. Emergency Response Procedures

In the event of an emergency, personnel will first dial 911 from an LLNL land line or 1-925-447-6880 from a cell phone to report to the Emergency Dispatcher, and then administer first aid, if necessary and if trained appropriately, to injured personnel. The Emergency Dispatcher uses reserved telephone lines to promptly relay the emergency call to the following branches of the LLNL Emergency Response Team:

- Fire Branch.

- Security Branch.
- ES&H Branch.
- Facilities Branch.
- Health Services.

The Emergency Response Team will go to the scene of the emergency immediately. The LLNL ES&H Manual describes the emergency response procedures in Document 22.1, "Emergency Preparedness and Response" and Document 22.2, "Environmental Emergency Preparedness and Response."

D-8. Applicable Documents

The following documents and/or sections thereof apply to the safe construction of Arroyo Seco pipeline extension and are incorporated into this Health and Safety Plan by reference.

D-8.1. Integration Work Sheet Safety Procedures

#11340 B843 Machine Shop Operations

#11579 ERD Electronic Routine Electronic Operations

Other integration worksheets to be developed.

D-8.2. LLNL Environment, Safety, and Health Manual Sections

Document 2.1 General LLNL Worker Responsibilities

Document 2.5 Managing Subcontracted Work at LLNL

Document 11.1 Personal Protective Equipment

Document 11.2 Hazards—General and Miscellaneous

- Section 2.0 Housekeeping
- Section 5.0 Hand and Portable Power Tools
- Section 11.0 Working Alone
- Section 14.0 Heat Stress
- Section 15.0 Walking and Working Surfaces
- Section 17.0 Working Outdoors

Document 12.6 LLNL Lockout/Tagout Program

Document 14.1 LLNL Chemical Safety Management Program

Document 15.2 Manual and Mechanical Material Handling

Document 15.6 Fall Protection

Document 16.1 Electrical Safety Program

Document 16.3	LLNL Electrical AHJ Requirements for Approving Electrical Equipment, Installations, and Work
Document 18.6	Hearing Conservation
Document 18.7	Working in Confined Spaces
Document 19.1	LLNL Ergonomics Program
Document 21.3	Vehicle Operations and Traffic
Document 22.1	Emergency Preparedness and Response
Document 22.2	Environmental Emergency Preparedness and Response
Document 22.5	Fire

D-9. References

ERD (2004), Operations and Maintenance Manual Volume 1: Treatment Facility Quality Assurance and Documentation. Lawrence Livermore National Laboratory, Livermore, Calif.

Kawaguchi, S. and A. C. Iyer (2003), Operations and Maintenance Manual, Volume II: Treatment Facility A (TFA), Lawrence Livermore National Laboratory,

Livermore, Calif. LLNL (2005), Site Safety Plan for Lawrence Livermore National Laboratory CERCLA Investigations at Livermore Site, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-21174 Rev. 3).

LLNL (2002), *Fire Protection Program Manual*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-MA-116646 Rev 1.).

LLNL (2006), LLNL Environment, Safety, and Health Manual.

LLNL (2004), Operations and Maintenance Manual Volume 1: Treatment Facility Quality Assurance and Documentation, Appendix L.

Appendix E

Field Sampling Plan

Appendix E

Field Sampling Plan

E-1. Introduction

This Field Sampling Plan has been developed to describe preconstruction testing that will be performed at locations along the planned Arroyo Seco pipeline extension alignment. The project includes installation of pipe into shallow utility trenches. No hazardous materials or environmental contamination are expected to be encountered during construction activities. The purpose of this plan is to describe a utility potholing program to confirm the location of suspected underground utilities and to collect soil samples for laboratory analysis.

E-1.1. Objectives

The objectives of the field sampling are described below.

- Confirm the suspected location, vertical elevation, size, and type of pipe or conduit for certain underground utilities along the planned pipeline extension.
- Determine the concentration of soil constituents along the planned pipeline extension.

