BRIERLEY ASSOCIATES

Creating Space Underground

EL DORADO CONDUIT RAW WATER CONVEYANCE TUNNEL INSPECTION

GEORGETOWN, CALIFORNIA

Report to:

Georgetown Divide Public Utility District

Georgetown, California

Submitted by:

BRIERLEY ASSOCIATES CORPORATION

WOODLAND HILLS, CA

January 2025

BRIERLEY ASSOCIATES
Creating Space Underground

January 8, 2025
File Number: 124141-000

Georgetown Divide Public Utility District
P.O. Box 4240
6425 Main Street
Georgetown, CA 95634

Attention: Mr. Adam Brown
Operations Manager

Subject: Tunnel Inspection Report
Raw Water Conveyance Tunnel Inspection
Georgetown, California

Mr. Adam Brown:

Brierley Associates Corporation (Brierley) is pleased to submit this report to Georgetown Divide Public Utility District (GDPUD) that presents the results of our inspection of the Raw Water Conveyance Tunnel located near Georgetown, California.

This report summarizes the field activities, collected data, and observations for the tunnel inspection that occurred on November 5, 2024. It also provides a tunnel condition assessment using the collected information from this and previous inspection, as-built drawings, and findings from previous studies; and provides recommendations for future inspections and rehabilitation considerations. This information can be used by GDPUD to evaluate changes in tunnel conditions during subsequent inspections, and aid in engineering analysis and design efforts as needed.

Please feel free to contact us should you have any questions about this report or require additional information.

Sincerely,

BRIERLEY ASSOCIATES CORPORATION

Nathan Stubley, PG
Senior Project Manager

Bill Zietlow, PE
Associate

TABLE OF CONTENTS

FIGURES

APPENDICES

1 INTRODUCTION

1.1 Tunnel Design and Construction

The Georgetown Divide Public Utility District (GDPUD) is responsible for the provision of domestic treated and irrigation water serving multiple communities within El Dorado County, California. This gravity fed water originates from the approximately 21,206 acre-ft Stumpy Meadows Reservoir and travels through approximately 70 miles of open ditches, pipelines, tunnels and conduits to Walton Lake Treatment Plant and Sweetwater Treatment Plant.

The El Dorado Conduit Tunnel is approximately six miles downstream of the Stumpy Meadows Reservoir and approximately eight miles northeast of the town of Georgetown. The tunnel consists of an inlet portal, a 0.9-mile long, 8 ft diameter unlined horseshoe shaped tunnel, and an outlet portal. Constructed in 1959, the tunnel was excavated entirely through bedrock with an inlet portal and outlet portal on the east and west side of Tunnel Hill, respectively. Figure 1 shows the location of the tunnel.

Reviewing the design drawings prepared by Clair A. Hill & Associates (1959), the tunnel grades downslope from east to west with an invert elevation difference of 21.25 ft (El. 3704.21 ft to El. 3682.96 ft). Topography along the tunnel alignment varies significantly, with a maximum surface elevation of approximately El. 4240 ft at the highest point, indicating up to approximately 540 ft of cover at roughly the mid-point of the tunnel.

The design drawings depicting the tunnel profile and topography are shown in Figure 2 and the tunnel inlet and outlet portals are shown in Figure 3 and 4, respectively. This shows that tunnel consists of a 4,617-ft long section of tunnel excavated below the ridge with transition portals at either end.

The tunnel was likely constructed using drill and blast methods and two types of support were proposed as shown on Figure 2. For sections of the tunnel requiring support, steel sets, with an unidentified dimension and spacing, were to be installed from invert to invert with a minimum 1 inch shotcrete coating around the steel sets. Lagging was to be installed between the steel sets and tunnel walls. In unsupported sections of the tunnel, rock bolts were to be installed in the crown as directed by the engineer.

As shown in Figure 3 and 4, the portal structures are both 10-ft long and appear to be constructed as reinforced cast-in-place concrete structures. The liner is shown as being a minimum of 8-in. thick. The inlet portion shows an elevation decrease from the open side to the tunnel side, which is also tied into the concrete channel upstream. The outlet portal is generally flat and also shows a tie-in to a channel on the open side, but which was absent during the inspection.

1.2 Previous Inspection and Repair

GDPUD provided records for one previous inspection and repair completed by Victor L. Wright Incorporated, titled ‘El Dorado Conduit Tunnel, Inspections & Repairs’ dated February 25, 1994, which Brierley reviewed prior to the tunnel inspection.

This document consists of observations and imagery of the original construction support, basic geologic conditions, and details of a collapse that was discovered in December 1993 (with further fallout in January 1994), which appears to be what prompted the initial inspection and subsequent repairs. There is no identification of water inflow locations, but the report notes approximately 10 to 30 gallons per minute (gpm) of water inflow throughout the tunnel. Limited details of the repairs made subsequent to the inspection are also provided.

Prior to the inspection Brierley made an initial summary of the tunnel defects and observations identified in the 1994 report as well as the repairs conducted subsequent to the inspection. A summarized table of findings was not included in the 1994 report, therefore specific identification was taken from the text and the basic tunnel profile with various annotations. Our findings from this assessment are summarized below and tables comparing the previous inspection notes and repairs are included in Appendix A.

- A total of 31 separate notes were recorded identifying tunnel support, basic rock mass conditions, and typical tunnel construction features
  - References and/or identification of support installed during tunnel construction are made at 20 locations throughout the tunnel length. These typically identify the presence of horseshoe shaped steel sets, rock bolts, mine straps, and shotcrete, either individually or a combination of two or more. Some shotcrete locations are noted as being possibly incomplete or spalled.
  - A total of eight car pass locations were noted. These locations consisted of the tunnel being widened on one side to a width of up to 14 ft. No increase in tunnel height was noted.
  - Basic rock mass conditions were noted at six locations. The descriptions are generally incomplete, only referring to blockiness or presence of joints. No dip or strike orientations are given for individual locations, but a general statement notes:

    "Formation foliation crosses tunnel centerline at wide angles and frequently dips 40 to 50 degrees upstream, but with opposite dip directions locally".
- Two main areas of the tunnel were rehabilitated based on the 1994 report, both of which relate to sections of the tunnel near the inlet and outlet portals
  - Minor repairs were made between approximately Sta. 451+56 and 451+80, which consisted of replacement of timber lagging above the first eight steels sets
  - The most extensive work was completed at the outlet portal, between approximately Sta. 493+25 to 493+60 (fallout zone) and Sta. 493+80 and 497+63. This consisted of installation of a combination of tunnel support types, including expansion anchor rock bolts and split set rock bolts, new timber lagging, and shotcrete with wire mesh.

No details are provided on the number of rock bolts installed between Sta. 493+25 and the portal exit; however, some details are provided on the type and quantity installed in the fallout zone. The following are based on Figure 2 taken from the repair report:

- 25 expansion anchor rock bolts at 6 and 8 ft lengths
- 17 split set rock bolts at 5 and 6 ft lengths

As with the rock bolts, little information can be gathered from the repair report regarding the type of wire mesh and specifications of the shotcrete. The report does state that shotcrete was applied from invert to invert in the fallout zone and approximately 12 ft downstream, but in the crown only at other locations. Furthermore, although at least 3 in. of shotcrete was expected to be applied, due to issues with the accelerator, only 1.5 in. was applied before the work was cancelled.

1.3 Local and Regional Geology

The El Dorado Conduit tunnel is located within the northern portion of the Sierra Nevada geomorphic province approximately seven miles to the east of Georgetown, California. The Sierra Nevada is a nearly 400 mile-long tilted fault block, with a gentle west slope and high, jagged fault scarp to the east. The highest point is Mt Whitney with an elevation of 14,495 ft.

As shown on the Geologic Map of the Sacramento Quadrangle (Wagner et al, 1981), an excerpt from which is presented in Figure 5, the El Dorado Conduit was constructed through Tunnel Hill, with the western portion excavated through undifferentiated Paleozoic metamorphic/metasedimentary rocks and eastern portion through Mesozoic granitic rocks. The rock units consist of the following:

- **Mesozoic granitic** (inlet)– predominantly granite to granodiorite
- **Paleozoic metasedimentary** (outlet) – Quartzite, pelitic schist, minor crystalline limestone and dolomite

Descriptions given to materials encountered in boreholes advanced prior to the original construction of the tunnel and those recorded during the repairs differ slightly from the geologic map referenced above.

The design drawing profile (Hill, 1959) provides descriptions of two boreholes located adjacent to the inlet and outlet tunnel. The descriptions at the approximate tunnel elevation are as follows:

- **Inlet –** Quartz schist. Gray to black. Core can be broken with moderate hammer blows. Closely spaced joints. Stained with sulfides.
- **Outlet –** Slates and Phyllites. Micaceous. Gray Occasional quartz vein. Core easily broken with hammer. Jointed with joints stained green with sulfides.

The description provided in the repair report provides the following description:

- Tunnel is moderately to slightly weathered hornfels and schist. Formational foliation crosses tunnel centerline at wide angles and frequently dips 40-50 degrees upstream but with opposite directions locally. Variable jointing and infrequent high-angle shears are typical. Water drips from the rock at shear locations. Total groundwater flow is estimated to be in the order of 10-30 gpm.

2 SCOPE OF WORK

Brierley were contracted by GDPUD to complete an inspection of the Raw Water Conveyance Tunnel. Associated work was performed in three tasks as summarized below:

- **Task 1 – Project Management, Records Review, and Schedule**
  - Coordination of subcontractors, prepare project documentation, liaison with GDPUD
  - Review prior construction records to develop tunnel inspection plan
  - Ongoing coordination with GDPUD project representative
- **Task 2 – Tunnel Inspection**
  - Project kick-off meeting with GDPUD and subcontractors
  - Field activities consisting of:
    - Safety orientation
    - Establish stationing in tunnel
    - Visual observations, measurements, photographic documentation of portal and tunnel conditions and deficiencies
- **Task 3 – Reporting**
  - Preparation of this report that includes:
    - Summary of field activities
    - Provide field notes and measurements, photographs of required stations and selected features
    - Comparison of current and previous inspection records, where possible, to determine if further deterioration has occurred
    - Profiles of the tunnel with specific observations made during the inspection including existing tunnel support, defects, and geologic conditions
    - Recommendations on future actions

3 PROJECT STATIONING AND ELEVATIONS

Tunnel stationing and elevations referenced in this report are based on and correspond with the stationing and elevations shown on the design drawings prepared by Clair A. Hill and Associates (1959).

- ***Tunnel Field Stationing.*** This refers to stationing that was marked on the tunnel walls during the inspection and used to reference observed defects.

4 PROJECT COORDINATION

4.1 Field Personnel and Subcontractors

Brierley provided supervision of its staff and subcontractors during planned field activities. Subcontracts and roles included:

- Barr Engineering Corporation (Barr), Reno, NV – tunnel inspection and reporting support
- Harrison Western (HW), Denver, CO – provided labor and equipment to manage tunnel safety including scaling of loose rock, air quality, and standby emergency response

4.2 Entry Requirements

Although not classified as a confined space, Brierley and its subcontractors were all trained in Confined Space Entry. Brierley personnel and subcontractors accessed the tunnel from the Inlet (East) Portal. Entry into the tunnel was controlled and documented by HW onsite staff.

4.3 Tunnel Inspection Work and HSE Plan

A project specific Health, Safety and Environmental (HSE) plan was included with the Tunnel Inspection Workplan. The HSE plan was developed to meet identified health and safety related risks that field personnel would be exposed to during the inspection and provided mitigation measures to reduce HSE risks to field personnel.

Personnel from Brierley and its subcontractors were made aware of the health and safety risks during a pre-mobilization briefing. A copy of the Tunnel Inspection Workplan and HSE Plan were kept onsite for reference. A health and safety meeting was held prior to tunnel entry. No HSE incidents occurred during tunnel inspection field activities.

4.4 Inspection Schedule

Tunnel inspection activities included establishing tunnel stationing, observing and recording lining defects and tunnel conditions, and observing and recording existing support elements. The work was performed during a single day shift between 07:00 and 17:00 on Tuesday November 5, 2024.

4.5 Tunnel Safety

Harrison Western mobilized a four-person safety team to support tunnel inspection operations. Two of the team members consisted of underground specialists used to working in a variety of tunnel conditions, who entered the tunnel and worked ahead of the inspection team. Their role was to ensure the work environment was safe for everyone to perform their duties and consisted of:

- Scaling any loose or unsafe rock in advance of the inspection team
- Monitor air quality using gas detectors continuously throughout the inspection

The other two team members were positioned at the inlet and outlet portals (one at each). Their role was a standby role with the remit to work with GDPUD personnel should an emergency rescue situation develop, which fortunately was not required.

In summary, there were very few areas that required scaling or removal of loose rock and no occurrences of poor air quality were encountered.

5 TUNNEL OBSERVATIONS

A single team composed of three members (two from Brierley and one from Barr) made observations and measurements of select conditions encountered along the tunnel and at the portals. Reference tunnel stationing was marked on the north side of the tunnel near the spring line at 50 ft intervals as the team transited from the inlet to outlet portal. This reference stationing was then used as reference points for locating observed conditions.

Because of the limited time available to perform the inspection, efforts were focused on identifying and documenting the most critical defects and collection of general geologic data along the tunnel alignment. Where identified, attention was given to areas of specific interest or concern within the tunnel and at the portals and to areas that were identified in any previous inspection or construction/repair documents. The specific data collected along the unlined sections of the tunnel consisted of:

- Tunnel portal conditions
- Existing tunnel support assessment
- Collection of rock and rock mass characteristic data
- Tunnel dimensions.
- Tunnel alignment
- Photographic and/or video survey – Photographs were collected on a 50 ft spacing and throughout the tunnel at closer spacing in areas of any specific interest. These photographs are included in Appendix B and Appendix C, respectively.

Along the unlined tunnel, observations were documented by use of field notebooks, tunnel maps showing geological data, and photographs. All notes included the observation time and date and stationing to ensure areas of interest can be relocated during future inspections.

Select photos from the photographic survey are included in Appendix C, tabulated logs of the observations and annotated tunnel profiles showing observations are included in Appendix D, and geologic maps showing data recorded in the field are shown in Appendix E.

5.1 Tunnel Portals

Both the tunnel inlet and outlet have a cast-in-place concrete structure with a 10 ft length as a transition from portal to tunnel. Based on the project drawings (Sheet no. C-002 and C-003) from 1959, the concrete is reinforced with No. 4 steel bars spaced at six inches. Some general observations on tunnel/transition structure interfaces are provided below based on our visual inspection in November 2024:

- The inlet transition structure is located between the trash rack (tunnel station: 451+47) and the tunnel about Sta. 451+57. The outlet transition structure is located between tunnel about Sta.497+53 and 497+63.
- Interfaces at both inlet and outlet appeared to be intact and be in contact with the rock surface from the tunnel crown to the walls. Observations at the tunnel invert were not possible due to ponded water.
- The concrete surface at the inlet has some rust and efflorescence, especially along cracks. There was no delamination, scaling, spalling, exposed rebar, honeycombing, or active leakage. While brown staining was mainly present where the concrete is close to the trash rack and the first steel sets in the tunnel, light-colored and greenish staining was typical in the middle section. An approximately seven-ft long longitudinal crack on the south wall shoulder appeared to be surficial and was observed with some efflorescence in the middle. Due to a light-colored deposit build-up on the crack, the crack width was not determined at this location but appeared to be in the range of 0.012 to 0.1 inch.

