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The Northern California Pipe User's Group
22nd Annual Sharing Technologies Seminar

Berkeley, CA
February 20, 2014

THE STANLY RANCH HDD PROJECT—2,290 FEET OF BUNDLED RECYCLED WATER AND SEWER PIPE BENEATH THE NAPA RIVER

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ABSTRACT: Stanly Ranch is located a half-mile west of the Napa Sanitation District's Soscol Water Treatment and Recycling Facility in Napa, California. Despite its close proximity, the ranch has no sanitary sewer and recycled water conveyance pipelines to and from the facility. Between the ranch and the facility are railroad tracks, the Napa River, the West Napa fault, a dirt access road to the river, and wetlands adjacent to the river. Subdivision plans for the ranch include a five-star St. Regis resort. The subdivision development requires sanitary sewer and irrigation water services. Geotechnical findings led to the horizontal directionally drilled (HDD) design and construction of an 8-inch-diameter sanitary sewer force main and a 24-inch-diameter recycled water pipeline between the ranch and the facility. The pipelines were bundled and installed together in one 2,290-foot-long continuous HDD reach to depths of 67 feet below the ground surface and 48 feet below the Napa River. This paper summarizes the project history and alignment, key geotechnical findings, and the project design and construction.

1. INTRODUCTION

Stanly Ranch is located 5 miles south of downtown Napa, California. Privately owned by Stanly Ranch Vineyards LLC, the ranch consists of approximately 700 acres of gently sloping topography (400 currently used as vineyards) bordered by State Highway 29/12 on the north, agricultural fields on the west, and the Napa River and its floodplain wetlands on the south and east (Figure 1). Views from Stanly Ranch include San Francisco Bay (to the southwest) and surrounding hillsides that frame Napa Valley. Stanly Ranch Vineyards LLC obtained approval in 2003 to develop the ranch into an 18-parcel subdivision. Present parcel lot ownership and plans are the following:

- TVL Carneros Vineyards (Lots 1 and 2)
- Starmont Winery (Lot 7)
- The State of California (Lots 8 and 18)
- St. Regis Napa Valley Resort (Lots 3, 4, 9, and 10). The five-star resort will include restaurants; a 25,000-case winery; banquet and meeting areas; spa and fitness facilities; and 425 multi-bedroom units, some with kitchens.

Stanly Ranch is located a half mile west of the Napa Sanitation District's (NSD) Soscol Water Treatment and Recycled Water Facility. Despite their close proximity, there have been no pipelines constructed to provide recycled water and sanitary sewer services between the ranch and the facility. Irrigation water and sanitary sewer services for the ranch and its vineyards have historically been from the City of Napa (potable water) and by on-lot septic systems. In 2010, the Local Agency Formation Commission approved annexation of Stanly Ranch to the NSD.