E-2. Field Procedures

E-2.1. Field Sample Locations

The locations and depth of the planned potholes and shallow soil samples are shown on Figure E-1. Potholing will be performed at four locations where utilities are suspected but their depth is not confirmed. The potholes will be advanced to a depth of 1.5 feet below the pipeline invert. Soil samples will be collected at shallow borings located every 100 feet along the planned pipeline extension; in each boring, soil samples will be collected at a depth of between 2 and 3 feet below ground surface except in the boring near the leak detection vault where the soil sample will be collected at a depth of 5 ft below ground surface. A total of eleven shallow boring locations are planned. Where possible, shallow borings will be located (and soil samples collected) at the same location as the aforementioned potholes.

E-2.2. Pre-Field Activities

The activities below will be completed in advance of field work:

- An encroachment permit will be obtained from the City of Livermore.
- The planned soil boring locations will be marked, and Underground Service Alert (USA) will be contacted at least three days prior to beginning field work, to identify

and mark the locations of underground utilities relative to the planned drilling locations.

- A private utility-line locating service will be retained to verify the absence of subsurface utilities, at each planned soil boring location.

E-2.3. Utility Potholing

Utility potholing will be performed in specified locations along the planned pipeline extension. In sidewalk, curb or gutter areas, a concrete saw will be used to cut or core through the concrete section, to access underlying soil. Either a hand auger or air knife will then be utilized to dig to the required depth and identify the presence of subsurface utilities. Use of either an air knife or a hand auger will ensure that the required depth can be achieved while minimizing the potential for damage to underground utilities.

E-2.4. Shallow Soil Borings

After coring through surface asphalt or concrete at each location, an air knife and hand auger will be used to remove soil to near the target depth. Soil samples will be collected in accordance with ERD SOP-1.12, "Surface Soil Sampling" and SOP-1.2, "Borehole Sampling of Unconsolidated Sediments and Rocks", as appropriate.

Soil samples will be monitored for total volatile organic vapors utilizing an organic vapor analyzer (OVA), such as a photo ionization detector (PID). The equipment will be calibrated in accordance with the applicable LLNL or manufacturer's calibration manual or LLNL SOP 4.8, "Calibration/Verification and Maintenance of Field Instruments Used in Measuring Parameters of Surface Water, Ground Water, and Soils", as appropriate.

Quality Assurance/Quality Control (QA/QC) samples will be collected along with the primary samples and will be included with each sample shipment to the analytical laboratory according to LLNL SOP 4.9, "Collection of Field QC Samples". The results from QA/QC samples will be used to evaluate the reliability of the primary samples. Appropriate data collection forms (i.e. Chain-of-Custody [CoC], soil sampling observation forms), Document Control Logbook, labels, and any necessary shipping forms will be prepared according to LLNL SOP 4.2, "Sample Control and Documentation".

All non-dedicated, non-disposable soil sampling equipment used during this project will be decontaminated prior to and after each use according to LLNL SOP 4.5, "General Equipment Decontamination." In accordance with LLNL SOP 4.9, "Collection of Field QC Samples", equipment rinsate samples will be collected and submitted for analysis to ensure that non-dedicated equipment involved with sample collection has been properly decontaminated. All equipment used to collect samples will be brought to the study site pre-cleaned.

Procedures for sample numbering, completing COC forms, and packaging and shipping samples will be conducted according to LLNL SOP-4.4, "Guide to Packaging and Shipping of Samples".

Health and safety procedures outlined in Integration Worksheet #11578, "Drilling in VOC-contaminated Soils at the Livermore Site" prepared in accordance with LLNL Integrated Safety Management System, will be followed at all times during the field work.

The ground surface in the boring areas will be repaired to match existing conditions, after samples are collected. Soil will be placed back into the borehole and compacted manually. In the roadway, sidewalk, curb and gutter areas, the concrete or asphalt concrete will be repaired to match existing conditions. In the landscaped area, grass seed will be mixed into the top two inches of the replaced soil.