- The concrete surface at the outlet has some efflorescence especially along some surficial cracks. There was no delamination, scaling, spalling, exposed bar, honeycombing or active leakage. Cracks on the north wall were surficial and very thin, between 0.01 and 0.1 in. A light-colored deposit build-up was present along cracks that are five- to ten-inches long. Cracks on the south wall were also surficial and very thin in general. There was a crack extending perpendicular to the tunnel axis and with a light- been initiated. Staining was mainly present in green.

5.2 Steel Sets

Steel sets were generally installed within a short distance of the inlet (16 sets) and outlet (75) portals with a short section approximately 600 ft from the outlet (8). Some general observations on steel set locations are provided below based on our visual inspection. Note that the numbering system is based on transiting from the outlet to the inlet, i.e. steel set No. 1 is nearest to the outlet side of the tunnel.:

- At the inlet, between about Sta. 451+60 and 451+95, a total of 16 steel sets (No. 83 to No. 98) were observed at spacing of approximately 2 ft. The steel sets and tie-rods connecting them were typically covered with shotcrete and it was not possible to inspect the steel set surfaces under shotcrete. It was not clear if shotcrete cover was a protection measure for corrosion or something else. Where tie-rods were not covered with shotcrete, they appeared to be affected by significant corrosion. The wood blocking between the steel sets and rock surface appeared to be inadequate (i.e., some wood blockings were missing or widely spaced at the shoulders, walls and crown). At the location of last seven steel sets towards outlet in this interval, there was no contact between shotcrete and steel sets at the tunnel crown. This dramatically reduces the steel set capacity if rock wedges move to load the steel set.
- At the outlet, between about Sta. 496+00 and 497+50, a total of 49 steel sets (between No. 1 and No. 49) were observed at various spacings:
  - the first 21 steel sets (between No. 49 and No. 29) were spaced from 3.0 to 4.0 ft,
  - then, the next 14 steel sets (between No. 29 and No. 14) were spaced from 2.0 to 3.0 ft, and
  - the last 14 steel sets (between No. 14 and No. 1) near the outlet were spaced at approximately 2.0 ft.
- The steel sets and tie-rods connecting them were not covered with shotcrete, and they appeared to be affected by significant corrosion. Some occasional shotcrete applications were observed on steel sets closer to the tunnel invert. The wood blocking between the steel sets and rock surface were missing at the shoulders, walls and crown for the first ten steel sets. Tie-rods between the steel sets were missing at the following locations:
  - No. 13 - No. 14 on the south wall
  - No. 21 - No. 22 on the south wall
  - No. 24 - No.25 on the north wall
  - No. 28 - No. 29 on the south wall
  - No. 47 - No. 48 on the north wall
- Tie-rods between the steel sets were deformed or bent at the following locations:
  - No. 25 - No. 26 on the south wall
- Between about Sta. 494+80 and 495+75, a total of 25 steel sets (between No. 50 and No. 74) spaced at 4.0-ft were observed. A tie-rod between steel set No. 53 and No. 54 was missing on the south wall. Tie-rods between the steel sets were deformed or bent at the following locations:
  - No. 50 - No. 53 on the south wall
  - No. 56 - No. 57 on the south wall

  - No. 59 - No. 60 on the south wall
  - No. 72 - No. 73 on the north wall
- The wood blocking, shotcrete and timber lagging were observed to be inadequate (i.e., some wood blockings were missing at the shoulders, walls and crown; no shotcrete on rock surface and steel sets) between steel set No. 50 and No. 54, between steel set No. 60 and No. 74. The steel sets and tie-rods connecting them appeared to be affected by significant corrosion where not covered with shotcrete.
- Between about Sta. 493+10 and 493+40, a total of 8 steel sets (between No. 74 and No. 82) spaced at 4.0-ft were observed. This area is the previous fallout zone. There were about six drainpipes to collect or divert groundwater discharge at several locations within this interval. The wood blocking and timbers between the steel sets and rock surface were missing at the crown. Steel sets and tie-rods were covered with shotcrete. It was not possible to inspect the steel set surfaces under shotcrete. Tie-rods between the steel sets were missing at the following locations:
  - No. 76 - No. 78 at the crown
  - No. 79 - No. 82 at the crown

5.3 Shotcrete and Welded Wire Mesh

Shotcrete and/or welded wire mesh applications were observed at the following locations during our visual inspection:

- Inlet Portal (between about Sta.451+60 and 451+95): Shotcrete with no observation of welded wire mesh. Shotcrete appears in good condition.
- Sta. 461+20: Shotcrete observed together with mine straps, thin and white stalactites. Some delamination in places. Shotcrete thickness is less than approximately 1 in.
- Between Sta. 463+00 and 462+30: Shotcrete observed at full section of the tunnel together with thin white stalactites.
- Sta. 470+25: Shotcrete and welded wire mesh observed together with thin and white stalactites.
- Sta.476+50: Shotcrete and 4 in. welded wire mesh observed together with mine straps.
- Sta.477+70: Shotcrete and welded wire mesh observed together with mine straps at the crown.
- Between Sta.478+35 and 478+45: Shotcrete and welded wire mesh observed together with thin, white stalactites
- Sta.479+50: Shotcrete and 4 in. welded wire mesh observed together with thin, white stalactites
- Between Sta.493+00 and 493+55: Shotcrete and welded wire mesh observed together with thin, white stalactites
- Outlet: Occasional and incomplete shotcrete (i.e., to secure some of the steel sets it was applied closer to the tunnel invert) with no observation of welded wire mesh

5.4 Car Pass Tunnel Widening

Car pass locations, where the tunnel span ranges from 12 ft to 14 ft, were observed at the following stations:

- Sta. 455+20 - 455+40
- Sta. 460+70 - 460+90
- Sta. 468+20 - 468+40
- Sta. 473+30 - 473+50
- Sta. 478+45 - 478+65
- Sta. 483+50 - 483+70

- Sta. 487+55 - 487+75
- Sta. 493+34 - 493+50

Sediment depositions and some channeled shotcrete at the tunnel invert were observed in many of these car pass locations.

5.5 Geologic Mapping

As the inspection crew transited from the outlet to inlet tunnel, intermediate collection of rock mass and other geologic data were collected. Typically, geologic maps along 10 ft sections of the tunnel surface were collected every 500 ft, interspersed with measurements in areas where good exposures were observed. In addition, rock mass data was also collected at the surface around the tunnel portals. It should be noted that time did not allow for comprehensive mapping, and the collected data may not provide a complete representation of rock mass conditions. The geologic maps showing structural characteristics are included in Appendix E.

Water inflow has the potential to cause significant issues due to a variety of problems, such as structural instability and general deformation. When water flows through discontinuities in the rock mass, continued weathering occurs along the surface planes, potentially widening the space between the rock surface and depositing materials which can adversely affect rock mass properties, such as clay materials. Alternatively, in a rock mass where joints remain tight or are not exposed to the tunnel, the build-up of hydrostatic pressure can lead to rock deformation and collapse. The inspection therefore recorded active/ongoing water inflows, but also recorded the existence of features that provide evidence of past water inflow, such as the presence of stalactites.

6 TUNNEL CONDITION ASSESSMENT

6.1 Methodology

6.1.1 Tunnel Portal and Existing Support

Although there are no specific standards for the assessment of water tunnels, assessment of the tunnel portal structures followed assessment requirements the Specifications for National Tunnel Inventory (SNTI), specifically related to the element being inspected, which in this case is Cast-in-Place Concrete Portal.

A table provided in Appendix D summarizes the adopted defect condition state system used to assess the tunnel portals. It defines several defect categories including:

- Delamination/spalling/patched areas.
- Exposed reinforcement.
- Efflorescence/mineralization/rust staining.
- Cracking (crack type, maximum width, and spacing).
- Tunnel distortion; and
- Leakage.

Cracking is one of the most critical defects in assessing a tunnel's structural integrity and has been subdivided into three defect categories (crack type, maximum width, and spacing).

The defect condition state is based on a scale from one to four as follows:

- **Condition State 1:** Good condition with no or little notable distress.
- **Condition State 2:** Fair condition with isolated deterioration.
- **Condition State 3:** Poor condition with widespread deterioration or breakdowns without reducing load capacity.
- **Condition State 4:** Severe condition that warrants a structural review to determine the effect on strength or serviceability of the tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element of the tunnel.

A condition state was assigned for each recorded defect and recorded in tables provided in Appendix D.

Existing support installed during the original tunnel construction in 1959 or following the repairs in 1994 were assessed as part of the tunnel inspection. This support consisted of steel sets, mine straps, and rock bolts. This assessment was limited to a visual inspection only and non-destructive testing or other destructive testing was carried out. The main parameters observed during the inspection consisted of:

- **Rust and Scaling**: Visible signs of rust, flaking, or scaling on the steel supports.
- **Loss of Coating**: If the steel supports are coated (e.g., with paint or a protective layer), check for peeling or loss of the coating, which exposes the steel to corrosion.
- **Pitting**: Small localized pits or cavities on the surface of the steel, often indicating localized corrosion.
- **Discoloration**: Any change in the steel's color, which may be due to corrosion or staining from water infiltration.
- **Cracking or Deformation**: Corrosion can lead to cracking or bending of steel supports, especially in areas where rust has compromised the integrity of the material.

Qualitative descriptions of the condition states of the various supports and their location within the tunnel are discussed later in this report

6.1.2 Geologic Mapping

Visual assessment of rock mass was recorded and measurements of specific data collected as part of the mapping exercise to develop a Geomechanics Classification (Rock Mass Rating, RMR) (Bieniawski, 1989). The data collected included:

- Lithology – overall description including bedding thickness, strength, weathering, discontinuities (spacing, size, opening, infill, etc.). This was in general accordance with the United States Bureau of Reclamation Engineering Geology Field Manual (USBR, 1998)
- Areas of water inflow
- Structural data – dip and strike measurements of rock joints, signs of structural deformation, foliation.
- Fault/shear data – any areas which may show offset, gouge, brecciated material.

From this data, the six parameters used to classify the rock mass were extracted and applied to develop a Rock Mass Rating classification (RMR). The RMR classification is an empirical system used to assess the quality of rock masses, based on factors like intact rock strength, jointing, and water conditions, to help in geotechnical engineering and mining. The classification assigns a numerical value (RMR) that ranges from 0 to 100, representing the rock mass's quality. It considers parameters such as the uniaxial compressive strength of intact rock, the condition of joints (spacing, orientation, and roughness), groundwater conditions, and the number of discontinuities. The final RMR score is used to guide decisions regarding tunnel support and excavation design, slope stability, and excavation methods, with higher values indicating better rock quality and lower values suggesting poor quality or unstable conditions.

6.2 Findings

The following section provides an outline of the existing structural and geological conditions observed during the tunnel inspection including a visual assessment on the condition of the steel sets and timber lagging, the condition of shotcrete and wire mesh, and condition of localized areas of mine strap installation.

In addition to the existing tunnel support observations, the geological conditions encountered within the tunnel will be discussed. This includes an analysis of the rock mass quality, discontinuity condition, groundwater inflow, and any potential instabilities that may affect the stability of the tunnel. This assessment aims to provide a baseline from which future inspections can be assessed and provide insights into the ongoing performance of the tunnels support systems and the broader geological environment, guiding recommendations for necessary interventions or improvements.

6.2.1 Tunnel Portals

Two sections of tunnel are supported with cast-in-place concrete; each is 10-ft long at the inlet and outlet. It couldn't be observed during the inspection, but based on the project drawings, the concrete is reinforced with No. 4 steel bars spaced at six inches.

The concrete generally appeared to be in good condition apart from surficial cracks that are associated with some efflorescence.

The most significant crack was found at the inlet on the south wall shoulder (see Appendix B for a photo and Defect No. 1 in Appendix D):

- The longitudinal crack (about 7-ft long, with a width estimated between 0.012 and 0.1 in.) appears surficial, suggesting it may not penetrate deeply into the structure. The presence of efflorescence and light-colored deposits indicates moisture ingress carrying dissolved salts, which precipitate on the surface as water evaporates.

Rust staining near the trash rack and steel sets indicates possible corrosion of nearby embedded or adjacent steel elements.

While staining itself is not necessarily a sign of structural weakness, it indicates moisture intrusion, which can contribute to long-term degradation (e.g., steel corrosion, concrete carbonation).

No observation of delamination, scaling, spalling, patched areas, exposed reinforcement, honeycombing or active leakage on the concrete surfaces indicates that the concrete is generally intact.

6.2.2 Steel Sets

The current state of the tunnel's steel set support system was characterized by missing and corroded components, inadequate blocking, and uneven protection. In general, steel sets were typically spaced at 3 to 4 ft, with some areas of reduced spacing of 2 to 3 ft.

Corrosion of steel elements could induce a reduction in their load-carrying capacity (see Appendix B for a photo of an example at about Sta.496+00 – 497+50 and Defect No. 54 in Appendix D). It was not possible to evaluate the current state of the steel elements load-carrying capacity due to the limited inspection time. This would require detailed assessment of steel condition (pitting, cracking, peeling) and thickness by way of Non-Destructive Testing (NDT), including of accessory elements such as plates at joints, condition of welds, and any nuts and bolts. Such assessment was beyond the scope of this inspection.

Wood blocking between the steel sets and rock surface is critical for evenly transferring loads and preventing stress concentrations on the steel sets. Based on review of the design drawings, it appeared during the inspection that some blocking was missing in the first ten sets (see Appendix B for a photo of an example at about Sta.496+00 – 497+50 and Defect No. 54 in Appendix D).

Missing or deformed tie-rods compromise the interconnected stability of the sets, leading to a weaker and more vulnerable support system, especially under dynamic loading or further ground movement. Tie-rods were either missing or deformed or bent at multiple locations:

- Missing: No. 13–14, No. 21–22
- Deformed or bent: No. 25–26 (see Appendix B for a photo of an example at about Sta.496+00 – 497+50 and Defect No. 54 in Appendix D).

The absence of shotcrete on the steel sets exposes them to environmental factors, accelerating corrosion and reducing longevity. Occasional shotcrete applications near the invert do not provide uniform protection or reinforcement.

6.2.3 Shotcrete and Welded Wire Mesh

Throughout various reaches of the tunnel, shotcrete or a combination of shotcrete and either 0.5 inch or 4 inch welded wire mesh was installed. Our observations of the type and combination of support as well as condition are as follows:

- At the Inlet, welded wire mesh was not observed and shotcrete was the method of support. The shotcrete appeared to be in good condition with no observed areas of fallout, popping etc.