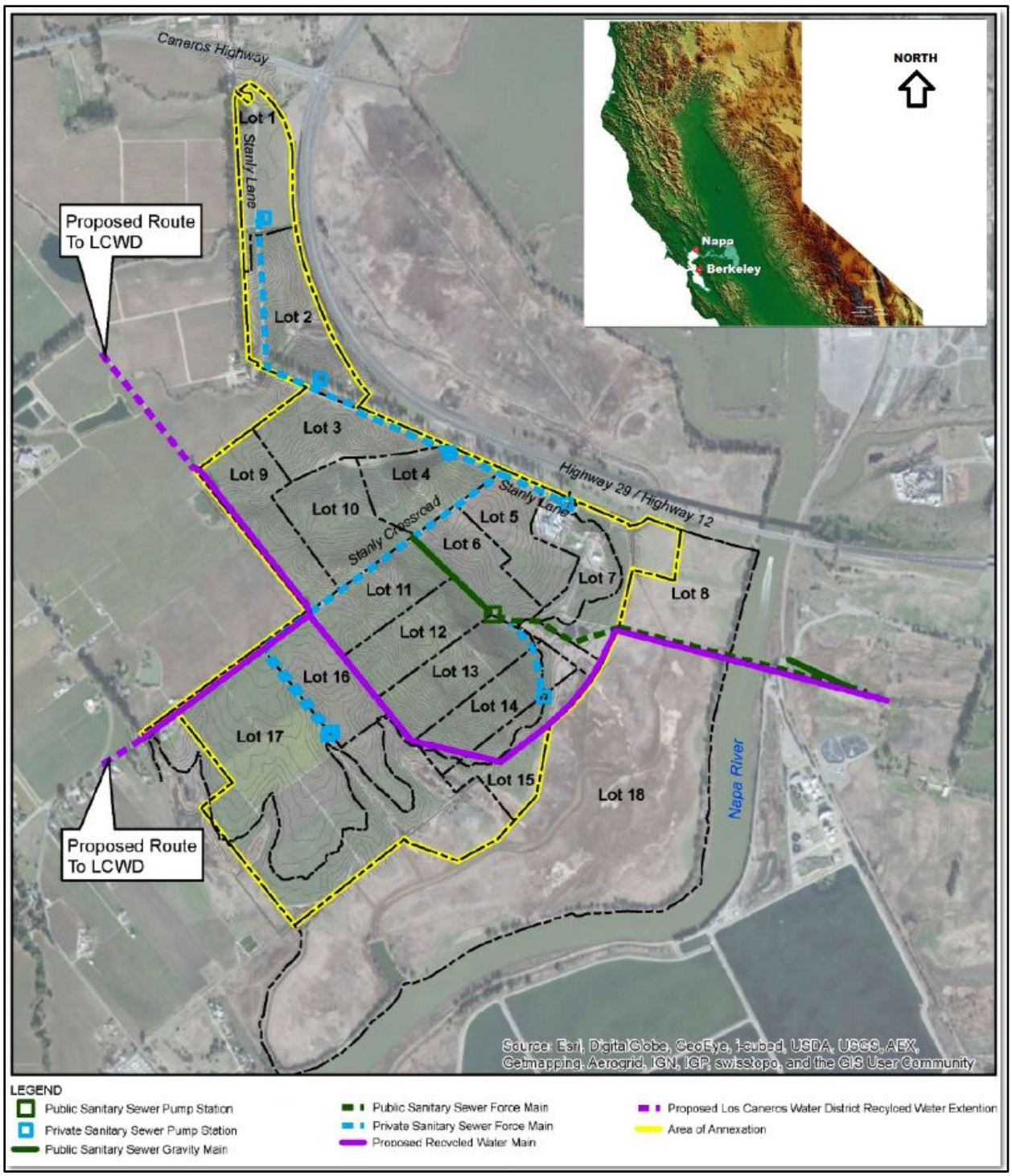

Figure 1. Map of the planned Stanly Ranch Subdivision and recycled water pipeline extensions to the Los Carneros Water District.

In January 2014, and after five years of planning, the Stanly Ranch Horizontal Directional Drill (HDD) project was completed. The project consisted of the design and construction of 2,290 feet of nominal 8-inch iron pipe size (IPS) dimension ratio (DR) 9 high density polyethylene (HDPE) sanitary sewer force main (6.6-inch ID and 8.6-inch OD); and nominal 24-inch ductile iron pipe size (DIPS) DR 9 HDPE recycled water pipeline (19.7-inch ID and 25.8-inch OD). The sewer and water pipelines were bundled

and installed together between Stanly Ranch and the Soscol Facility. The size of the recycled water pipeline was designed to service future westward build-out for the Los Carneros Water District. Stanly Ranch will give ownership of the conveyance pipelines to NSD once they are operational.

This paper summarizes the project history and alignment, key geotechnical findings that influenced the selection of the HDD construction method, and the project design and construction.

2. PROJECT ALIGNMENT

Visible surface features along the project alignment between Stanly Ranch and the NSD's Soscol Facility include Union Pacific Railroad tracks, access roads, the Napa River and its adjacent tree-lined levees and wetlands, and an alignment-parallel dirt road between the ranch and the west side of the Napa River. Features along the project alignment that are not visible from the surface include sanitary sewer pipelines incoming to the Soscol Facility east of the Napa River, the West Napa fault beneath the Napa River and/or below the adjacent wetlands to the west (see Section 3.2), and a 26-inch gas pipeline and a 36-inch water main that cross the project alignment west of the Napa River. The gas and water pipelines were constructed at shallow depths across the Napa River several decades ago.