E-2.5. Investigation Derived Waste

Investigation derived waste (IDW) will be handled, screened, and disposed according to LLNL SOP-1.8, "Disposal of Investigation-Derived Wastes (Drill Cutting, Core Samples, and Drilling Mud)".

E-3. Laboratory Analysis

Soil samples will be analyzed for: (1) volatile organic compounds (VOCs) by U.S. EPA Method 8260b; (2) total metals listed in Title 22 of the California Code of Regulations (CCR) by U.S. EPA Method 6010; (3) pesticides by U.S. EPA Method 8081a; and (4) gross alpha/beta by U.S. EPA Method 9310. The number and size of sample containers, preservation procedures, and holding time will be determined as indicated in LLNL SOP-4.3, "Sample Containers and Preservation." Results from laboratory analysis will be reviewed according to LLNL SOP-4.6, "Validation and Verification of Radiological and Nonradiological Data Generated by Analytical Laboratories."

E-4. Applicable Documents

The following documents and/or sections thereof apply to the collection of samples along the Arroyo Seco pipeline extension and are incorporated into this Field Sampling Plan by reference.

E-4.1. Integration Work Sheet Safety Procedures

IWS 11578 Drilling in VOC-contaminated Soils at the Livermore Site

E-4.2. Standard Operating Procedures (SOPs)

SOP 1.2 Borehole Sampling of Unconsolidated Sediments and Rocks

SOP 1.8 Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)

SOP 1.12 Surface Soil Sampling

SOP 4.1 General Instructions for Field Personnel

SOP 4.2 Sample Control and Documentation

SOP 4.3 Sample Containers and Preservation

SOP 4.4 Guide to Packaging and Shipping of Samples

SOP 4.5 General Equipment Decontamination

SOP 4.6 Validation and Verification of Radiological and Nonradiological Data Generated by Analytical Laboratories

SOP 4.8 Calibration/Verification and Maintenance of Field Instruments Used in Measuring Parameters of Surface Water, Ground Water, and Soils

SOP 4.9 Collection of Field QC Samples

E-5. References

Dibley, V. (1999), *Quality Assurance Project Plan LLNL Ground Water Project*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-103160 Rev. 2).

Goodrich, R., and G. Lorega (2009), *LLNL Livermore Site and Site 300 Environmental Operating Procedures (SOPs)*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-MA-109115 Rev. 13).

LLNL (2006), LLNL Environment, Safety, and Health Manual.

U.S. Environmental Protection Agency (1987), *A Compendium of Superfund Field Operations Methods,* EPA/540/P-87/001.