- Sta. 461+20, thin shotcrete (<1 inch) with moisture infiltration (evidenced by stalactites). Some areas of delamination (see Appendix B for a photo and Defect No. 13 in Appendix D). Between Sta. 463+00 and 462+30: a full-section coverage of shotcrete. Stalactites indicating moisture ingress (see Appendix B for a photo and Defect No. 22 in Appendix D). Sta. 470+25: welded wire mesh combined with shotcrete (see Appendix B for a photo and Defect No. 22 in Appendix D). Stalactites point to moisture infiltration, which may corrode welded wire mesh or degrade shotcrete over time.
- Sta. 476+50: thick welded wire mesh and mine straps (see Appendix B for a photo and Defect No. 24 in Appendix D). Stalactites indicate ongoing moisture issues, which could corrode exposed steel elements.
- Sta. 477+70: welded wire mesh and mine straps focused at the crown (see Appendix B for a photo and Defect No. 26 in Appendix D). This setup provides sufficient stability for crown support but requires periodic inspection to ensure the welded wire mesh and straps remain effective under potential stress or corrosion.
- Between Sta. 478+35 and 478+45: combined shotcrete and welded wire mesh (see Appendix B for a photo and Defect No. 27 in Appendix D). Stalactites suggest moisture ingress
- Sta. 479+50: 4 inch welded wire mesh (see Appendix B for a photo and Defect No. 29 in Appendix D). Stalactites point to water infiltration.
- Between Sta. 493+00 and 493+55: similar to other sections, this combination is effective for stability. Stalactites observed (see Appendix B for a photo and Defect No. 43 in Appendix D).
- Outlet: Incomplete shotcrete coverage and steel sets exposed. Absence of welded wire mesh

6.2.4 Car Pass Tunnel Widening

At the car pass locations:

- Span size is moderate (12 to 14 ft). Did not observe any evidence of instability at any of the car pass locations.
- Sediment accumulation observed at all car pass locations (see Appendix B for a photo of an example at about Sta.473+30 – 473+50 and Defect No. 23 in Appendix D). Generally, within widened section of tunnel and not within main tunnel channel.
- Channeled shotcrete observed at some locations but it was not immediately clear if this was produced at time or shortly after application.

6.2.5 Geologic Conditions

The rock types identified in the geotechnical investigation for the tunnel construction and during the previous inspection are outlined earlier in the document. At the western end from the outlet portal at Sta. 497+53 to Sta. 486+70 the materials appeared to align with those as described (Slate), which was slightly to moderately weathered (USBR W4 weathering description), moderately hard to hard (USBR H3/4 hardness /strength description), and intensely to moderately fractured (USBR FD6 fracture density description).

Between the inlet portal at Sta. 451+56 and approximate station Sta. 486+70 our descriptions align with the geologic maps which describe the material as Mesozoic granitic rocks, and specifically a fine- to medium grained granodiorite. This material was classified as slightly weathered (USBR W3 weathering description), hard (USBR H3 hardness /strength description), and moderately to slightly fractured (USBR FD4 fracture density description).

A possible contact was identified at Sta. 486+70, which also appeared to have been delineated during a previous inspection. Limited observations were made, but this may be the location of the Hornfels identified in the 1994 report, which likely grades into slate between here and the outlet structure.

No documentation of ground conditions noted during construction was available for review, therefore information on groundwater inflow conditions could not be assessed. It was reported in the 1994 inspection report that approximately 10 to 30 gpm was entering the tunnel through seepage and inflows. Based on our observations, this figure appears to be a low and we estimate inflows to be in the range of 30 to 50 gpm, with most being supplied nearest the tunnel portals where rock mass conditions are of poorer quality. Throughout wetter months and during the spring melt we expect that water inflow would be much higher due to the increased groundwater flow, and other areas of the tunnel that appeared dry during this inspection, such as locations where stalactites were noted, may also contribute to much higher volumes of inflow.

Specific observations and detailed geologic description for the tunnel are provided on the tunnel profiles in Appendix D.

6.3 Evaluation of Geologic Conditions

From the rock mass characteristics collected at various points along the tunnel alignment, two rock classifications were identified using the RMR classification system. A copy of the table with the classification parameters and their ratings and a summary of the station, measurements recorded, and values for each of the RMR parameters are included in Appendix E along with the geologic maps. Table 1 below summarizes the sections of the tunnel and their respective RMR rating, class, and classification.

Table 1. Summary of RMR Classifications

Tunnel Station	Rock Description	RMR Rating	RMR Class Number	RMR Rock Classification
Inlet Portal (above ground)	Granodiorite	48	III	Fair
451+56 to 486+70	Granodiorite	63 to 70	II	Good
486+70 to 497+63	Slate	41 to 44	III	Fair
Outlet Portal (above ground)	Slate	52	III	Fair

Generally, the areas of existing support installed during original construction and during the repair work in 1994 align with areas of fair quality rock. Some tunnel support was noted in good quality rock, but due to the presence of this support it wasn't possible to observe the rock mass. Based on the 1994 inspection and repair documents, we expect these areas are likely to be isolated areas of weathered and intensely fractured rock.

7 RECOMMENDATIONS

7.1 General Recommendations

Based on review of the condition assessment and the previously presented findings, the GDPUD Raw Water Tunnel Conveyance Tunnel does not appear to show signs of any significant instability since the previous inspection and repairs in 1994. However, as the tunnel is over 60 years old, regular monitoring will be required and scheduled maintenance and planned repair activities will be essential to extend its useful life. We recommend GDPUD initiate the following activities at a minimum. In addition, short term recommendations and longer term outlooks on the potential rehabilitation that GDPUD should begin to plan for are provided in subsequent sections.

- A limited personnel-entry inspection of the tunnel should be carried out annually for the next two years extending to every two years depending on any observed changes. At a minimum, this limited inspection should be focused on the portals where the tunnel support is deteriorating as well as a general tunnel walkthrough to observe overall conditions.
- A detailed personnel-entry inspection of the tunnel similar to the 2024 inspection summarized in this report should be performed every 5 years. This inspection should assess the changes to the conditions of observed and logged defects and identify any new defects.
- An appropriately planned inspection or series of inspections should be carried out as soon as practical after an earthquake by a qualified consultant. This may consist of a limited person entry to assess conditions nearest the portals and/or an uncrewed inspection using autonomous vehicles to assess conditions further into the tunnel. Due to the potential for significant instability above ground around the portals and within the tunnel, we do not recommend self-perform these inspections.

All tunnel inspections should make use of the profiles and table of defects in Appendix D to identify the location of each defect. All observations, photographs, and defects should reference tunnel field and design stationing as noted in this report. Tunnel field stationing marked in the tunnel by Brierley during the 2024 inspection can be used to locate observed defects and any newly identified defects.

7.2 Steel Sets

The current state of the tunnel's steel set support system, characterized by missing and corroded components, inadequate blocking, and uneven protection, is of concern. Although instability appears to have been minimal throughout these sections since the previous inspection, with little evidence of significant fallouts from the crown or sidewalls, further assessment is required to understand the support systems' ability to perform as designed. We therefore recommend the following short-term and long-term considerations.

Short-term recommendations

- Conduct preliminary rock wedge/loading analysis, and a structural assessment of support systems to determine the remaining capacity of the corroded sets and tie-rods. This would consist of a more detailed inspection of rock mass conditions and assessment of support in select reaches of the tunnel. This data would be used to evaluate the importance and urgency of the instituting any combination of the following improvements:
  - Reinforce or replace corroded and missing components
  - Apply shotcrete or another protective coating to prevent further corrosion and enhance the steel set contact with the rock.
  - Replace or restore the missing wood blocking to ensure proper load distribution.

  - Revaluation of the suggested inspection program timelines to monitor the system for further deformation, corrosion progression, or signs of instability.

Long-term recommendations

- Implement improvements included in short term recommendations if not done so following preliminary engineering and structural assessment.
- Improve drainage to control water ingress, reduce corrosion rates and potential buildup of hydrostatic pressures.
- Consider retrofitting the tunnel support system with modern technologies like fiber-reinforced shotcrete or grouted rock bolts.

7.3 Tunnel Portals

Based on the observations, the portals appear structurally stable at present. The issues identified are primarily maintenance concerns that, if left unaddressed, could lead to long-term deterioration. Proactive monitoring and maintenance are essential to ensure the inlet and outlet portals remain stable and functional. The following actions are recommended should any of the identified, or new, defects deteriorate:

- Inspection and Monitoring
  - Perform detailed crack mapping and determine whether the crack width or length increases over time, and sealing the crack is necessary to prevent further deterioration
- Corrosion Assessment
  - Inspect steel components near rust-stained areas (e.g., trash rack and steel sets) to evaluate their condition. Apply protective coatings or repair corroded elements as necessary.

7.4 Shotcrete and Welded Wire Mesh

The tunnel includes varying levels of support capacity, and no obvious areas of instability were observed during the limited inspection. However, issues like thin shotcrete, delamination, incomplete coverage, and persistent moisture present risks that are likely to require targeted maintenance and improvements to ensure long-term safety and functionality. Some of these long term improvement considerations are as follows:

- Moisture Management: The presence of stalactites at multiple locations indicates persistent moisture infiltration, which can corrode welded wire mesh. Improving drainage and sealing moisture sources may be required depending on the results of future inspections and observance of any further deterioration.
- Shotcrete Thickness and Quality: Thin and delaminated shotcrete (e.g., at Sta. 461+20) may need future attention. Reapplication with adequate thickness (2–4 in.) and proper surface preparation would be appropriate.
- Welded wire mesh and Mine Straps: Sections with welded wire mesh and mine straps are better supported than those without. After conducting preliminary rock wedge/loading analysis, an evaluation of whether expanding the use of these reinforcements where missing (e.g., inlet, outlet) to improve overall stability is recommended.
- Upgrade Measures: After conducting preliminary rock wedge/loading analysis and potential subsequent further analysis, in critical areas with high stress or significant deterioration, needs for retrofitting with modern systems like fiber-reinforced shotcrete or grouted rock bolts for enhanced stability would be assessed.

7.5 Car Pass Tunnel Widening

After the inspection observations specific to the car pass locations, no immediate rehabilitation is required at these locations. However, the following considerations would be appropriate at these locations:

- Shotcrete Re-surfacing: Reapply or repair shotcrete at the channeled areas to restore surface integrity. Ensure proper application thickness and curing to resist future wear. Consider using abrasion-resistant shotcrete or protective coatings in high-flow areas to mitigate erosion.
- Support System Evaluation: Inspect the existing support system (e.g., sets, mesh, or full-lining shotcrete) at wider spans (12 ft–14 ft) to confirm structural adequacy. Reinforce spans where deformation or instability is detected, using additional rock bolts, reinforced shotcrete, or steel sets as needed.
- If sediment deposition and channeled shotcrete are recurring issues, investigate potential upstream causes, such as:
    - Groundwater ingress or erosion.
    - Insufficient upstream sediment control measures
    - Excessive flow velocities in specific tunnel sections.

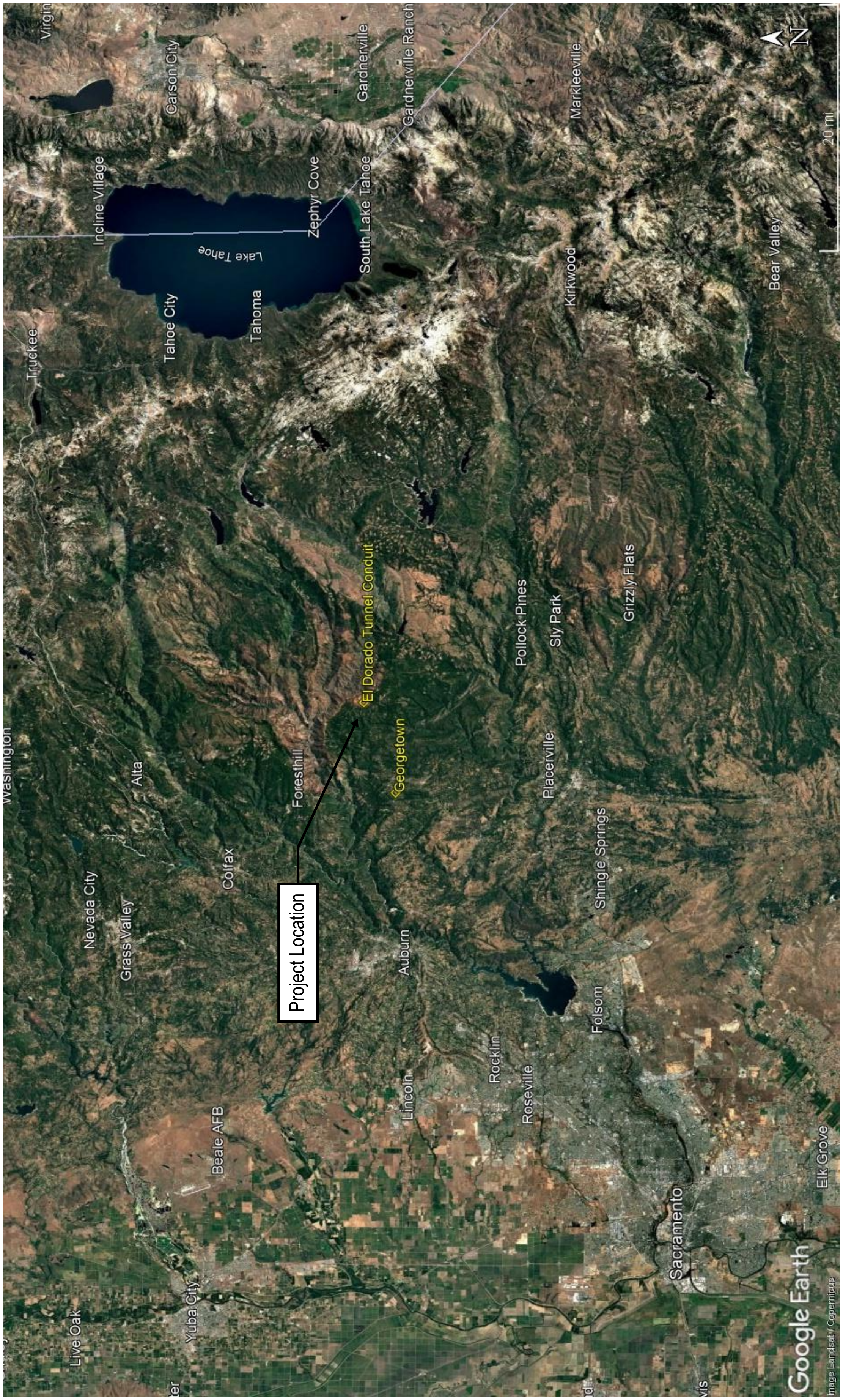
8 REMARKS AND LIMITATIONS

This report has been made and issued for the sole use of GDPUD. Brierley has performed its inspection services in accordance with the generally accepted engineering standards currently used in this area. All referenced standards and codes (e.g., ASTM, USBR, etc.) were only used as guidelines for completing the inspection, qualitatively assessing the condition of the tunnel support and rock mass conditions and developing this report. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or other instrument of service.

Any statements regarding the structural integrity of the tunnel support are based solely on qualitative assessment of information collected during the inspection, as-built tunnel drawings, review of information from previous inspections, and findings from previous studies by Brierley. More information may need to be collected to perform detailed engineering analysis to better assess the structural integrity and long-term performance of the tunnel.

Brierley should be retained to assist with any engineering studies to further assess the structural integrity of the tunnel and design of improvements that may be needed to increase structural integrity.

