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TECHNICAL MEMORANDUM DRAFT

TO: Scott Dixon; Breana Soto

FROM: Abe Salinas, PE, CFM; Austin Grojean, EIT

DATE: June 04, 2025

SUBJECT: Garcia Creek Channel Stabilization - Preliminary Engineering Evaluation

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1.0 Introduction

This memorandum summarizes KFA’s findings from the preliminary engineering evaluation of Garcia Creek, conducted for the City of Castroville. The project limits extend approximately 500 linear feet, from Athens Street at the downstream end to Geneva Street upstream (**Figure 1**). The purpose of this study is to assess existing channel conditions, evaluate stabilization alternatives to address observed erosion and infrastructure risks, and provide preliminary design recommendations to protect public and private assets adjacent to Garcia Creek.

The evaluation included a topographic survey, field investigations to observe channel bank erosion, geotechnical analysis and the development of conceptual design alternatives. K Friese + Associates (KFA) focused on three key areas for stabilization, prioritizing the Geneva Street culvert outfall, the adjacent northern bank, where erosion actively threatens nearby residential properties, and the side channel near Athens Street.

This project was identified as Project D-03, ranked third, in the City’s *2022 Stormwater Master Plan*, which prioritized drainage improvement needs based on risk and urgency.

Project objectives include:

- **Stabilize the Geneva Street Culvert Headwall** – Protect the culvert and an 8-inch waterline buried beneath the apron.
- **Improve Channel Bank Stability –** Mitigate erosion along approximately 400 linear feet of channel to protect private property.
- **Repair or Replace the Side Channel –** Address deficiencies in the concrete channel discharging into Garcia Creek.

KFA developed four alternative solutions and advanced one preferred option to 30% design. The current scope includes preliminary plans and a construction cost estimate to confirm feasibility within a total project cost goal of approximately $1.2 million.

It is important to note that this evaluation did not include a holistic global stability review from the Medina River to River Bluff. The analysis focused on the most immediate and urgent erosion risks based on field observations and the City's prioritization. Additional evaluation of the full channel reach may be warranted in future phases to address long-term system-wide stability.

Figure 1 - Project Study Limits

2.0 Existing Conditions Assessment

2.1 Data Sources and Methodology

This assessment incorporated visual inspections, geotechnical investigations, topographic survey, and desktop analysis. While a full geomorphic assessment was beyond the scope, the evaluation documents current conditions, identifies erosion mechanisms, and outlines opportunities to improve long-term stability.

2.2 Drainage Patterns

Garcia Creek flows west to east toward the Medina River, draining an approximately 200-acre watershed. The upstream area includes the River Bluff Subdivision and roughly 40 acres (20%) of undeveloped pasture. Runoff is conveyed via roadways and small tributary channels into Garcia Creek.

The watershed's moderate relief (~4.1% slope) channels runoff rapidly to the stream, contributing to peak flows. As urbanization increases impervious cover, the watershed will likely experience reduced infiltration, increased peak discharge, and higher stream power, leading to greater erosive potential.

Urbanization-related stressors, such as increasing peak flows, exposed utility crossings, and increasing risks to public infrastructure, are evident in the current channel conditions.

Refer to **Sections 3.0 and 4.0** for hydrologic and hydraulic analyses.

2.3 Environmental

Desktop review using the Environmental Protection Agency's *My Waters Mapper* and the U.S. Fish and Wildlife Service's (USFWS) *National Wetlands Inventory* database identified intermittent riverine wetlands within the project area (**Figure 2**). No standing water was observed during multiple field visits, suggesting low likelihood of Waters of the U.S. classification. However, a formal delineation is recommended. If jurisdictional wetlands are impacted, a Section 404 permit may be required, such as a USACE Nationwide Permit.

A Phase I Environmental Site Assessment is recommended to confirm the presence of jurisdictional wetlands and if a Section 404 permit may be required.

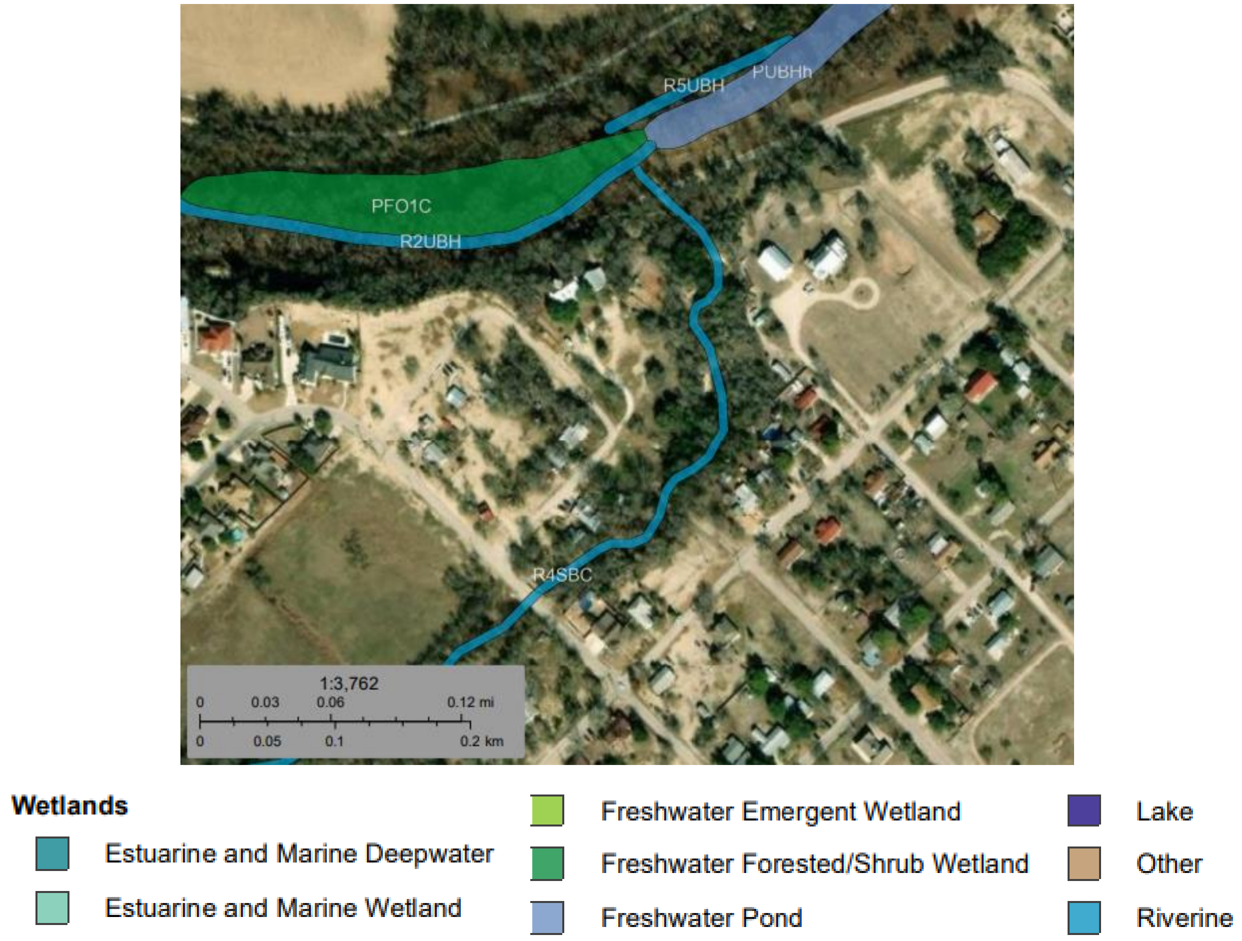

Figure 2 - USFWS National Wetlands Inventory

2.4 Water Quality

A preliminary review of the 303(d) list of impaired waters indicates that no impaired waters would likely be impacted by the project.

The project should apply reasonable methods to maintain current quality of water within the receiving water bodies, including stormwater pollution prevention measures during construction.

2.5 Rare, Threatened, and Endangered Species

A review of the National Endangered Species Act (ESA) *Habitat Mapper* and the USFWS *Critical Habitat for Threatened & Endangered Species* database indicates that no designated critical habitat or listed species are present within the project area.

Based on this review and the nature of the proposed stabilization alternatives, impacts to rare, threatened, or endangered species are not anticipated.

It is recommended that a Phase I Environmental Site Assessment be conducted during final design to confirm site conditions and identify any potential environmental constraints.

2.6 Cultural Resources

A review of the Texas Historical Commission’s (THC) *Historic Sites Atlas* indicates that the Castroville Historic District begins along Mexico Street and is located just east of the project area. Additional historical markers, including those at St. Louis Catholic Church and the Alsatians of Texas site, are located approximately 0.75 miles east of the project limits.

No mapped archaeological sites are located within or immediately adjacent to the project area; therefore, impacts to cultural resources are not anticipated.

Further action or coordination with the THC is not expected to be required.

2.7 Utilities

Identified utilities within the study area are generally located within the Geneva Street right-of-way.

Known utilities include water, sewer, gas, and overhead electric. No detailed subsurface utility investigations were performed as part of this study and identification of utilities is based on available GIS data and observed surface features during field investigations.

Known utilities and their approximate locations are mapped using the City’s GIS data viewer and provided in **Figure 3**. The summarized potential conflicts are provided below.

- **Water:** 8-inch ductile iron water main is located on the east side of Geneva Street and crosses underneath the concrete apron of the culvert crossing. The water main is exposed and at risk of collapse. Relocation of this utility may be required.
- **Sewer:** 8-inch wastewater main located on the west side of Geneva Street. No work is proposed in this area and not anticipated to be in conflict.
- **Gas:** Unknown size gas main located along the west side of Geneva Street. No work is proposed in this area and not anticipated to be in conflict.
- **Overhead Electric:** Overhead electric utility located along the east side of Geneva Street. Power poles are anticipated to be outside of the work area and not in conflict.

Further investigations and verification to identify all utilities for the selected alternative is recommended to further identify and quantify the extent of the utility conflicts and relocation that may be required.

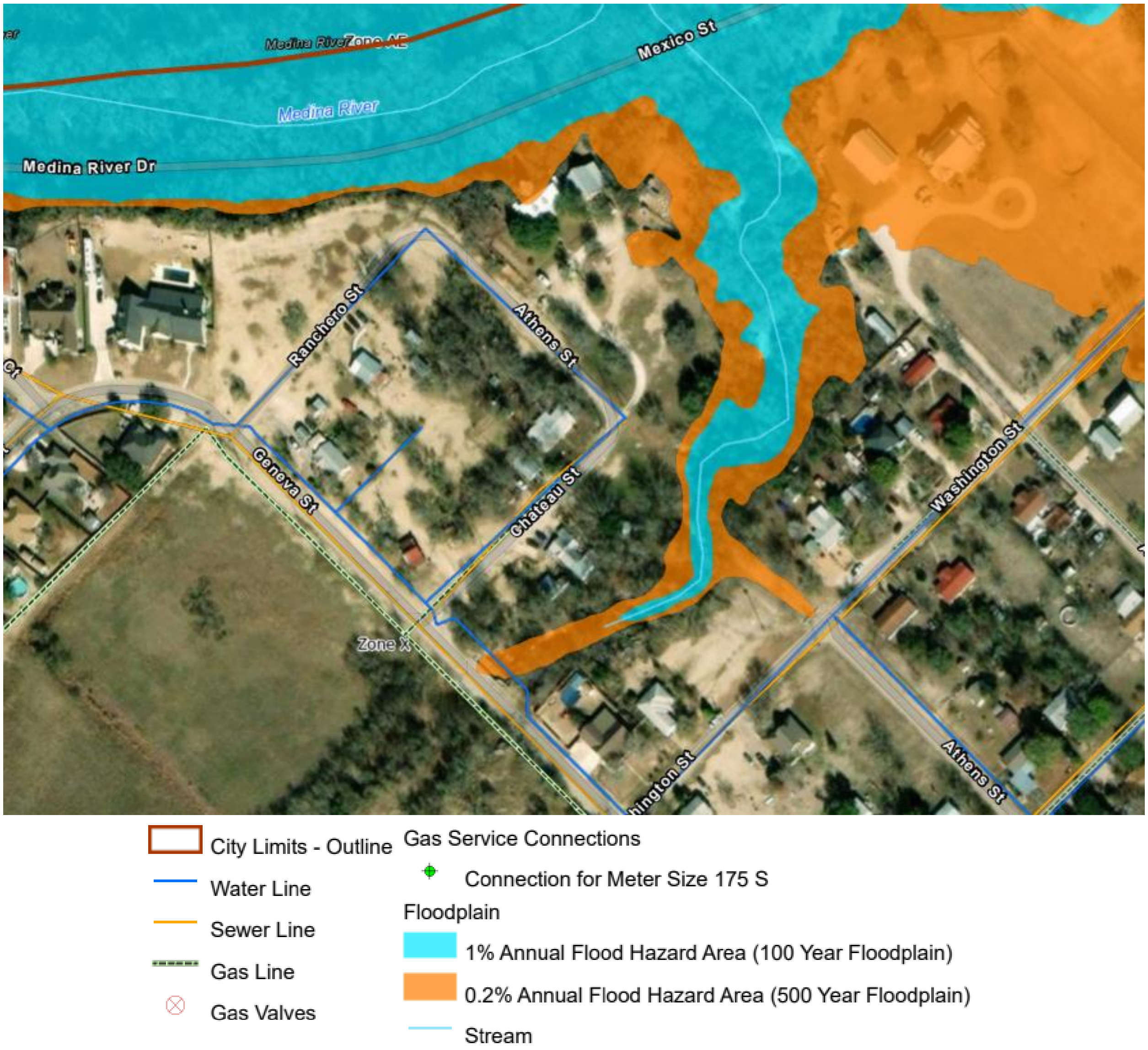

Figure 3 – City GIS Data Map (Utilities, Floodplain)

2.8 Soil Types within Study Area

The Natural Resource Conservation Services (NRCS) Soils Map shows the area primarily consists of Sabenyo clay loam (SaC), MoC (Monteola gravelly clay), and Divot clay loam (Dp), as shown in **Figure 4**.

The hydrologic soil groups are B, C, and D. The hydrologic soil groups are based on estimated runoff potential. Group C is considered to have a slow infiltration rate when thoroughly wet and Group D is considered to have even less infiltration. The study area consists of approximately 12% in Group B, located primarily between Geneva Street and Old River Road; 23% in Group C, located along Old River Road (Mexico Street); and 65% in Group D, located primarily within the mid and upper areas of the watershed.

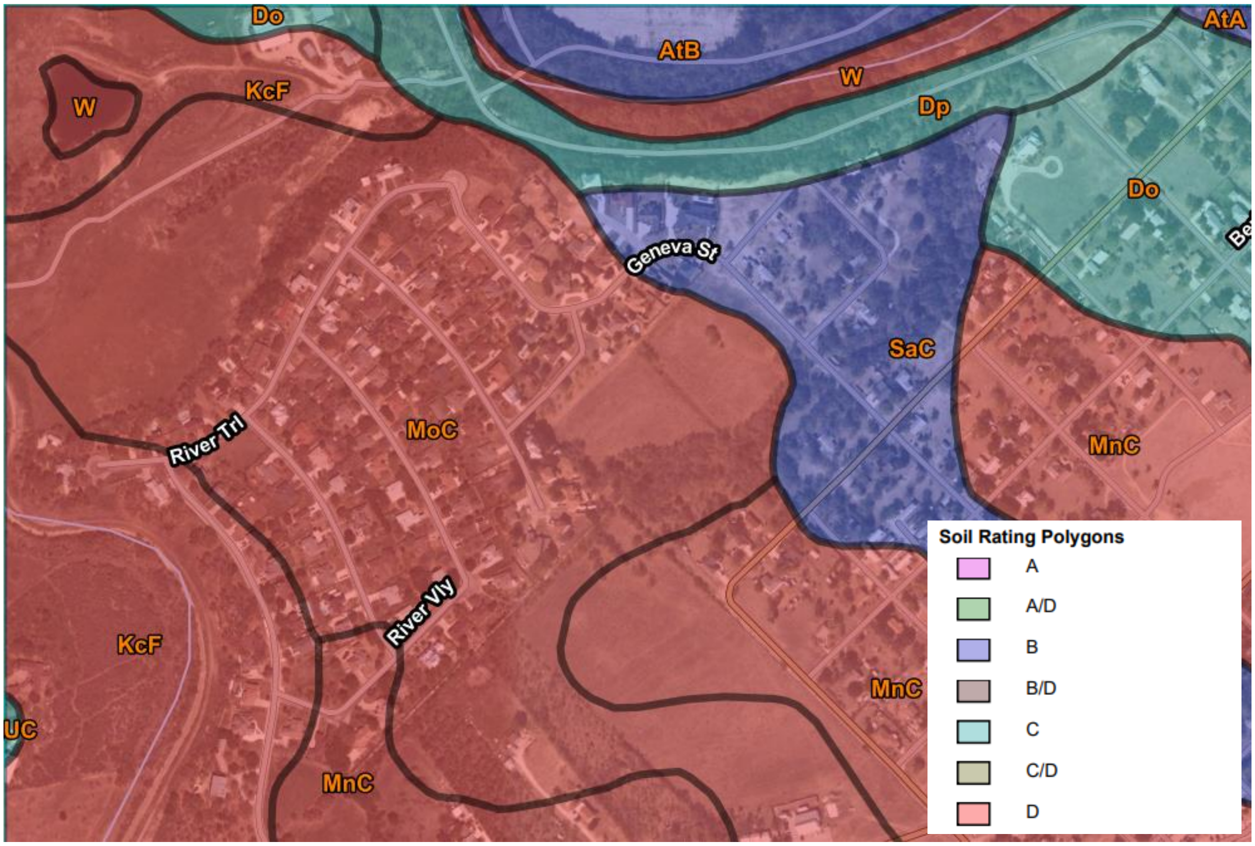

Figure 4 - Hydrologic Soil Groups (NRCS)

Based on the boring logs and geological report developed by HVJ, found in attachment C, the general geology within the study area is Fluviatile Terrace Deposits (Qt) generally consisting of unconsolidated limestone gravel, sand, silt, and clay in various proportions. The Fluviatile Terrace Deposits are derived from Cretaceous deposits in the drainage area.

The Escondido Formation (Kes) is comprised of shales, siltstone, and sandstone. The shales are gray to bluish gray and would be expected to be like the shales of the Navarro Formation in the San Antonio area. The siltstones are typically brownish yellow and thin bedded.

2.9 Floodplain

FEMA's Flood Insurance Rate Maps designate much of the project corridor as Zone AE, with base flood elevations defined (**Figure 5**). As a result, any structural modifications to the channel (e.g., culvert work, walls, grade controls) will require a floodplain development permit from the City, along with supporting modeling to demonstrate no adverse impacts to flood elevation or conveyance capacity.

Figure 5 - FEMA Effective Floodplain (Zone AE)

2.10 Channel Conditions and Stability Classification

Garcia Creek exhibits varying channel characteristics along the study reach. Longitudinal (channel bottom) observations, beginning at the upstream limit, indicate that the bed consists primarily of hard clayey sand with gravel. Sediment bars composed of sands and gravels were observed, primarily on the inside of meanders.

Channel slopes across the study reach range from 0.004 ft/ft to 0.10 ft/ft, with an average slope of approximately 0.026 ft/ft. For reference, slopes greater than 0.02 ft/ft (2%) are generally considered steep enough to generate erosive forces, especially in unlined or poorly vegetated channels. Portions of Garcia Creek exceed this threshold, increasing the potential for bank instability and sediment transport.

From Old River Road to Geneva Street, both stream banks exhibit varying degrees of toe erosion. This toe scour has resulted in undercutting, cantilevered soil masses, vertical banks, and ongoing mass wasting in multiple locations. **Figure 6** illustrates the location of observed failure types along the study reach. **Figure 7** provides field observation photos of the failure condition.

The riparian corridor includes grasses, shrubs, and mature trees, which contribute to reinforcement of the soils and some resistance to bank failure. However, in many areas this vegetation is not sufficient to counteract the active erosional forces.

Field observations indicate that Garcia Creek is experiencing progressive instability. Channel incision is evident and contributing to upstream-migrating headcuts. These erosional features are likely to continue until intercepted by a structural or geologic control point. Currently, Old River Road serves as the downstream structural control, while the Geneva Street culvert functions as the upstream structural control point, temporarily anchoring bed stability. However, the Geneva Street outfall is experiencing active scour and undermining, placing the structure at increasing risk of failure. If the culvert fails, accelerated upstream degradation and broader channel destabilization are likely to follow, posing a significant public safety risk if roadway integrity is compromised.

The most severe erosion was observed between locations 3 and 5, shown ~~on~~in **Figure 6**. Based on qualitative field observations, an estimated 40% of the study reach appears to be severely eroded and exhibiting signs of complete instability. Approximately 15% shows moderate erosion and moderate instability, while roughly 25% shows slight erosion and appears slightly unstable. No segments were identified as fully stable. These estimates are approximate and based on visual assessment rather than quantitative measurement.

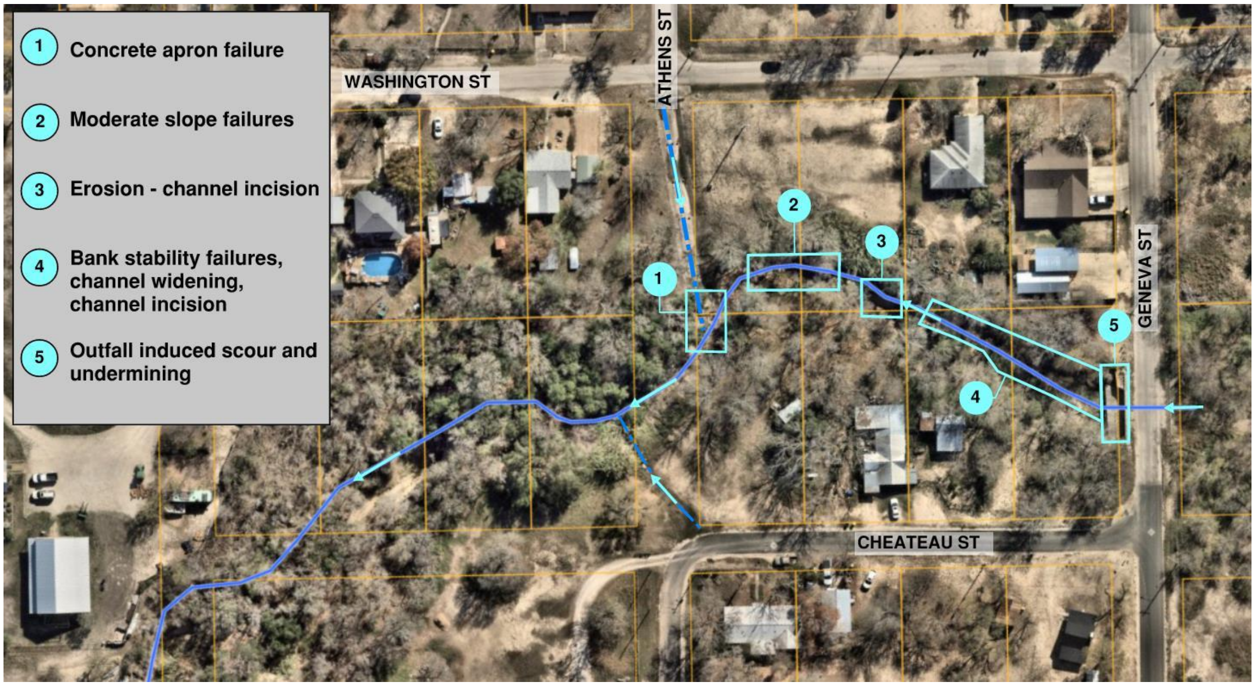

Figure 6 – Geomorphic Channel Conditions

1 – Structural failure of the side channel concrete apron due to scour-induced undermining. (Facing downstream)

2a – Moderate slope failures (Facing upstream)

2b – Moderate slope failures (Facing downstream)

3 – Channel degradation. Deep incision due to steep channel bottom and constriction of flow resulting in increased velocities. (Facing upstream)

4a – Overhanging bank condition caused by toe erosion resulting in bank collapse, vertical banks (~15 ft. height) and mass wasting.

4b – Overhanging bank condition caused by toe erosion resulting in bank collapse, vertical banks (~15 ft. height) and mass wasting. (Facing downstream)

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5a – Geneva Street culvert showing scour erosion, undermining of the concrete apron to a cantilevered condition, exposure of water line, accelerated failure of the northern bank. (Facing upstream)

5b – Geneva Street culvert showing scour erosion, undermining of the concrete apron to a cantilevered condition, exposure of water line. (Facing upstream)

In a natural system, a stream is considered to be in dynamic equilibrium when its dimension, pattern, and profile remain relatively stable over time without significant aggradation or degradation. When that balance is disrupted—by changes in flow regime, watershed development, or physical constraints—erosion and instability can accelerate as the stream attempts to establish a new equilibrium.

To better understand where Garcia Creek falls in this adjustment process, reference is made to the Incised Channel Evolution Model (e.g., Schumm, 1984), which describes the typical progression of channel responses following disturbance. Based on this framework, the current condition of the study area is consistent with a Type III reach (Degradation) transitioning into Type IV (Widening) (**Figure 7**). The dominant processes observed include bed incision, steep bank angles, and the onset of bank instability which support this classification. If left unaddressed, further lateral widening and loss of property or infrastructure may occur as the channel progresses through subsequent stages of geomorphic adjustment.

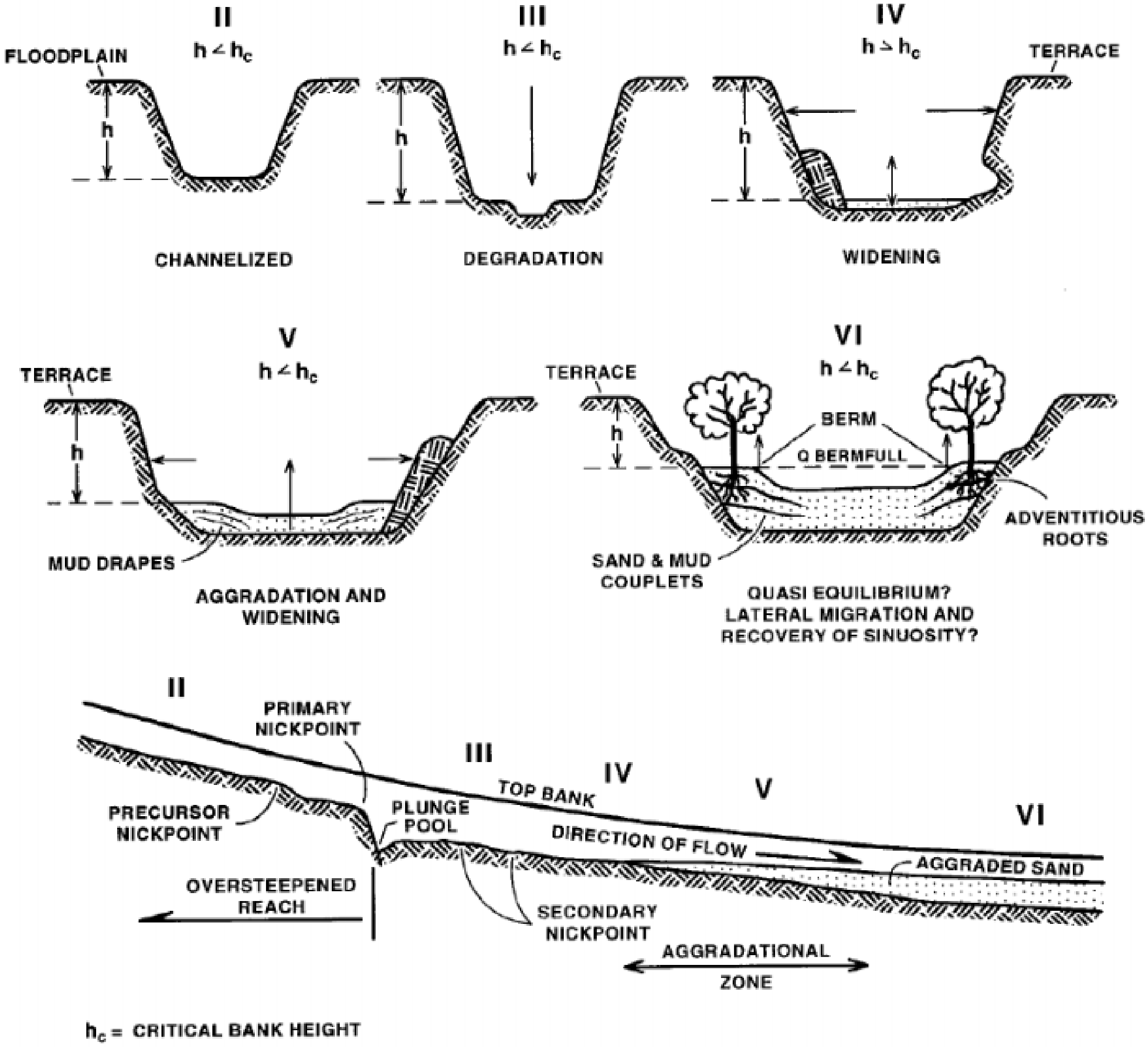

Figure 7 – Channel Evolution Model

3.0 Hydrology

Existing conditions hydrology was calculated using HEC-HMS software version 4.12 to simulate the Annual Exceedance Probability (AEP) storm events. The purpose of the HEC-HMS model was to develop peak flow data to generate rainfall hydrographs as input parameters for the accompanying hydraulic analysis, flood inundation mapping, and review of the channel velocities and shear stress distributions within the study area.