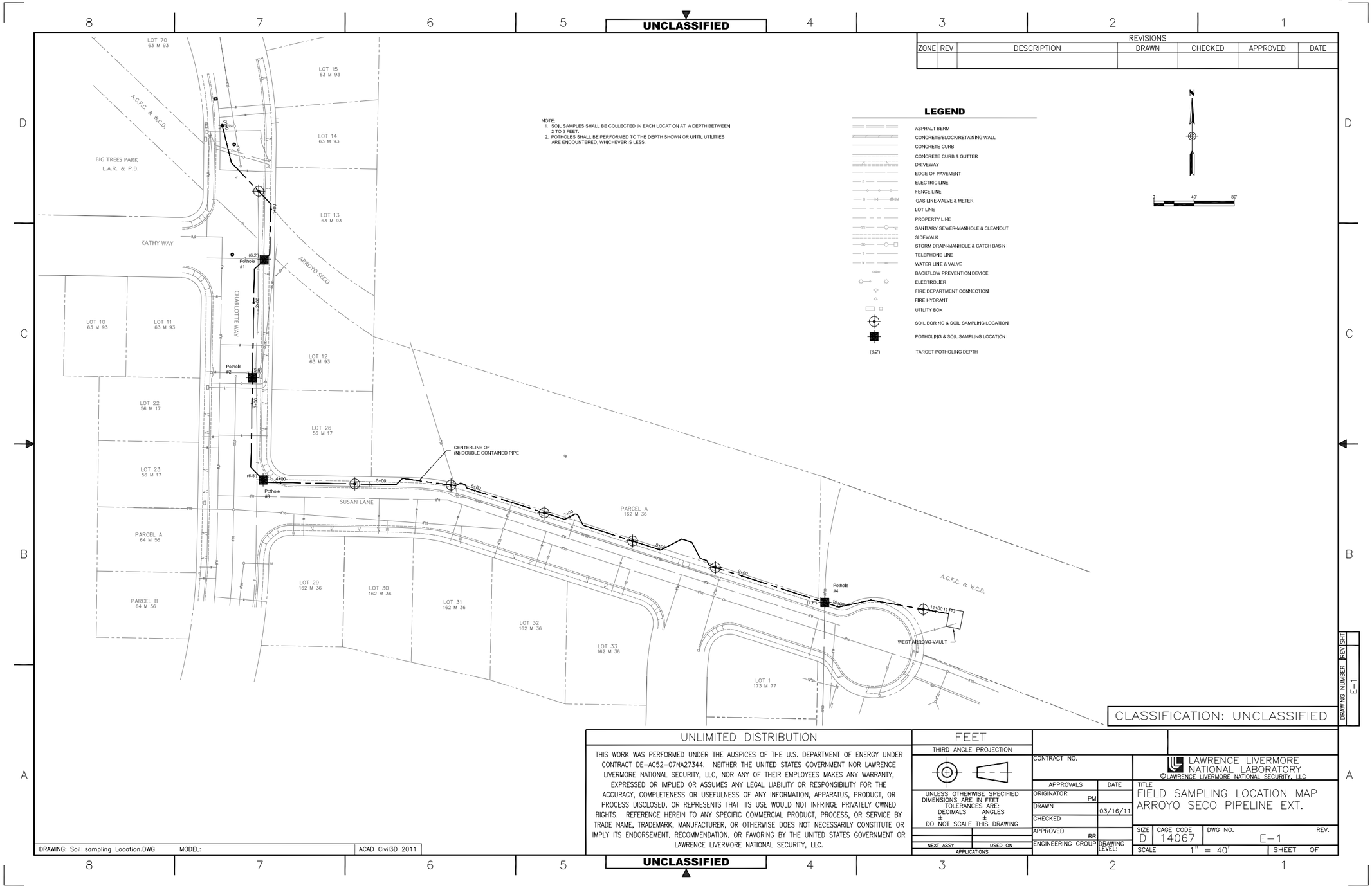


Figure E-1. Field Sampling Location Map.

Appendix F

Dust Control and Air Monitoring Plan

Appendix F

Dust Control and Air Monitoring Plan

F-1. Introduction

This Dust Control and Air Monitoring Plan has been developed for the Arroyo Seco pipeline extension project. The project includes installation of pipe into shallow utility trenches. No hazardous materials or environmental contamination are expected to be encountered during construction activities. The purpose of this plan is to define dust control measures and perimeter zone air monitoring to minimize impacts to the local community during construction. The construction contractor shall also perform work zone air monitoring per Occupational Safety and Health Administration (OSHA) in accordance with the construction Health and Safety Plan. The contractors work zone monitoring is not described in this plan.

F-2. Dust Control Measures

Dust control measures will be implemented during all trenching activities in areas within and around the construction zone. Lawrence Livermore National Laboratory (LLNL) personnel will liaison with community members on issues related to dust control. Contact information for the dust control liaison will be provided to affected community members and he or she will respond to dust complaints within 48 hours and prepare documentation.

The measures listed below will be implemented for dust control.