FIGURES



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

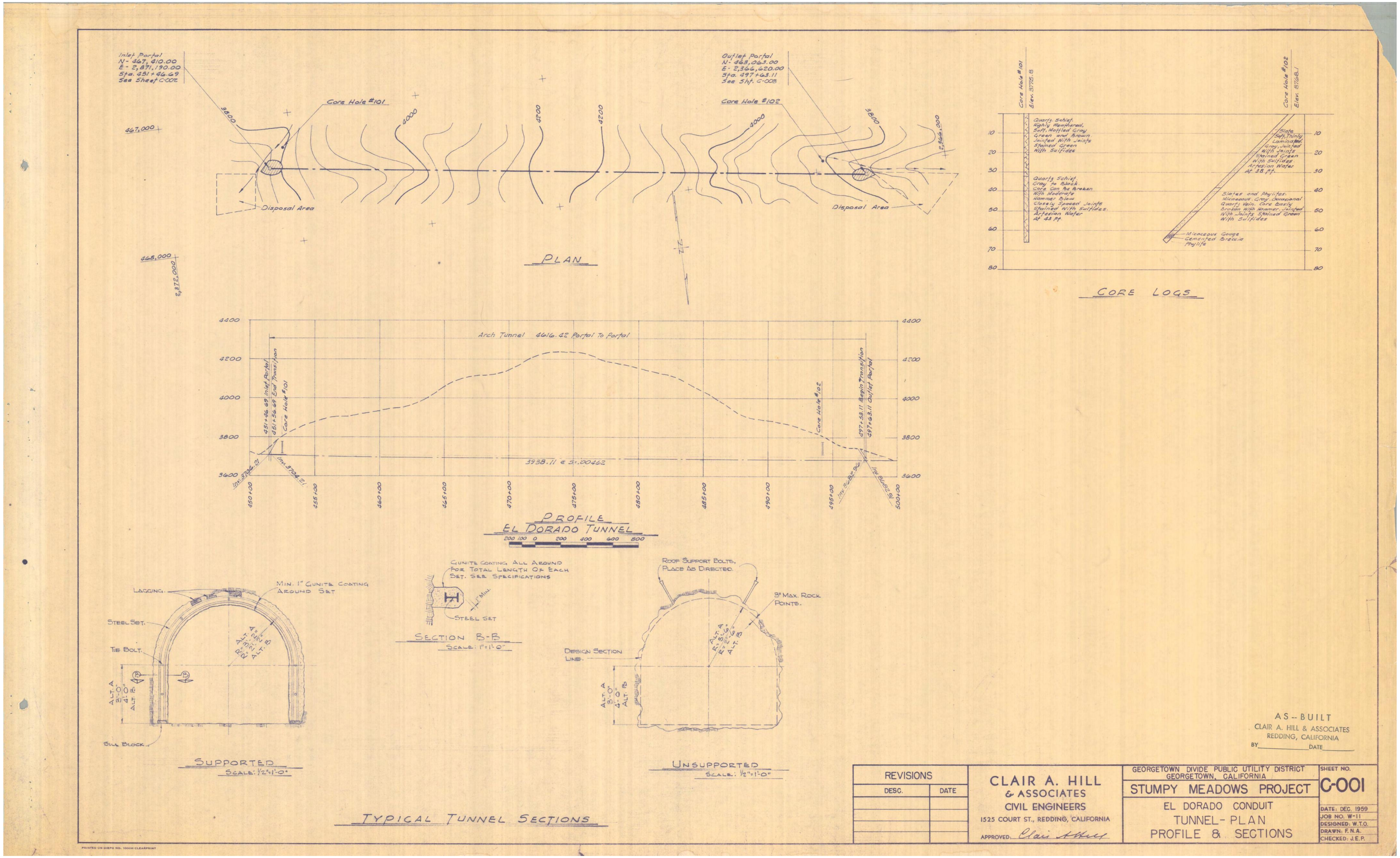
FIGURE TITLE

PROJECT LOCATION PLAN

FIGURE NUMBER

FIG-01

1 OF 5



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE

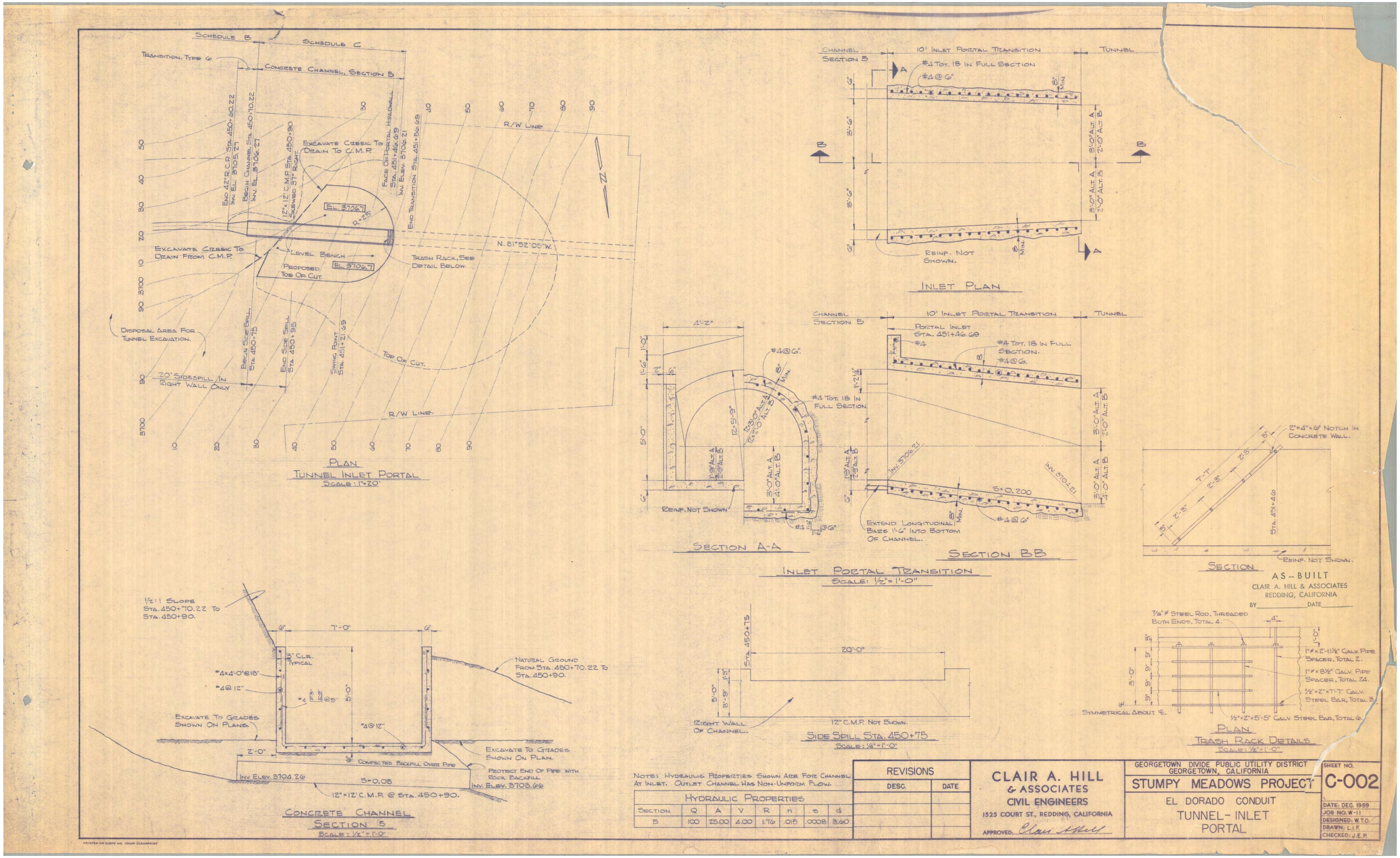
TUNNEL PROFILE AS-BUILT

FIGURE NUMBER

FIG-02

Published: 12/6/2024 9:48:17 AM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg

BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554



CLIENT
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT
GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

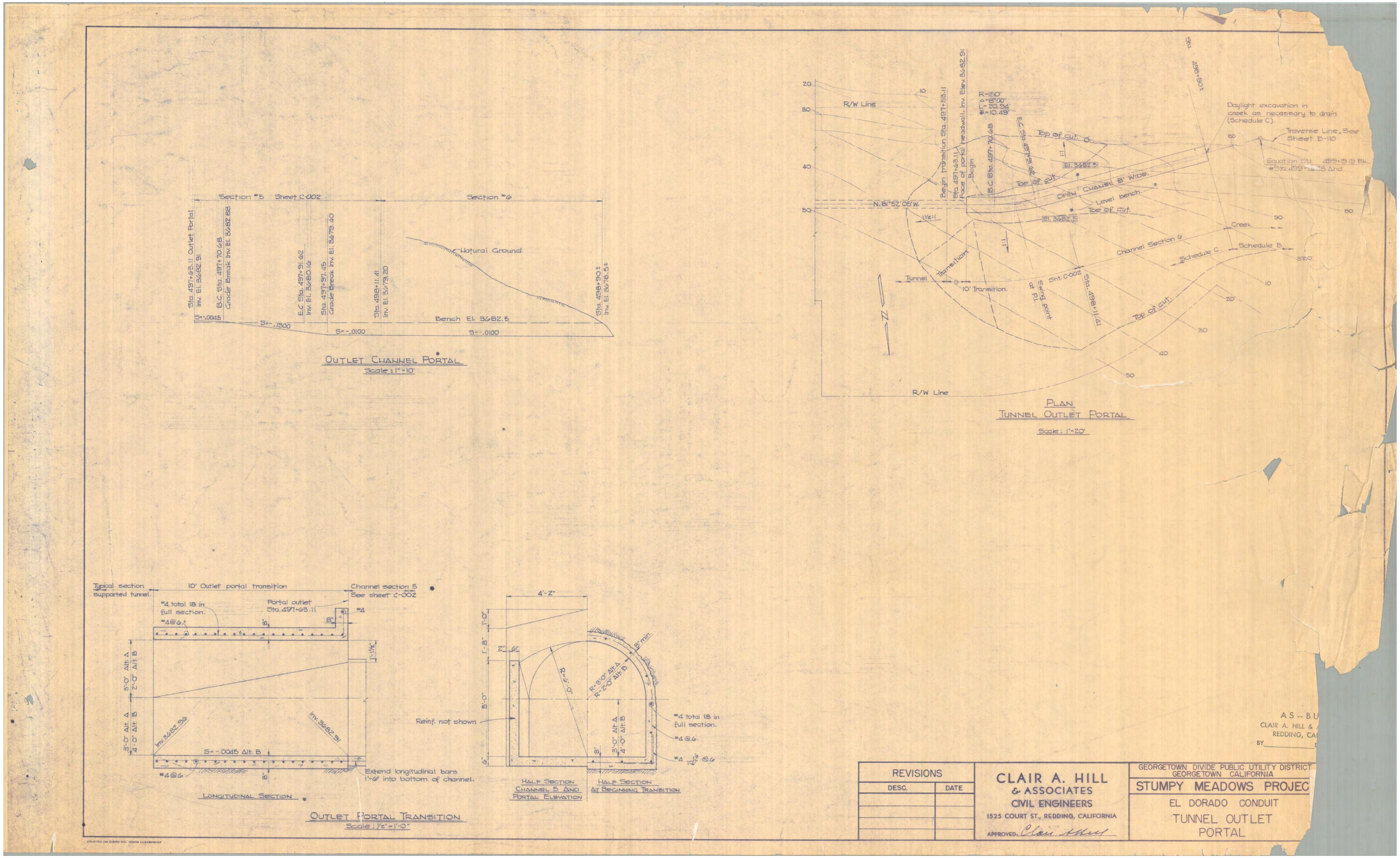
GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE
TUNNEL INLET AS-BUILT

FIGURE NUMBER
FIG-03
3 OF 5

Published: 12/6/2024 9:48:22 AM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg



BRIERLEY
ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

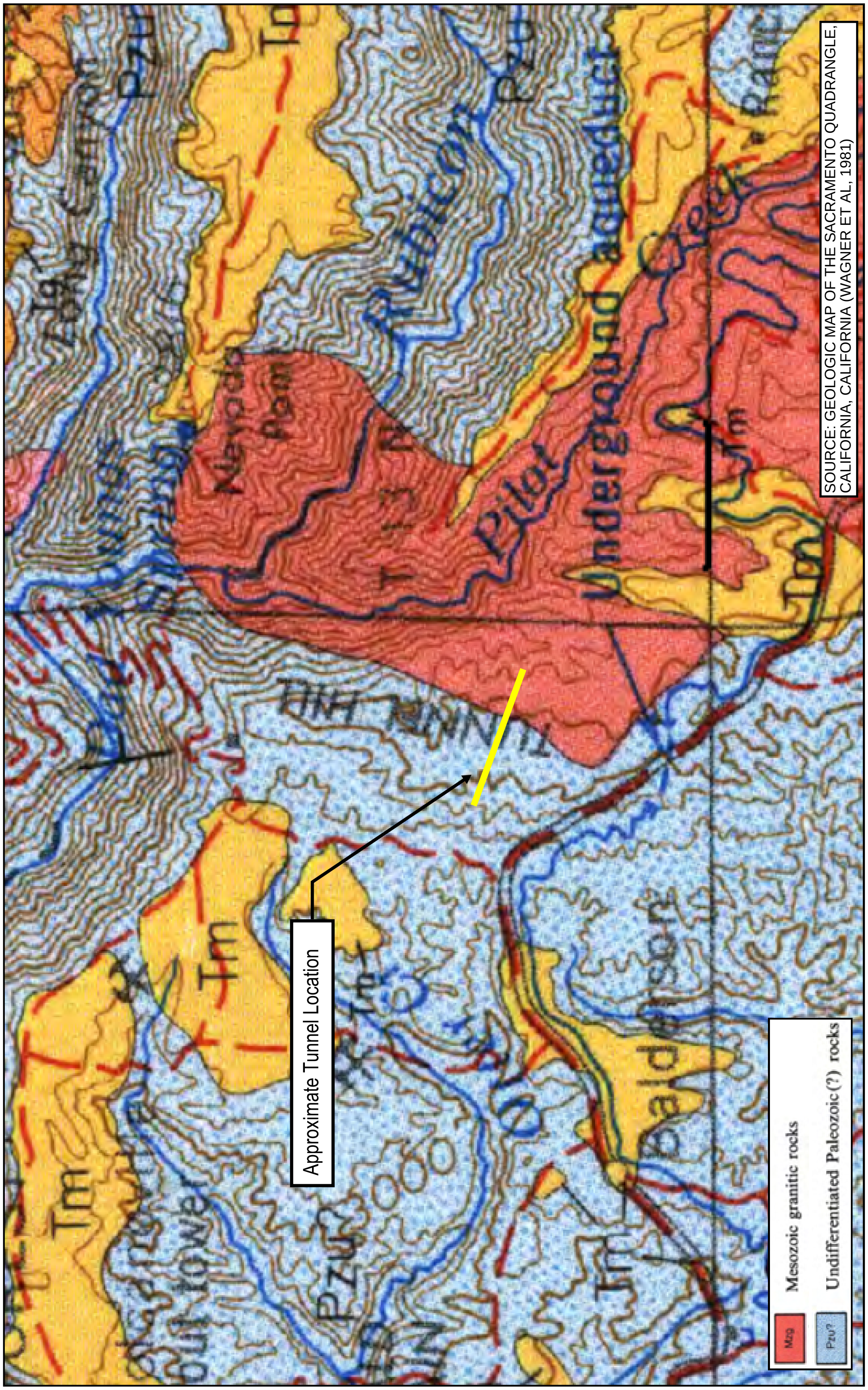
FIGURE TITLE

TUNNEL OUTLET
AS-BUILT

FIGURE NUMBER

FIG-04

Published: 12/6/2024 9:48:26 AM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE