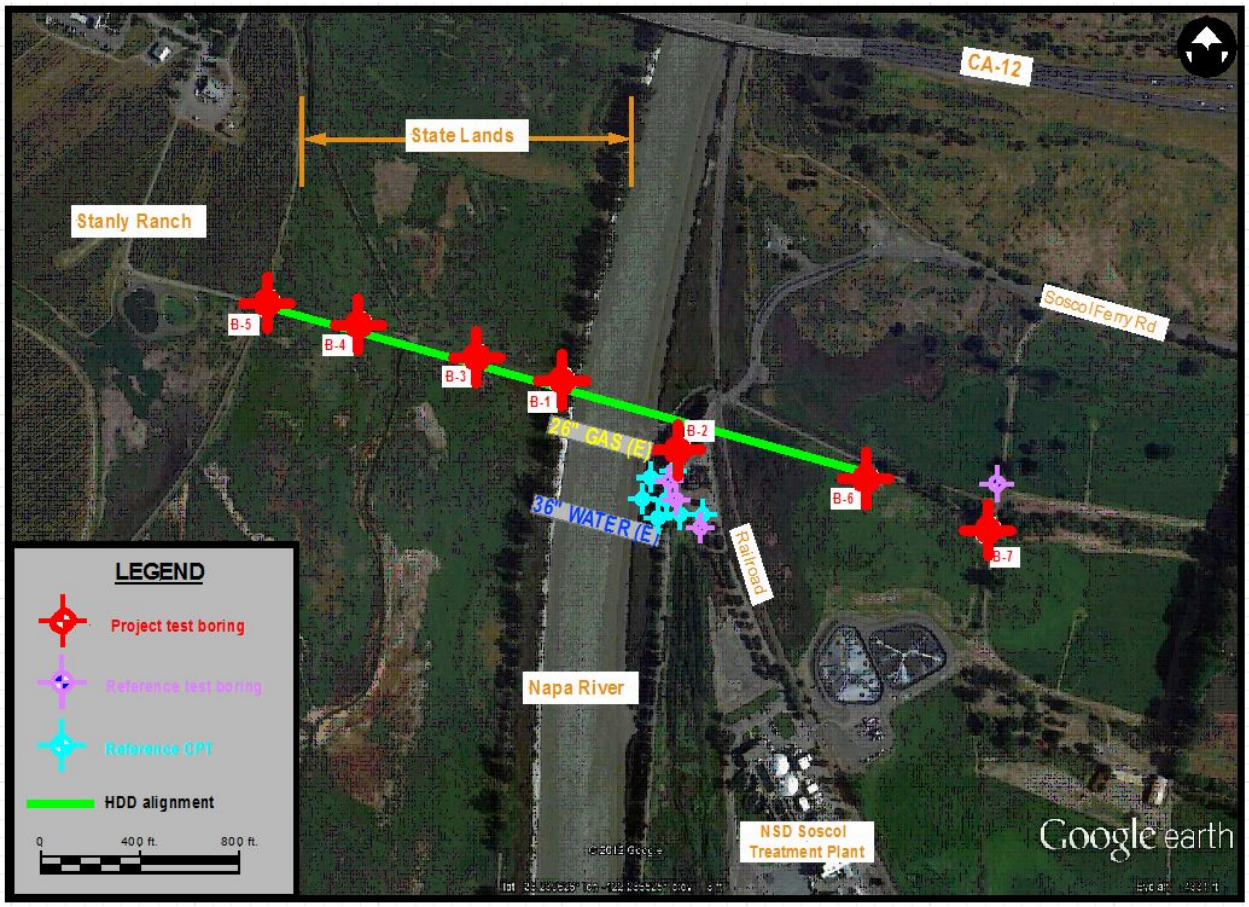

Figure 2. Satellite image annotated with features and locations of test borings and cone penetration tests (CPTs) near the project alignment (also referred to as the HDD alignment). See Figure 3 for a schematic geotechnical profile along the alignment.

3. GEOTECHNICAL INVESTIGATION

The following sections summarize geotechnical findings that influenced the project design.

3.1 Site History

Development in the project area dates back to at least the early 1900s, and includes railroads, drainageway modifications, NSD's Soscol Facility, and the subsurface utilities described in Section 2 (Figure 3).