- The wind direction and velocity will be measured at an appropriate frequency based on weather conditions but not less than twice per day using a hand-held anemometer during all trenching activities.
- Dust suppression application techniques will be performed in such a manner as to minimize surface water run-off. A water truck will be available on-site for dust suppression during all trenching activities.
- Trucks containing soil, fill material, base rock, or other dust generating materials will be secured with covers before they leave the site.
- Truck tires exiting the site from Charlotte Way will be brushed to remove soil and debris which will then be collected using brooms and bins for use as utility backfill, landscape soil or will be properly disposed offsite. Streets will be swept daily, and more frequently, if visible soil material is carried onto adjacent public streets.
- Exposed stockpiles will be enclosed, covered, and watered twice daily.
- Drill cuttings will be covered with the plastic sheeting.

- The maximum vehicle speed in or near construction zone will be 15 miles per hour (mph).
- Vehicle idling times will be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes.
- Trenching activity will be suspended when winds exceed 20 mph.
- Work areas will be sprayed with clean water, as needed, to control dust.
- Equipments and excavation faces will be wetted, as needed, to control dust.
- Temporary fencing with windscreens for security and dust control will be installed, as needed, during construction activities generating dust.

F-3. Air Quality Monitoring

No hazardous materials or environmental contamination are expected to be encountered during construction activities. Air quality monitoring will be implemented during construction. Procedures are described below for monitoring particulate dust. Monitoring stations will be located upwind and downwind of the day's construction activities. Up to four monitoring stations may be required, depending on project activity.

F-3.1. Particulate Dust Monitoring, Response Levels, and Actions

Particulate concentrations will be monitored continuously at the upwind and downwind perimeter of the construction area at temporary particulate monitoring stations. The monitoring will be performed using real-time monitoring equipment capable of measuring particulate matter (PM) less than 10 micrometers (μm) in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment will have an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration will be visually assessed during all work activities. The equipment will be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below. Table F-1 presents a summary of the PM-10 instrument reading action levels and associated actions.

- The action level will be 0.05 milligrams per cubic meter (mg/m^3) for a 15 minute average. If the downwind PM-10 level is 0.05 mg/m^3 greater than background (upwind perimeter) for a 15-minute period or if airborne dust is observed leaving the work area, work will be temporarily halted and then dust suppression techniques will be employed. If decreasing dust concentrations decrease, work will continue with dust suppression techniques and continued monitoring if downwind PM-10 particulate levels do not exceed 0.15 mg/m^3 above the upwind level, and if no visible dust is migrating from the work area.
- If, after implementation of dust suppression techniques, downwind PM-10 levels are greater than 0.15 mg/m^3 above the upwind level, work will be stopped and activities re-evaluated. Work will resume if dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 0.15 mg/m^3 of the upwind level and in preventing visible dust migration. Should

PM-10 levels continue to exceed 0.15 mg/m^3, work will be stopped.

- PM-10 will be monitored by equipment meeting the following minimum performance standards:
    - Objects to be measured: Dust, mists or aerosols
    - Particle Size Range of Maximum Response: 0.1-10 μm
    - Measurement Ranges: 0.001 to 400 mg/m^3
    - Logged Data: Each data point with average concentration, time/date and data point number
    - Operating Temperature: -10 to 50º Celsius (C) (14 to 122º Fahrenheit [F])
    - Particulate levels will be integrated over a period not to exceed 15 minutes
- To ensure the data validity of the dust measurements, appropriate Quality Assurance/Quality Control (QA/QC) will be applied per manufacturer's instructions for measurement devices.

Table F-1. Particle Matter (PM-10) Instrument Reading Action Levels and Actions.

Location	Action Levels (Measured in mg/m^3)	Frequency / Duration	Action
Downwind Perimeter	**<0.05 above upwind perimeter**	**15-minute average measurements collected continuously**	**Continue monitoring**
Downwind Perimeter	**0.05 to <0.15 above upwind perimeter**	**15-minute average measurements collected continuously**	**Temporarily halt work; evaluate dust suppression techniques; resume work if concentrations decrease**
Downwind Perimeter	**>0.15 above upwind perimeter**	**15-minute average measurements collected continuously**	**Stop work; enhance dust control measures; resume work if concentrations decrease to <0.15 above upwind perimeter**

Notes:

mg/m^3 = Milligrams per cubic meter.

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