GEOLOGIC MAP

FIGURE NUMBER

FIG-05

APPENDIX A

Comparison of 1994 and 2024 Inspection Records

Comparison of 1994 and 2024 Inspection Records

Object ID	1994 Start Station[1]	1994 End Station[1]	Description	1994 Repair Description	2024 Station[2]	2024 Defect Number	2024 Photograph Number	2024 Inspection Comment
1	497+63.11	-	Outlet (west portal)	New timber blocking was installed for existing steel sets in this reach. 4" steel horseshoe sets: 72 on 4' spacing; 11 on 2' spacing	497+63.11		_120207	The steel ribs and tie-bars were not covered with shotcrete, and they appeared to be affected by significant corrosion. Some occasional shotcrete applications were observed on steel ribs closer to the invert to secure the steel sets. The wood blocking between the steel ribs and rock surface were missing at the shoulders, walls and roof for the first ten steel ribs. The first 21 steel ribs (between #49 and #29) were spaced at from 3.0 to 4.0-ft; then, the next 14 steel ribs (between #29 and #14) were spaced at from 2.0 to 3.0-ft; and the last 14 steel ribs (between #14 and #1) near the outlet were spaced at approximately 2.0-ft. Some tie-bars between the steel ribs were missing and deformed.
2	497+63.11	-	Photo 17 Set 17	Drilling for rock bolt installations, left side of tunnel. 5' split set rock bolt ready to be pushed in.	496+95		_120207	See above
3	497+63.11	-	Photo 18 Looking upstream from set 18	Rock bolts and explanded metal in place prior to shotcreting	496+92.5		_120346	See above (1)
4	493+23.95	-	Photo 19 Right side of set 17 in fallout zone	First coat of shotcrete. Note pipe drains	493+30		_130111	Steel ribs, shotcrete and wire mesh observed together with thin and white stalactites. A total of 8 steel ribs (between #74 and #82) spaced at 4.0-ft were observed. This area is the previous fallout zone. There were about six drainpipes to collect or divert groundwater discharge at several locations within this interval. The wood blocking and timbers between the steel ribs and rock surface were missing at the roof. Steel ribs and tie-bars were covered with shotcrete. It was not possible to inspect the steel rib surfaces under shotcrete. Some tie-bars between the steel ribs were missing.
5	493+23.95	-	Photo 20 Looking upstream from set 21	First coat of shotcrete in fallout zone	493+15		_130225	See above (4)
6	493+23.95	-	Photo 21	Shotcrete used to secure sets		NA	NA	NA
7	493+23.95	-	Photo 22	New timbering at set 45				See above (4)
8	493+23.95	-	Car pass location (11 to 14' wide tunnel)	Fallout zone and adjacent steel-supported reach were scaled of loose rock and reinfoireced with rock bolts. After bolting, the fallout cavity and the high overbeak zone that extends about 12 feet downstrewam from the fallout were given lining of ~1.5 inches of shotcrete. Shotcreteing was limited to tunnel crown for the remaining steel sets. Note: approximately 3 inches of shotcrete lining was proposed, but due to issues with accelarator	493+34 - 493+50		_130038	Shotcrete and wire mesh observed together with thin and white stalactites. Tunnel widened on south wall up to approximately 14 feet
9	451+56.69	-	Inlet (east portal)	New timber blocking was installed above the first 8 sets at the portal	451+60 - 451+95		_163950, 164004, 164010, 164018, 164022, 164031, 164044, 164054, 164057	A total of 16 steel ribs were observed. All have been shotcreted therefore condition unknown. Shotcrete appears in good condition and no spalling noted.

[1]Estimated based on details provided in 1994 inspection and repair reports
[2]Based on design drawings provided