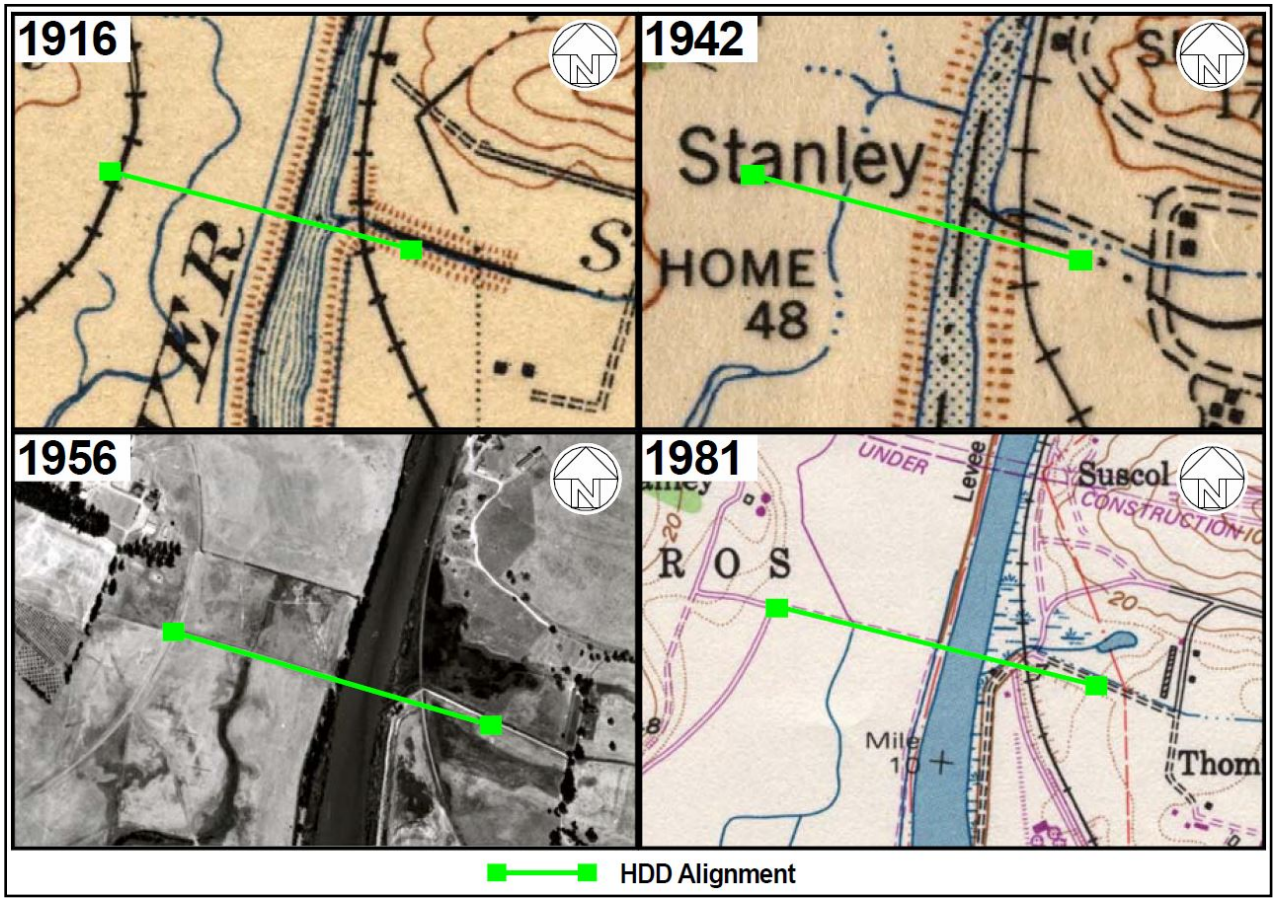

Figure 3. Topographic maps (modified from the U.S. Geological Survey's Cuttings Wharf 7.5-minute quadrangle map), and aerial photographs (modified from Pacific Aerial Surveys) of the project area.

2.2 Geologic Mapping

A geologic map of the project area is illustrated and described in Figure 4. Interpretation of the geologic map suggests that near-surface artificial fill and Bay Mud overlie alluvium and the Huichica Formation west of the Napa River, and that near-surface artificial fill and Bay Mud overlie alluvium and Sonoma Volcanics east of the Napa River. Sonoma Volcanics contain relatively large quantities of iron-rich magnetic minerals that recorded and preserved the magnetic signature of the region within their atomic lattices at the time they crystallized.

Located about a mile south of the project area, and hence not shown in Figure 4, is the northernmost known extent of the active West Napa fault. The West Napa fault is a right-lateral strike slip fault. Northward extrapolation of the West Napa fault into the project area places it along the Napa River, or its wetland margins. Prehistoric movement along the West Napa fault may have juxtaposed the Huichica Formation against the Sonoma Volcanics. The speculated fault contact between the Huichica Formation

and the Sonoma Volcanics is concealed beneath the younger deposits of alluvium and Bay Mud in the project area. No conclusive evidence of active fault displacement (i.e., displacement within the last 11,000 years) across the project alignment has been reported by fault studies in the region (Joyce Associates, 1993; Wesling and Hanson, 2008).