The total drainage basin for the study was found to be 200.2 acres. The basin was divided into two points of interest, one at generally Athens Street and another at Geneva Street (**Figure 8**).

Curve Numbers were computed using the Soil Conservation Service (SCS) Unit Hydrograph method. The SCS runoff Curve Numbers (CN) were calculated using the National Resource Conservation Service (NRCS) soil type data in conjunction with the National Land Cover Database (NLCD) which provides impervious cover values.

The soil classifications for the drainage areas are generally characterized as Type B, C, and D soils, as represented in the USDA's Web Soil Survey (**Section 2.8**). These soils are regarded to have moderate to slow infiltration rates and high runoff potential.

A summary of the calculated Curve Numbers representing existing conditions soil and land use classifications are provided in **Table 1**.

Table 1 - Drainage Basin Properties

Drainage ID	Discharge Point	Area (Acres)	Tc (min.)	Lag (min.)	Curve Number (CN)
S-1	Geneva Street	150.5	65.82	39.49	78.9
S-2	Mexico Street	49.7	67.49	40.49	76.3

Rainfall utilized NOAA Atlas-14 Rainfall values and are summarized in **Table 2**.

Table 2 - Rainfall Depth Duration Values based on Atlas 14 Precipitation Data

Duration	Depth of Precipitation by Recurrence Interval (inches)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
5 min.	0.530	0.661	0.768	0.915	1.030	1.140
10 min.	0.843	1.050	1.230	1.460	1.650	1.820
15 min.	1.060	1.320	1.530	1.820	2.040	2.260
30 min.	1.500	1.860	2.150	2.540	2.840	3.130
1 hour	1.960	2.450	2.840	3.390	3.800	4.210
2 hour	2.400	3.060	3.630	4.450	5.090	5.770
3 hour	2.640	3.430	4.130	5.140	5.960	6.850
6 hour	3.080	4.060	4.960	6.290	7.400	8.630
12 hour	3.510	4.660	5.720	7.300	8.640	10.100
24 hour	3.980	5.290	6.500	8.330	9.870	11.600

Time of Concentration methodology follows the guidance provided in the U.S. Department of Agriculture's Technical Release No. 55 (TR-55), *Urban Hydrology for Small Watersheds*. Lag times for each drainage area were calculated using TR-55 procedures. Reach routing was not applied due to the short length of the flow paths, which are assumed to have negligible impact on hydrograph timing.

Peak discharge rates are summarized in **Table 3**.

Table 3 - Summary of Existing Conditions Peak Discharge Rates

	Geneva Street (cfs)	Mexico Street (cfs)
2-yr	159.1	205.0
5-yr	238.5	309.6
10-yr	306.5	399.7
50-yr	475.9	624.8
100-yr	550.0	723.6

The peak flow hydrographs generated from HEC-HMS were then imported into the HEC-RAS 2D hydraulic model as inflow hydrographs applied at Geneva Street and near Athens Street. Refer to **Figure 8** below for the configuration of the hydrologic HMS model.

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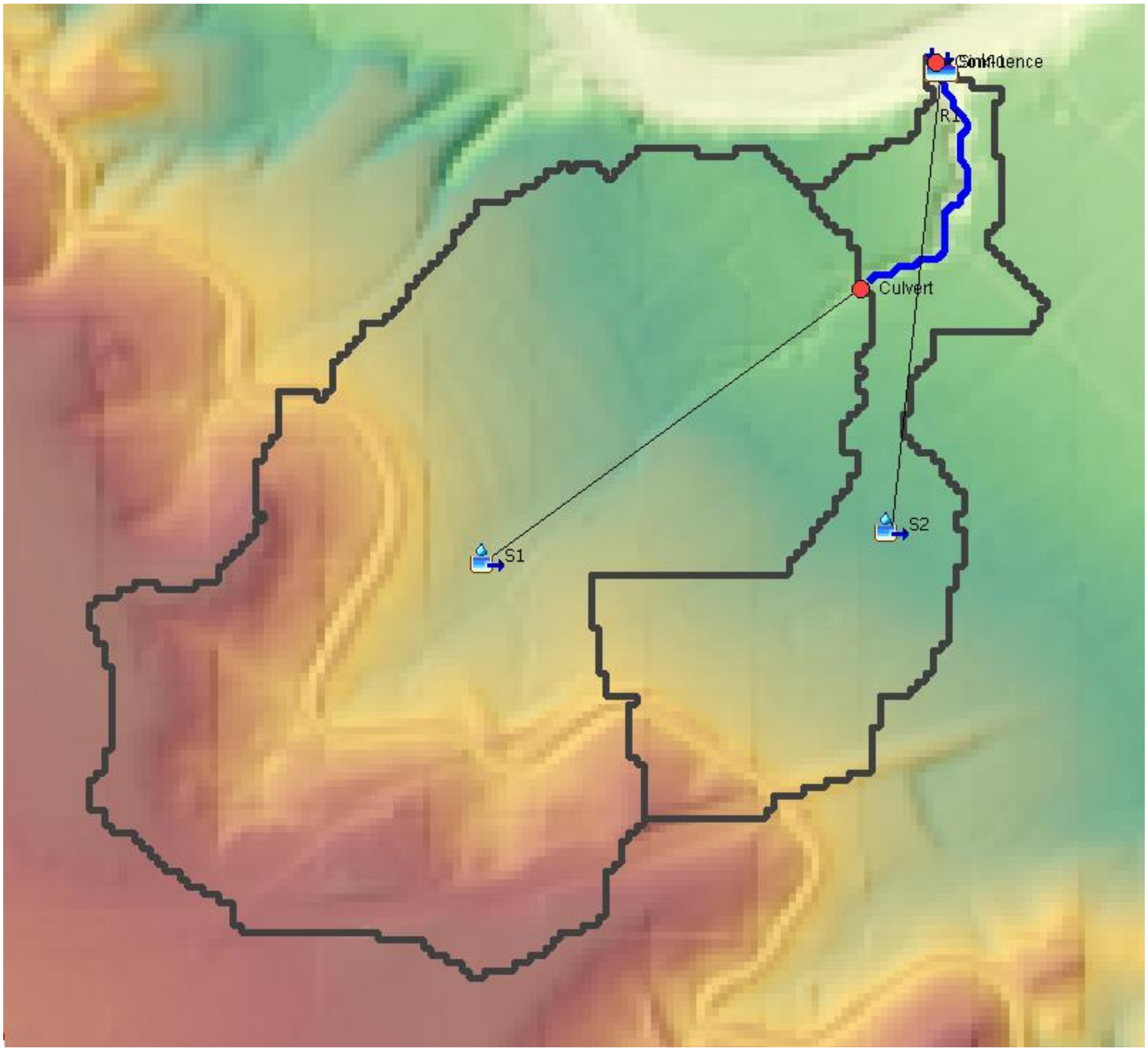

Figure 8 - HMS Model Setup

4.0 Hydraulics

The purpose of the hydraulic modeling for this study was to assess the erosive potential of Garcia Creek within the project reach and to evaluate the effectiveness of proposed stabilization measures. The model was used to simulate a range of storm events to determine the resulting flow velocities and shear stresses acting on the existing channel geometry.

The hydraulic model was developed using HEC-RAS version 6.5 and incorporates 2018 USGS LiDAR terrain data along with field survey data collected in November 2024. The model domain extends from a point downstream of the confluence with the Medina River upstream through the Geneva Street culvert. Analysis was conducted using 2D unsteady flow simulation (RAS 2D).

A 2D hydraulic analysis was selected for this study because detailed evaluation of flow velocity and shear stress distributions were essential for assessing channel erosion potential and the performance of stabilization measures. Unlike 1D models, which provide averaged flow characteristics at cross sections, 2D modeling offers a spatially continuous representation of hydraulic conditions across the channel and floodplain. This approach allows for a more accurate identification of localized high-velocity zones, shear stress concentrations, and complex flow patterns—all of which are critical in areas with irregular geometry, overbank flow, or active erosion.

The 2D component of the RAS 2D model is heavily dependent upon an accurate terrain surface to appropriately simulate surface flow. The 2018 LiDAR data along with the captured field survey data was combined to develop the surface terrain model. RAS 2025 was utilized for refinement of the mesh cells and additions of break lines.

The boundary condition utilizes normal depth to establish the starting water surface elevation at the downstream limit. Normal depth is established by calculating the average slope of the channel. The boundary condition is additionally influenced by the Medina River, also known as tailwater conditions. However, due to the focus of this analysis being on the localized erosion condition, no tailwater condition was assumed for the Medina River.

4.1 Hydraulic Results

The hydraulic model evaluated flow conditions for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events to assess the erosive potential of Garcia Creek under a range of design flows. Particular focus was placed on the 2-year and 100-year events to capture both the geomorphic and flood risk perspectives.

The 2-year event is widely recognized in fluvial geomorphology as the channel-forming flow which is the discharge most responsible for shaping channel morphology through sediment transport and bank erosion. This flow typically corresponds to near-bankfull conditions and represents the equilibrium condition of natural stream processes.

The 100-year event serves as the upper bound for evaluating performance under extreme flood conditions, allowing assessment of risks to public infrastructure, adjacent private property, and the long-term stability of proposed improvements. **Figure 9** illustrates the 100-year flood inundation mapping, which highlights areas of potential overbank flow and flood risk.

Focusing on these two design events allows for a balanced understanding of both the routine geomorphic stresses acting on the channel and the capacity of stabilization measures to withstand rare, high-impact flood events.

Figure 9 - Flood Inundation Mapping Results (100-year)

4.2 Velocity Analysis

Flow velocity plays a critical role in channel erosion and sediment transport. The 2-year storm event, in particular, is of interest as it generally represents the channel-forming flow—the flow frequency most responsible for shaping the stream channel through routine geomorphic processes such as bed mobilization and bank retreat.

Model results indicate that flow velocities in several channel segments exceed 5 ft/s, which is generally above the maximum permissible velocity for native soils and existing vegetation. These elevated velocities are most pronounced in the narrow segments of the channel reach with steep side slopes, where flow is confined and shear stresses are concentrated. These segments are especially vulnerable to bed degradation, toe scour, and progressive bank erosion.

Hotspot areas were identified:

- Immediately downstream of the Geneva Street culvert, where the culvert outfall is directed towards the northern bank.
- At the segment where the channel narrows in width, resulting in degradation of the channel bottom.
- The mid-channel reach, where flow convergence and tight bends concentrate energy along the outer banks.
- The side channel confluence near Athens Street, where flow transitions and turbulence contribute to localized erosion.

In addition to localized hotspots, the cumulative erosive potential along entirety of the reach from Mexico Street to upstream of Geneva poses a concern for global slope stability, particularly where eroding banks encroach near residential fences and structures.

Figure 10 illustrates the spatial distribution of flow velocities under the 2-year storm conditions, highlighting areas where velocities exceed erosion-resistant thresholds (yellow to red shading) and should be prioritized for stabilization.

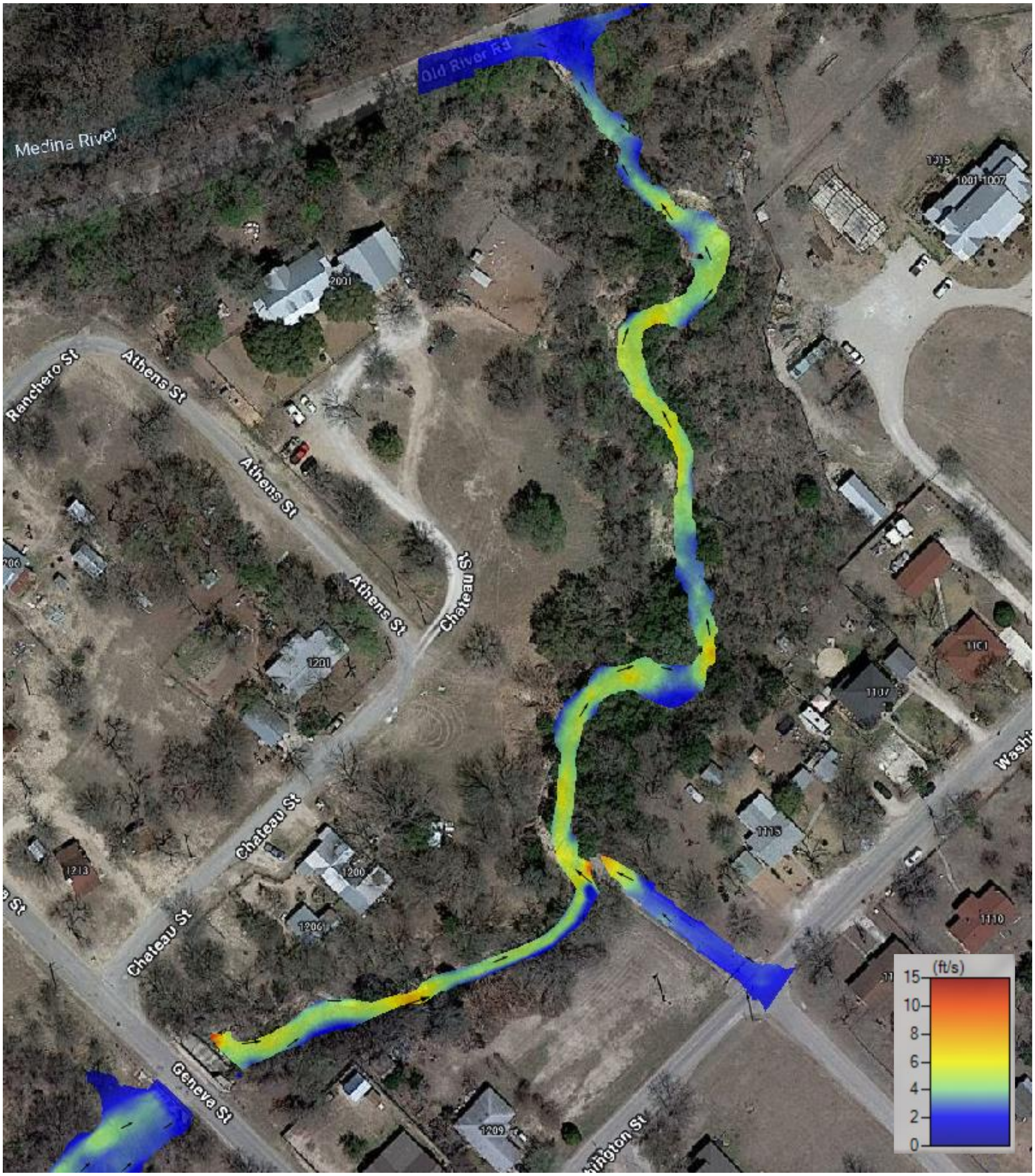

Figure 10 - Velocity Distribution (2-year)

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4.3 Shear Stress Analysis

Shear stress represents the force per unit area that flowing water exerts on the bed and banks of a channel. It is a critical parameter in evaluating erosion potential, as erosion occurs when the applied shear stress exceeds the permissible threshold of the native soil or protective vegetation.

In the Garcia Creek study area, modeled shear stress values during the 2-year storm event range from approximately 1.2 to 11.3 lb/ft². In contrast, estimated permissible shear stress values for the native sandy-loam and vegetated banks are generally in the range of 0.3 to 2.0 lb/ft², depending on root structure and ground cover. This discrepancy indicates multiple areas where the applied forces significantly exceed the natural resistance, resulting in active and ongoing erosion.

High shear stress zones are concentrated in key locations:

- At the Geneva Street culvert where flow drops down in the channel and is directed along the northern channel bank.
- Along the northern outer bank adjacent to residential properties, where bank curvature and concentrated flow generate sustained lateral forces.
- Where flow constricts between Geneva Street and Athens Street
- Near the confluence of the side channel, where flow turbulence and shifts in alignment intensify shear along the channel toe.

These conditions pose risks not only for localized erosion but also for longer-term bank instability, which could lead to undercutting, slumping, and eventual channel migration or widening as the system seeks a new dynamic equilibrium.

Figure 11 displays the spatial distribution of modeled shear stress across the study reach. Highlighted in the figure are zones where shear stress values exceed permissible thresholds (yellow to red shading) —these should be prioritized for stabilization, particularly where they coincide with infrastructure, utilities, or steep, unprotected banks.

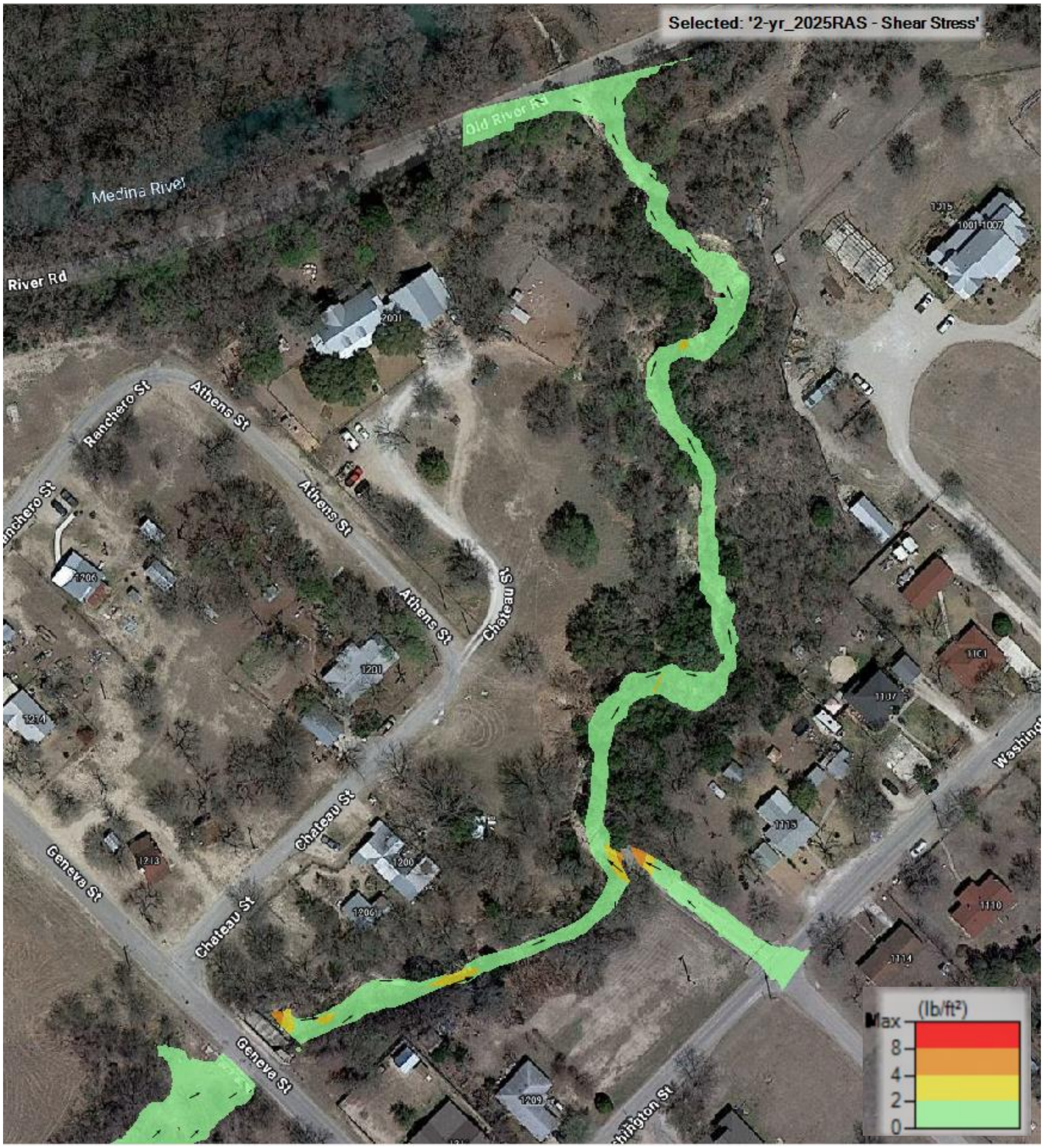

Figure 11 - Shear Stress Distribution (2-year)

5.0 Proposed Improvement Alternatives

KFA evaluated four improvement alternatives to address erosion and structural instability along Garcia Creek. Each alternative includes stabilization at the Geneva Street culvert outfall as a critical element. Conceptual designs were developed to a preliminary level for cost and feasibility comparison.

Alternative 1 – Geneva Street Culvert and Channel Wall Stabilization (Recommended)

This alternative includes stabilization of the culvert outfall and targeted improvements to the channel using structural solutions. It features retaining walls to protect eroding embankments, reinforced with rock riprap placed along the channel bottom and a concrete drop structure at the Geneva Street outfall to manage vertical channel stability and prevent further erosion. Full reconstruction of the entire reach is not feasible due to budgetary and easement limitations.

To address this constraint, the design proposes driven metal sheet piles embedded within the channel bottom. These subsurface controls function as grade stabilization structures and anchoring points, intercepting degrading flows and limiting further bed incision. This approach targets the most critical erosion hotspots while minimizing the extent of excavation and reconstruction.

Implementation would require significant reconstruction of the channel banks, including retaining walls up to 15 feet in height in certain sections, as well as the removal of mature trees along the corridor. Substantial permanent and temporary easements would be needed to facilitate construction.

Easement acquisition would involve four parcels across two property owners.

Construction access may be provided via City-owned property near the side channel, and potentially from Geneva Street with ramped access down into the channel bottom.

The rough order-of-magnitude cost estimate for this option ranges from $1.1 million to $1.5 million, aligning with the project’s budget constraints. It prioritizes stabilization of the most vulnerable segments of the creek while achieving long-term structural resilience.

Refer to **Attachment B** for preliminary design plans and easement acquisition needs.

- **Pros**: Provides critical protection at the most vulnerable point; structural controls extend stability benefits beyond immediate construction limits; relatively straightforward construction in constrained areas.
- **Cons**: High cost; does not address full-stream instability; requires extensive tree removal; modest ecological benefit; requires easements.
- **Cost**: $1,100,000 to $1,500,000

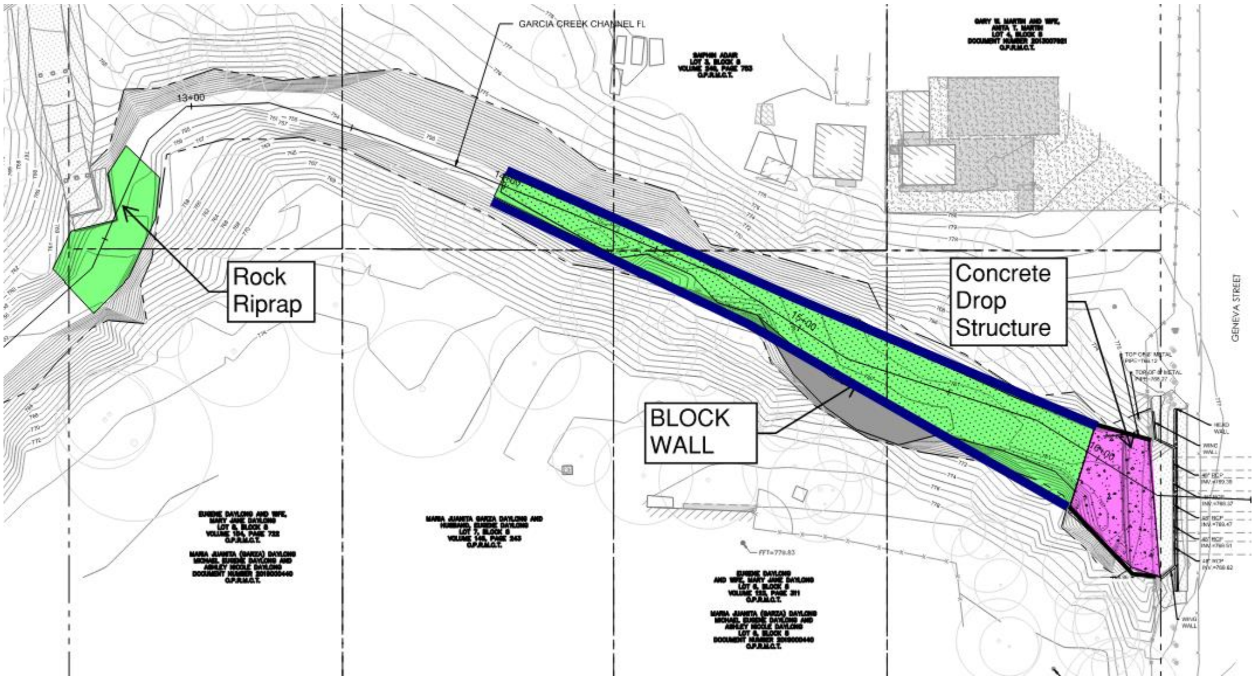

Figure 12 – Alternative 1

Alternative 2 – Geneva Street Culvert Stabilization and Channel Armoring

This alternative focuses on structural protection at the Geneva Street culvert outfall. A concrete-reinforced drop structure would be constructed to provide grade control, dissipate flow energy, and redirect water away from the eroding northern bank. In addition, rock riprap would be placed along the channel bed and at the toe of both banks in the most actively eroding segments, particularly downstream of the culvert.

This approach offers immediate protection for the culvert and nearby infrastructure and can be implemented more quickly and at a lower cost than full channel reconstruction. However, it is a localized solution and does not address broader hydraulic or geomorphic instability within the reach. The channel will likely remain vulnerable to continued vertical incision and lateral widening over time.

This option is best viewed as a short- to medium-term stabilization measure to preserve key infrastructure and mitigate ongoing erosion at the outfall.