APPENDIX B

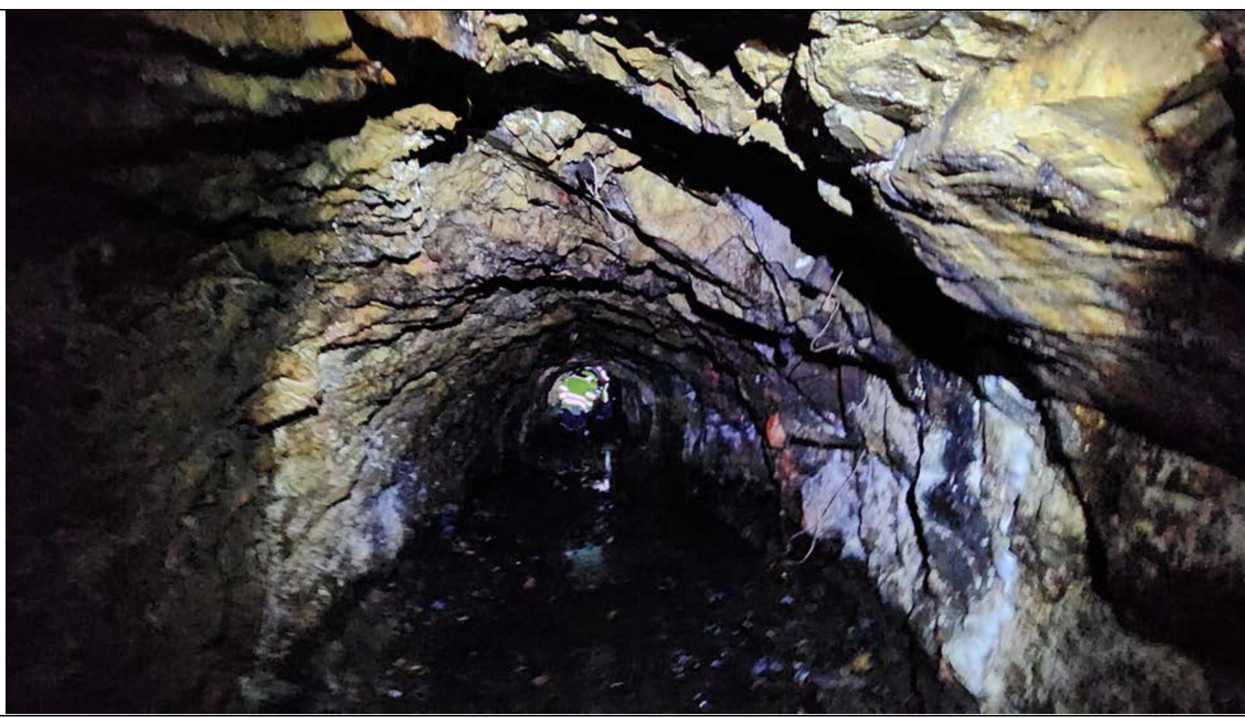
Photographic Survey

STATION: 451+50

STATION: 452+00

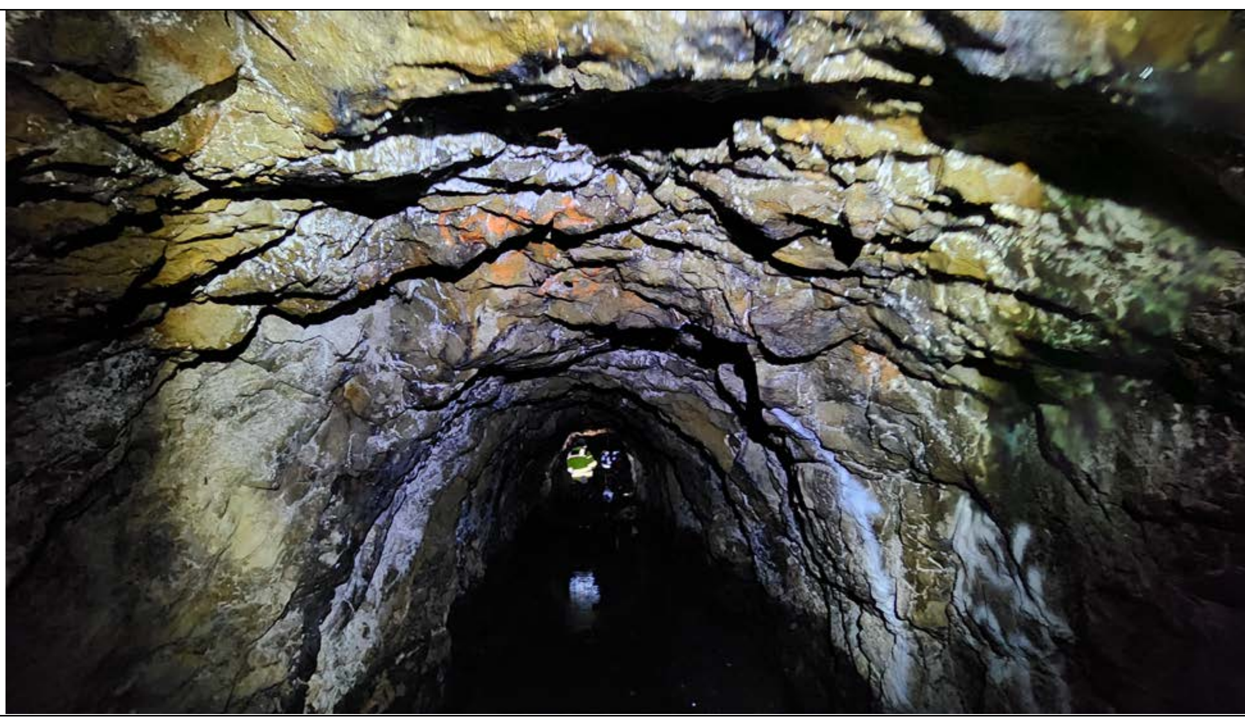
STATION: 452+50

STATION: 453+00



STATION: 453+50

STATION: 454+00

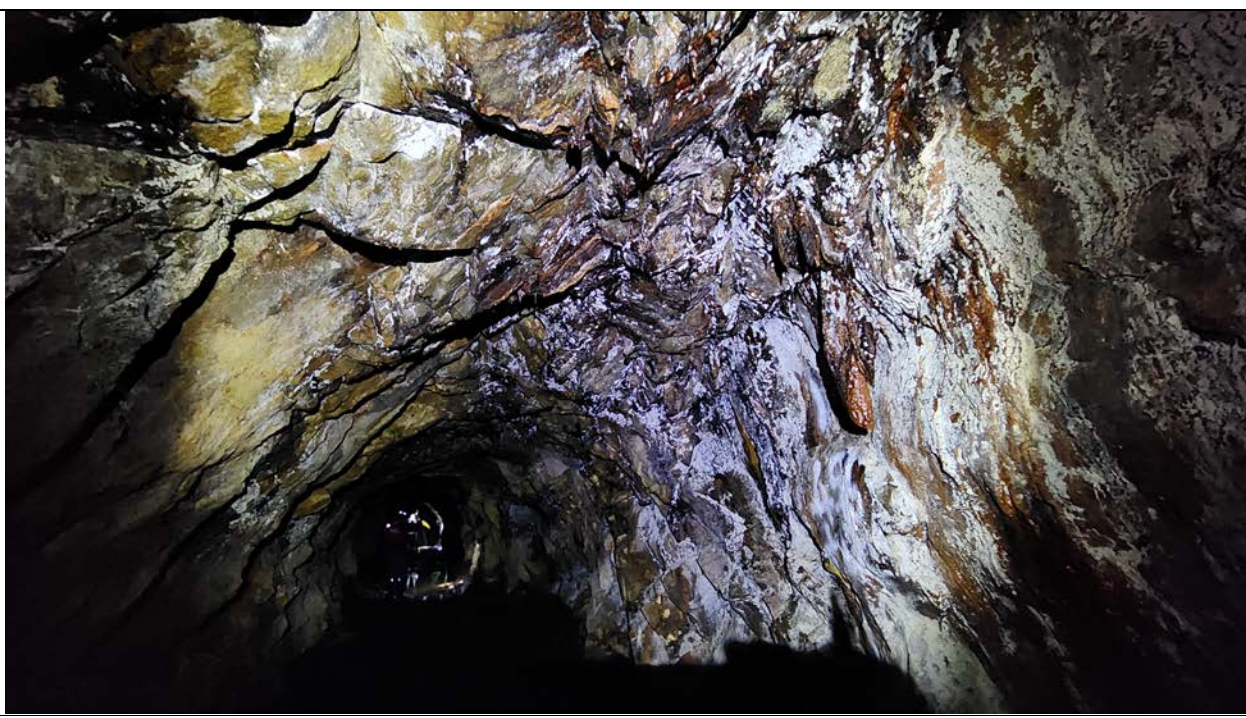


STATION: 454+50

STATION: 455+00

STATION: 455+50

STATION: 456+00



STATION: 456+50

STATION: 457+00

STATION: 457+50

STATION: 458+00

STATION: 458+50

STATION: 459+00

STATION: 459+50

STATION: 460+00

STATION: 460+50

STATION: 461+00

STATION: 461+50

STATION: 462+00

STATION: 462+50

STATION: 463+00

STATION: 463+50

STATION: 464+00

STATION: 464+50

STATION: 465+00

STATION: 465+50

STATION: 466+00

STATION: 466+50

STATION: 467+00

STATION: 467+50

STATION: 468+00

STATION: 468+50

STATION: 469+00

STATION: 469+50

STATION: 470+00

STATION: 470+50

STATION: 471+00

STATION: 471+50


STATION: 472+00


STATION: 472+50

STATION: 473+00

STATION: 473+50

STATION: 474+00

STATION: 474+50

STATION: 475+00

STATION: 475+50


STATION: 476+00


STATION: 476+50

STATION: 477+00

STATION: 477+50

STATION: 478+00

STATION: 478+50

STATION: 479+00

STATION: 479+50

STATION: 480+00

STATION: 480+50

STATION: 481+00

STATION: 481+50

STATION: 482+00

STATION: 482+50

STATION: 483+00

STATION: 483+50

STATION: 484+00

STATION: 484+50

STATION: 485+00

STATION: 485+50

STATION: 486+00

STATION: 486+50

STATION: 487+00

STATION: 487+50

STATION: 488+00

STATION: 488+50

STATION: 489+00

STATION: 489+50

STATION: 490+00

STATION: 490+50


STATION: 491+00


STATION: 491+50

STATION: 492+00

STATION: 492+50

STATION: 493+00

STATION: 493+50

STATION: 494+00

STATION: 494+50

STATION: 495+00

STATION: 495+50

STATION: 496+00

STATION: 496+50

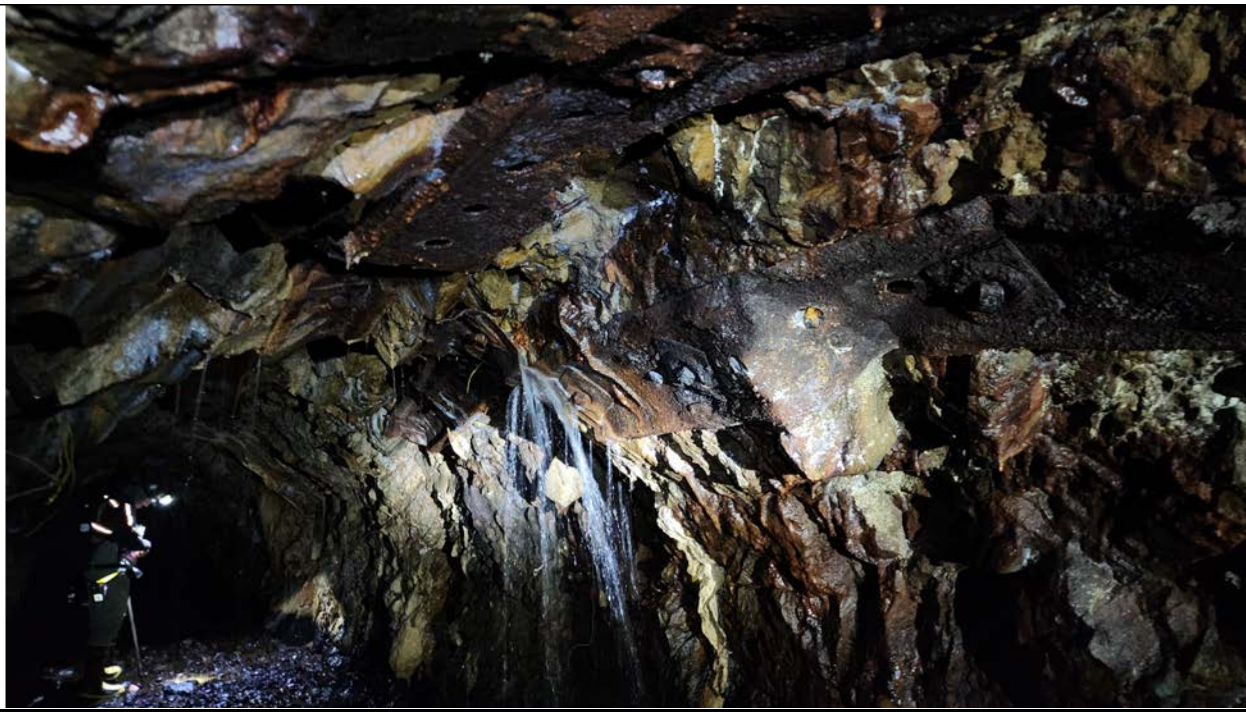
STATION: 497+00

APPENDIX C

Photographic Survey – Specific Locations

STATION: 451+50

STATION: 451+47 – 451+57

STATION: 452+65 – 452+75


STATION: 455+20 – 455+40


STATION: 456+00


STATION: 460+70 – 460+90

STATION: 461+20

STATION: 461+50


BRIERLEY ASSOCIATES
Creating Space Underground

STATION: 462+30 – 463+00

STATION: 468+20 – 468+40

STATION: 470+25

STATION: 473+30 – 473+50

STATION: 476+50

STATION: 477+35 – 477+50

STATION: 477+70


STATION: 478+45 – 478+65


STATION: 479+50

STATION: 481+30 – 481+50

STATION: 483+50 – 483+70

STATION: 486+70

STATION: 493+00 – 493+55

STATION: 493+05 – 493+35

STATION: 497+50


STATION: 497+50


STATION: 496+00 - 497+50

STATION: 496+00 - 497+50

APPENDIX D

Tunnel Profiles and Tunnel Defect Observations Log

Table D2. Defect Condition State Definitions

Defect	CONDITION STATE (CS)			
	CS 1	CS 2	CS 3	CS 4
Delamination, Spalling, and/or Patched Area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition may warrant a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Reinforcement (e.g., Rebar, steel beams, steel cables, etc.)	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	
Efflorescence, Mineralization, and/or Rust Staining	No to some efflorescence/mineralization, no to minor rust staining.	Heavy build-up of mineralization, no to minor rust staining.	No to some efflorescence and/or mineralization, and significant rust staining.	
Maximum Crack Width	Less than 0.0125 in	0.0125 - 0.1 in	Greater than 0.1 in	
Crack Type	Radial (Circumferential)	Diagonal or longitudinal	Diagonal and/or longitudinal intersecting radial, spiral	
Crack Spacing	Greater than 5 ft	5 to 1 ft	Less than 1 ft	
Leakage	No visible active seepage.	Visible active seepage.	Visible active spring(s).	
Distortion	None	Has received structural review and has been mitigated.	Has received structural review and could require mitigation.	

Notes:
1. Defect and Condition Stations based upon Cast-in-Place Concrete Tunnel Liner condition state matrix from Specifications for the National Tunnel Inventory (SNTI) (FHWA, 2015).

Legend:

1	Condition State 1	3	Condition State 3
2	Condition State 2	4	Condition State 4

Tunnel Defect Observations Log

Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
1	451+47.00	451+57.00	_164249 _164300	The concrete surface of transition structure has some rust and efflorescence especially along a crack. There was no delamination, scaling, spalling, exposed bar, honeycombing or active leakage. While brown staining was mainly present where the concrete is close to the trash rack and first steel ribs in the tunnel, light-colored and greenish staining was in the middle section. Condition State: CS2
2	451+57.00	452+15.00		A total of 16 steel ribs (between #83 and #98) were observed at spacing of approximately 4-ft. The steel ribs and tie-bars were usually covered with shotcrete and it was not possible to inspect the steel rib surfaces under shotcrete. Shotcrete appears in reasonable condition and no spalling noted. Where tie-bars were not covered with shotcrete, they appeared to be affected by significant corrosion. The wood blocking between the steel ribs and rock surface appeared to be inadequate. Some minor water inflow through shotcrete at certain locations, mainly on south wall, totalling 5-10gpm
3	452+50.00	452+75.00	IMG_5062.HEIC _163252	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length. Significant water inflow, 10-20gpm.
4	454+00.00	451+53.00	_162854	Tunnel height reduced to approximately 6.5 feet
5	454+50.00	454+70.00	IMG_5059.HEIC _162846	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length
6	454+95.00	455+05.00		Geologic Map - see tunnel Geologic Map 01 in Appendix E
7	455+20.00	455+40.00	IMG_5054.HEIC _161829	Car pass - tunnel widened on north wall up to approximately 12 feet. Minor water inflow (<1gpm). Observed sediment (clay/sand) deposition at the tunnel floor at N
8	455+40.00	455+70.00	IMG_5056.HEIC _161058	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length
9	456+00.00	-	_160405	Evidence of previous water inflow with 6 to 12 inch long stalactites
10	456+20.00	456+70.00	IMG_5052.HEIC _161000	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length
11	459+90.00	460+00.00	_160405	Geologic Map - see tunnel Geologic Map 02 in Appendix E
12	460+70.00	460+90.00	IMG_5036.HEIC _155006	Car pass - tunnel widened on north wall up to approximately 12 feet. Observed sediment (clay/sand) deposition at the tunnel floor at N
13	460+50.00	461+20.00	IMG_5035.HEIC _154821	Shotcrete and mine straps with some delamination in places. Shotcrete up to 1 inch thickness with few cracks. Thin light colored stalacties, likely from leaching of shotcrete
14	461+50.00	-	IMG_5033.HEIC _154235	Geologic measurements - refer to Appendix E
15	462+30.00	463+00.00	IMG_5030.HEIC _153249	Shotcrete in crown and tunnel walls, including invert. Shotcrete up to 1 inch thickness with few cracks. No spalling observed. Thin light colored stalacties, like from leaching of shotcrete.
16	462+50.00	463+00.00	_152936	Evidence of previous water inflow with 6 to 12 inch long stalactites
17	464+20.00	464+30.00		Geologic Map - see tunnel Geologic Map 03 in Appendix E

Tunnel Defect Observations Log

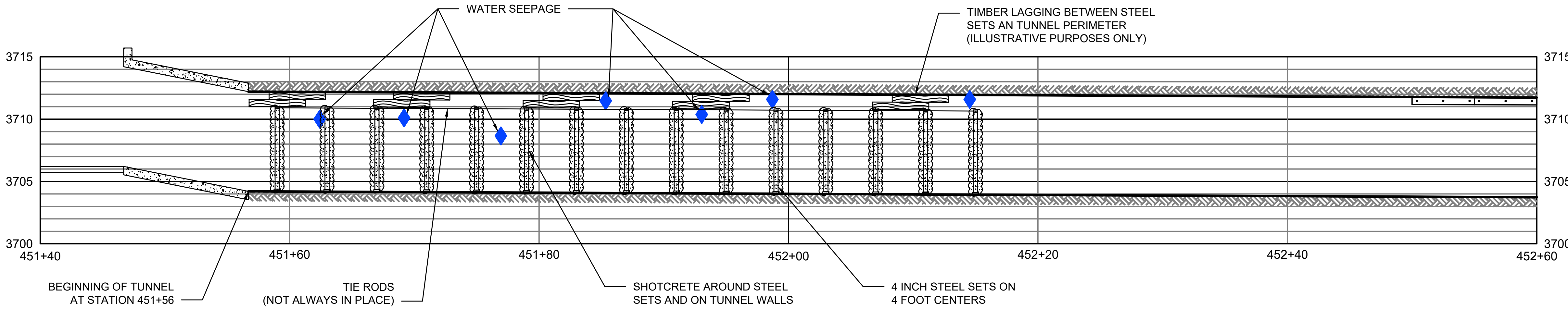
Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
18	465+10.00	465+18.00	IMG_5023.HEIC	Shotcrete and 4 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Thin light colored stalacties, like from leaching of shotcrete.
19	467+00.00	-	_151657	Possible breakthrough as tunnel walls become kinked
20	468+20.00	468+40.00	IMG_5016.HEIC _151448	Car pass - tunnel widened on south wall up to approximately 12 feet wide. Observed sediment (clay/sand) deposition at the tunnel floor at S
21	469+90.00	470+00.00	_151224	Geologic Map - see tunnel Geologic Map 04 in Appendix E
22	470+25.00	470+35.00	IMG_5012.HEIC _145739	Shotcrete and 4 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some thin light colored stalacties, like from leaching of shotcrete.
23	473+30.00	473+50.00	IMG_5005.HEIC _145236	Car pass - tunnel widened on south wall up to approximately 12 feet. Observed sediment (clay/sand) deposition at the tunnel floor
24	476+45.00	476+60.00	IMG_4997.HEIC _143713	Incomplete shotcrete with 4 inch WWM. WWM exposed in many areas. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some efflorescence and thin light colored stalactites, likely from leaching of shotcrete. Mine straps in crown.
25	477+35.00	477+50.00	_143433	Single mine strap installed in crown
26	477+70.00	-	IMG_4988.HEIC _143353	0.5 inch WWM and mine straps in crown. Water seep with iron oxide discoloration; tunnel walls wet; 2 to 3 foot wide quartz vein, vertical
27	478+35.00	478+45.00	IMG_4985.HEIC _142810	Incomplete shotcrete with 4 inch and 0.5 inch WWM. WWM exposed in many areas. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some efflorescence and thin light colored stalactites, likely from leaching of shotcrete. Mine straps in crown.
28	478+45.00	478+65.00	IMG_4980.HEIC _142617	Car pass - tunnel widened on south wall up to approximately 12 feet. Shotcrete and mine straps installed in the crown. Observed sediment (clay/sand) deposition at the tunnel floor
29	479+50.00	-	IMG_4977.HEIC _142322	Shotcrete and 0.5 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed.Some efflorescence and thin light colored stalactites, likely from leaching of shotcrete. Some iron oxide staining from water inflow and corrosion of WWM.
30	480+20.00	-	_142142	Small breakout on north wall with dimensions of 5 x 5 x 5 feet
31	481+30.00		IMG_4970.HEIC _141534	Geologic measurements - refer to Appendix E
32	483+50.00	483+70.00	IMG_4965.HEIC _141123	Car pass - tunnel widened on south wall up to approximately 12 feet. Observed sediment (clay/sand) deposition at the tunnel floor
33	484+00.00	-	_140926	Geologic measurements - refer to Appendix E
34	486+00.00	-	IMG_4956.HEIC	Groundwater flow, <1gpm. 2 inch drain installed and clogged.
35	486+00.00	-	_140656	Geologic Map - see tunnel Geologic Map 05 in Appendix E
36	486+70.00	-	_135253	Possible contact between slate/hornfels(?) and granodiorite
37	487+55.00	487+75.00	_132647	Car pass - tunnel widened on south wall up to approximately 14 feet. No shotcrete or other apparent support. Some stalactites showing evidence of previous water inflow.
38	489+00.00		IMG_4945.HEIC	Moderately weathered rock, walls are damp to wet