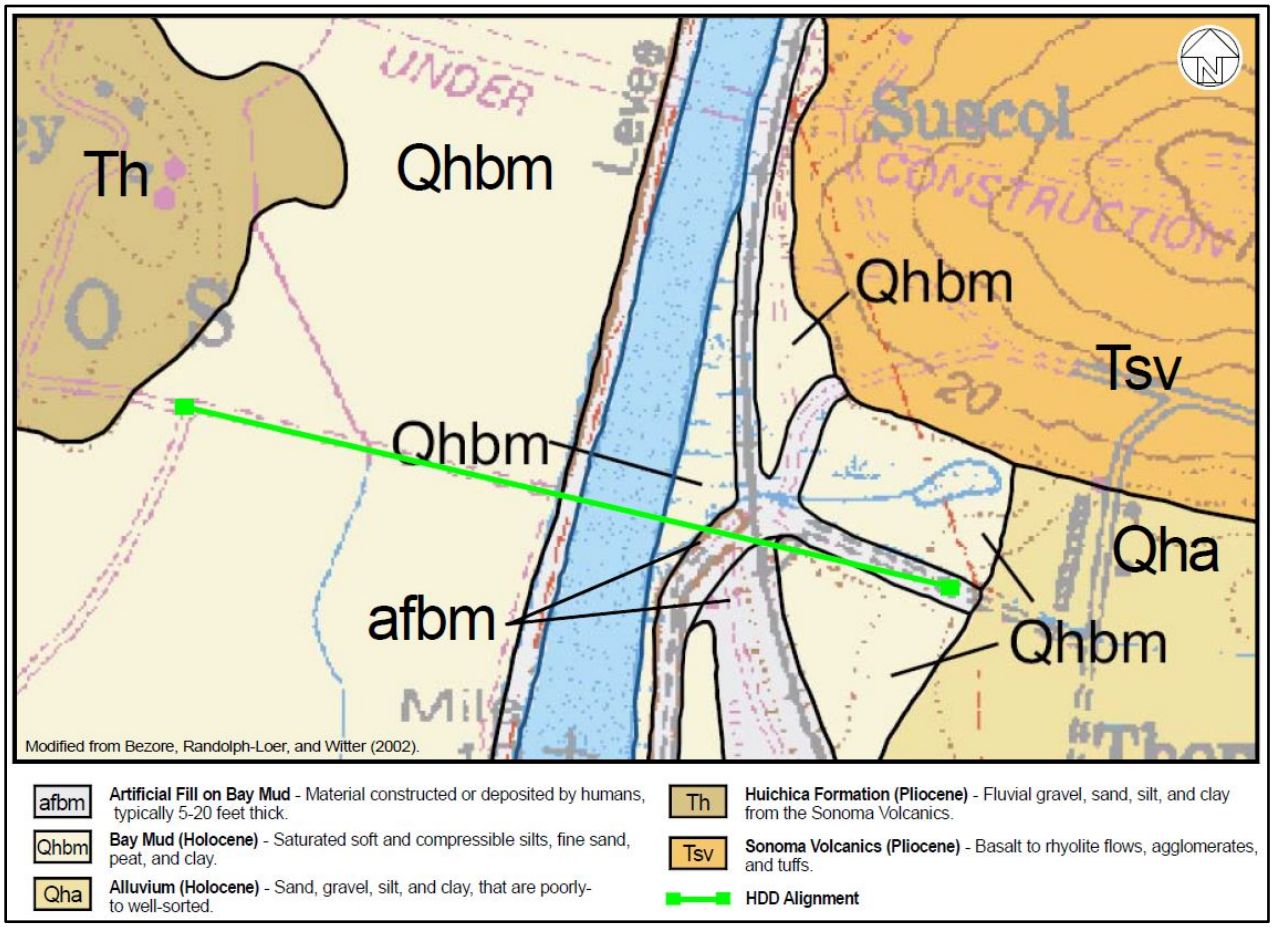

Figure 4. Geologic map of the project area.

2.3 Test Borings

A schematic geotechnical profile from findings of test borings drilled along the project alignment is provided in Figure 5. Test borings were drilled with 8-inch-diameter hollow stem augers and 5-inch-diameter tri-cone mud-rotary bits. The test borings encountered artificial fill and very soft, compressible and organic-rich Bay Mud over a vertically and laterally variable alluvial sequence of stiff to hard clays and silts, and medium dense to very dense sands and gravels. The depth to groundwater approximated the tidally-influenced elevation of the Napa River. The results of gradation tests performed on test boring samples are provided in Figure 6. The drilled cutting and test boring samples did not contain any particles larger than coarse gravel, and there was no drill-rig reaction that indicated the presence of cobbles and boulders. Detailed inspection of the samples shows that the gravel particles are predominantly “floating” in a finer-grained matrix (i.e., there was little gravel-to-gravel point contact).