- **Pros**: Cost-effective; relatively straightforward construction; provides critical protection at a vulnerable point.
- **Cons**: Limited in addressing broader channel instability; does not resolve long-term degradation processes; modest ecological benefit; higher likelihood of continued failure, easement acquisition needs.
- **Cost**: $400,000 to $600,000

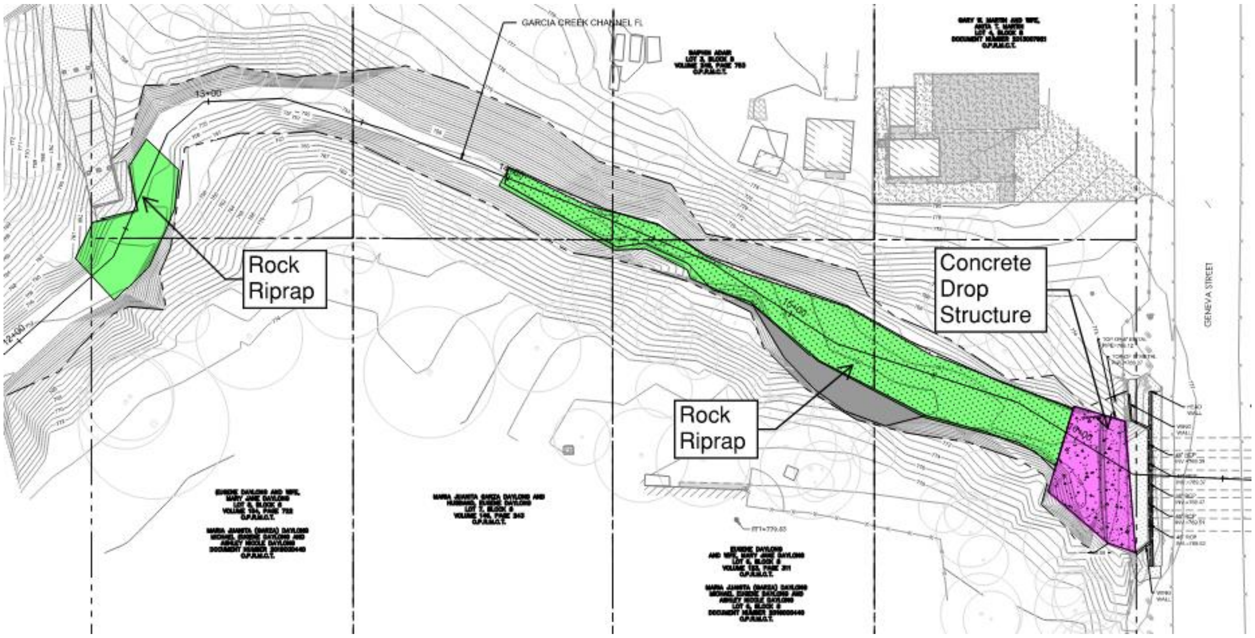

Figure 13 – Alternative 2

Alternative 3 - Reinforced Concrete Box with Secondary Bypass Channel, Geneva Street Culvert Stabilization

This is an innovative option that still prioritizes the stabilization of the Geneva Street Culvert. To overcome the steep channel banks this proposes to install a box culvert to convey the 50-year storm event and containing the 100-year within an overflow channel above the pipe. The benefits include less disturbances to the channel banks thereby preserving trees and protecting the natural character of the channel while also creating a less deep of a channel.

- **Pros**: Preserves trees along channel banks, reduces the depth of the channel.
- **Cons**: High construction complexity, more expensive
- **Cost**: $2.0M to $2.5M
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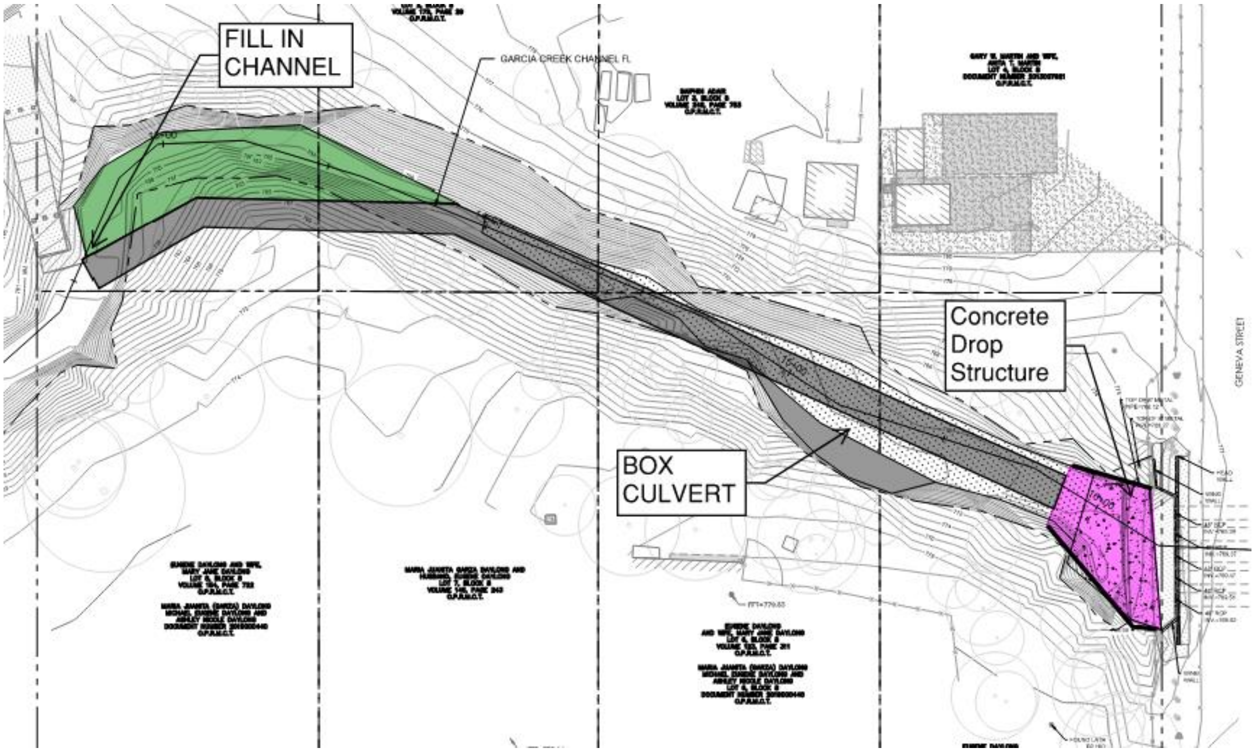

Figure 14 – Alternative 3

Alternative 4 – Property Buyouts, Geneva Street Culvert Stabilization

This alternative includes stabilization of the Geneva Street culvert outfall and the voluntary acquisition of the property at 1206 Chateau, where the greatest erosion risk exists. Stabilization measures at the culvert would likely include a concrete drop structure and riprap armoring, similar to Alternatives 1 and 2, to protect existing infrastructure and prevent further degradation at the outfall.

The property buyout would eliminate future risk to structures on the most vulnerable parcel and provide long-term flexibility for future channel restoration or expansion if needed. This approach reduces risk to life and property but does not resolve broader instability along the remainder of the creek.

This option offers a strategic retreat from high-risk areas while still preserving critical infrastructure.

- **Pros**: Eliminates risk to highest-risk structure; provides long-term solution extensive channel reconstruction; creates flexibility for future restoration activities.
- **Cons**: Does not address ongoing instability upstream or downstream; requires coordination with property owner and displacement of the residential property; does not improve channel function or habitat.
- **Cost**: $700k to $1.0M

6.0 Recommendations

Based on the findings of the preliminary engineering analysis, field reconnaissance, and hydraulic modeling, Alternative 1 – Geneva Street Culvert and Channel Wall Stabilization is recommended for advancement to final design. This alternative provides the greatest benefit in terms of protecting critical infrastructure, arresting the most severe erosion processes, and reducing the risk of culvert failure and further upstream degradation.

The use of driven sheet piles as structural grade controls embedded within the channel bed is a key design feature that enables stabilization of vertical channel degradation while reducing the need for full reconstruction along the entire reach. This hybrid approach balances constructability, performance, and cost.

Although implementation will require significant tree removal, bank reconstruction, and temporary and permanent easements, this approach fits within the City’s estimated $1.2 million project budget while addressing the highest priority erosion concerns.

Next steps include:

- Secure permanent drainage and temporary construction easements via City property or from private landowners, with potential access from the side channel area and Geneva Street.
- Advance Alternative 1 to full design, including final grading, structural detailing, and erosion control measures.
- Conduct a formal wetland delineation and complete a Phase I Environmental Site Assessment.

- Potential coordination with the U.S. Army Corps of Engineers to determine Section 404 permitting requirements if any jurisdictional features are confirmed.
- Perform subsurface utility investigations (SUE) to confirm utility locations and identify potential conflicts.
- Evaluate future phases of improvement upstream and downstream of the current study area to improve overall channel stability over time.

This staged, priority-based approach enables the City to take action on a critical issue while building a foundation for continued long-term watershed resilience and public infrastructure protection.

Enclosures:

Attachment A – Rough Order of Magnitude Costs (DRAFT)

Attachment B – Design Concept Plan Sheets (DRAFT)

Attachment C – Geotechnical Report (DRAFT)

ATTACHMENT A

ROUGH ORDER OF MAGNITUDE COSTS

City of Castroville - Garcia Creek Channel Stabilization

Alt 1 – Geneva Street Culvert and Channel Wall Stabilization

BID ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	TOTAL
MOBILIZATION	LS	1	4%	$ 31,965
PREPARING RIGHT-OF-WAY	LS	1	10%	$ 79,912
CHANNEL EXCAVATION	CY	100	$ 60.00	$ 6,000
EMBANKMENT	CY	485	$ 30.00	$ 14,563
FURNISHING AND PLACING TOPSOIL (4")	CY	108	$ 45.00	$ 4,861
GRADE CONTROL STRUCTURE	EA	2	$ 10,000.00	$ 20,000
TRENCH EXCAVATION AND SAFETY PROTECTION	LF	350	$ 8.00	$ 2,800
FLOWABLE FILL	CY	475	$ 180.00	$ 85,500
DRY ROCK RIPRAP (D50 18")	CY	120	$ 180.00	$ 21,600
CONCRETE DROP STRUCTURE	CY	85	$ 1,500.00	$ 127,500
FLUME OUTFALL	LS	1	$ 30,000.00	$ 30,000
FLEXBASE (24-INCH THICKNESS)	CY	20	$ 100.00	$ 2,000
TREE REMOVAL	EA	50	$ 800.00	$ 40,000
RETAINING WALL, SEGMENTAL	SF	3,000	$ 130.00	$ 390,000
TREE AND VEGETATION PROTECTION	LS	1	$ 10,000.00	$ 10,000
ROCK FILTER DAMS (INSTALL/REMOVE)	LF	500	$ 75.00	$ 37,500
CONSTRUCTION EXITS (INSTALL/REMOVE)	SY	1	$ 2,500.00	$ 2,500
TEMPORARY SEDIMENT CONTROL FENCE	LF	600	$ 6.00	$ 3,600
CHAIN LINK FENCE TEMP. (INSTALL/REMOVE)	LF	100	$ 7.00	$ 700
			SUBTOTAL	$ 911,001
			CONTINGENCY (30%)	$ 273,300.28
			ENGINEERING (20%)	$ 236,860.2
			TOTAL	$ 1,421,161

Alt 2 – Geneva Street Culvert Stabilization and Channel Armoring

BID ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	TOTAL
MOBILIZATION	LS	1	4%	$ 10,776
PREPARING RIGHT-OF-WAY	LS	1	5%	$ 13,470
CHANNEL EXCAVATION	CY	100	$ 60.00	$ 6,000
EMBANKMENT	CY	50	$ 30.00	$ 1,500
GRADE CONTROL STRUCTURE	EA	5	$ 10,000.00	$ 50,000
CONC HEADWALL WITH WINGS, HW= XFT	EA	1	$ 20,000.00	$ 20,000
FLOWABLE FILL	CY	220	$ 180.00	$ 39,600
DRY ROCK RIPRAP (D50 18")	CY	500	$ 180.00	$ 90,000
TREE REMOVAL	EA	10	$ 800.00	$ 8,000
TREE AND VEGETATION PROTECTION	LS	1	$ 10,000.00	$ 10,000
ROCK FILTER DAMS (INSTALL/REMOVE)	LF	500	$ 75.00	$ 37,500
CONSTRUCTION EXITS (INSTALL/REMOVE)	SY	1	$ 2,500.00	$ 2,500
TEMPORARY SEDIMENT CONTROL FENCE	LF	600	$ 6.00	$ 3,600
CHAIN LINK FENCE TEMP. (INSTALL/REMOVE)	LF	100	$ 7.00	$ 700
			SUBTOTAL	$ 293,646
			CONTINGENCY (30%)	$ 88,093.80
			ENGINEERING (20%)	$ 76,348.0
			TOTAL	$ 458,088

Alt 3 – Reinforced Concrete Box with Secondary Bypass Channel, Geneva Street Culvert Stabilization

BID ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	TOTAL
MOBILIZATION	LS	1	4%	$ 58,278
PREPARING RIGHT-OF-WAY	LS	1	5%	$ 72,848
CHANNEL EXCAVATION	CY	300	$ 60.00	$ 18,000
EMBANKMENT	CY	2,000	$ 30.00	$ 60,000
FURNISHING AND PLACING TOPSOIL (4")	CY	150	$ 45.00	$ 6,750
GRADE CONTROL STRUCTURE	EA	5	$ 10,000.00	$ 50,000
TRENCH EXCAVATION AND SAFETY PROTECTION	LF	350	$ 8.00	$ 2,800
PRECAST REINFORCED CONCRETE BOX (6'X4')	LF	700	$ 1,500.00	$ 1,050,000
CONC HEADWALL WITH WINGS, HW= XFT	EA	2	$ 20,000.00	$ 40,000
FLOWABLE FILL	CY	220	$ 180.00	$ 39,600
DRY ROCK RIPRAP (D50 18")	CY	100	$ 180.00	$ 18,000
VERTICAL STILLING BASIN	CY	65	$ 1,500.00	$ 97,500
TREE REMOVAL	EA	25	$ 800.00	$ 20,000
TREE AND VEGETATION PROTECTION	LS	1	$ 10,000.00	$ 10,000
ROCK FILTER DAMS (INSTALL/REMOVE)	LF	500	$ 75.00	$ 37,500
CONSTRUCTION EXITS (INSTALL/REMOVE)	SY	1	$ 2,500.00	$ 2,500
TEMPORARY SEDIMENT CONTROL FENCE	LF	600	$ 6.00	$ 3,600
CHAIN LINK FENCE TEMP. (INSTALL/REMOVE)	LF	100	$ 7.00	$ 700
			SUBTOTAL	$ 1,588,076
			CONTINGENCY (30%)	$ 476,422.65
			ENGINEERING (20%)	$ 412,899.6
			TOTAL	$ 2,477,398

Alt 4 – Property Buyouts, Geneva Street Culvert Stabilization

BID ITEM DESCRIPTION	UNIT	QTY	UNIT PRICE	TOTAL
MOBILIZATION	LS	1	4%	$ 11,225
PREPARING RIGHT-OF-WAY	LS	1	5%	$ 14,031
CHANNEL EXCAVATION	CY	20	$ 60.00	$ 1,200
EMBANKMENT	CY	20	$ 30.00	$ 600
FURNISHING AND PLACING TOPSOIL (4")	CY	25	$ 45.00	$ 1,125
GRADE CONTROL STRUCTURE	EA	5	$ 10,000.00	$ 50,000
TRENCH EXCAVATION AND SAFETY PROTECTION	LF	350	$ 8.00	$ 2,800
CONC HEADWALL WITH WINGS, HW= XFT	EA	2	$ 20,000.00	$ 40,000
FLOWABLE FILL	CY	220	$ 180.00	$ 39,600
DRY ROCK RIPRAP (D50 18")	CY	100	$ 180.00	$ 18,000
VERTICAL STILLING BASIN	CY	65	$ 1,500.00	$ 97,500
TREE REMOVAL	EA	10	$ 800.00	$ 8,000
TREE AND VEGETATION PROTECTION	LS	1	$ 10,000.00	$ 10,000
ROCK FILTER DAMS (INSTALL/REMOVE)	LF	100	$ 50.00	$ 5,000
CONSTRUCTION EXITS (INSTALL/REMOVE)	SY	1	$ 2,500.00	$ 2,500
TEMPORARY SEDIMENT CONTROL FENCE	LF	600	$ 6.00	$ 3,600
CHAIN LINK FENCE TEMP. (INSTALL/REMOVE)	LF	100	$ 7.00	$ 700
			SUBTOTAL	$ 305,881
			CONTINGENCY (30%)	$ 91,764.38
			ENGINEERING (20%)	$ 79,529.1
			TOTAL	$ 477,175

Property Acquisition / Buyouts

Parcel 14012	%	200%	53600	$ 107,200
Parcel 14013	%	200%	84690	$ 169,380
Parcel 36181	%	175%	26800	$ 46,900
			TOTAL	$ 323,480

TOTAL (IMPROVEMENTS + BUYOUTS) $ 800,655

ATTACHMENT B

DESIGN CONCEPT PLAN SHEETS

CITY OF CASTROVILLE
GARCIA CREEK
DRAINAGE IMPROVEMENTS

PREPARED FOR:

CITY OF CASTROVILLE, TEXAS

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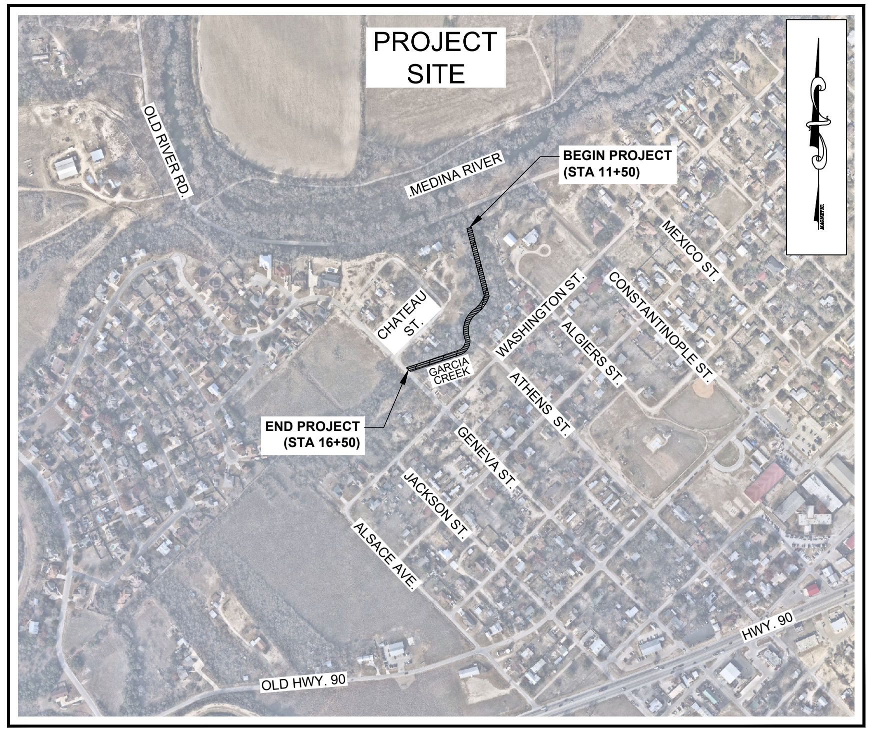
JUNE 2025



LOCATION MAP
NTS

PREPARED BY:

K·FRIESE
+ ASSOCIATES
A LOCHNER COMPANY

40 NE Loop 410
Mercantile Building, Suite 545
San Antonio, Texas 78216
P 210.491.2391
TBPE Firm No. 6535
www.kfriese.com

SUBMITTED FOR APPROVAL BY:

ABE A. SALINAS, PE K FRIESE & ASSOCIATES, LLC	DATE

ACCEPTED FOR CONSTRUCTION

NAME, PE MEDINA COUNTY ENGINEER	DATE

ACCEPTED FOR CONSTRUCTION

NAME - TITLE CITY OF CASTROVILLE, TEXAS	DATE

NOTES:
COORDINATES ARE SURFACE VALUES BASED ON THE TEXAS STATE PLANE COORDINATE SYSTEM, NAD 83, SOUTH CENTRAL ZONE.
TO CONVERT COORDINATES AND DISTANCES TO GRID VALUES MULTIPLY BY A COMBINED SURFACE ADJUSTMENT FACTOR OF 0.99987384.
ELEVATIONS REPORTED ARE NAVD88 ORTHOMETRIC GPS HEIGHTS.

SHEET INDEX

Sheet Number	Sheet Title
1	COVER SHEET
2	SHEET INDEX
3	GENERAL NOTES AND QUANTITIES
4	EXISTING CONDITIONS PLAN
5	DRAINAGE PLAN & PROFILE
6	EXISTING CHANNEL CROSS SECTIONS (1 OF 4)
7	EXISTING CHANNEL CROSS SECTIONS (2 OF 4)
8	EXISTING CHANNEL CROSS SECTIONS (3 OF 4)
9	EXISTING CHANNEL CROSS SECTIONS (4 OF 4)
10	CHANNEL DETAILS
11	DRAINAGE CHANNEL LAYOUT
12	CULVERT LAYOUT
13	TREE SURVEY AND PROTECTION PLAN
4	GENERAL QUANTITIES
7	CROSS SECTION LAYOUT

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CASTROVILLE, TEXAS
CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

SHEET
INDEX

NOTES	NAME	DATE
SURVEY BY	ZAM	####
DRAWN BY	JH	####
DESIGNED BY	TJ	####
CHECKED BY	MG	####
REVIEWED BY	MP	####

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ARENAS, ROYD

GENERAL NOTES:

1. GRADING AND GROUND ELEVATIONS SHOWN ARE BASED UPON 3RD PARTY INFORMATION AND HAVE NOT BEEN VERIFIED. CONTRACTOR TO VERIFY EXISTING ELEVATIONS, EXISTING DRAINAGE AND UTILITY ROW LOCATION, AND EXISTING UTILITIES WITHIN THE GRADING LIMITS. PROPOSED GRADING SHALL BE CONTAINED WITHIN THE EXISTING ROW LIMITS AND ADJUSTED AS NECESSARY TO AVOID ANY UTILITY IMPACTS.

2. A CONSTRUCTION ENTRANCE SHALL BE LOCATED SO AS TO PROVIDE THE LEAST AMOUNT OF DISTURBANCE TO THE FLOW OF TRAFFIC IN AND OUT OF THE SITE.

3. THE NATURE OF THIS SITE'S CONSTRUCTION CONSISTS OF:
   A. CLEARING AND GRUBBING
   B. PRELIMINARY GRADING
   C. FINAL GRADING AND STABILIZATION

4. POST CONSTRUCTION STORM WATER POLLUTION CONTROL MEASURES INCLUDE STABILIZATION BY PERMANENT LANDSCAPING.

5. DISTURBED PORTIONS OF SITE MUST BE STABILIZED. STABILIZATION PRACTICES MUST BE INITIATED WITHIN 14 DAYS IN PORTIONS OF THE SITE WHERE CONSTRUCTION HAS BEEN EITHER TEMPORARILY OR PERMANENTLY CEASED. CONTRACTOR SHALL REMOVE TEMPORARY EROSION CONTROL DEVICES UPON COMPLETION OF STABILIZATION AND PERMANENT DRAINAGE FACILITIES.

6. CONTRACTOR SHALL INSPECT DISTURBED AREAS, MATERIAL STORAGE AREAS EXPOSED TO PRECIPITATION, STRUCTURAL CONTROL MEASURES, AND VEHICLE ENTRY AND EXIT AREAS AT LEAST ONCE EVERY 14 CALENDAR DAYS AND WITHIN 24 HOURS OF A STORM EVENT OF 0.5 INCHES OR GREATER.

7. CONTRACTOR IS SOLELY RESPONSIBLE FOR SELECTION, IMPLEMENTATION, MAINTENANCE, AND EFFECTIVENESS OF ALL SWPPP CONTROLS.

8. CONTRACTOR SHALL RECORD INSTALLATION, MAINTENANCE OR MODIFICATION, AND REMOVAL DATES FOR EACH EROSION CONTROL BMP EMPLOYED.

9. TEMPORARY AND PERMANENT STABILIZATION PRACTICES AND BMP'S SHALL BE INSTALLED AT THE EARLIEST POSSIBLE TIME DURING THE CONSTRUCTION SEQUENCE. AS AN EXAMPLE, PERIMETER SILT FENCE SHALL BE INSTALLED BEFORE COMMENCEMENT OF ANY GRADING ACTIVITIES. OTHER BMP'S SHALL BE INSTALLED AS SOON AS PRACTICABLE AND SHALL BE MAINTAINED UNTIL FINAL SITE STABILIZATION IS ATTAINED.

10. THE DISTRUBED AREAS TO RECEIVE SEED MIXES SHALL BE FROM HYDROSEED. COORDINATE HYDROSEED MIX WITH SEED SUPPLIERS CURRENT RECOMMENDATION BY APPLICATION AND SLOPE ASPECT.

11. PERMANENT STABILIZATION SEED MIX: FROM SEPTEMBER 1 TO MARCH 1, 1 POUND PER 1,000 SQUARE FEET OF UNHULLED BERMUDA FROM MARCH 2 TO AUGUST 31, 1 POUND PER 1,000 SQUARE FEET OF HULLED BERMUDA

12. ALTERNATE SEED MIXES CAN BE USED WITH ENGINEER'S WRITTEN APPROVAL.

13. FROM SEPTEMBER 1 TO MARCH 1, 70 POUNDS PER ACRE OF WINTER RYE WITH A PURITY OF 95% WITH 90% GERMINATION SHALL BE ADDED TO EACH SEED MIX.

14. FROM MARCH 2 TO AUGUST 31, 30 POUNDS PER ACRE OF FOXTAIL MILLET WITH A PURITY OF 95% WITH 85% GERMINATION SHALL BE ADDED TO EACH SEED MIX.

15. FERTILIZER SHALL BE A WATER SOLUBLE FERTILIZER WITH AN ANALYSIS OF 15-15-15 AT THE RATE OF 1.5 POUNDS PER 1,000 SQUARE FEET.

16. RESTORATION SHALL BE ACCEPTABLE WHEN THE GRASS HAS GROWN AT LEAST 1-1/2 INCHES HIGH WITH 95% COVERAGE, PROVIDED NO BARE SPOTS LARGER THAN 16 SQUARE FEET EXIST.

17. CONTRACTOR SHALL IDENTIFY AND PROTECT EXISTING PUBLIC, PRIVATE, FRANCHISE, TELEPHONE, ELECTRIC, CABLE, GAS, AND OTHER UTILITY SERVICE LINES DURING CONSTRUCTION. ANY DAMAGE TO THESE FACILITIES SHALL BE REPAIRED AT NO ADDITIONAL PAY. ADDITIONAL UTILITIES MAY EXIST WHICH ARE NOT SHOWN ON THESE PLANS.

18. CONFLICTS IN PLANS AND/OR SPECIFICATIONS FOUND BY THE CONTRACTOR SHALL BE PROMPTLY REPORTED TO THE CITY BEFORE PROCEEDING WITH CONSTRUCTION.

19. DURING CONSTRUCTION, THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTENANCE OF FENCING. DAMAGED FENCING SHALL BE REPLACED WITH EQUAL OR BETTER MATERIALS AND WORKMANSHIP. THE CONTRACTOR SHALL COORDINATE WITH THE LANDOWNER FOR ANY WORK WITHIN PRIVATE PROPERTY.

20. NO WASTE MATERIALS SHALL BE PLACED IN EXISTING LOWS THAT WILL BLOCK OR ALTER THE FLOW OF WATER WITHIN THE CHANNEL.

21. CONSTRUCTION SPOILS WILL BE DISPOSED OFFSITE IN COMPLIANCE WITH CURRENT APPLICABLE REGULATIONS AND THESE PLANS AND SPECIFICATIONS.