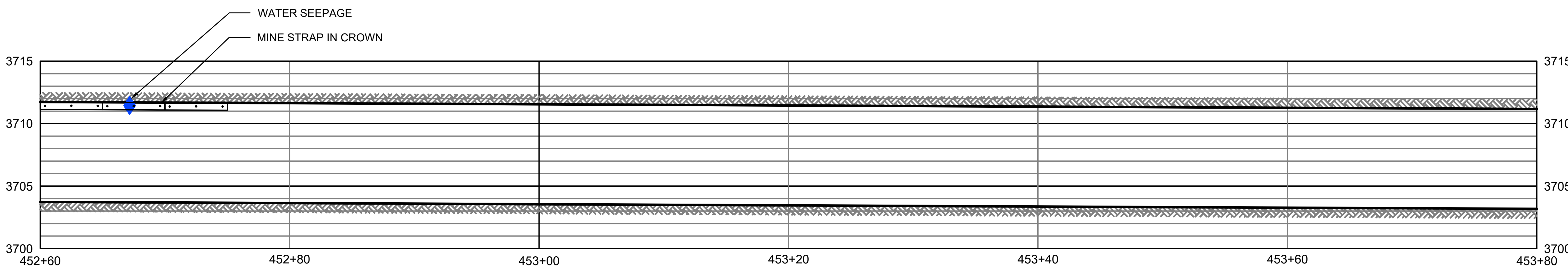
Tunnel Defect Observations Log

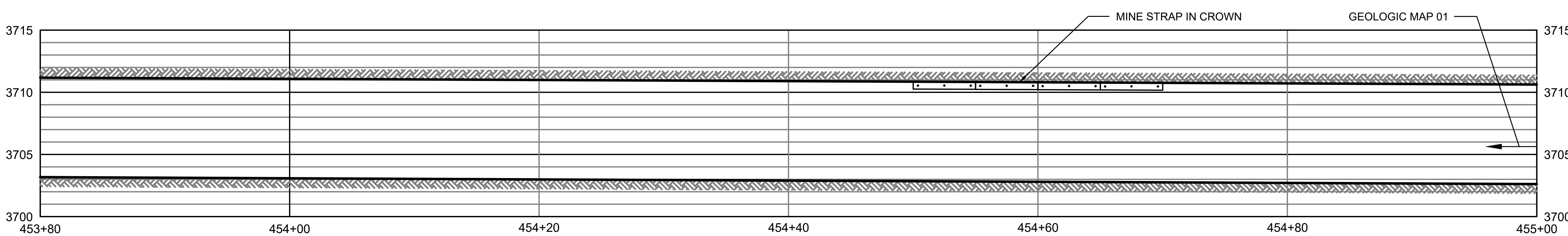
Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
39	489+40.00	-	_132348	3 foot wide band of moderately weathered highly jointed rock. Joints are vertical
40	489+90.00	-	_131953	Geologic measurements - refer to Appendix E
41	490+80.00	-	_131318	Minor water inflow (<1gpm) and evidence of previous water inflow in additional locations due to existing stalactites. Significant iron oxide discoloration. Stalactites in crown
42	491+85.00	492+50.00	_130751	Water inflow and evidence of previous water inflow in additional locations due to existing stalactites. Single seepage point near invert under slight pressure (artesian) at Sta. 492+50. Significant iron oxide discoloration
43	493+00.00	493+55.00	_105650	Shotcrete and 0.5 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some thin light colored stalactites, likely from leaching of shotcrete.
44	493+10.00	493+34.00	_130107	A total of 8 steel ribs (between #74 and #82) spaced at 4.0-ft were observed. This area is the previous fallout zone. There were about six drainpipes to collect or divert groundwater discharge at several locations within this interval. The wood blocking and timbers between the steel ribs and rock surface were missing at the roof. Steel ribs and tie-bars were covered with shotcrete. Some tie-bars were missing.
45	493+34.00	493+50.00	_130038	Car pass - tunnel widened on south wall up to approximately 14 feet
46	493+50.00	-	_125849	Water inflow of 2-3gpm. Several small seepage points at springline under slight pressure (artesian) at Sta. 493+50.
47	493+95.00	-	_125016	Geologic measurements - refer to Appendix E
48	494+30.00	-	_124830	Water inflow of approximately 1-2gpm
49	494+50.00	464+60.00	_124705	Significant iron oxide discoloration; water inflow of approximately 1-2gpm
50	494+50.00			Mine straps in crown moderately corrdoded and held with 0.75 inch pins of unknown length
51	494+80.00	495+75.00		A total of 25 steel ribs (between #50 and #74) spaced at 4.0-ft were observed. A tie-bar between the steel rib #53 and #54 were missing on S wall, and some tie-bars were deformed. The wood blocking, shotcrete and timbers were observed to be inadequate at some locations
52	494+80.00	495+75.00	_123028 to _	Iron oxide discoloration and significant stalactites, evidence of previous water inflow throughout section
53	494+30.00	-	_123645	Water inflow of approximately <1gpm and iron oxide discoloration
54	496+00.00	497+50.00	IMG_4926.HEIC	Steel ribs (quantity 49). The first 21 steel ribs (between #49 and #29) were spaced at from 3.0 to 4.0-ft; then, the next 14 steel ribs (between #29 and #14) were spaced at from 2.0 to 3.0-ft; the last 14 steel ribs (between #14 and #1) near the outlet were spaced at approximately 2.0-ft. The steel ribs and tie-bars were not covered with shotcrete, and they appeared to be affected by significant corrosion. Some occasional shotcrete applications were observed on steel ribs closer to the tunnel invert to secure the steel sets. The wood blocking between the steel ribs and rock surface were missing at the shoulders, walls and roof for the first ten steel ribs. Some tie-bars between the steel ribs were missing and deformed.
55	496+00.00	497+53.11	_123124	Significant water inflow throughout entire section. Estimated 10 to 20gpm
56	497+00.00	-	_120351	Geologic measurements - refer to Appendix E
57	497+40.00	497+50.00	_120109	Geologic Map - see tunnel geologic map 05 in Appendix E

Tunnel Defect Observations Log

Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
58	497+53.00	497+63.00		The concrete surface of transition structure has some efflorescence especially along some surficial cracks. There was no delamination, scaling, spalling, exposed bar, honeycombing or active leakage. Cracks on the north wall were surficial and very thin between 0.01 and 0.1 inches. A light-colored deposit build-up as in the form of efflorescence was present along a couple cracks that are five to ten inches long. Cracks on the south wall were also surficial and very thin in general. There was a crack extending perpendicular to the tunnel axis and with a light-colored deposit build-up as in the form of efflorescence. It was uncertain how and when this crack had been initiated. Staining was mainly present in light-color and green. Condition State: CS2
59	497+63.00	-		Geologic measurements - refer to Appendix E

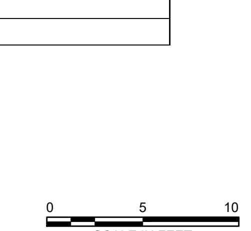






Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
1	451+47.00	451+57.00	_164249 _164300	The concrete surface of transition structure has some rust and efflorescence especially along a crack. There was no delamination, scaling, spalling, exposed bar, honeycombing or active leakage. While brown staining was mainly present where the concrete is close to the trash rack and first steel ribs in the tunnel, light-colored and greenish staining was in the middle section. Condition State: CS2
2	451+57.00	452+15.00		A total of 16 steel ribs (between #83 and #98) were observed at spacing of approximately 4-ft. The steel ribs and tie-bars were usually covered with shotcrete and it was not possible to inspect the steel rib surfaces under shotcrete. Shotcrete appears in reasonable condition and no spalling noted. Where tie-bars were not covered with shotcrete, they appeared to be affected by significant corrosion. The wood blocking between the steel ribs and rock surface appeared to be inadequate. Some minor water inflow through shotcrete at certain locations, mainly on south wall, totalling 5-10gpm

Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
3	452+50.00	452+75.00	IMG_5062.HEIC _163252	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length. Significant water inflow, 10-20gpm.
4	454+00.00	451+53.00	_162854	Tunnel height reduced to approximately 6.5 feet
5	454+50.00	454+70.00	IMG_5059.HEIC _162846	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length
6	454+95.00	455+05.00		Geologic Map - see tunnel Geologic Map 01 in Appendix E



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

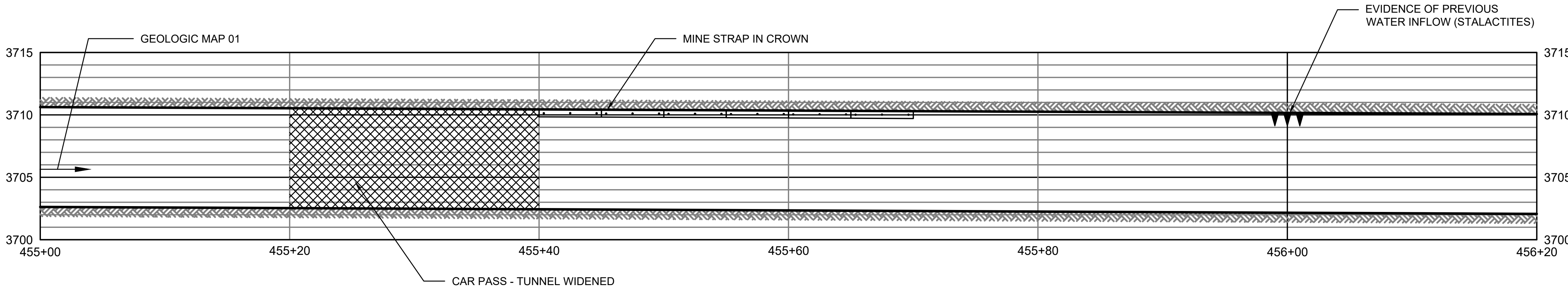
FIGURE TITLE

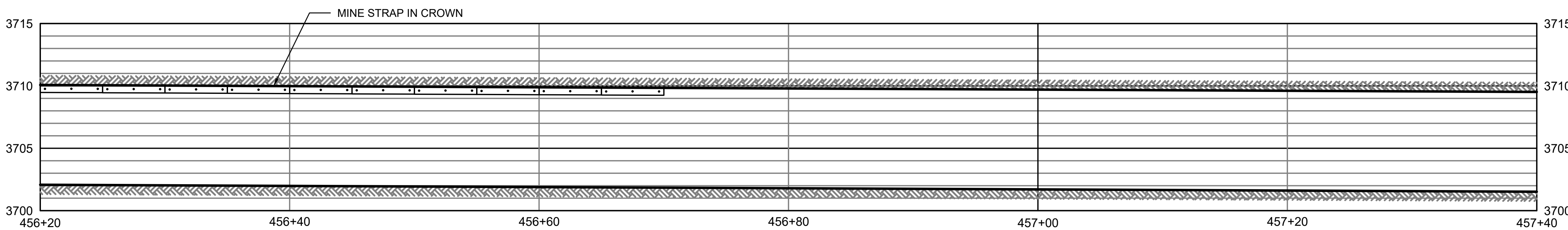
TUNNEL INSPECTION PROFILES

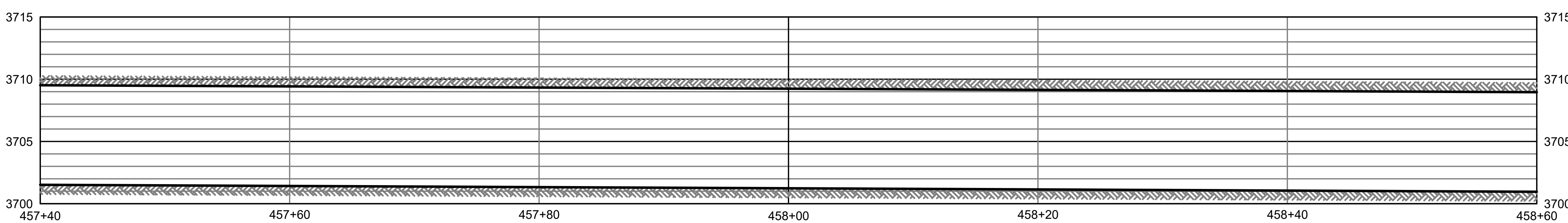
FIGURE NUMBER

FIG-01

Published: 12/10/2024 2:01:01 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
7	455+20.00	455+40.00	IMG_5054.HEIC _161829	Car pass - tunnel widened on north wall up to approximately 12 feet. Minor water inflow (<1gpm). Observed sediment (clay/sand) deposition at the tunnel floor at N
8	455+40.00	455+70.00	IMG_5056.HEIC _161058	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length
9	456+00.00	-	_160405	Evidence of previous water inflow with 6 to 12 inch long stalactites
10	456+20.00	456+70.00	IMG_5052.HEIC _161000	Mine straps in crown corrdoded and held with 0.75 inch pins of unknown length

BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE

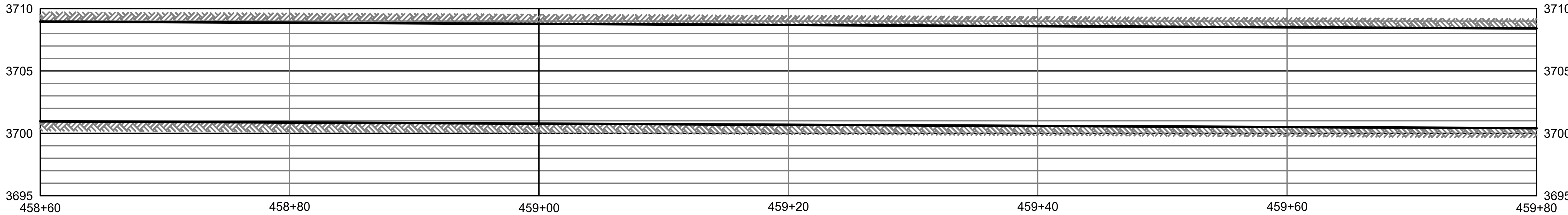
TUNNEL INSPECTION PROFILES

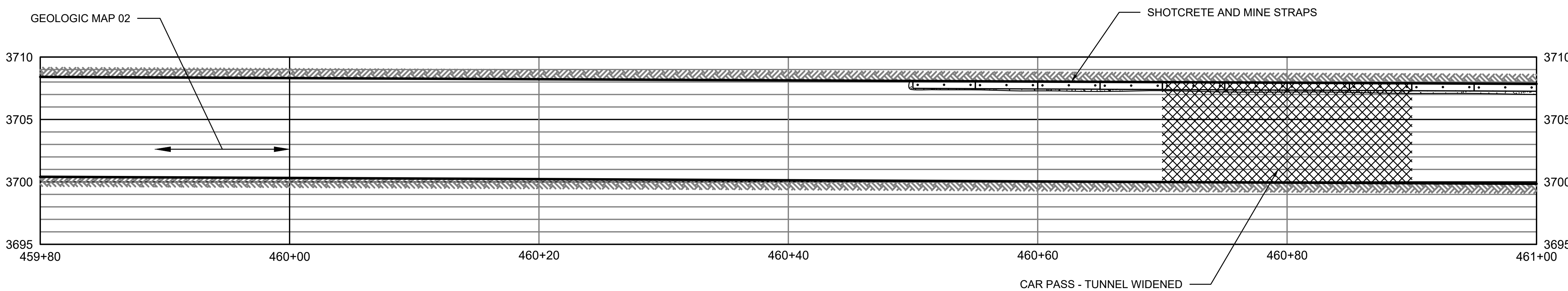
0 5 10 SCALE IN FEET

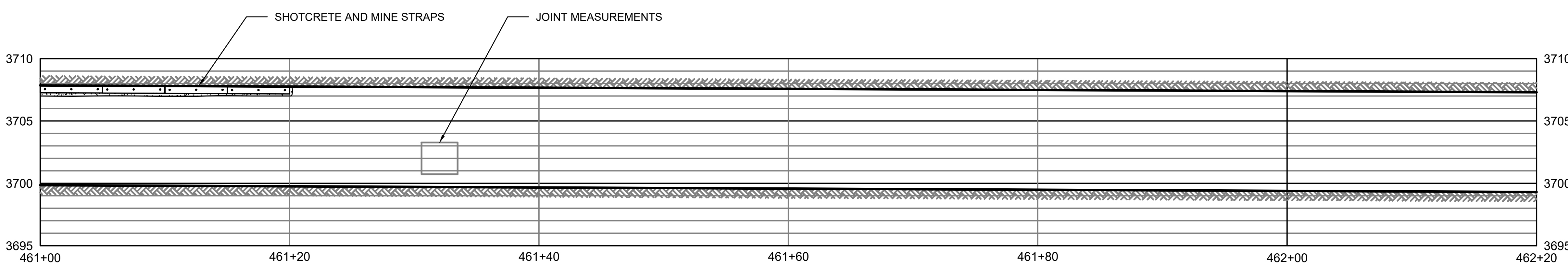
FIGURE NUMBER

FIG-02

Published: 12/10/2024 2:01:08 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
11	459+90.00	460+00.00	_160405	Geologic Map - see tunnel Geologic Map 02 in Appendix E
12	460+70.00	460+90.00	IMG_5036.HEIC _155006	Car pass - tunnel widened on north wall up to approximately 12 feet. Observed sediment (clay/sand) deposition at the tunnel floor at N
13	460+50.00	461+20.00	IMG_5035.HEIC _154821	Shotcrete and mine straps with some delamination in places. Shotcrete up to 1 inch thickness with few cracks. Thin light colored stalacties, likely from leaching of shotcrete
14	461+50.00	-	IMG_5033.HEIC _154235	Geologic measurements - refer to Appendix E