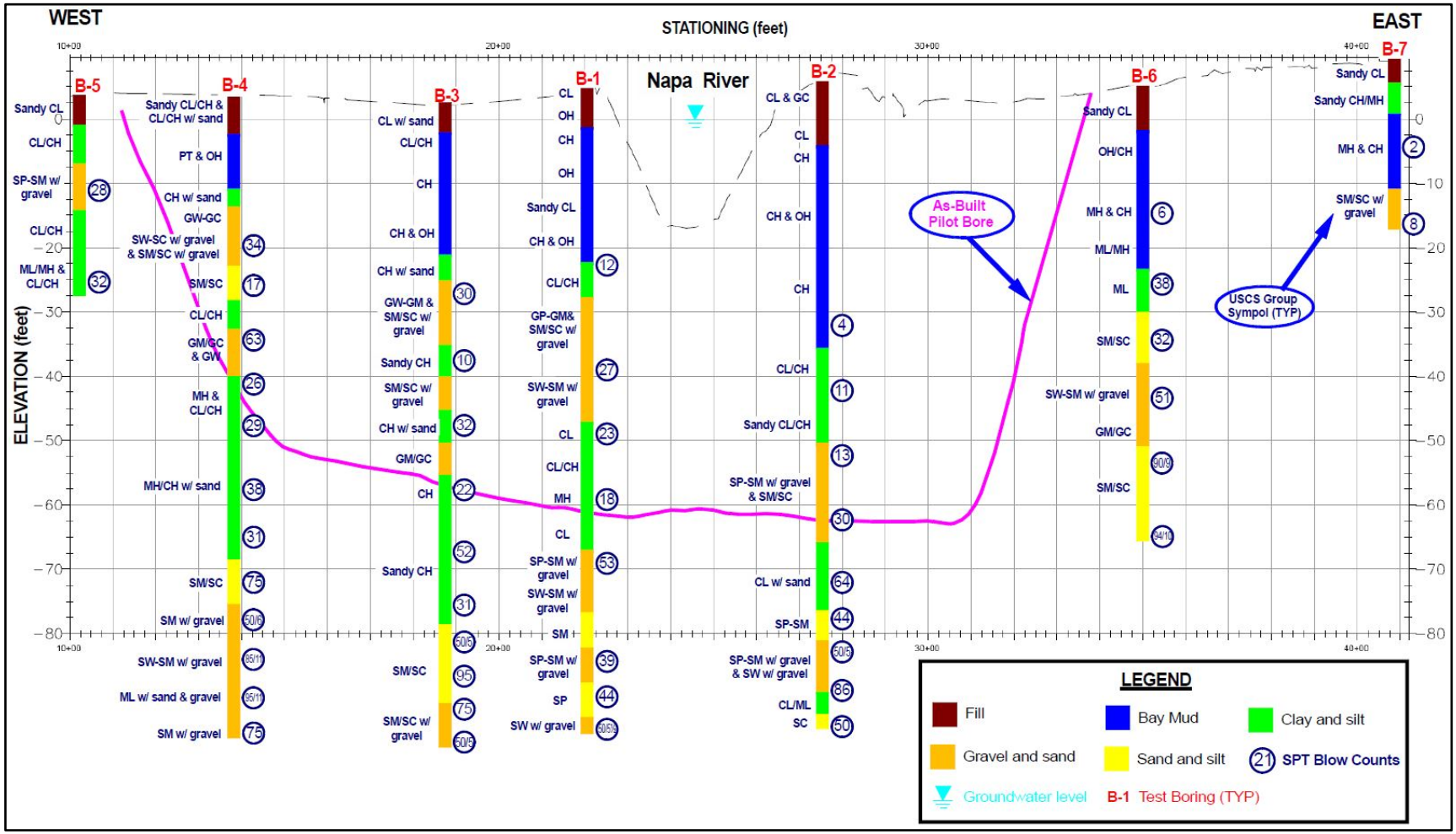

Figure 5. Schematic geotechnical profile of the project alignment with abbreviated test boring logs. The locations of the test borings relative to the project alignment are illustrated in Figure 2. Superimposed on the profile is the As-Built profile of the Stanly Ranch HDD. SPT blow counts refer to ASTM D1586 N-Values. USCS Group Symbols are those of the Unified Soil Classification System.

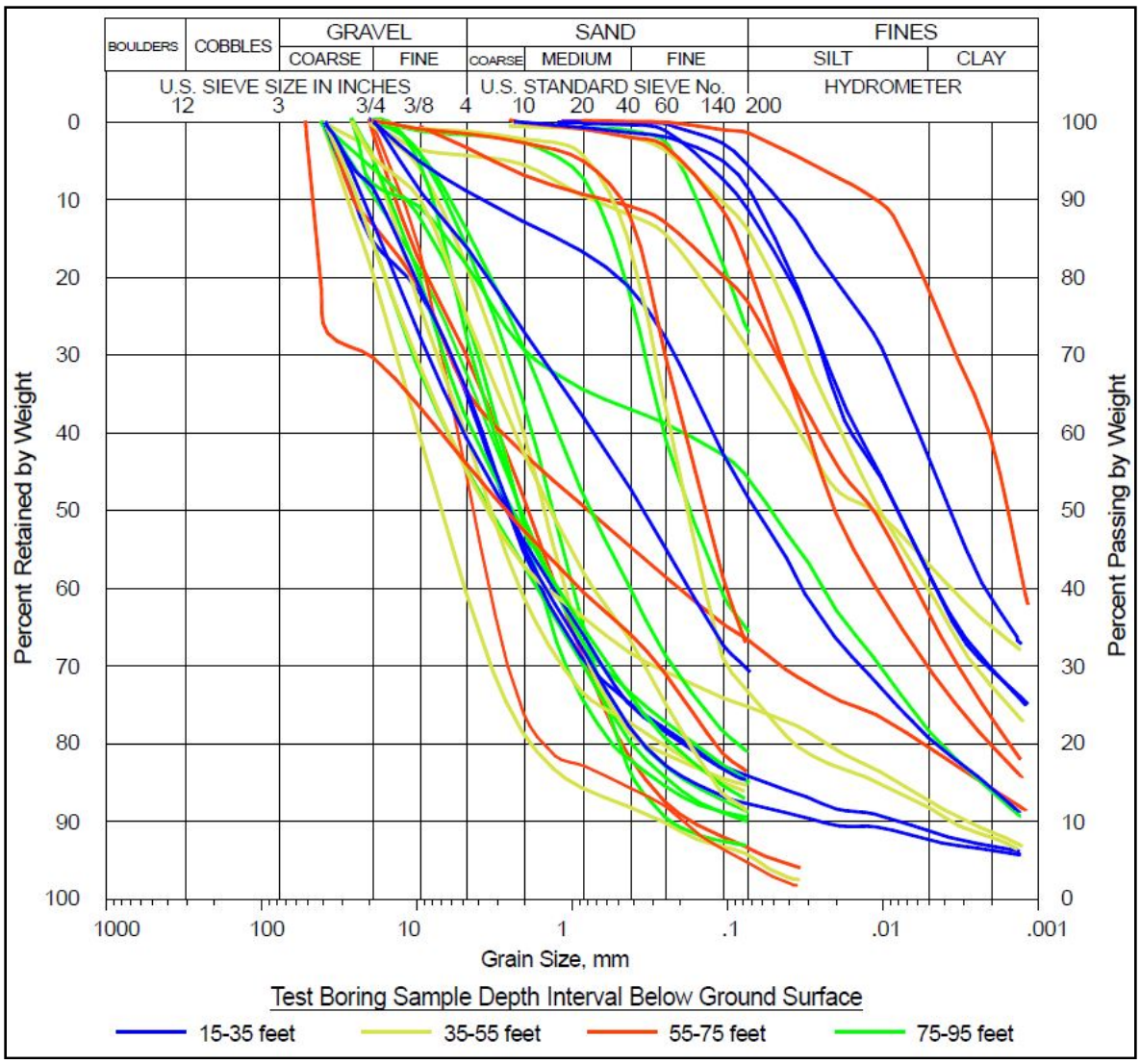

Figure 6. Gradation results of soils sampled from various depths in test borings along the project alignment. Gradation curves truncated at or near the No. 200 sieve are where hydrometer analyses were not performed.