22. ESTABLISH FINAL GRADES TO ASSURE POSITIVE DRAINAGE.

GENERAL QUANTITIES

BID ITEM DESCRIPTION	**UNIT**	**QTY**
MOBILIZATION	LS	1
PREPARING RIGHT-OF-WAY	LS	1
CHANNEL EXCAVATION	CY	100
EMBANKMENT	CY	485
FURNISHING AND PLACING TOPSOIL (4")	CY	108
GRADE CONTROL STRUCTURE	EA	2
TRENCH EXCAVATION AND SAFETY PROTECTION	LF	350
FLOWABLE FILL	CY	475
DRY ROCK RIPRAP (D50 18")	CY	120
CONCRETE DROP STRUCTURE	CY	85
FLUME OUTFALL	LS	1
FLEXBASE (24-INCH THICKNESS)	CY	20
TREE REMOVAL	EA	50
RETAINING WALL, SEGMENTAL	SF	3,000
TREE AND VEGETATION PROTECTION	LS	1
ROCK FILTER DAMS (INSTALL/ REMOVE)	LF	500
CONSTRUCTION EXITS (INSTALL/ REMOVE)	SY	1
TEMPORARY SEDIMENT CONTROL FENCE	LF	600
CHAIN LINK FENCE TEMP. (INSTALL/ REMOVE)	LF	100

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CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

GENERAL NOTES AND
QUANTITIES

NOTES	NAME	DATE
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DRAWN BY	JH	####
DESIGNED BY	TJ	####
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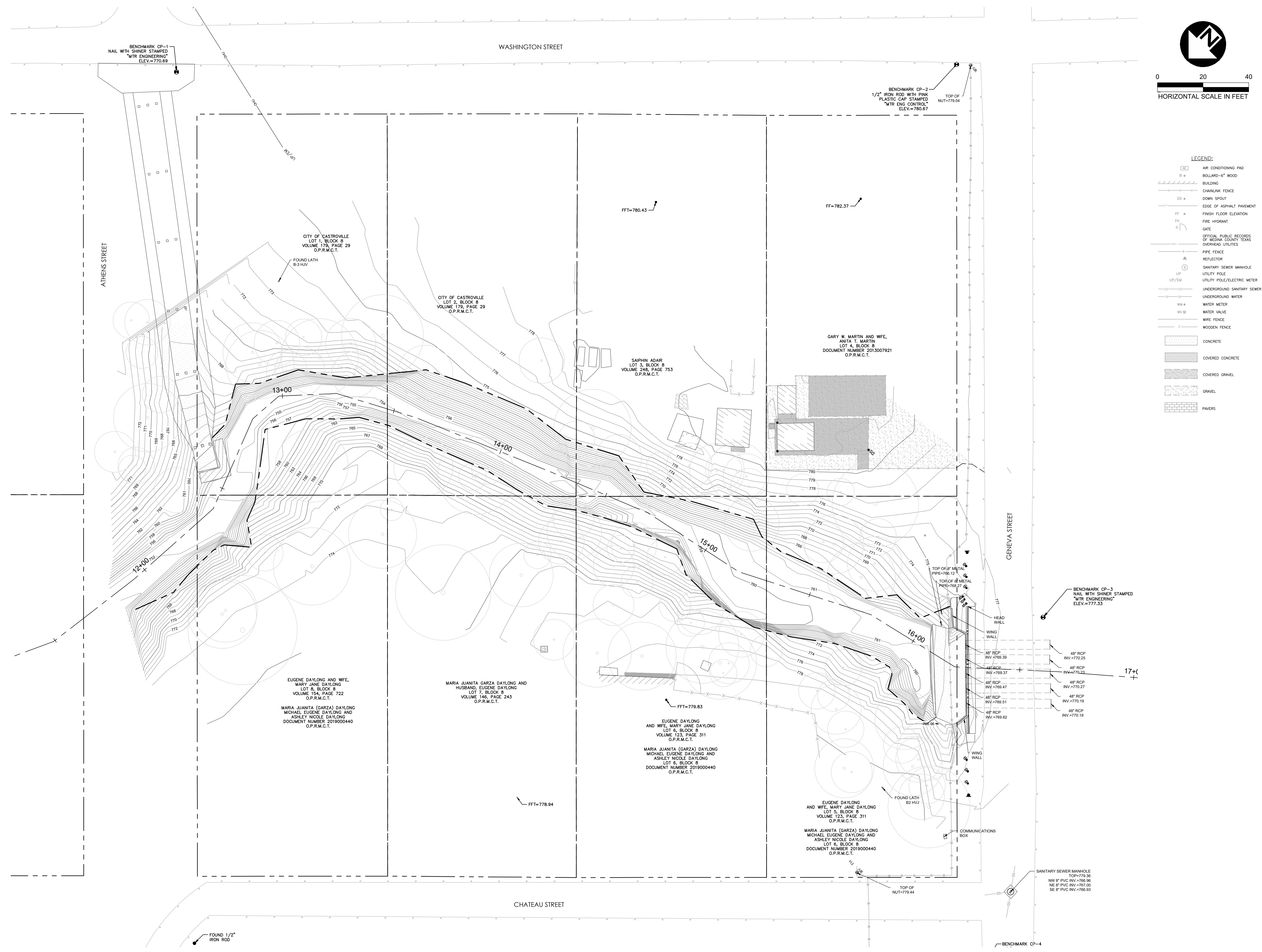

LEGEND:

AC	AIR CONDITIONING PAD
B ●	BOLLARD-6" WOOD
⁄⁄⁄⁄⁄⁄⁄⁄	BUILDING
—X—X—X—	CHAINLINK FENCE
DS ●	DOWN SPOUT
——	EDGE OF ASPHALT PAVEMENT
FF ●	FINISH FLOOR ELEVATION
FH	FIRE HYDRANT
G	GATE
	OFFICIAL PUBLIC RECORDS OF MEDINA COUNTY TEXAS
—OHU—	OVERHEAD UTILITIES
—□—	PIPE FENCE
●	REFLECTOR
Ⓢ	SANITARY SEWER MANHOLE
UP	UTILITY POLE
UP/EM	UTILITY POLE/ELECTRIC METER
—SS—SS—	UNDERGROUND SANITARY SEWER
—W—W—	UNDERGROUND WATER
WM ●	WATER METER
WV ⊗	WATER VALVE
—x—x—x—	WIRE FENCE
—//—	WOODEN FENCE
▨	CONCRETE
▨	COVERED CONCRETE
▨	COVERED GRAVEL
▨	GRAVEL
▦	PAVERS

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CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

EXISTING
CONDITIONS PLAN

NOTES	NAME	DATE
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DESIGNED BY	TJ	####
CHECKED BY	MG	####
REVIEWED BY	MP	####

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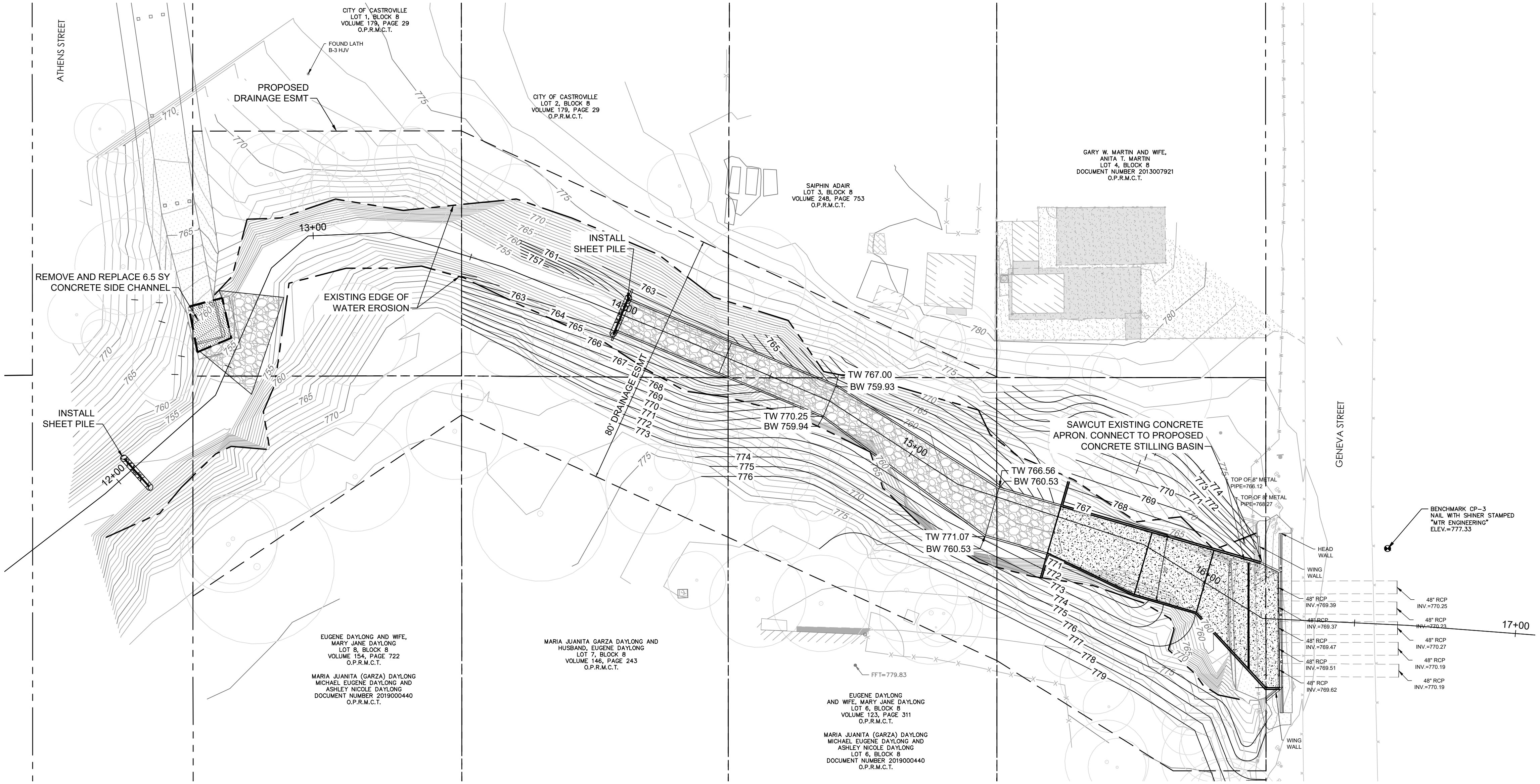

0 20 40
HORIZONTAL SCALE IN FEET

0 5 10
VERTICAL SCALE IN FEET

LEGEND:

AC	AIR CONDITIONING PAD
B ●	BOLLARD–6" WOOD
⁄⁄⁄⁄⁄⁄⁄⁄	BUILDING
—X—X—X—	CHAINLINK FENCE
DS ●	DOWN SPOUT
——	EDGE OF ASPHALT PAVEMENT
FF ●	FINISH FLOOR ELEVATION
FH	FIRE HYDRANT
	GATE
O.P.R.M.C.T.	OFFICIAL PUBLIC RECORDS OF MEDINA COUNTY TEXAS
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—▫—	PIPE FENCE
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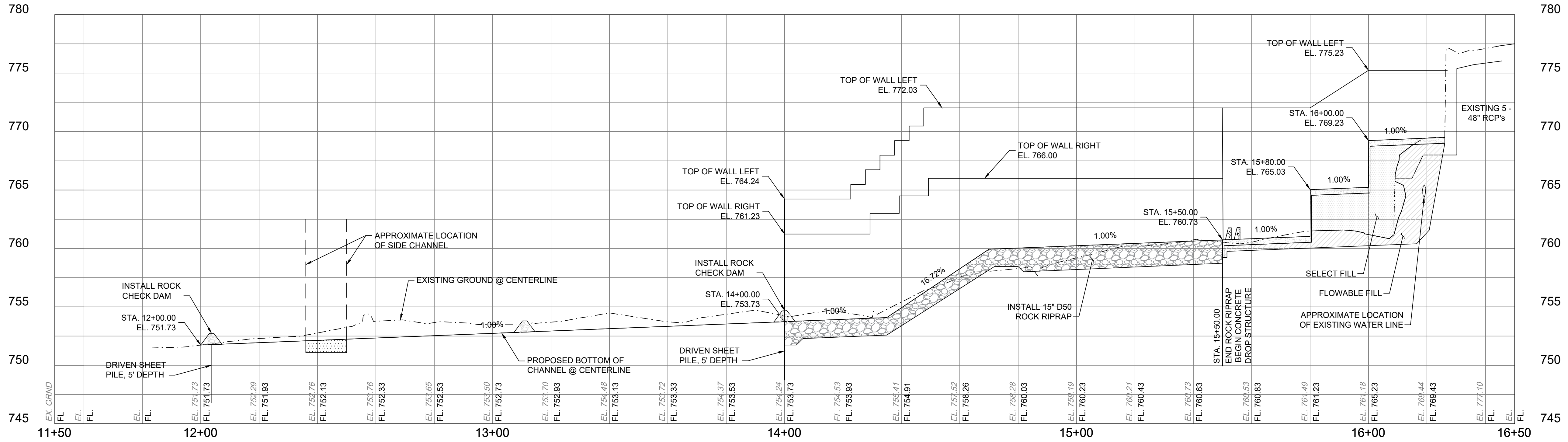
UP/EM	UTILITY POLE/ELECTRIC METER
—SS—SS—	UNDERGROUND SANITARY SEWER
—W—W—	UNDERGROUND WATER
WM ●	WATER METER
WV ⊗	WATER VALVE
—x—x—x—	WIRE FENCE
—//—	WOODEN FENCE
⠿	CONCRETE
▨	COVERED CONCRETE
▨	COVERED GRAVEL
⠿	GRAVEL
▦	PAVERS



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CASTROVILLE, TEXAS
CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

DRAINAGE PLAN & PROFILE

NOTES	NAME	DATE
SURVEY BY	ZAM	####
DRAWN BY	JH	####
DESIGNED BY	TJ	####
CHECKED BY	MG	####
REVIEWED BY	MP	####

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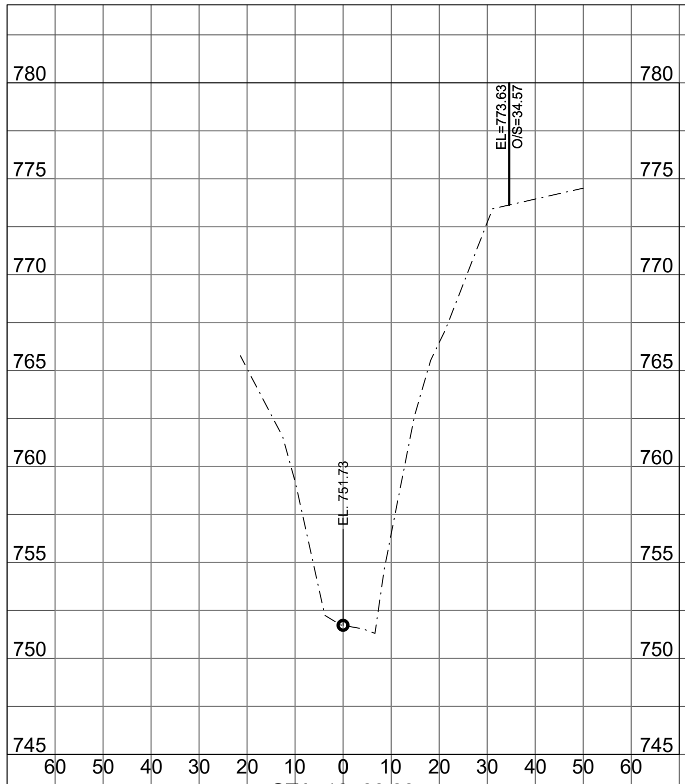

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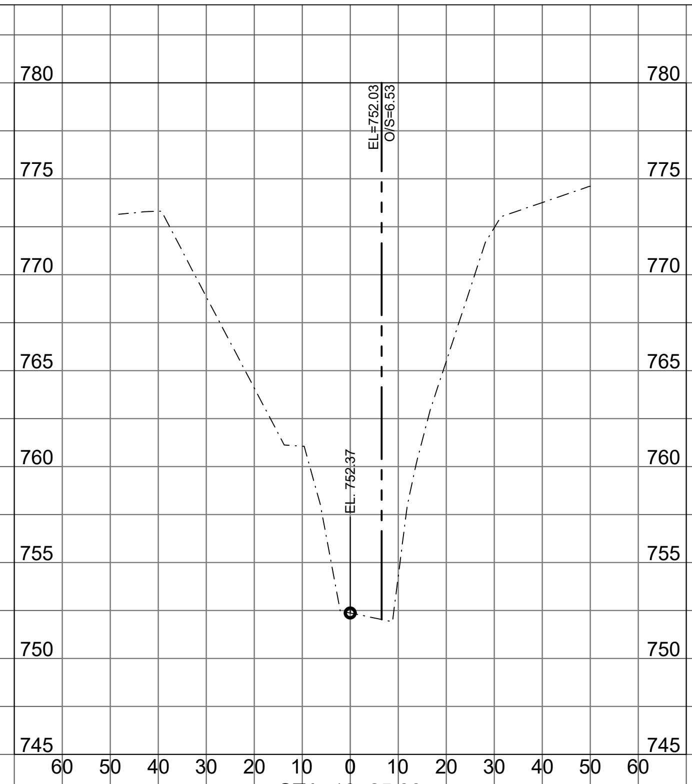

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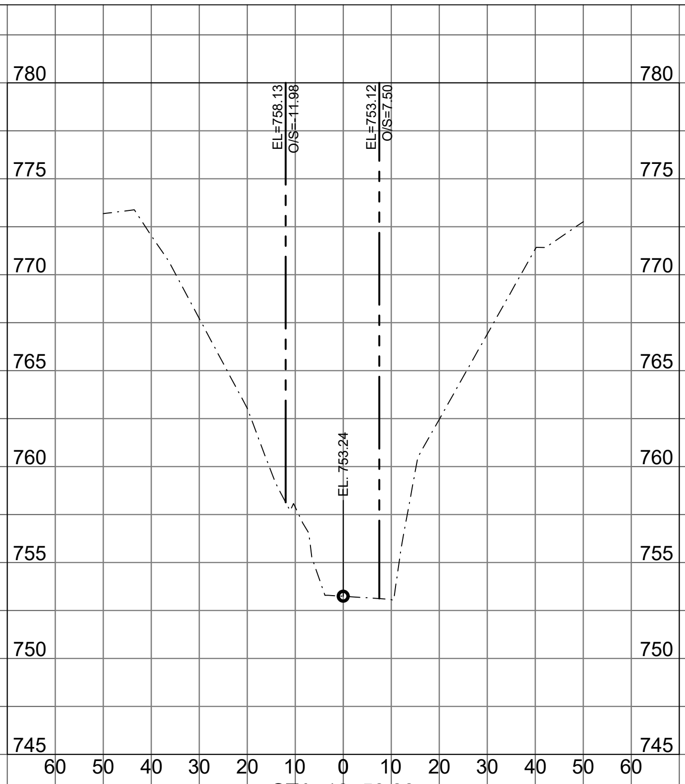

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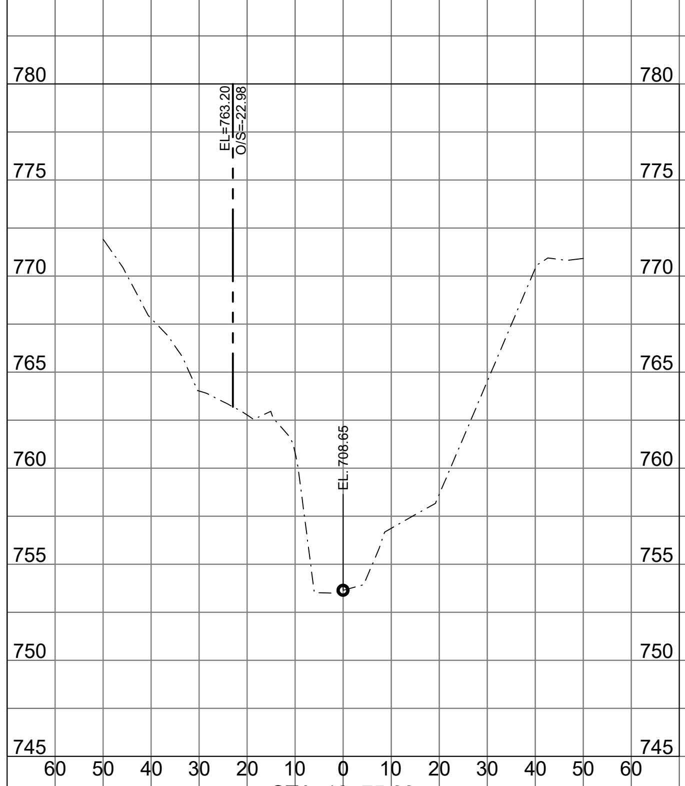

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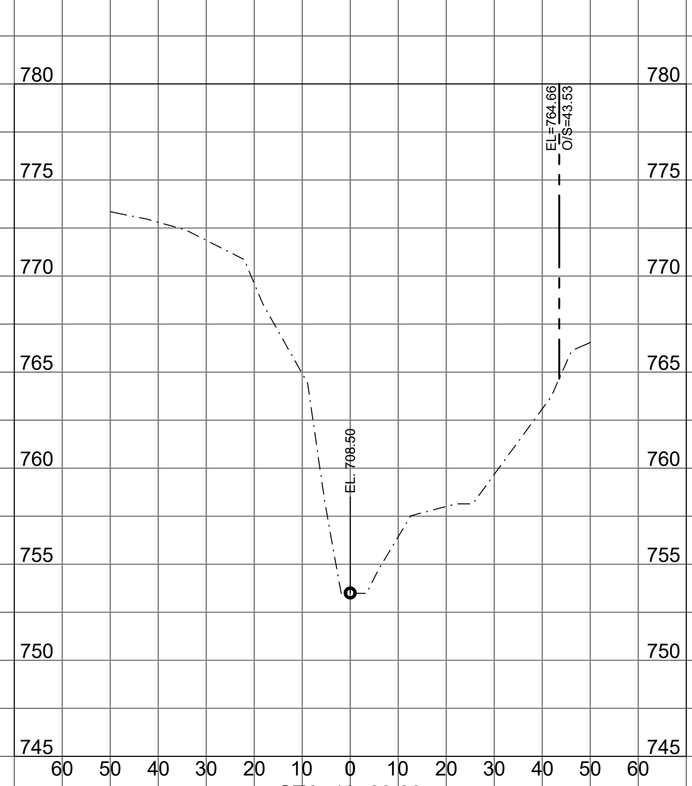

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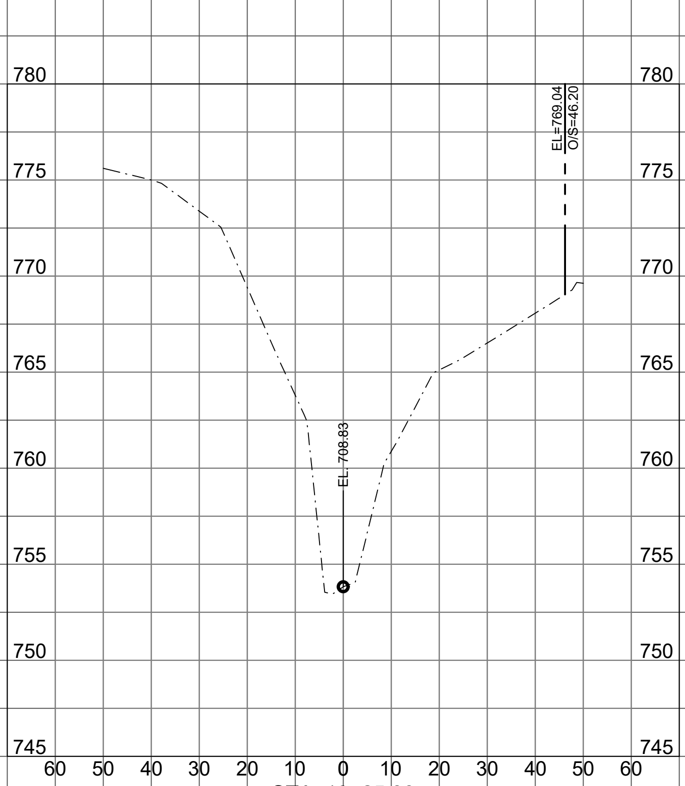

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VERTICAL SCALE IN FEET

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CASTROVILLE, TEXAS
CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

EXISTING CHANNEL CROSS SECTIONS
(SHEET 1 OF 4)

NOTES	NAME	DATE
SURVEY BY	ZAM	####
DRAWN BY	JH	####
DESIGNED BY	TJ	####
CHECKED BY	MG	####
REVIEWED BY	MP	####

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DR201 6 OF 17

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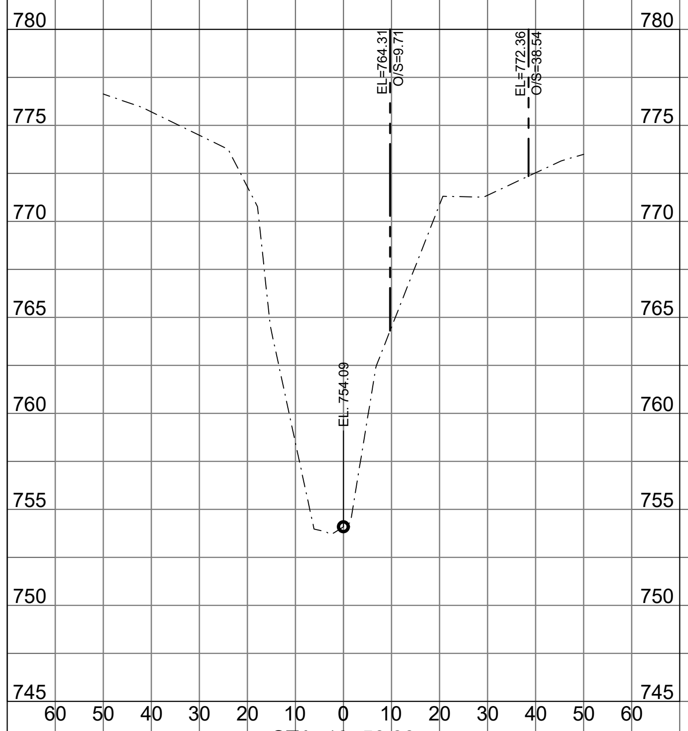

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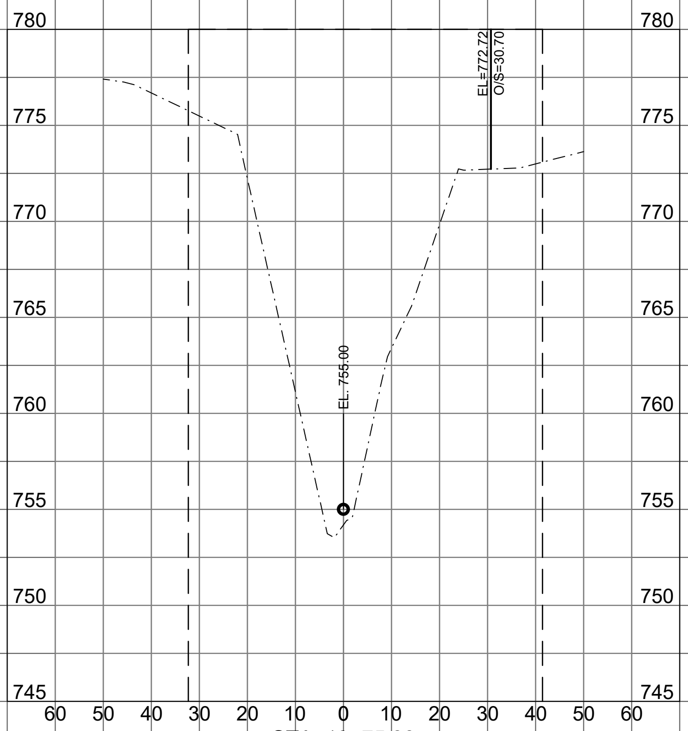

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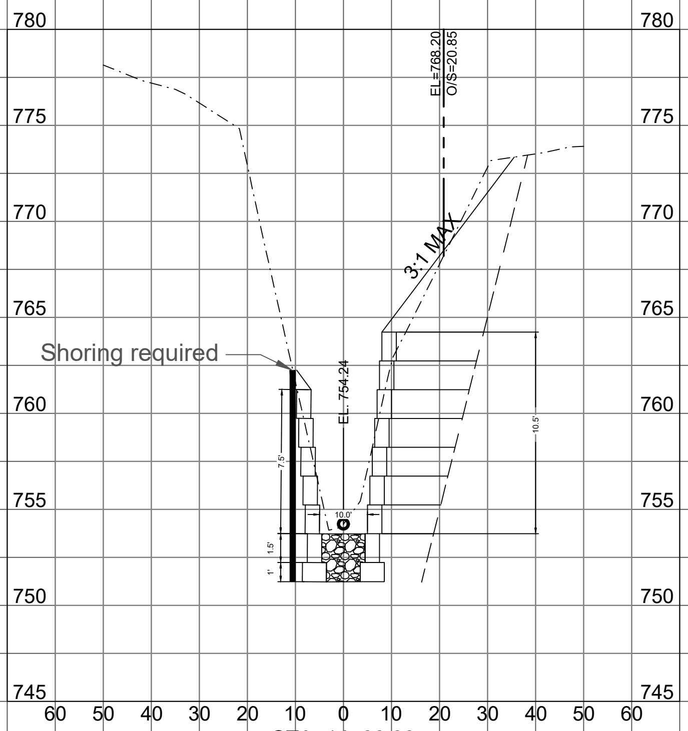

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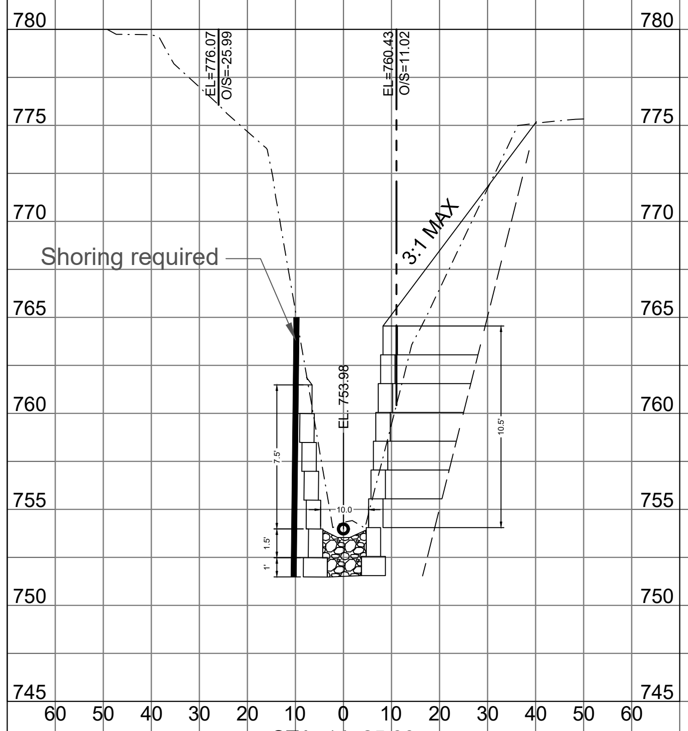

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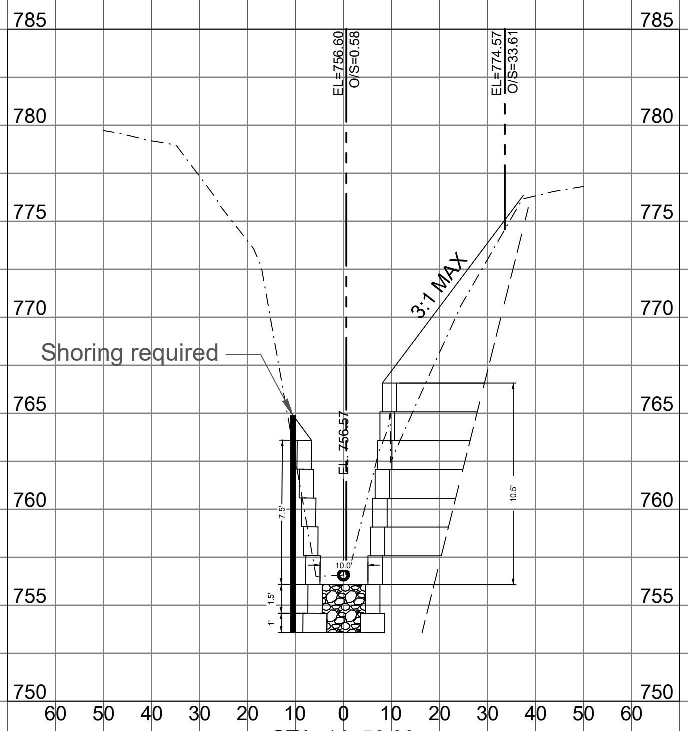

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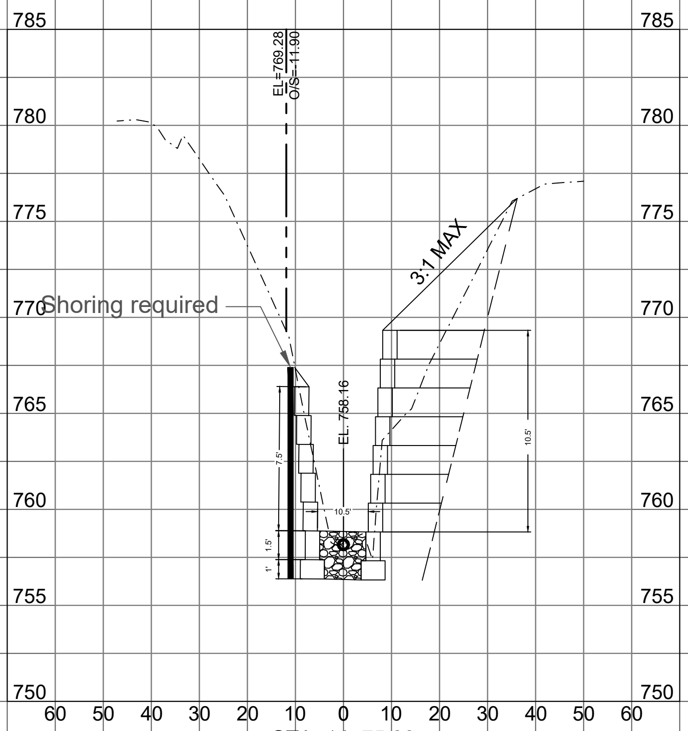

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VERTICAL SCALE IN FEET

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CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

EXISTING CHANNEL CROSS SECTIONS
(SHEET 2 OF 4)

NOTES	NAME	DATE
SURVEY BY	ZAM	####
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DESIGNED BY	TJ	####
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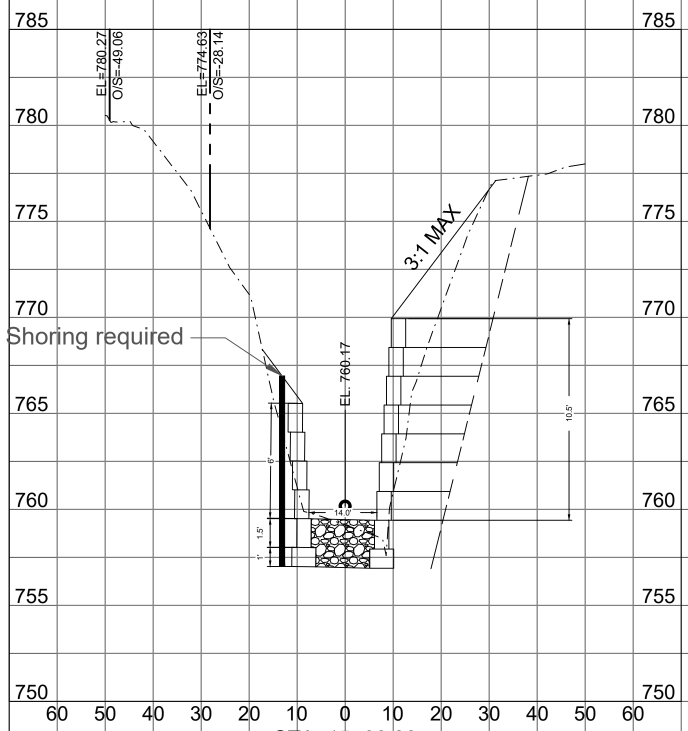

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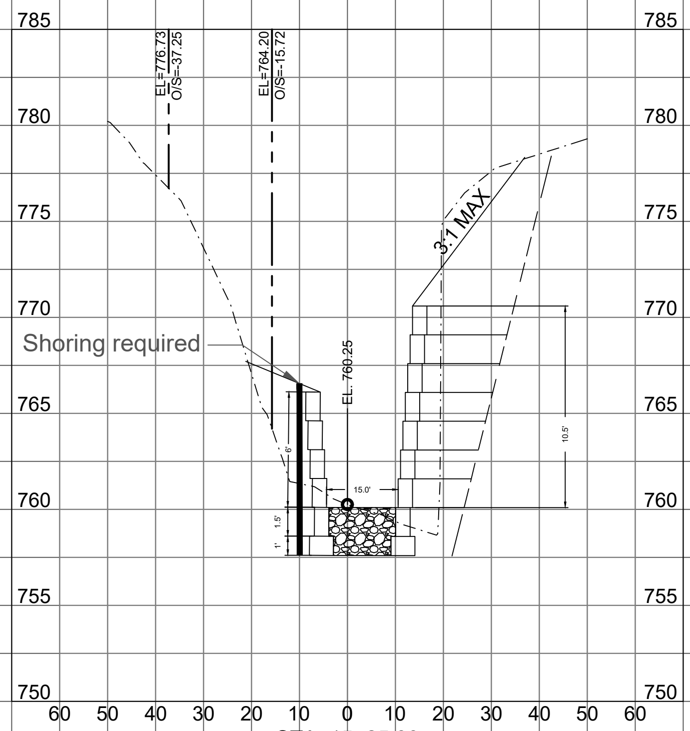

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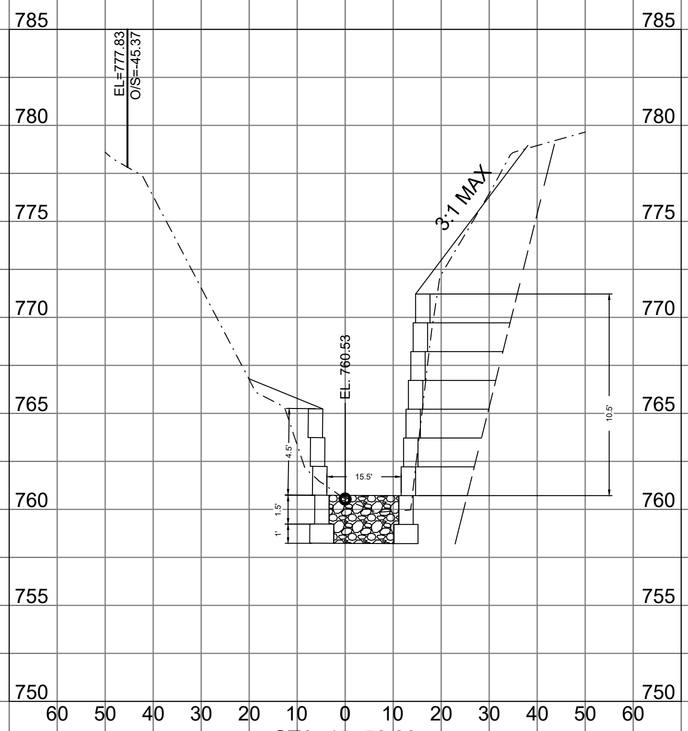

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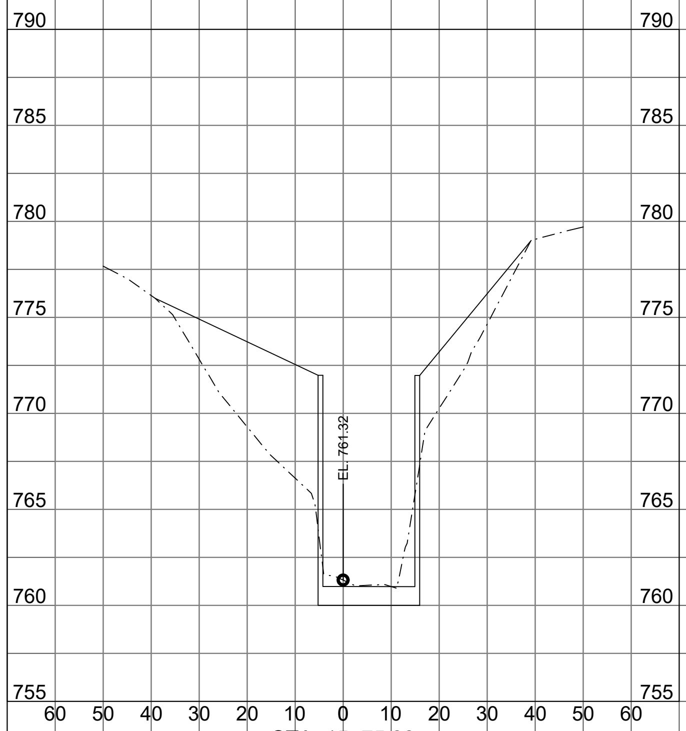

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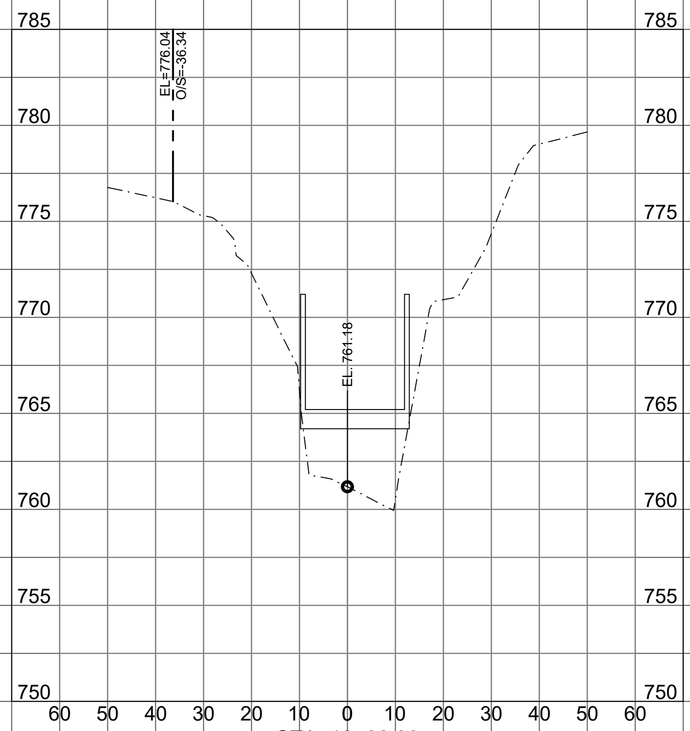

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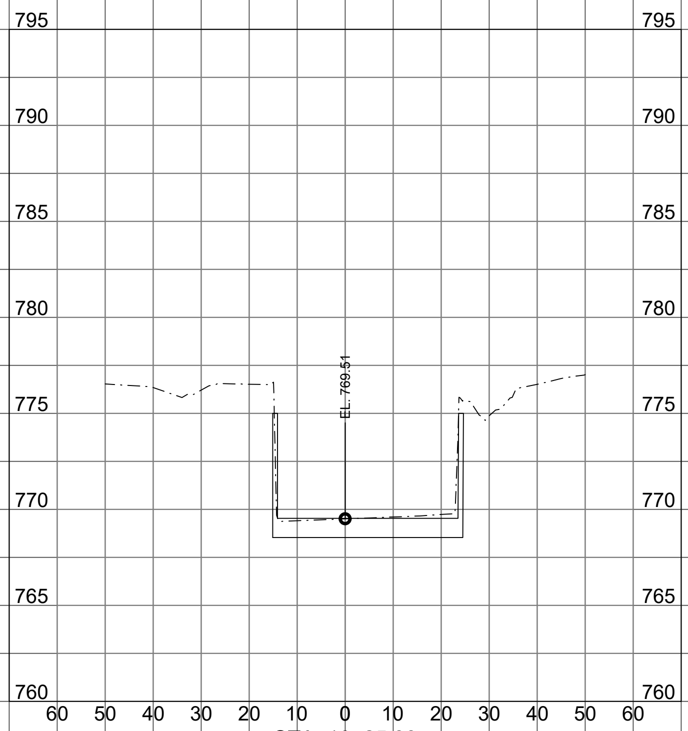

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CASTROVILLE, TEXAS
CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

EXISTING CHANNEL CROSS SECTIONS
(SHEET 3 OF 4)

NOTES	NAME	DATE
SURVEY BY	ZAM	####
DRAWN BY	JH	####
DESIGNED BY	TJ	####
CHECKED BY	MG	####
REVIEWED BY	MP	####

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DR203 8 OF 17

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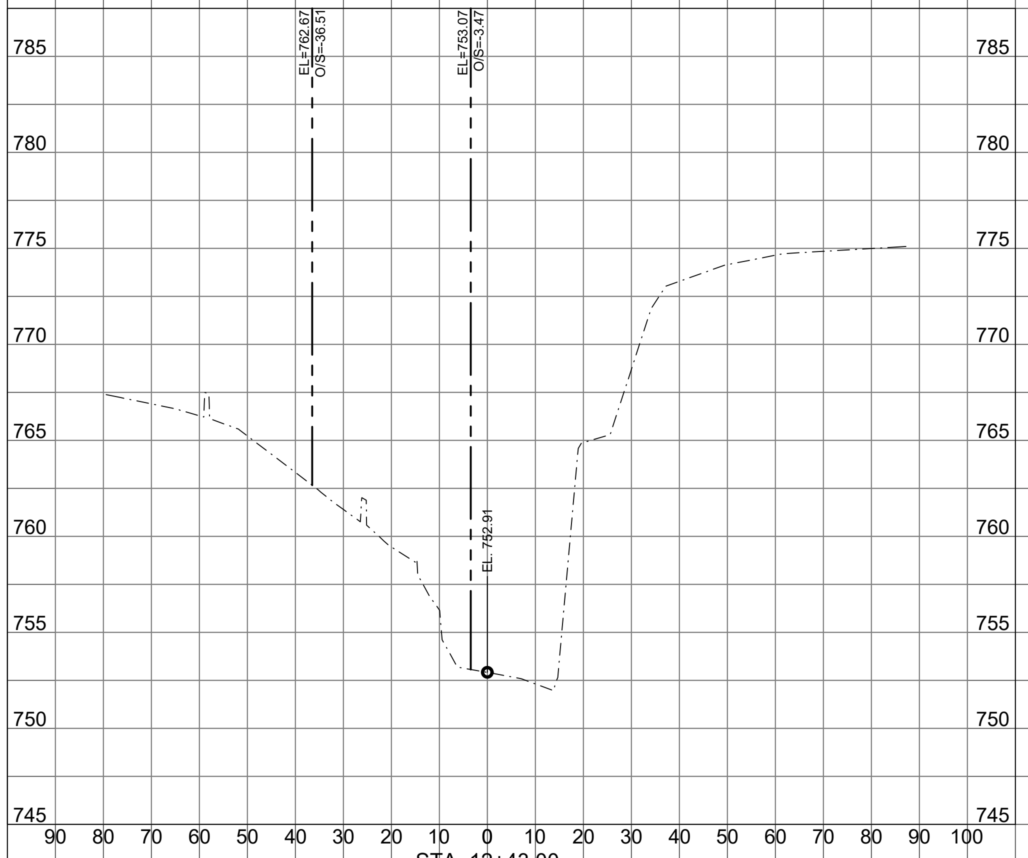

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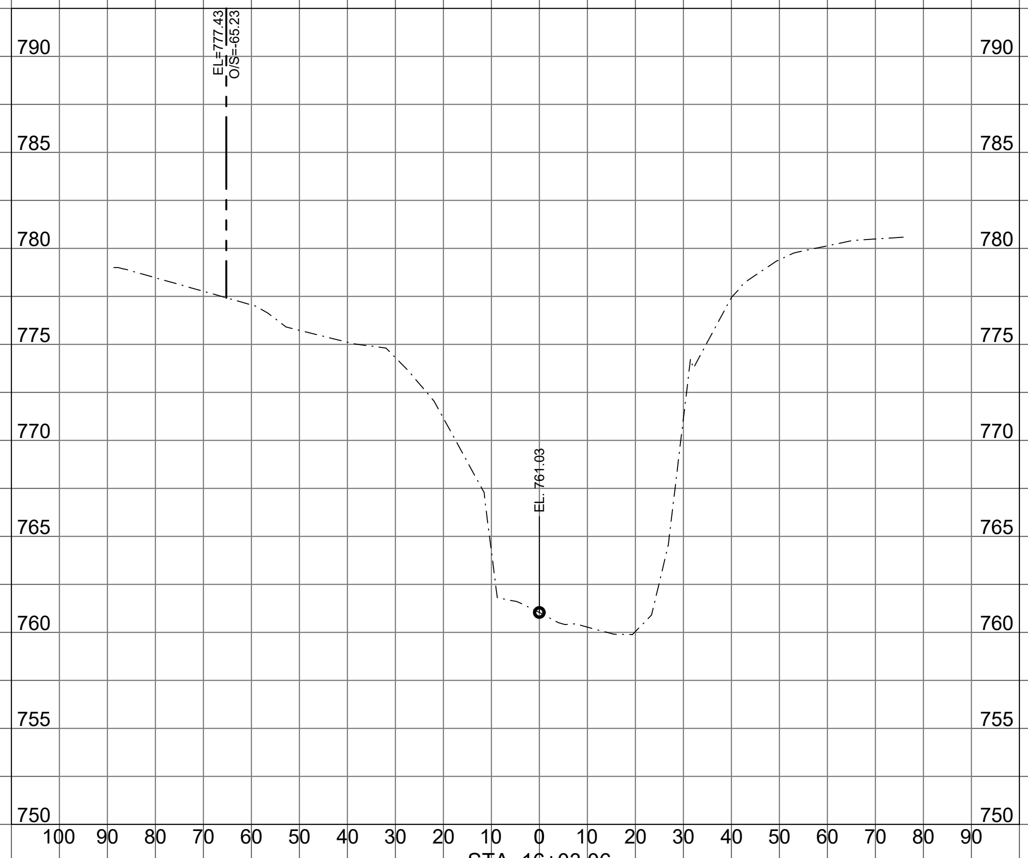

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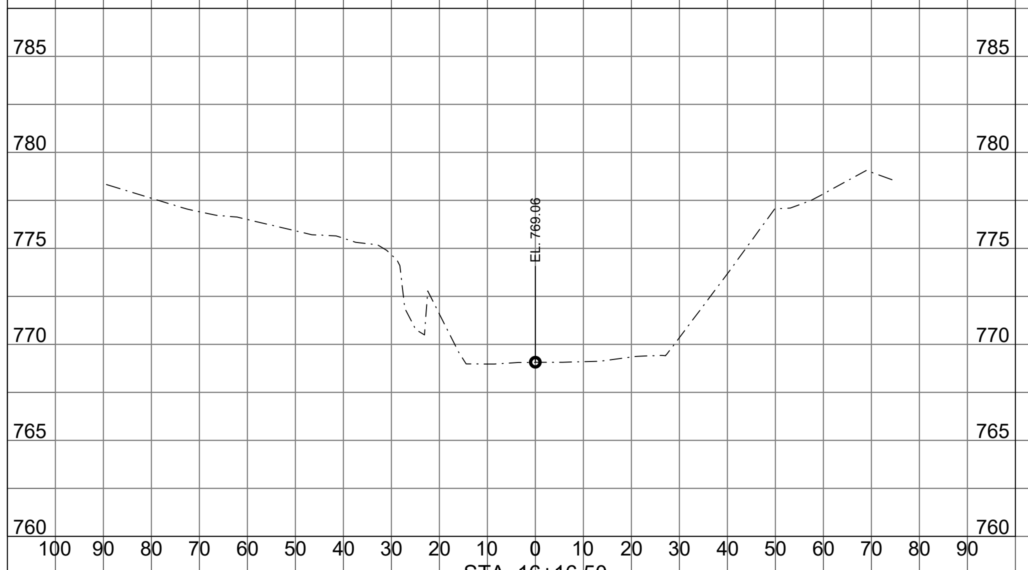

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0 20 40
HORIZONTAL SCALE IN FEET

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VERTICAL SCALE IN FEET

REV. NO.	BY	DATE	REVISION DESCRIPTION
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CASTROVILLE, TEXAS
CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

EXISTING CHANNEL CROSS SECTIONS
(SHEET 4 OF 4)

NOTES	NAME	DATE
SURVEY BY	ZAM	####
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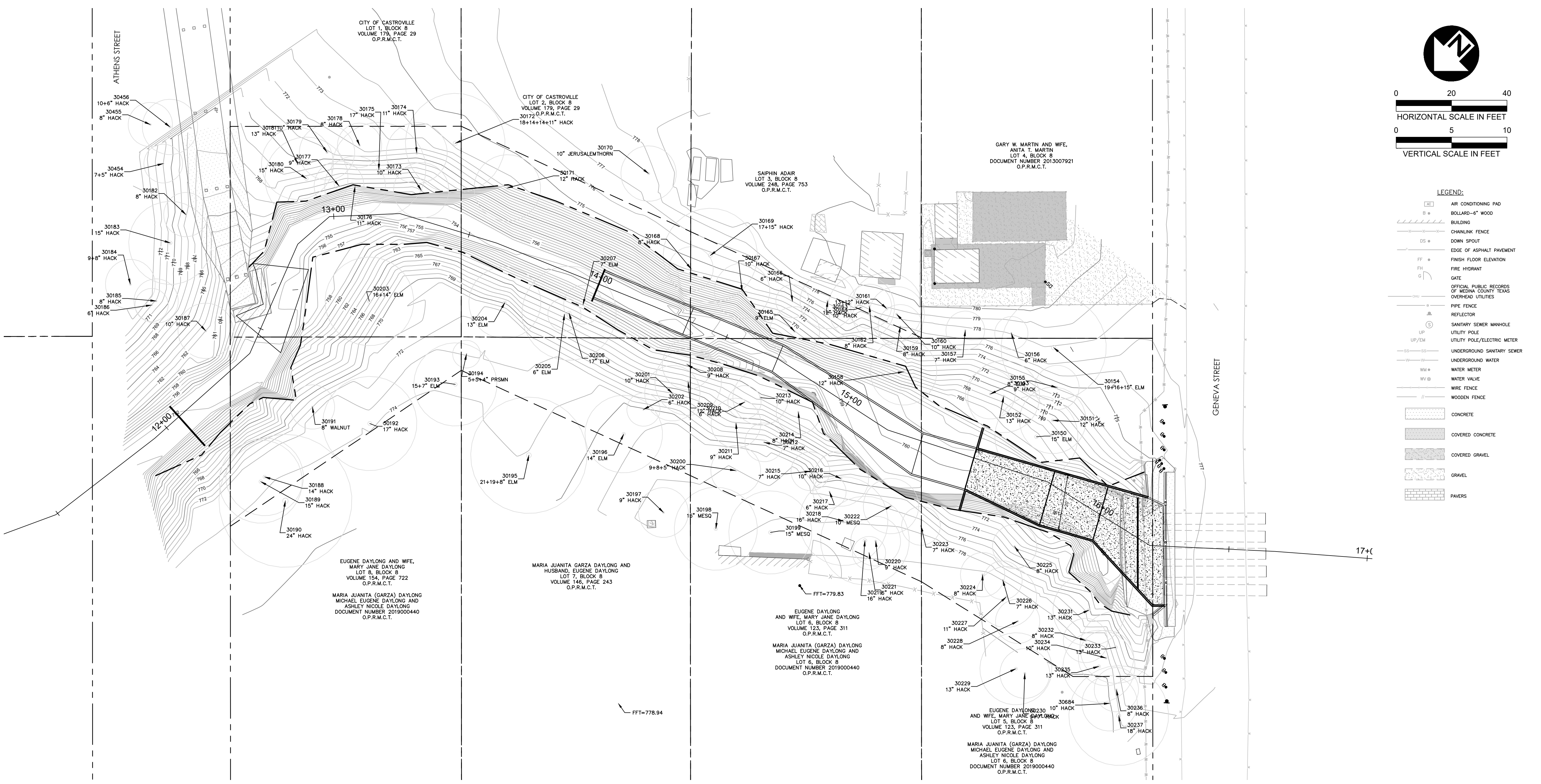

TREES	
Tree Tag #	Description
30150	15" ELM
30151	12" HACK
30152	13" HACK
30153	9" HACK
30154	19+16+15" ELM
30155	8" ELM
30156	6" HACK
30157	7" HACK
30158	12" HACK
30159	8" HACK
30160	10" HACK
30161	13+12" HACK
30162	8" HACK
30163	12" HACK
30164	10" HACK
30165	9" ELM
30166	6" HACK
30167	10" HACK
30168	8" HACK
30169	17+15" HACK

TREES	
Tree Tag #	Description
30170	10" JERUSALEMTHORN
30171	12" HACK
30172	18+14+14+11" HACK
30173	10" HACK
30174	11" HACK
30175	17" HACK
30176	11" HACK
30177	9" HACK
30178	8" HACK
30179	10" HACK
30180	15" HACK
30181	13" HACK
30182	8" HACK
30183	15" HACK
30184	9+8" HACK
30185	8" HACK
30186	6" HACK
30187	10" HACK
30188	14" HACK
30189	15" HACK

TREES	
Tree Tag #	Description
30190	24" HACK
30191	8" WALNUT
30192	17" HACK
30193	15+7" ELM
30194	5+5+4" PRSMN
30195	21+19+8" ELM
30196	14" ELM
30197	9" HACK
30198	15" MESQ
30199	15" MESQ
30200	9+8+5" HACK
30201	10" HACK
30202	6" HACK
30203	16+14" ELM
30204	13" ELM
30205	6" ELM
30206	17" ELM
30207	7" ELM
30208	9" HACK
30209	12" HACK

TREES	
Tree Tag #	Description
30210	6" HACK
30211	9" HACK
30212	7" HACK
30213	10" HACK
30214	8" HACK
30215	7" HACK
30216	10" HACK
30217	6" HACK
30218	16" HACK
30219	16" HACK
30220	9" HACK
30221	6" HACK
30222	10" MESQ
30223	7" HACK
30224	8" HACK
30225	8" HACK
30226	7" HACK
30227	11" HACK
30228	8" HACK
30229	13" HACK

TREES	
Tree Tag #	Description
30230	9+7" HACK
30231	13" HACK
30232	8" HACK
30233	13" HACK
30234	10" HACK
30235	13" HACK
30236	8" HACK
30237	18" HACK
30454	7+5" HACK
30455	8" HACK
30456	10+6" HACK
30684	10" HACK

TREE PROTECTION NOTES

1. ALL TREES SHOWN ON THIS PLAN TO BE RETAINED SHALL BE PROTECTED DURING CONSTRUCTION WITH TEMPORARY FENCING. FENCING WILL NOT BE PAID FOR DIRECTLY, BUT SHALL BE SUBSIDIARY TO ITEM NO. 100 PREPARING RIGHT-OF-WAY.