3. DESIGN AND CONSTRUCTION

Initially, the concept for the Stanly Ranch project was to design and construct the recycled water and sanitary sewer pipelines together in a large-diameter steel casing installed by microtunnel pipe-jacking (microtunneling) beneath the Napa River. Installing the pipelines by HDD was originally considered very risky because of the potential for encountering very hard and abrasive volcanic cobbles and boulders in the alluvial deposits beneath the river. The design team had previously encountered hard and abrasive volcanic cobbles and boulders during the microtunneling installation of a 72-inch steel casing beneath the Napa River, 5 miles upstream of Stanly Ranch, for a different NSD project (see Kahl et al., 2007).

After geotechnical test borings along the Stanly Ranch project alignment were completed, HDD was chosen as the preferred method of installation because none of the test borings encountered cobbles and boulders (see Section 2.3). HDD was preferred over microtunneling, not only because it would be less expensive for this project, but also because it would provide the opportunity to cross both the Napa River and the environmentally sensitive wetlands adjacent to the river in one continuous reach. The designed

HDD alignment is shown in Figure 2. The designed HDD profile avoided gravelly horizons as much as possible, and is approximated by the As-Built profile provided in Figure 5.

Elements of the project design and construction are summarized in Table 1.

Table 1. Project Design Values [As-Built]	
Pilot Bore Drill Pipe / Hole Diameter	5" / 10" inches using a roller cone spud bit and a 1.75° bent sub
Temporary Entry Casing	225' [164'] of 18" steel in 24" forward-reamed hole
Bundled Pipe Width / Equiv. OD	34.4" / 27"
Intermediate / Final Ream Diameter	36" [17"] / 48" [42"] (with fly-cutter and barrel reamers)
Entry / Exit Angles	10° [12°] / 9°
Entry / Exit / Pullback Layout Radii	1,200' [1,000'] / 1,200' / 125'
Annular Pilot Drilling Backflow Rate	200 gal/min
Reaming / Pullback Flow Rates	300 (intermediate) and 150 (final) / 150 gpm
Drilling Fluid Weight / Yield / Viscosity	<9.7 lb/gal / 0.5 lb/ft^2 / 50 centipoise
HDD Rig Thrust and Pullback/Torque	330,000 lbf / 40,000 ft-lbs (American Augers DD-330)
Pilot Bore Tracking / Pressure Sub	TruTracker Coil with Tensor Wire-line / Tensteer
Mud Processing System	Mud Tanks with Shakers, De-sanders and De-silters

At the 50 percent design level, The HDD Company joined the design team, and eventually constructed the project. Early design participation by The HDD Company was instrumental in the expedited project approval from California State Lands Commission and the Union Pacific Railroad. HDD construction of the project included the following: 164 feet of pilot bore, 24-inch forward reaming, and temporary entry casing installation (Figure 7A); 2,000 feet of pilot bore to within 300 feet of the planned exit point (approximately 6 days); 2,000 feet of intermediate (17-inch) forward reaming (2 days); final pilot bore to the planned exit point (Figure 7B); removal of temporary entry casing; 2,290 feet of 42-inch forward reaming (10 days); final swabbing (5 days); HDPE pipeline layout (Figure 8); final fusing, bundling, and water filling (3 days); and 10 hours of continuous pullback.

Figure 7. (A) 164-foot long section of 18-inch-diameter temporary casing installed at the HDD entry. (B) Pilot bore exiting within a few feet of the staked target.

3.1 HDPE Pipe

HDPE pipe was selected for the project because of its tight bending radius. It was necessary that the bending radius of the pipe material accommodate the above-grade, 125-foot-radius horizontal curve at

the west end of the crossing (see Figures 1 and 8A). This curve was necessary in order to lay-out and fuse the entire bundled pipeline in one long continuous reach along existing vineyard roadways, and to avoid disturbing rows of established grapevines (see Figure 8B).

Figure 8. (A) Fused and bundled pipelines attached to the final swab/barrel reamer ready for pullback from Stanly Ranch. (B) 3-inch HDPE water pipeline used to fill the 24-inch HDPE recycled water pipeline during pullback to mitigate the effects of buoyant uplift.

3.2 Hydrofracture

Drilling fluids inadvertently returned to the ground surface during pilot bore drilling, at the locations indicated in Figure 9. Most of the inadvertent return locations were where analyses performed prior to construction showed minimum drilling fluid pressures would exceed the formation limit pressures.