2. TREE PROTECTION FENCES SHALL BE INSTALLED PRIOR TO THE COMMENCEMENT OF ANY SITE PREPARATION WORK(CLEARING, GRUBBING OR GRADING).

3. FENCES SHALL COMPLETELY SURROUND THE TREE OR CLUSTERS OF TREES; WILL BE LOCATED AT THE OUTERMOST LIMITS OF THE TREE BRANCHES (DRIPLINE); AND WILL BE MAINTAINED THROUGHOUT THE CONSTRUCTION PROJECT IN ORDER TO PREVENT THE FOLLOWING:
   A. SOIL COMPACTION IN THE ROOT ZONE AREA RESULTING FROM VEHICULAR TRAFFIC OR STORAGE OF EQUIPMENT OR MATERIALS;
   B. ROOT ZONE DISTURBANCES DUE TO GRADE CHANGES (GREATER THAN 6 INCHES CUT OR FILL) OR TRENCHING NOT REVIEWED AND AUTHORIZED BY THE COUNTY;
   C. WOUNDS TO EXPOSED ROOTS, TRUNK OR LIMBS BY MECHANICAL EQUIPMENT;
   D. OTHER ACTIVITIES DETRIMENTAL TO TREES SUCH AS CHEMICAL STORAGE, CEMENT TRUCK CLEANING, AND FIRES.

4. EXCEPTIONS TO INSTALLING FENCES AT TREE DRIP LINES MAY BE PERMITTED IN THE FOLLOWING CASES:
   A. WHERE PERMEABLE PAVING IS TO BE INSTALLED, ERECT THE FENCE AT THE OUTER LIMITS OF THE PERMEABLE PAVING AREA;
   B. WHERE TREES ARE CLOSE TO PROPOSED BUILDINGS, ERECT THE FENCE NO CLOSER THAN 6 FEET TO THE BUILDING;
   C. WHERE THERE ARE SEVERE SPACE CONSTRAINTS DUE TO TRACT SIZE, OR OTHER SPECIAL REQUIREMENTS, CONTACT THE ENGINEER TO DISCUSS ALTERNATIVES.

5. WHERE ANY OF THE ABOVE EXCEPTIONS RESULT IN A FENCE BEING CLOSER THAN 4 FEET TO A TREE TRUNK, PROTECT THE TRUNK WITH STRAPPED-ON PLANKING TO A HEIGHT OF 8 FEET (OR TO THE LIMITS OF LOWER BRANCHING) IN ADDITION TO THE REDUCED FENCING PROVIDED.

6. WHERE ANY OF THE ABOVE EXCEPTIONS RESULT IN AREAS OF UNPROTECTED ROOT ZONES (UNDER DRIPLINES) THOSE AREAS SHOULD BE COVERED WITH 4 INCHES OF ORGANIC MULCH TO MINIMIZE SOIL COMPACTION.

7. ALL GRADING WITHIN PROTECTED ROOT ZONE AREAS SHALL BE DONE BY HAND OR WITH SMALL EQUIPMENT TO MINIMIZE ROOT DAMAGE. PRIOR TO GRADING, RELOCATE PROTECTIVE FENCING TO MINIMIZE ROOT DAMAGE. PRIOR TO GRADING, RELOCATE PROTECTIVE FENCING TO 2 FEET BEHIND THE GRADE CHANGE AREA.

8. ANY ROOTS EXPOSED BY CONSTRUCTION ACTIVITY SHALL BE PRUNED FLUSH WITH THE SOIL. BACKFILL ROOT AREAS WITH GOOD QUALITY TOP SOIL AS SOON AS POSSIBLE. IF EXPOSED ROOT AREAS ARE NOT BACKFILLED WITHIN 2 DAYS, COVER THEM WITH ORGANIC MATERIAL IN A MANNER WHICH REDUCES SOIL TEMPERATURE AND MINIMIZES WATER LOSS DUE TO EVAPORATION.

9. PRIOR TO EXCAVATION OR GRADE CUTTING WITHIN TREE DRIPLINES MAKE A CLEAN CUT BETWEEN THE DISTURBED AND UNDISTURBED ROOT ZONES WITH A ROCK SAW OR SIMILAR EQUIPMENT TO MINIMIZE DAMAGE TO REMAINING ROOTS.

10. TREES MOST HEAVILY IMPACTED BY CONSTRUCTION ACTIVITIES SHOULD BE WATERED DEEPLY ONCE A WEEK DURING PERIODS OF HOT, DRY WEATHER. TREE CROWNS SHOULD BE SPRAYED WITH WATER PERIODICALLY TO REDUCE DUST ACCUMULATION ON THE LEAVES.

11. ANY TRENCHING REQUIRED FOR THE INSTALLATION OF LANDSCAPE IRRIGATION SHALL BE PLACED AS FAR FROM EXISTING TREE TRUNKS AS POSSIBLE.

12. NO LANDSCAPE TOPSOIL DRESSING GREATER THAN 4 INCHES SHALL BE PERMITTED WITHIN THE DRIPLINE OF TREES. NO SOIL IS PERMITTED ON THE ROOT FLARE OF ANY TREE.

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CASTROVILLE, TEXAS
CITY OF CASTROVILLE

GARCIA CREEK
DRAINAGE IMPROVEMENTS

TREE SURVEY AND
PROTECTION PLAN

NOTES	NAME	DATE
SURVEY BY	ZAM	####
DRAWN BY	JH	####
DESIGNED BY	TJ	####
CHECKED BY	MG	####
REVIEWED BY	MP	####

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ATTACHMENT C
GEOTECHNICAL REPORT

GEOTECHNICAL DATA REPORT
CASTROVILLE – GARCIA CREEK CHANNEL STABILIZATION
CASTROVILLE, TEXAS

SUBMITTED TO
K FRIESE & ASSOCIATES, LLC.
40 NE INTERSTATE 410 LOOP, SUITE 545
SAN ANTONIO, TX 78216

BY
HVJ SOUTH CENTRAL TEXAS – M&J, INC.
NOVEMBER 8, 2024

DRAFT

REPORT NO.: SG 24 10218

HVJ
ASSOCIATES

4201 Freidrich Lane, Suite 110
Austin, Texas 78744
512.447.9081 Ph
512.443.3442 Fax
www.hvj.com

November 8, 2024

Mr. Abe Salinas, PE, CFM
Drainage Business Practice Lead
K Friese and Associates, LLC.
40 NE Loop 410, Suite 545
San Antonio, TX 78216

Re: Geotechnical Data Report
Castroville - Garcia Creek Channel Stabilization
Castroville, Texas
Owner: City of Castroville
HVJSCTx Project No.: SG 24 10218

Dear Mr. Salinas,

Submitted herein is the draft Geotechnical Data Report for the above referenced project. This study was performed in accordance with our proposal number SG 24 10218 dated June 3, 2024, and the executed contract dated July 24, 2024.

It has been a pleasure to work for you on this project and we appreciate the opportunity to be of service. Please notify us if there are questions or if we may be of further assistance.

Sincerely,

HVJ South Central Texas – M&J, Inc.
Texas Firm Registration No. F-18091

DRAFT

Alireza Shiri, E.I.T.	Golam Kibria, PhD, PE
Staff Engineer	Vice-President of Operations

Copies submitted: (1) Electronic

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PLATES

APPENDIX

EXECUTIVE SUMMARY

HVJ South Central Texas - M&J, Inc., (HVJSCTx) was retained by K Friese and Associates, LLC. (KFA) to perform a geotechnical investigation for the "Castroville – Garcia Creek Channel Stabilization" project in Castroville, Texas. Based on the information provided to us by KFA, the project includes stabilizing Geneva Street culvert, protecting the water main under the culvert apron, stabilizing the banks near the culvert apron, and providing grade controls in the stream to stabilize the channel bottom for the City of Castroville. The project site is located at the east of Geneva Street, just south of its intersection with Chateau Street in Castroville, Texas.

This data report presents field investigation and laboratory testing performed to date pertinent to the project.

A brief summary of the geotechnical investigational findings are as follows:

1. Four (4) borings were drilled, each to a depth of 40 feet below the existing ground surface, for a total combined footage of 160 LF.

2. Two (2) bulk scour samples were collected to aid in the scour analysis.

3. Based on review of available geological information, and the field exploration program, the project site lies within the Fluviatile Terrace Deposits (Qt) overlying Escondido Formation (Kes).

4. In general, the subsurface materials consist of Fluviatile Terrace Deposits (Qt) overlying Escondido Formation (Kes).

   Fluviatile Terrace Deposits were encountered in all the borings and generally consisted of Lean Clay with Sand (CL), Sandy Lean Clay (CL), Lean Clay with Gravel (CL), Gravelly Lean Clay (CL), Fat Clay (CH), Fat Clay with Sand (CH), Sandy Fat Clay (CH), Fat Clay with Gravel (CH), Sandy Fat Clay with Gravel (CH), Clayey Sand (SC), Clayey Sand with Gravel (SC), Clayey Gravel (GC), and Clayey Gravel with Sand (GC). Fluviatile Terrace Deposits were encountered at depths approximately ranging from 0 to 38.5 feet below the existing grades, and the thickness of Fluviatile Terrace Deposits ranged approximately from 33.5 to 38.5 feet.

   Underlying the Fluviatile Terrace Deposits, Escondido Formation (Kes) was encountered in all the borings that generally consisted of Lean Clay (CL), Lean Clay with Sand (CL), and Fat Clay (CH). Escondido Formation was encountered at depths approximately ranging from 33.5 to 38.5 feet below the existing grades and continued to the termination depths of the borings.

5. Groundwater was not encountered in any of the borings during drilling operations. It should be noted that groundwater levels may fluctuate seasonally, in response to climatic conditions, and with precipitation events. Perched groundwater conditions may also exist at the interface between the cohesive and cohesionless soil layers. Also, the water level at the Medina River and Garcia Creek in the vicinity of the project site may affect subsurface water level at this site.

Please note that this executive summary does not fully relate our findings. Those findings are only presented though our full report.

1 INTRODUCTION

1.1 General

HVJ South Central Texas - M&J, Inc., (HVJSCTx) was retained by K Friese and Associates, LLC. (KFA) to perform a geotechnical investigation for the "Castroville – Garcia Creek Channel Stabilization" project in Castroville, Texas. Based on the information provided to us by KFA, the project includes stabilizing Geneva Street culvert, protecting the water main under the culvert apron, stabilizing the banks near the culvert apron, and providing grade controls in the stream to stabilize the channel bottom for the City of Castroville. The project site is located at the east of Geneva Street, just south of its intersection with Chateau Street in Castroville, Texas. The location of the project is shown in the Site Vicinity Map on Plate 1.

1.2 Scope of Work

The primary objective of this study was to gather subsurface information at the project site. This objective was accomplished by:

1. Drilling four (4) borings, each to a depth of 40 feet below the existing ground surface, for a total combined footage of 160 LF.
2. Two (2) bulk scour samples were collected to aid in the scour analysis.
3. Performing laboratory tests on select samples to determine physical and engineering characteristics of the subsurface materials.
4. Providing a Geotechnical Data Report summarizing the subsurface conditions and laboratory test results.

Subsequent sections of this report contain descriptions of the field exploration, laboratory testing program, subsurface conditions, groundwater conditions, and limitations.

Pertinent design information and cross sections of the existing slopes were not available during preparation of this report. A separate geotechnical design memorandum will be issued including slope stability analyses, channel stabilization and culvert recommendations.

2 SUBSURFACE EXPLORATION

2.1 General

The field exploration for the project was performed on September 10 and September 11, 2024. The borings were drilled with a truck mounted drill rig equipped with soil sampling equipment. The boring locations were selected by KFA in consultation with HVJSCTx. The boring and scour sampling locations are shown on the Plan of Borings on Plate 3. Table 2-1 below summarizes the boring and scour sampling details.

Table 2-1: Boring Details

Boring	Depth (ft)	Latitude	Longitude	Northing	Easting	Elevation (ft)	Groundwater Depth (ft)
B-1	40	29.355584	-98.890434	13676844.4	2003400.8	775	NE
B-2	40	29.355831	-98.890653	13676934.2	2003331.0	780	NE
B-3	40	29.355892	-98.889572	13676956.7	2003675.3	774	NE
B-4	40	29.356063	-98.889863	13677018.8	2003582.5	774	NE
S-1	2	29.355753	-98.890295	13676905.9	2003445.0	760	NE
S-2	2	29.356055	-98.889716	13677015.9	2003629.4	756	NE

Note: Borings were not professionally surveyed. The locations were obtained using handheld GPS device and are approximate. Coordinates in Northing and Easting are based on the Texas State Plane Coordinate System, South Central Zone, NAD 83(2011). The elevations were obtained from https://www.freemaptools.com/elevation-finder.htm and are approximate. Units: US Survey Feet. The notation NE denotes for "Not Encountered."

2.2 Field Testing and Sampling Methods

Fine grained, cohesive soils encountered were sampled using a 3-inch outer diameter thin-walled tube, which was pushed into the soil in general accordance with ASTM D1587 - *Thin-Walled Tube Sampling of Soils*. The samples were extruded in the field and a calibrated pocket penetrometer was used to obtain an estimate of the unconfined compressive strength of the sample. Extruded relatively undisturbed sample lengths are presented in the boring logs along with the measured pocket penetrometer values.

Standard Penetration Tests (SPTs) were conducted within stiff to very hard cohesive and non-cohesive soils. The SPTs were performed in accordance with ASTM D1586 – *Penetration Test and Split-Barrel Sampling of Soils*. This consisted of driving a standardized 1.50 ± 0.005-inch inner diameter split-spoon sampler into undisturbed soil with a safety 140-pound hammer. A safety hammer with a 30-inch drop was used to perform the test. The split-spoon sampler was first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows from the hammer. The number of hammer blows required to drive the sampler each 6-inch increment was recorded. The penetration resistance "N-value" is defined as the number of hammer blows required to drive sampler the final 12 inches and was used in the field to estimate the density of granular soils or consistency of cohesive soils. In very dense or hard materials, the SPT test was typically stopped after 50 blows from the hammer and the measurement was recorded as 50 blows per distance penetrated (e.g., 50 over 3 inches).

Classification and field test results for collected samples were recorded onto field logs, which included a visual description in accordance with ASTM D2488 – *Visual Description and Identification of Soils*. After field documentation and logging were complete, the individual soil samples were placed in sealed containers to prevent loss of moisture and were transported to our laboratory for further examination and testing.

The sampling information recorded in the field was used in conjunction with additional laboratory examination and testing to generate the final boring logs, which are provided in Plates 4 to 7. The key to terms and symbols for the boring logs is provided in Plate 8.

2.3 Groundwater Conditions

Groundwater was not encountered in any of the borings during drilling operations. It should be noted that groundwater levels may fluctuate seasonally, in response to climatic conditions, and with precipitation events. Perched groundwater conditions may also exist at the interface between the cohesive and cohesionless soil layers. Also, the water level at the Medina River and Garcia Creek in the vicinity of the project site may affect subsurface water level at this site.

2.4 Borehole Completion

The project borings were backfilled with soil cuttings and bentonite chips to match the existing ground surface elevation upon completion of drilling.

3 LABORATORY TESTING

3.1 General

Soil samples transported to our laboratory were further examined and described and a preliminary soil classification was assigned to each sample based on ASTM D2487 – *Classification of Soil for Engineering Purposes* and our experience with local geological conditions.

Classification testing, which included moisture contents, Atterberg limits, and percent passing the No. 200 sieve, was subsequently conducted on select samples. Also, unconfined compressive strength and direct shear tests with wet and dry unit weight determinations were performed on select cohesive soil samples. In addition, grain size analysis with hydrometer was conducted on select soil samples. Laboratory testing was performed in accordance with the relevant ASTM and TxDOT Standards as required. The results of these tests were used to confirm or modify the preliminary soil classifications.

The sampling information obtained in the field was used in conjunction with the laboratory examination and testing to generate final boring logs, provided in Plates 4 through 7. Keys of Terms and Symbols for the boring logs are provided on Plate 8. The laboratory test results are provided on the borings logs as well as in the Laboratory Tests Results Summary in Appendix A.

3.2 Moisture Content

Moisture content testing was performed on select soil samples to determine the in-situ state of moisture of the sample. A fresh sample was weighed before being placed in an oven with a controlled temperature of 230°F and dried back to a constant mass. Upon the drying and reweighing of the sample, the total mass of water lost was recorded. The ratio of the water loss to the dried mass is recorded as the moisture content. This test was performed in accordance with ASTM D2216 (Tex-103-E). The test results are presented in the boring logs and also in Appendix A: laboratory test results summary.

3.3 Atterberg Limits

Select samples were tested to determine the Atterberg Limits in accordance with ASTM D4318 (Tex-104-E, and 105-E). The Atterberg Limit test is used to classify the soil using the Unified Soil Classification System (USCS). The Atterberg Limit test consists of two parts: a liquid limit test and a plastic limit test. The liquid limit equipment setup consists of a brass cup partially filled with soil which is grooved with a specialized grooving tool, and then dropped freely from a specified height to the rubber base below at a constant rate of 2 drops per second. The liquid limit test is performed on soil that has been sieved through the No. 40 sieve and brought to a moisture content that would close the ½-inch groove within 20 to 30 blows for two consecutive tests. The moisture content of the soil is then measured and recorded as the liquid limit. The second part of the test consists of a rolling a remolded sample between the tips of the fingers and a glass plate until transverse cracks appear at a rolled diameter of 1/8-inch. The moisture content of the rolled sample is taken and recorded as the plastic limit. The test results are presented in the boring logs and also in Appendix A: laboratory test results summary.

3.4 Percent Passing the No. 200 Sieve

Select soil samples were tested in accordance with ASTM D1140 (Tex-111-E) to determine the amount of material finer than the No. 200 sieve for use in classification. An oven dried sample of material is weighed then washed over a 75-µm (No. 200) sieve, allowing clay and other particles to be dispersed and removed from the soil. The retained material is oven dried then reweighed. The loss in mass resulting from the washing is calculated as mass percent of the original sample and is reported as the percentage of material finer than a No. 200 sieve. The results are used in conjunction with the Atterberg Limits determination to classify the soil using the Unified Soil Classification System (USCS). The test results are presented in the boring logs and also in Appendix A: laboratory test results summary.

3.5 Grain Size Analysis

Grain size analyses were performed on two (2) grab samples collected from two (2) locations to determine particle size distribution of the soil to aid in the scour analysis. Oven dried material was weighed and then mechanically shaken through a full set of sieves, ranging in size from 4.75 mm (No. 4) through 75-µm (No. 200) with the weights retained on each sieve recorded. This test was performed in accordance with ASTM D6913 (Tex-110-E). In addition, grain size analysis was performed on soils passing 75-µm (No. 200) sieve using hydrometer in accordance with ASTM D7928. The results of grain size analyses are provided in Appendix B.

3.6 Pocket Penetrometer

A spring-loaded rod (1/4-inch diameter) is pushed into soil to a penetration of 6 mm and the gauge read for unconfined compressive strength (equals to twice the undrained shear strength) in tons per square foot (tsf). Penetration is limited to soils with unconfined compressive strength less than and equal to 4.5 tsf. Data are representative for soils with Plasticity Index (PI) greater than 12. Below this value, the angle of internal friction of granular particles increases strength to more than the measured value of the undrained shear strength. The test results are presented in the boring logs and also in Appendix A: laboratory test results summary.

3.7 Grain Size Analysis

Grain size analyses were performed on select samples taken from the borings to determine particle size distribution of the soil for use of the Unified Soil Classification System. Oven dried material was weighed and then mechanically shaken through a full set of sieves, ranging in size from 4.75 mm

(No. 4) through 75-µm (No. 200) with the weights retained on each sieve recorded. This test was performed in accordance with ASTM D6913 (Tex-110-E). In addition, grain size analysis was performed on soils passing 75-µm (No. 200) sieve using hydrometer in accordance with ASTM D7928. The results of grain size analyses are provided in Appendix B.

3.8 Unconfined Compressive Strength of Soil

Three (3) cohesive soil samples were tested for unconfined compressive strength in accordance with ASTM D2166. The intact specimen is placed in a loading device and subjected to a load producing an axial strain at a rate between 0.5% and 2% per minute. The load is applied until failure occurs at the maximum rate of strain. The maximum axial strain is then used to calculate the soil's unconfined compressive strength. The test results are provided in the boring logs presented in Plates 4 through 7.

3.9 Direct Shear Test

Direct shear test was performed on one (1) select soil sample in accordance with ASTM D3080. This test is performed on a relatively undisturbed soil sample. A specimen is placed in a shear box and a confining stress is applied vertically to the specimen, and the upper ring is pulled laterally until the sample fails, or through a specified strain. The load applied and the strain induced is recorded at frequent intervals to determine a stress-strain curve for each confining stress. Three (3) to four (4) specimens are tested at varying confining stresses to determine the shear strength parameters, the soil cohesion (c') and the angle of internal friction (φ'). The y-intercept of the curve which fits the test results is the cohesion, and the slope of the line or curve is the friction angle. The test results are provided in Appendix C.

4 SITE CHARACTERIZATION

4.1 General Geology

Based on review of available geological information[1], and the field exploration program, the project alignment lies within the Fluviatile Terrace Deposits (Qt) underlain by Escondido Formation (Kes) as shown on the Geology Map in Plate 2.

The Fluviatile Terrace Deposits (Qt) generally consist of unconsolidated limestone gravel, sand, silt, and clay in various proportions. The Fluviatile Terrace Deposits are derived from Cretaceous deposits in the drainage area.

The Escondido Formation (Kes) is comprised of shales, siltstone, and sandstone. The shales are gray to bluish gray and would be expected to be like the shales of the Navarro Formation in the San Antonio area. The siltstones are typically brownish yellow and thin bedded.

4.2 Subsurface Stratigraphy

Subsurface conditions at the project site described herein are based on information obtained at the boring locations only. Significant variations at areas not explored by the project borings may require

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[1] https://webapps.usgs.gov/txgeology/

reevaluation of our findings and conclusions. The subsurface as encountered at the project site are discussed below.

In general, the subsurface materials consist of Fluviatile Terrace Deposits (Qt) overlying Escondido Formation (Kes).

Fluviatile Terrace Deposits were encountered in all the borings and generally consisted of Lean Clay with Sand (CL), Sandy Lean Clay (CL), Lean Clay with Gravel (CL), Gravelly Lean Clay (CL), Fat Clay (CH), Fat Clay with Sand (CH), Sandy Fat Clay (CH), Fat Clay with Gravel (CH), Sandy Fat Clay with Gravel (CH), Clayey Sand (SC), Clayey Sand with Gravel (SC), Clayey Gravel (GC), and Clayey Gravel with Sand (GC). Fluviatile Terrace Deposits were encountered at depths approximately ranging from 0 to 38.5 feet below the existing grades, and the thickness of Fluviatile Terrace Deposits ranged approximately from 33.5 to 38.5 feet.

Underlying the Fluviatile Terrace Deposits, Escondido Formation (Kes) was encountered in all the borings that generally consisted of Lean Clay (CL), Lean Clay with Sand (CL), and Fat Clay (CH). Escondido Formation was encountered at depths approximately ranging from 33.5 to 38.5 feet below the existing grades and continued to the termination depths of the borings.

Detailed descriptions of the materials encountered in the borings are displayed on the final boring logs presented in Plates 4 through 7. A summary of the laboratory test statistics for each layer is shown on the next page in Table 4-1. A complete summary of the laboratory test results can be found in Appendix A.

4-1: Laboratory Testing Statistics by Strata

Laboratory Test	Average	Maximum	Minimum	Standard Deviation	No. Tested
Fluviatile Terrace Deposits					
% Passing No. 200 Sieve	58	91	16	24.7	22
Liquid Limit (%)	43	71	23	11.9	21
Plasticity Index (%)	28	46	10	10.3	21
Moisture Content (%)	11.3	17.6	3.1	4.0	36
Wet Unit Weight (pcf)	127	134	119	7.5	3
Dry Unit Weight (pcf)	111	117	104	6.4	3
Unconfined Compressive Strength (tsf)	14.6	19.7	7.5	6.3	3
Pocket Penetrometer (tsf)	4.5+	4.5+	4.5+	0.0	6
Escondido Formation					
% Passing No. 200 Sieve	83	98	71	12.6	4
Liquid Limit (%)	58	69	47	12.7	4
Plasticity Index (%)	37	43	30	7.2	4
Moisture Content (%)	22.4	29.8	14.7	8.2	4

4.3 Grain Size Analysis

Grain size analyses were performed on two (2) select samples. The D_{50} and D_{90} grain sizes were determined from the particle size distribution curves and are provided in Table 4-2. The complete results of the sieve analyses are presented in Appendix B.

Table 4-2: Sieve Analyses Results

Sample	Location	Site	Soil Classification	D_{90} Size (mm)	D_{50} Size (mm)
S-1	Upstream	Garcia Creek	Silty Clayey Gravel with Sand (GC-GM)	41.2	4.5
S-2	Downstream	Garcia Creek	Clayey Gravel with Sand (GC)	23.5	7.1

4.4 Direct Shear Test

Direct shear test was performed on one (1) select soil sample. The test results are provided below in Table 4-3, as well as in Appendix C.

Table 4-3: Direct Shear Test Results

Boring	Depth (ft)	USCS Soil Type	Peak Parameters		Post-peak Parameters	
			Angle of Internal Friction ϕ' (degrees)	Cohesion c' (psi)	Angle of Internal Friction ϕ' (degrees)	Cohesion c' (psi)
B-1	8-10	Lean Clay (CL)	20.7	1.8	17.7	0.8

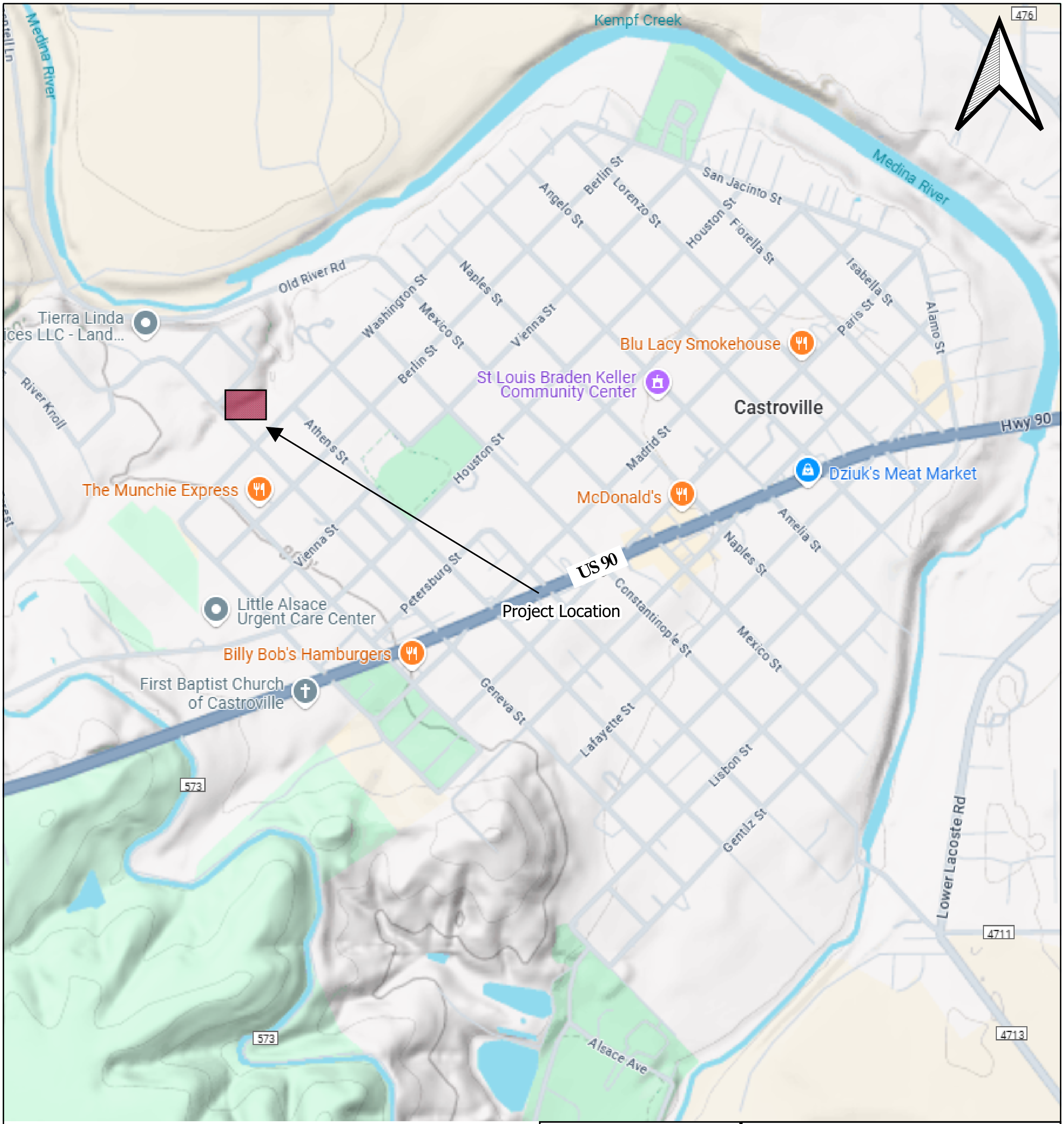
5 LIMITATIONS

This study was performed for the exclusive use of K Friese and Associates, LLC. and the City of Castroville for the "Castroville – Garcia Creek Channel Stabilization" project in Castroville, Texas. HVJSCTx has endeavored to comply with generally accepted geotechnical engineering practices common in the local area. HVJSCTx makes no warranty, expressed or implied. Any information contained in this report are based on data obtained from subsurface exploration, laboratory testing performed, and our experience with similar soils and site conditions.

The methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations. Should any subsurface conditions other than those described in our boring logs be encountered, HVJSCTx should be immediately notified so that further investigation and supplemental information can be provided.

In the event that any changes in the nature, design, or location of the project are made, any information in this report should not be considered valid until the changes are reviewed and the information modified or verified in writing by HVJSCTx.

PLATES



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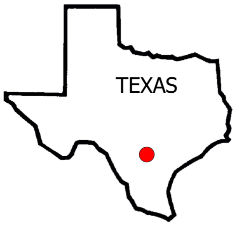


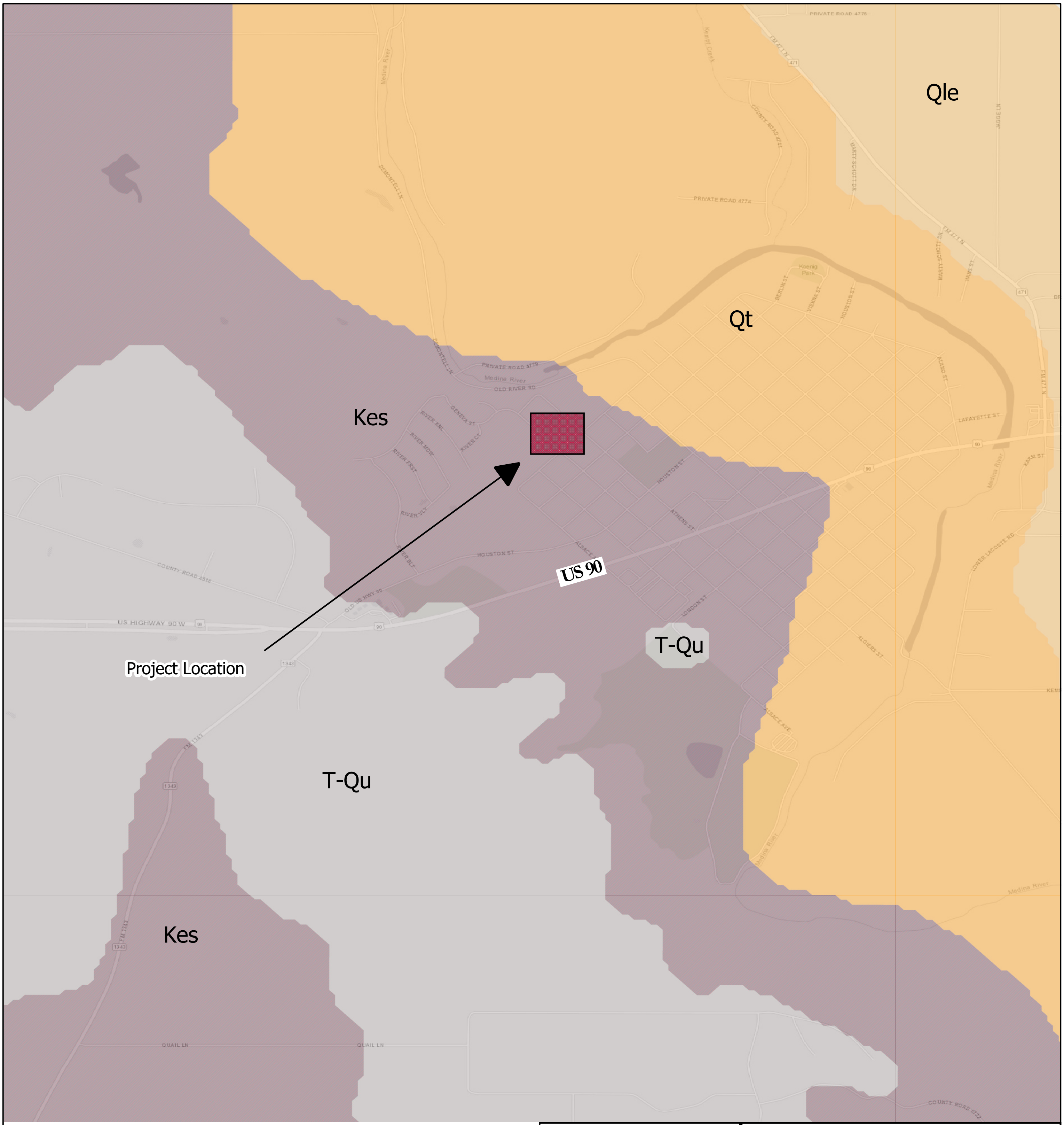
MAP LOCATION

HVJ ASSOCIATES

Scale: NTS		
DATE: 10/07/2024		
DRAWN BY: AS	PROJ. CHK: GK	APPRV. BY: JS

VICINITY MAP
CASTROVILLE - GARCIA CREEK CHANNEL STABILIZATION
CASTROVILLE, TEXAS

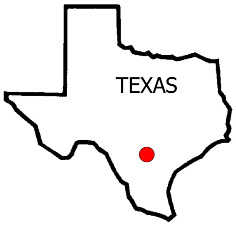
PROJECT NO.: SG 24 10218	FILENAME: VIC	PLATE 1



SOURCE: https://txpub.usgs.gov/txgeology/

LEGEND:

Kes	Escondido Formation
T-Qu	Uvalde Gravel
Qt	Fluviatile terrace deposits
Qle	Leona Formation



MAP LOCATION

H V J
ASSOCIATES

Scale: NTS

DATE: 10/07/2024

DRAWN BY:	PROJ. CHK:	APPRV. BY:
AS	GK	JS

GEOLOGY MAP
CASTROVILLE - GARCIA CREEK CHANNEL STABILIZATION
CASTROVILLE, TEXAS

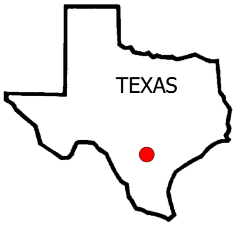
PROJECT NO.:	FILENAME:	
SG 24 10218	GEO	PLATE 2

SOURCE: Google Maps

LEGEND:

⊕ **Boring Locations**

⊕ **Scour Locations**



MAP LOCATION

HVJ ASSOCIATES

0 75 150 ft

DATE: 10/07/2024

DRAWN BY:	PROJ. CHK:	APPRV. BY:
AS	GK	JS

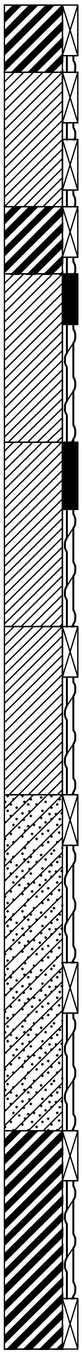
PLAN OF BORING
CASTROVILLE - GARCIA CREEK CHANNEL STABILIZATION
CASTROVILLE, TEXAS

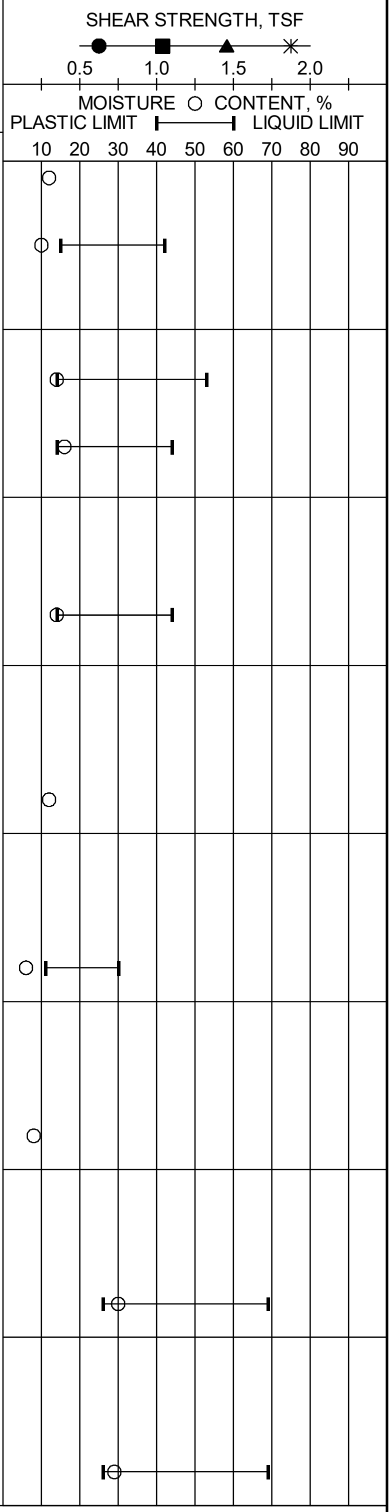
PROJECT NO.:	FILENAME:	
SG 24 10218	POB	PLATE 3

LOG OF BORING

Project: Castroville - Garcia Creek Channel Stabilization
Project No.: SG 24 10218
Boring No.: B-1
Date: 9/10/2024
Elevation: 775.1 feet
Groundwater during drilling: Not Encountered
Northing: 13,676,844.4
Station: --
Groundwater after drilling: Not Encountered
Easting: 2,003,400.8
Offset: --

ELEV.	DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
775	0	5-8-14	Brown, very stiff, **SANDY FAT CLAY with GRAVEL (CH)**, moist. [Fluviatile Terrace Deposits]		
		13-17-18 12-17-13	Brown, hard to very stiff, **LEAN CLAY with SAND (CL)**, slightly moist, few gravel, traces of ferrous stainings and organics. [Fluviatile Terrace Deposits]	73	
770	5	9-9-12	Brown, very stiff, **FAT CLAY (CH)**, moist. [Fluviatile Terrace Deposits]	90	
		PP: 4.5+ tsf REC: 16"	Brown, hard, **LEAN CLAY (CL)**, moist. [Fluviatile Terrace Deposits]		
765	10				
		PP: 4.5+ tsf REC: 21"	Light brown, hard, **LEAN CLAY with SAND (CL)**, moist. [Fluviatile Terrace Deposits]	81	
760	15				
		50/3"	Light brown, hard, **LEAN CLAY with GRAVEL (CL)**, moist. [Fluviatile Terrace Deposits]		
755	20				
		50/5"	Light brown, very dense, **CLAYEY SAND with GRAVEL (SC)**, slightly moist. [Fluviatile Terrace Deposits]	37	
750	25				
		10-27-50/3"			
745	30				
		10-11-13	Brown to gray and dark gray, very stiff to hard, **FAT CLAY (CH)**, moist. [Escondido Formation]	88	
740	35				
		17-20-22		98	
	40				



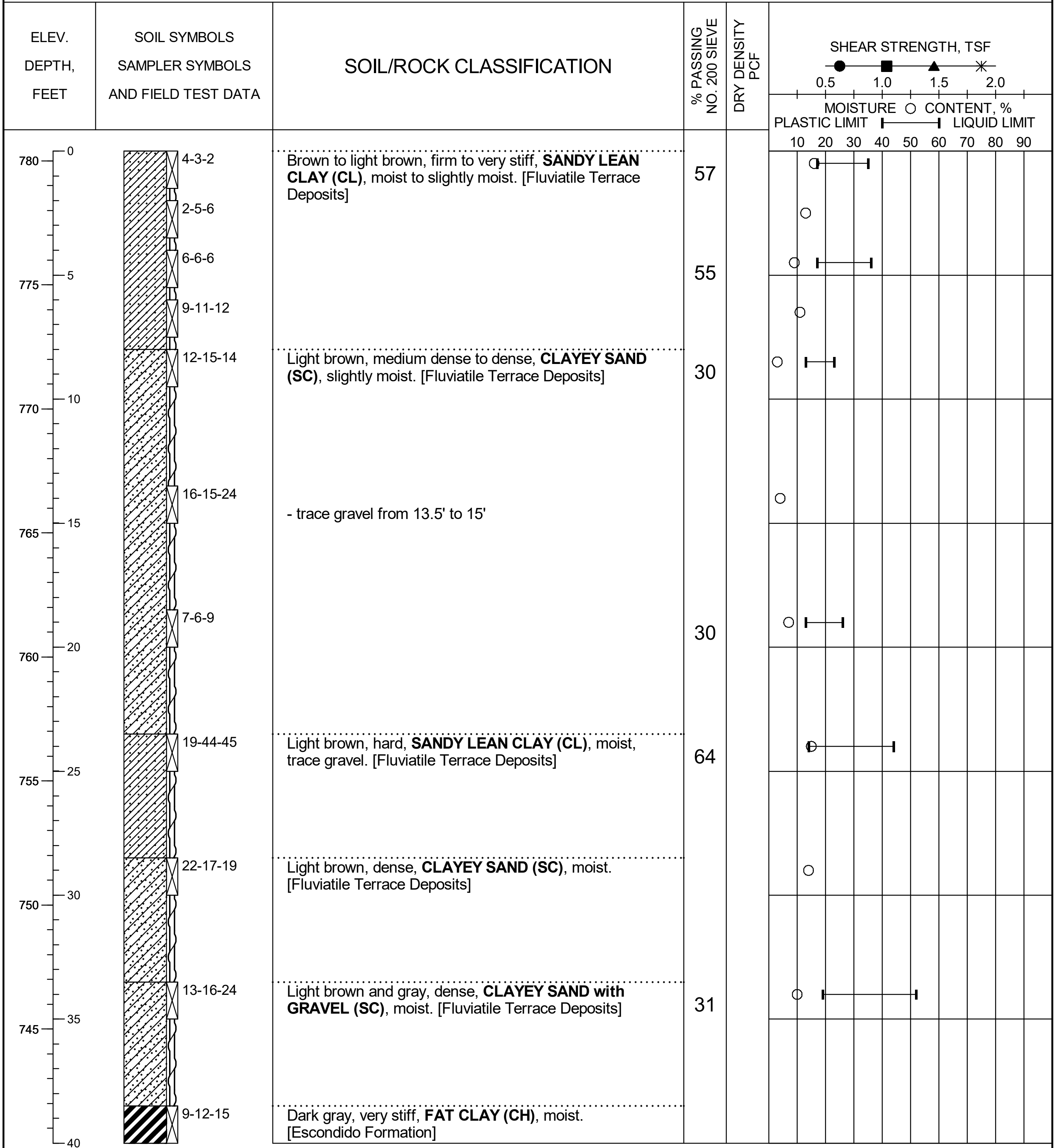


Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

LOG OF SOIL BORING SG 24 10218 GARCIA CREEK CULVERT STABILIZATION.GPJ HVJ.GDT 10/30/24

LOG OF BORING

Project: Castroville - Garcia Creek Channel Stabilization
Project No.: SG 24 10218
Boring No.: B-2
Date: 9/11/2024
Elevation: 780.4 feet
Groundwater during drilling: Not Encountered
Northing: 13,676,934.2
Station: --
Groundwater after drilling: Not Encountered
Easting: 2,003,331.0
Offset: --



Brown to light brown, firm to very stiff, **SANDY LEAN CLAY (CL)**, moist to slightly moist. [Fluviatile Terrace Deposits]

Light brown, medium dense to dense, **CLAYEY SAND (SC)**, slightly moist. [Fluviatile Terrace Deposits]

- trace gravel from 13.5' to 15'

Light brown, hard, **SANDY LEAN CLAY (CL)**, moist, trace gravel. [Fluviatile Terrace Deposits]

Light brown, dense, **CLAYEY SAND (SC)**, moist. [Fluviatile Terrace Deposits]

Light brown and gray, dense, **CLAYEY SAND with GRAVEL (SC)**, moist. [Fluviatile Terrace Deposits]

Dark gray, very stiff, **FAT CLAY (CH)**, moist. [Escondido Formation]

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

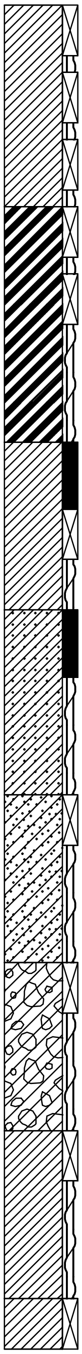
PLATE 5

HVJ ASSOCIATES

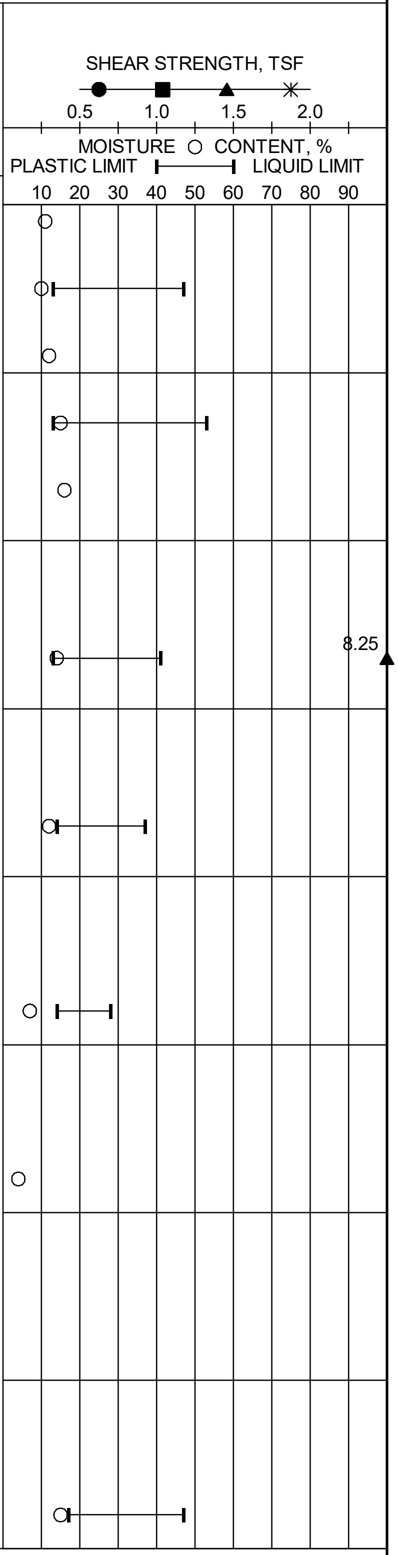
LOG OF SOIL BORING SG 24 10218 GARCIA CREEK CULVERT STABILIZATION.GPJ HVJ.GDT 10/30/24

LOG OF BORING

Project: Castroville - Garcia Creek Channel Stabilization
Project No.: SG 24 10218
Boring No.: B-3
Date: 9/10/2024
Elevation: 774.1 feet
Groundwater during drilling: Not Encountered
Northing: 13,676,956.7
Station: --
Groundwater after drilling: Not Encountered
Easting: 2,003,675.3
Offset: --



ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL/ROCK CLASSIFICATION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
0	4-7-7	Brown, stiff, **LEAN CLAY with SAND (CL)**, moist. [Fluviatile Terrace Deposits]		
	4-4-6	-Brown and light brown.	82	
770 5	5-6-7	-few gravel.		
	7-7-7	Brown, stiff to very stiff, **FAT CLAY (CH)**, moist. [Fluviatile Terrace Deposits]	91	
765 10	8-10-13			
760 15	PP: 4.5+ tsf REC: 12" 12-16-21	Brown, hard, **LEAN CLAY with SAND (CL)**, moist, few gravel. [Fluviatile Terrace Deposits]	77	117
755 20	PP: 4.5+ tsf REC: 14"	Light brown, hard, **SANDY LEAN CLAY (CL)**, moist. [Fluviatile Terrace Deposits]	68	
750 25	6-15-18	Light brown, dense, **CLAYEY SAND with GRAVEL (SC)**, slightly moist. [Fluviatile Terrace Deposits]	28	
745 30	11-5-6	Light brown, medium dense, **CLAYEY GRAVEL with SAND (GC)**, slightly moist. [Fluviatile Terrace Deposits]	16	
740 35	10-16-18	Dark brown to gray, hard, **LEAN CLAY (CL)**, moist, trace of gypsum. [Escondido Formation]		
735 40	21-32-46	Gray, hard, **LEAN CLAY with SAND (CL)**, moist. [Escondido Formation]	71	

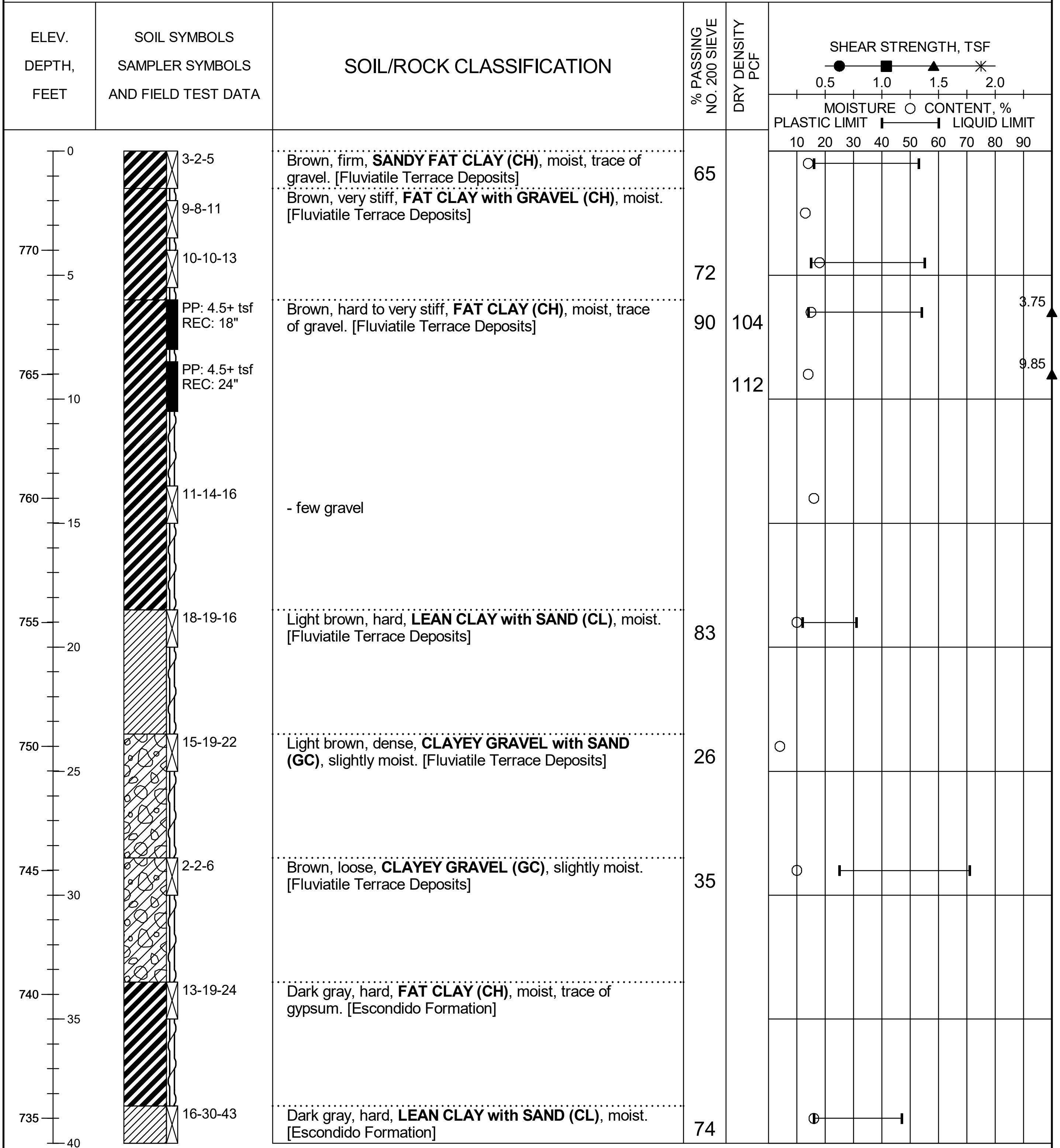


Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 6

LOG OF BORING

Project: Castroville - Garcia Creek Channel Stabilization
Project No.: SG 24 10218
Boring No.: B-4
Date: 9/11/2024
Elevation: 774.0 feet
Groundwater during drilling: Not Encountered
Northing: 13,677,018.8
Station: --
Groundwater after drilling: Not Encountered
Easting: 2,003,582.5
Offset: --



Sampler Symbols and Field Test Data	Soil/Rock Classification	% Passing No. 200 Sieve	Dry Density PCF
3-2-5	Brown, firm, **SANDY FAT CLAY (CH)**, moist, trace of gravel. [Fluviatile Terrace Deposits]	65	
9-8-11	Brown, very stiff, **FAT CLAY with GRAVEL (CH)**, moist. [Fluviatile Terrace Deposits]		
10-10-13		72	
PP: 4.5+ tsf REC: 18"	Brown, hard to very stiff, **FAT CLAY (CH)**, moist, trace of gravel. [Fluviatile Terrace Deposits]	90	104
PP: 4.5+ tsf REC: 24"			112
11-14-16	- few gravel		
18-19-16	Light brown, hard, **LEAN CLAY with SAND (CL)**, moist. [Fluviatile Terrace Deposits]	83	
15-19-22	Light brown, dense, **CLAYEY GRAVEL with SAND (GC)**, slightly moist. [Fluviatile Terrace Deposits]	26	
2-2-6	Brown, loose, **CLAYEY GRAVEL (GC)**, slightly moist. [Fluviatile Terrace Deposits]	35	
13-19-24	Dark gray, hard, **FAT CLAY (CH)**, moist, trace of gypsum. [Escondido Formation]		
16-30-43	Dark gray, hard, **LEAN CLAY with SAND (CL)**, moist. [Escondido Formation]	74	

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✳ = UU Triaxial

PLATE 7

LOG OF SOIL BORING SG 24 10218 GARCIA CREEK CULVERT STABILIZATION.GPJ HVJ.GDT 10/30/24

HVJ ASSOCIATES

SOIL SYMBOLS

Soil Types

▨	▥	░	▩
Clay	Silt	Sand	Fill

Modifiers

▨	▥	▨	⁘
Clayey	Silty	Sandy Clay	Cemented

Construction Materials

▤	⁘	▩	⬡
Asphaltic Concrete	Stabilized Base	Fill or Debris	Base

SAMPLER TYPES

▮	Thin Walled Shelby Tube	▱	No Recovery
☒	Split Barrel	≀	Auger
▤	THD Cone Penetration Test	⧗	Jar Sample

WATER LEVEL SYMBOLS

▼	Groundwater level determined during drilling operations
▽	Groundwater level after drilling in open borehole or piezometer

SOIL GRAIN SIZE

Classification	Particle Size	Particle Size or Sieve No. (U.S. Standard)
Clay	< 0.002 mm	< 0.002 mm
Silt	0.002 - 0.075 mm	0.002 mm - #200 sieve
Sand	0.075 - 4.75 mm	#200 sieve - #4 sieve
Gravel	4.75 - 75 mm	#4 sieve - 3 in.
Cobble	75 - 200 mm	3 in. - 8 in.
Boulder	> 200 mm	> 8 in.