4. CONCLUSIONS

The completion of the Stanly Ranch Horizontal Directional Drill Project in January 2013 is the first phase of the development of the Stanly Ranch Subdivision. The project has provided the means for recycled water and sanitary sewer conveyance between the ranch and the NSD's Soscol Water Treatment and Recycling Facility. Keys to the successful completion of the project included careful design integration of information from the geotechnical investigation with recommendations from a locally experienced HDD contractor. The project will not only benefit Stanly Ranch and the NSD, but also the Los Carneros Water District and the City of Napa. Among other benefits, the project will provide both Stanly Ranch and the Los Carneros Water District with irrigation water that has previously been provided by the City of Napa from its potable water supply. The City of Napa will be able to divert the potable water formerly used at Stanly Ranch to other domestic uses.

5. ACKNOWLEDGMENTS

We gratefully acknowledge Heather Lugassy and Jim Winters (GHD); Rusty Arend, Mark Pinske, and Timothy Shu (Jacobs Associates); and Steven Donovan (SHN Consulting Engineers & Geologists) for providing information used in this paper. We also thank Anne Prudhel (Carollo Engineers) for her review comments on an earlier draft of this paper.

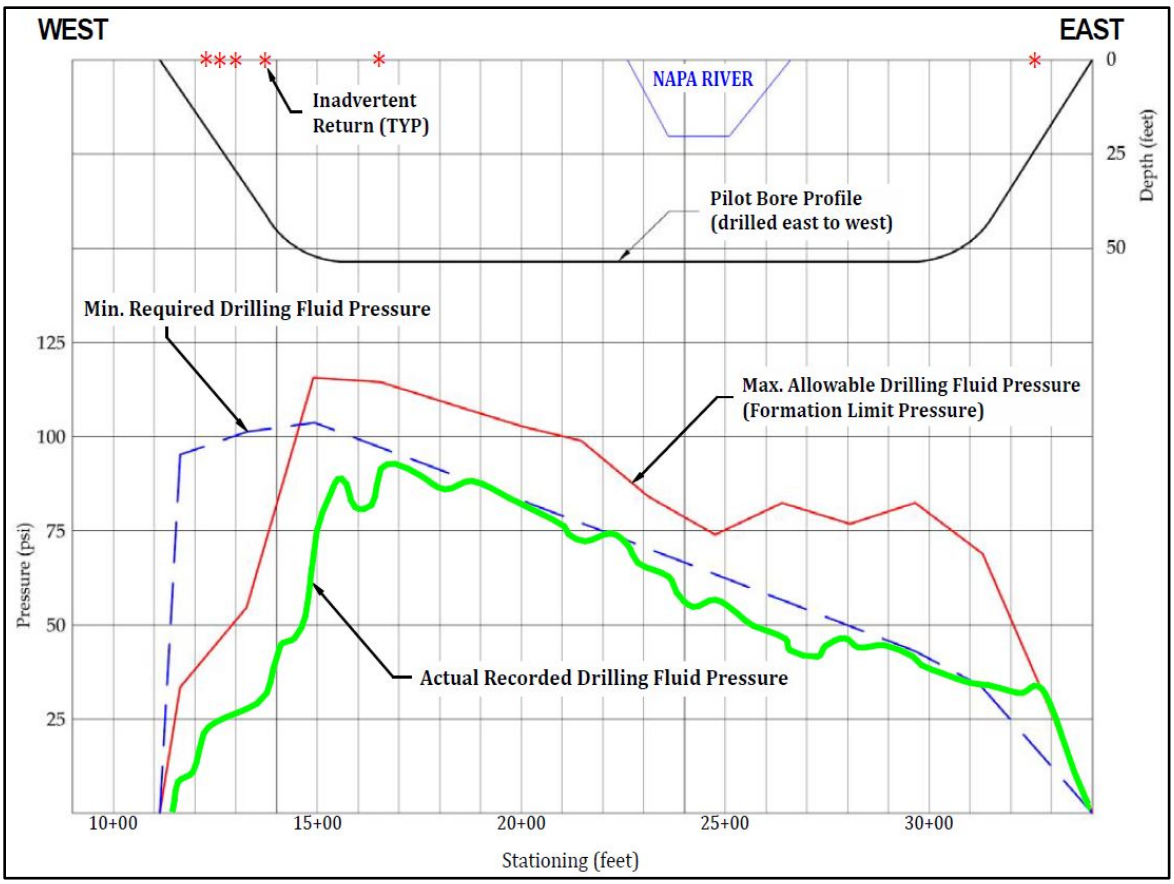

Figure 9. Modeled (modified from SHN, 2013) and actual fluid pressures for the Stanly Ranch HDD Project. Inadvertent returns to the ground surface were anticipated where minimum required drilling fluid pressures exceeded formation limit pressures. The modeled pressures were calculated with input parameters provided by The HDD Company (see Table 1) and from findings of the project geotechnical investigation. The red asterisks are locations at projected stationing where inadvertent returns to the ground surface occurred during construction.

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