DENSITY OF COHESIONLESS SOILS

Descriptive Term	Penetration Resistance "N" * Blows/Foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

CONSISTENCY OF COHESIVE SOILS

Consistency	Undrained Shear Strength (tsf)
Very Soft	0 - 0.125
Soft	0.125 - 0.25
Firm	0.25 - 0.5
Stiff	0.5 - 1.0
Very Stiff	1.0 - 2.0
Hard	> 2.0

PENETRATION RESISTANCE

3/6	Blows required to penetrate each of three consecutive 6-inch increments per ASTM D-1586 *
50/4"	If more than 50 blows are required, driving is discontinued and penetration at 50 blows is noted
0/18"	Sampler penetrated full depth under weight of drill rods and hammer

* The N value is taken as the blows required to penetrate the final 12 inches

TERMS DESCRIBING SOIL STRUCTURE

Slickensided	Fracture planes appear polished or glossy, sometimes striated
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Inclusion	Small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Parting	Inclusion less than 1/4 inch thick extending through the sample
Seam	Inclusion 1/4 inch to 3 inches thick extending through the sample
Layer	Inclusion greater than 3 inches thick extending through the sample
Laminated	Soil sample composed of alternating partings of different soil type
Stratified	Soil sample composed of alternating seams or layers of different soil type
Intermixed	Soil sample composed of pockets of different soil type and laminated or stratified structure is not evident
Calcareous	Having appreciable quantities of calcium carbonate
Ferrous	Having appreciable quantities of iron
Nodule	A small mass of irregular shape

HVJ ASSOCIATES

PROJECT NO.: SG 24 10218

DRAWING NO.: PLATE 8

KEY TO TERMS AND SYMBOLS
USED ON BORING LOGS FOR SOIL

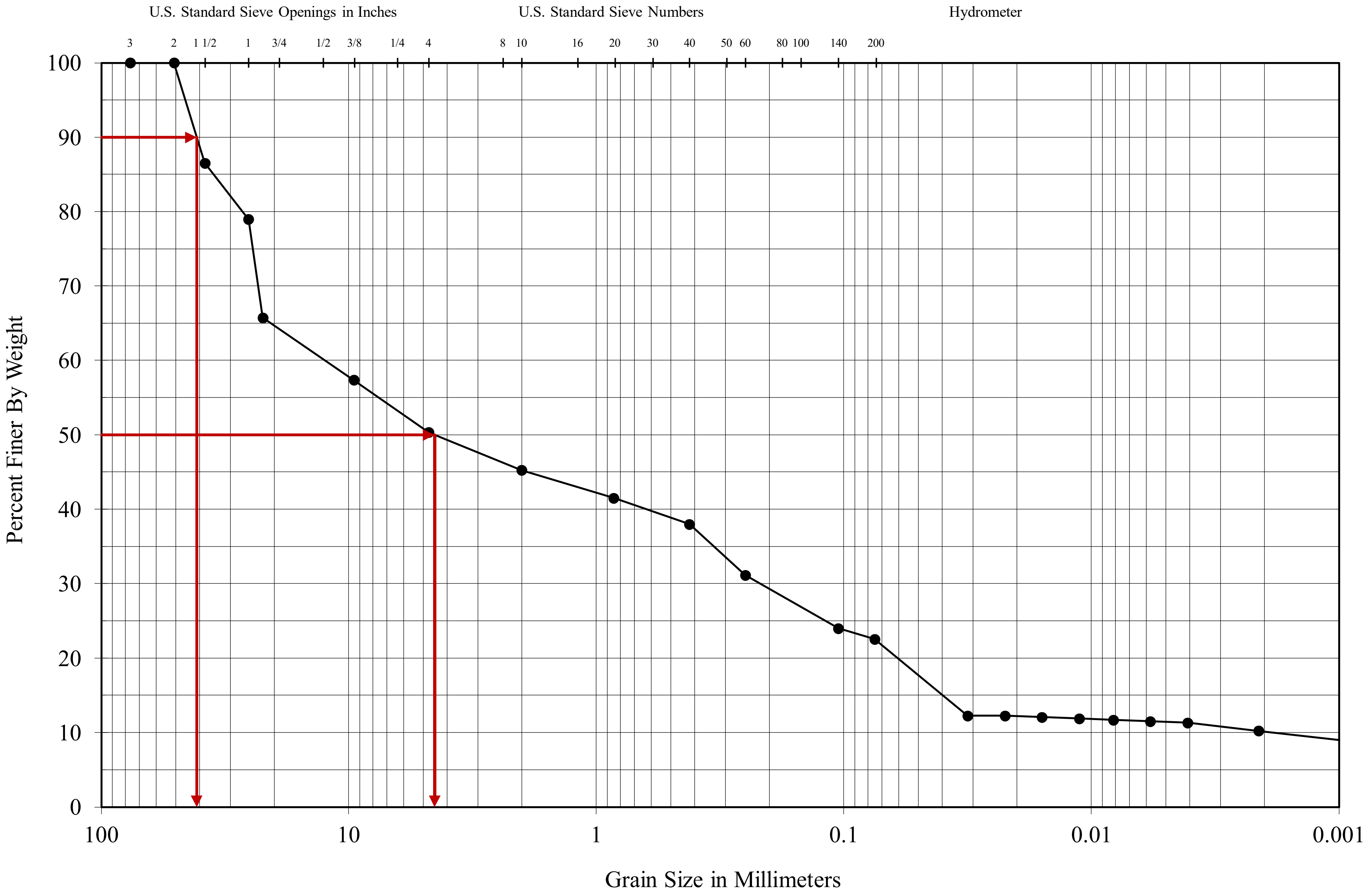
DATE: 7/14/2023 4:15:14 PM
FILE: C:\Users\shari\OneDrive\Documents\HVJ\Stonehill\CAD\SOIL_ROCK.dwg

APPENDIX A
LABORATORY TEST RESULTS SUMMARY

LABORATORY TEST RESULTS SUMMARY
Project Name: Castroville - Garcia Creek Culvert Stabilization
Project Number: SG 24 10218

Boring Number	Depth (ft)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	Moisture Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Unconfined Compressive Strrength (tsf)	Pocket Penetrometer (tsf)
B-1	0-1.5				12.2				
	2-3.5	73	42	27	10.1				
	6-7.5	90	53	39	14.1				
	8-10		44	30	16.4				4.5+
	13-15	81	44	30	14.4				4.5+
	18.5-20				11.7				
	23.5-25	37	30	19	5.9				
	28.5-30				7.8				
	33.5-35	88	69	43	29.8				
	38.5-40	98	69	43	29.3				
B-2	0-1.5	57	35	18	15.9				
	2-3.5				12.5				
	4-5.5	55	36	19	9.1				
	6-7.5				10.7				
	8-9.5	30	23	10	3.1				
	13.5-15				3.6				
	18.5-20	30	26	13	6.6				
	23.5-25	64	44	30	15.2				
	28.5-30				14.2				
	33.5-35	31	52	33	9.6				
B-3	0-1.5				10.6				
	2-3.5	82	47	34	10.4				
	4-5.5				11.6				
	6-7.5	91	53	40	14.8				
	8-9.5				16.2				
	13-15	77	41	28	14.4	134	117	16.5	4.5+
	18-20	68	37	25	12.0				4.5+
	23.5-25	28	28	14	6.6				
	28.5-30	16			3.8				
	38.5-40	71	47	30	14.7				
B-4	0-1.5	65	53	37	13.5				
	2-3.5				13.3				
	4-5.5	72	55	40	17.6				
	6-8	90	54	40	14.8	119	104	7.5	4.5+
	8.5-10.5				14.3	128	112	19.7	4.5+
	13.5-15				15.5				
	18.5-20	83	31	19	9.9				
	23.5-25	26			3.8				
	28.5-30	35	71	46	10.3				
	38.5-40	74	47	31	15.9				

APPENDIX B
GRAIN SIZE ANALYSIS TEST RESULTS



Location	D90 and D50	Classification
S-1 (Upstream)	D90 = 41.2 mm D50 = 4.5 mm	SILTY CLAYEY GRAVEL WITH SAND (GC-GM)

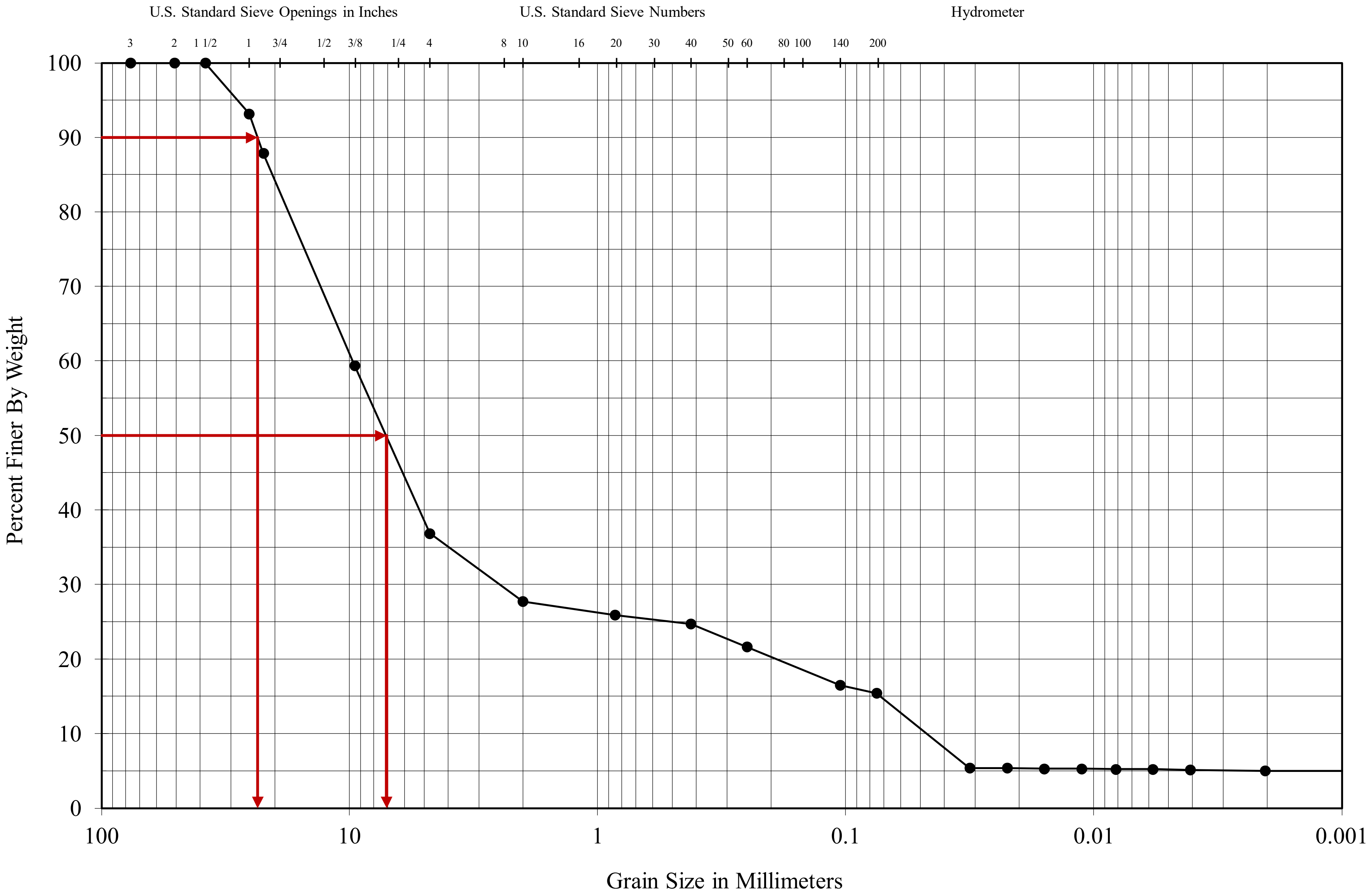
HVJ Associates, Inc.

SIEVE ANALYSIS CURVE

Castroville Garcia Creek Channel Stabilization
Medina County, Texas

PROJECT NO.
SG 24 10218

APPENDIX B-1



Location	D90 and D50	Classification
S-2 (Downstream)	D90 = 23.5 mm D50 = 7.1 mm	CLAYEY GRAVEL WITH SAND (GC)

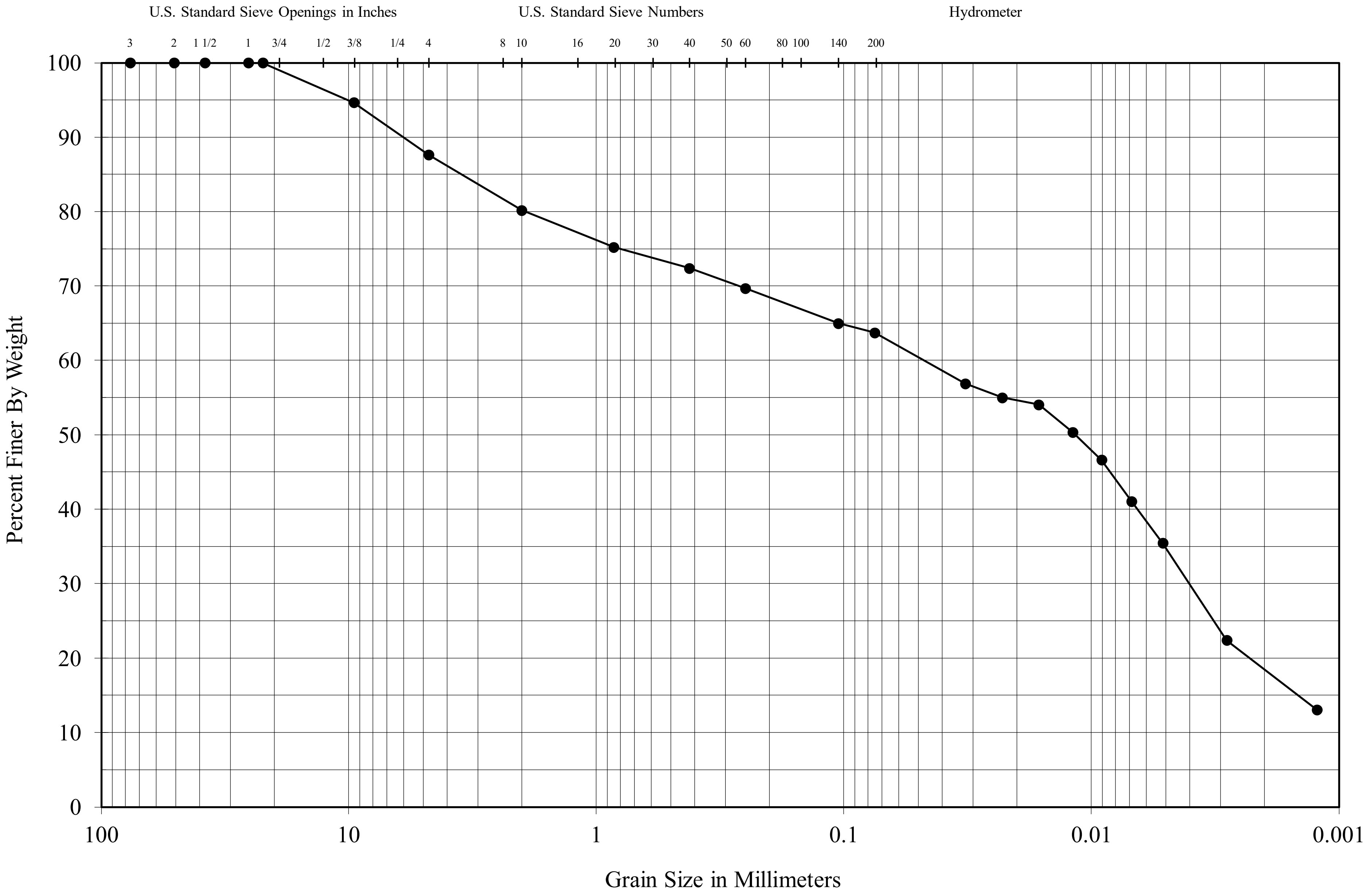
HVJ Associates, Inc.

SIEVE ANALYSIS CURVE

Castroville Garcia Creek Channel Stabilization
Medina County, Texas

PROJECT NO.
SG 24 10218

APPENDIX B-2



Location

B-2 (23.5'-25')

Classification
SANDY LEAN CLAY (CL)

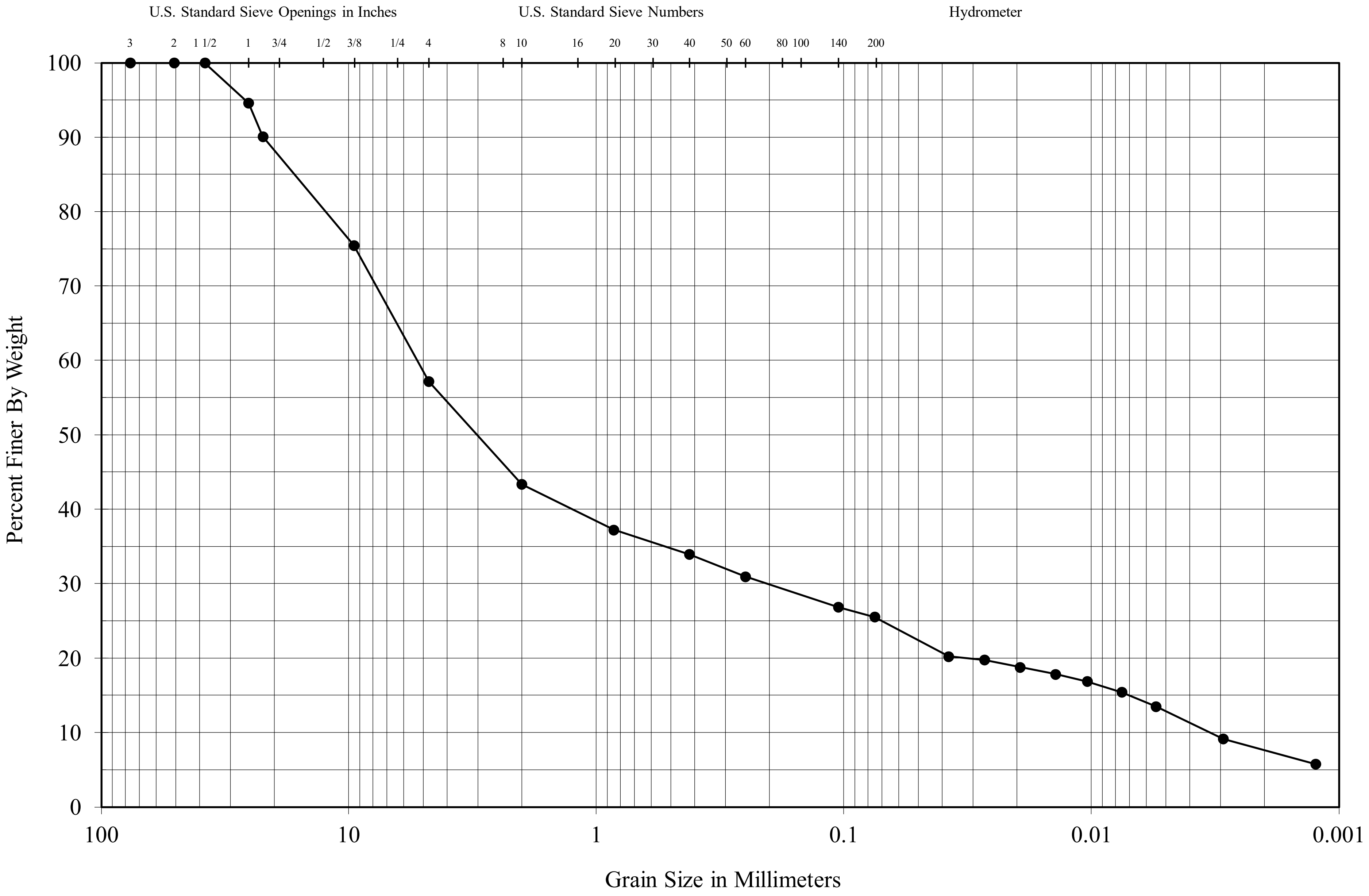
HVJ Associates, Inc.

SIEVE ANALYSIS CURVE

Castroville Garcia Creek Culvert Stabilization
Medina County, Texas

PROJECT NO. SG 24 10218	APPENDIX B-3

HVJ ASSOCIATES



Location

B-4 (23.5'-25')

Classification

CLAYEY GRAVEL WITH SAND (GC)

HVJ Associates, Inc.

SIEVE ANALYSIS CURVE

Castroville Garcia Creek Culvert Stabilization

Medina County, Texas

PROJECT NO.

SG 24 10218

APPENDIX B-4

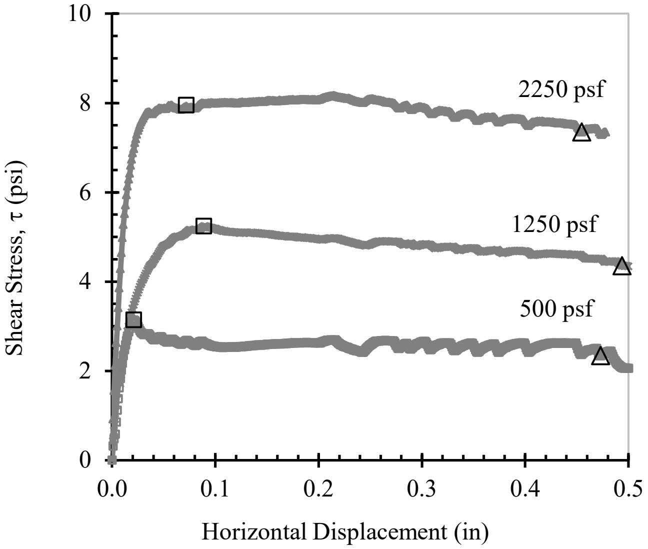
APPENDIX C
DIRECT SHEAR TEST RESULTS

Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

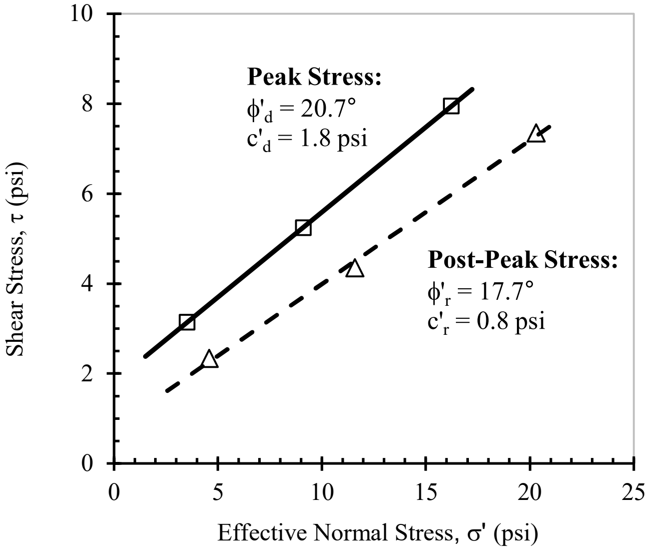
Direct Shear Consolidated Drained Test
(ASTM D3080)

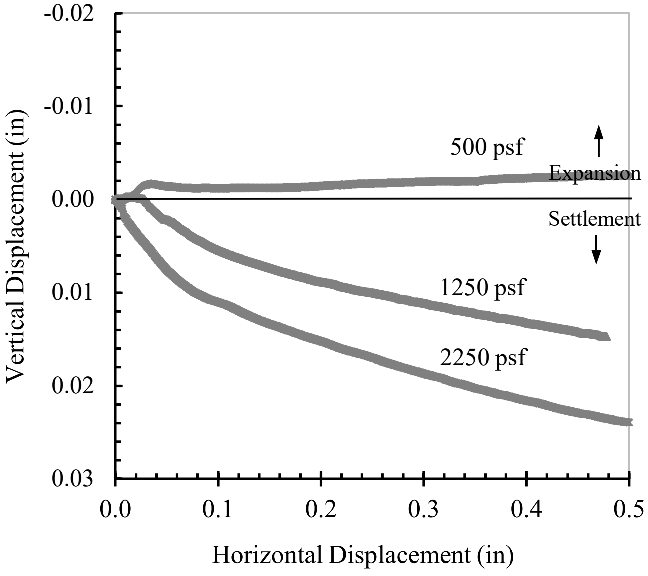
Client: HVJ South Central Texas - M&J, Inc.
Project Name: Garcia Creek Culvert Stabilizat (PN: SG 24 10218)
Sample ID: B-1 (8-10 ft)

Alpine Project No.: 2409340
Test Date: 09/17/24
Tested By: T.D.
Method of Preparation: *Shelby Tube*



Note: Area Correction Has Been Applied





	Specimen Number	1	2	3
Initial Condition	Diameter, in	2.51	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	13.9	13.4	13.8
	Degree of Saturation, %	57.7	53.1	59.6
	Dry Unit Weight, pcf	101.7	99.9	103.3
	Void Ratio, e_0	0.64	0.67	0.62
After Consolidation	Height, in (prior to shear)	1.01	1.00	1.02
	Final Water Content, %	25.8	24.9	22.1
	Dry Unit Weight, pcf	100.5	99.5	100.9
	Void Ratio, e_f	0.66	0.68	0.66
Peak Normal Stress, σ' (psi)		3.5	9.1	16.2
Peak Shear Stress, τ (psi)		3.1	5.2	7.9
Displacement at Failure (in)		0.02	0.09	0.07
Displacement Rate (in/min)		0.00025		
Peak Strength Parameters		ϕ'_d, degree		**20.7**
		c'_d, psi		**1.8**
Post-Peak Strength Parameters		ϕ'_r, degree		**17.7**
		c'_r, psi		**0.8**

Note: The Shelby tube sample was extruded and provided by the client. Specimens were trimmed using a trimming turntable. The specific gravity of 2.68 was assumed.

Cheng-Wei Chen, Ph.D. 09/22/24
Reviewed By / Date

Direct Shear Consolidated Drained Test
(ASTM D3080)

Client:	HVJ South Central Texas - M&J, Inc.	Alpine Project No.:	2409340
Project Name:	Garcia Creek Culvert Stabilizat (PN: SG 24 10218)	Test Date:	09/17/24
		Tested By:	T.D.
Sample ID:	B-1 (8-10 ft)	Method of Preparation:	*Shelby Tube*

(1) Normal Load = 500 psf

(2) Normal Load = 1250 psf

(3) Normal Load = 2250 psf