0 5 10
SCALE IN FEET

BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT
GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT
GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

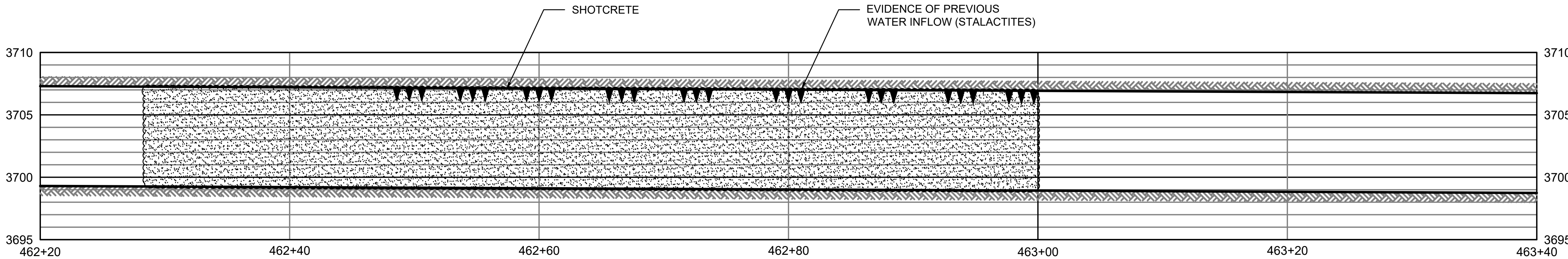
GEORGETOWN RAW WATER TUNNEL INSPECTION

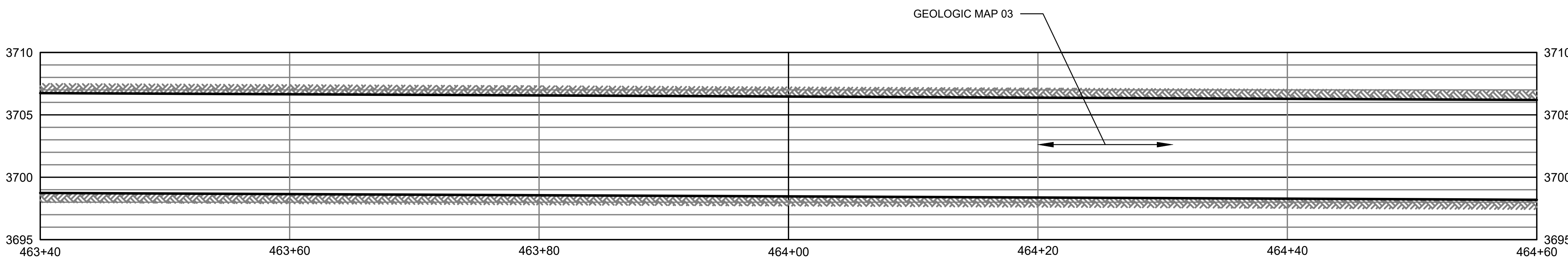
PROJECT NO 124141-000

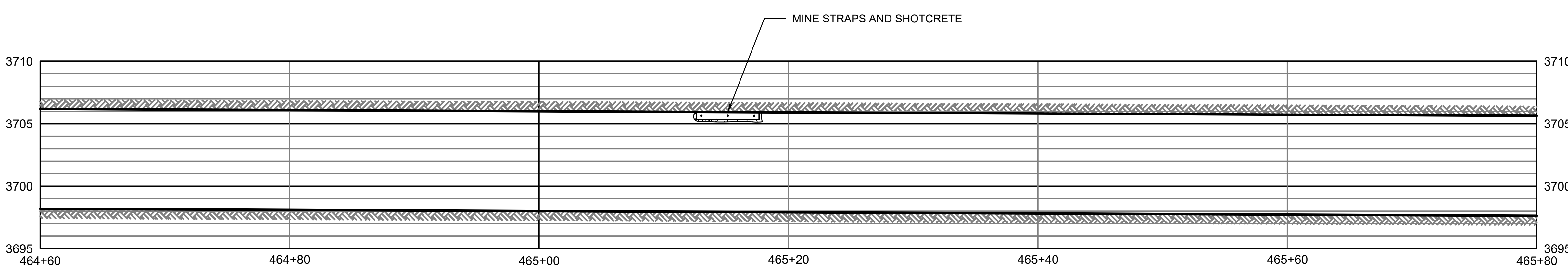
FIGURE TITLE
TUNNEL INSPECTION PROFILES

FIGURE NUMBER
FIG-03

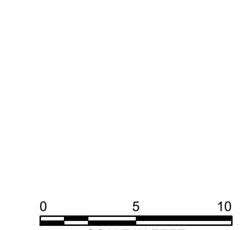
Published: 12/10/2024 2:01:13 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
15	462+30.00	463+00.00	IMG_5030.HEIC _153249	Shotcrete in crown and tunnel walls, including invert. Shotcrete up to 1 inch thickness with few cracks. No spalling observed. Thin light colored stalacties, like from leaching of shotcrete.
16	462+50.00	463+00.00	_152936	Evidence of previous water inflow with 6 to 12 inch long stalactites
17	464+20.00	464+30.00		Geologic Map - see tunnel Geologic Map 03 in Appendix E
18	465+10.00	465+18.00	IMG_5023.HEIC	Shotcrete and 4 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Thin light colored stalacties, like from leaching of shotcrete.



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

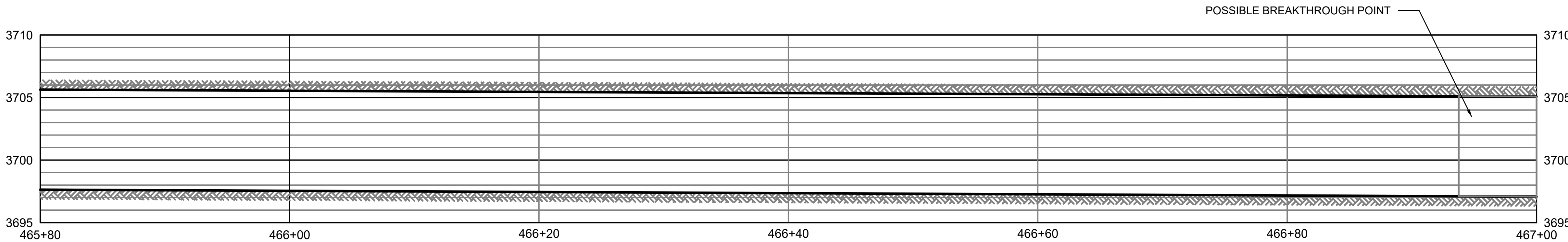
FIGURE TITLE

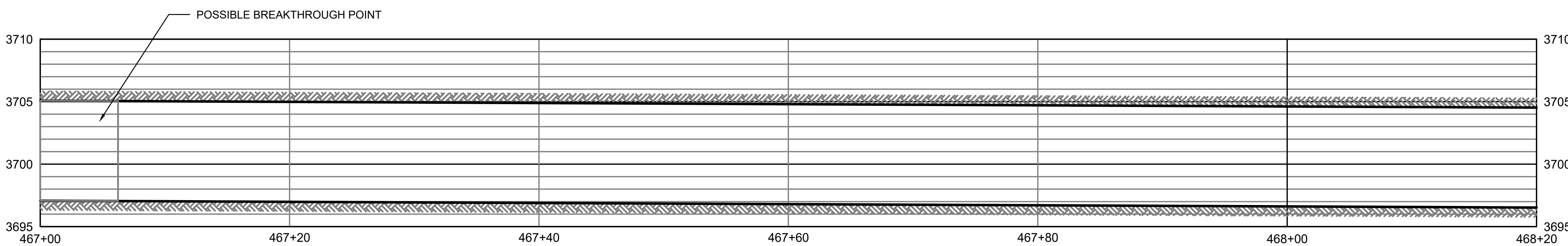
TUNNEL INSPECTION PROFILES

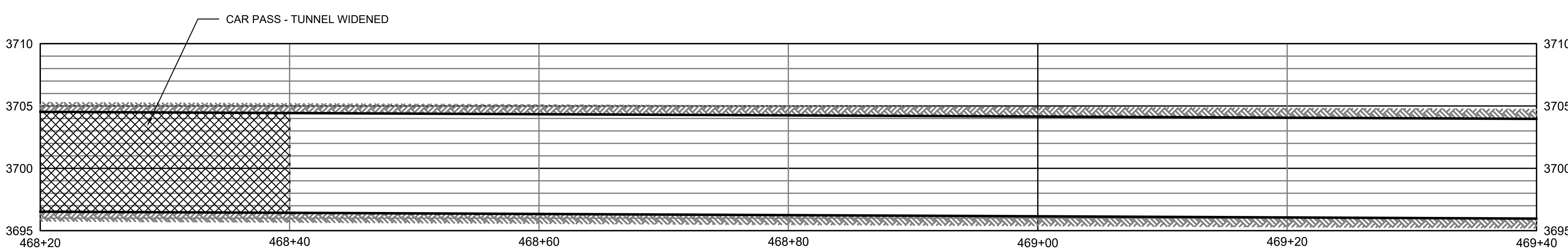
FIGURE NUMBER

FIG-04

Published: 12/10/2024 2:01:18 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
19	467+00.00	-	_151657	Possible breakthrough as tunnel walls become kinked
20	468+20.00	468+40.00	IMG_5016.HEIC _151448	Car pass - tunnel widened on south wall up to approximately 12 feet wide. Observed sediment (clay/sand) deposition at the tunnel floor at S

0 5 10
SCALE IN FEET

0 5 10

BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

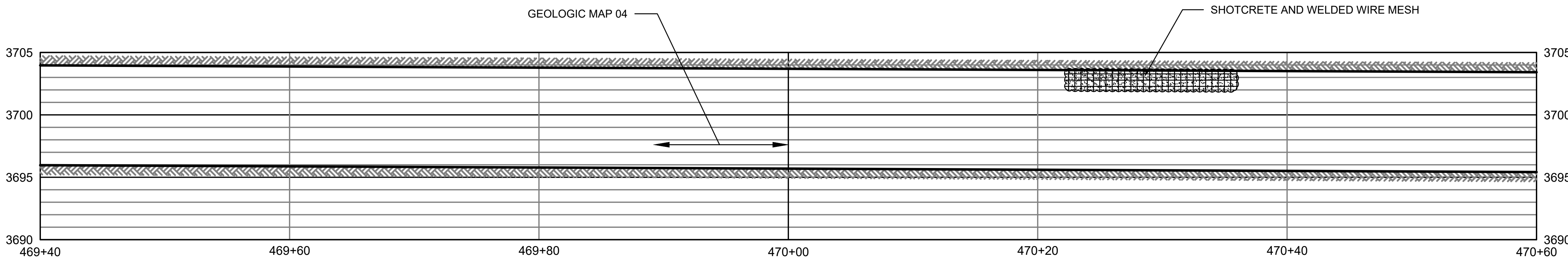
FIGURE TITLE

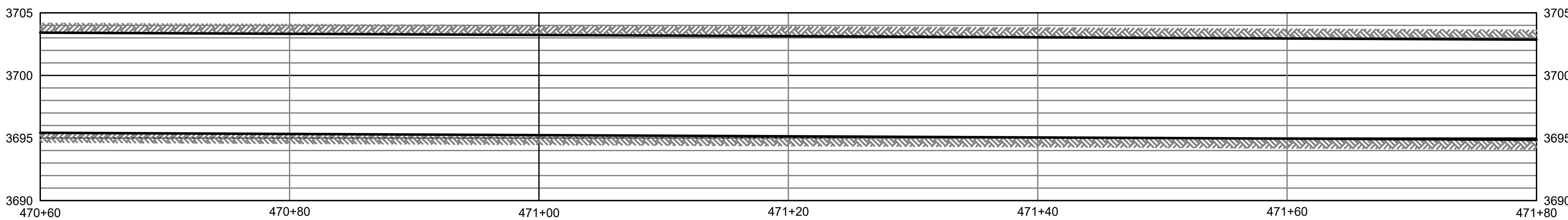
TUNNEL INSPECTION
PROFILES

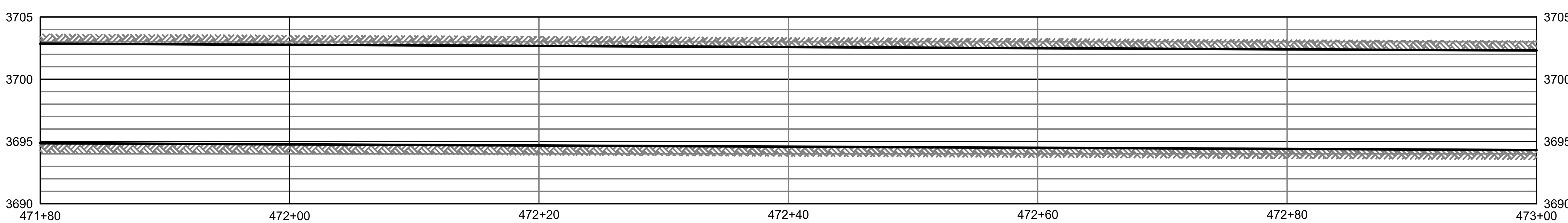
FIGURE NUMBER

FIG-05

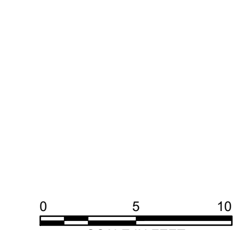
Published: 12/10/2024 2:01:23 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
21	469+90.00	470+00.00	_151224	Geologic Map - see tunnel Geologic Map 04 in Appendix E
22	470+25.00	470+35.00	IMG_5012.HEIC _145739	Shotcrete and 4 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some thin light colored stalacties, like from leaching of shotcrete.



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE

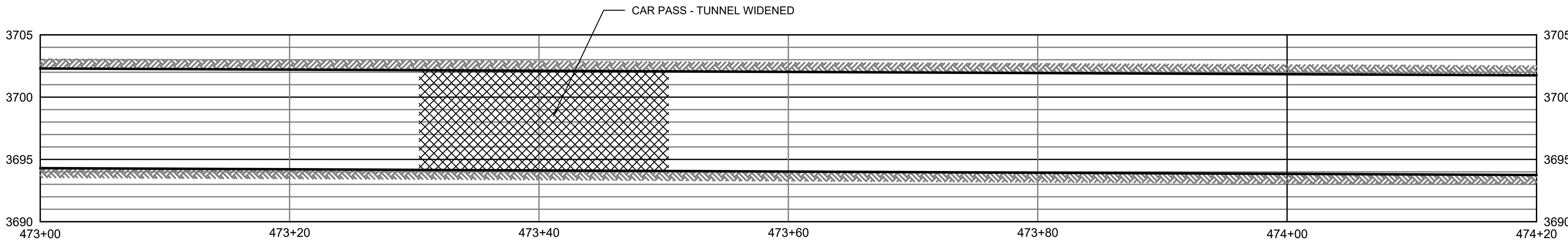
TUNNEL INSPECTION PROFILES

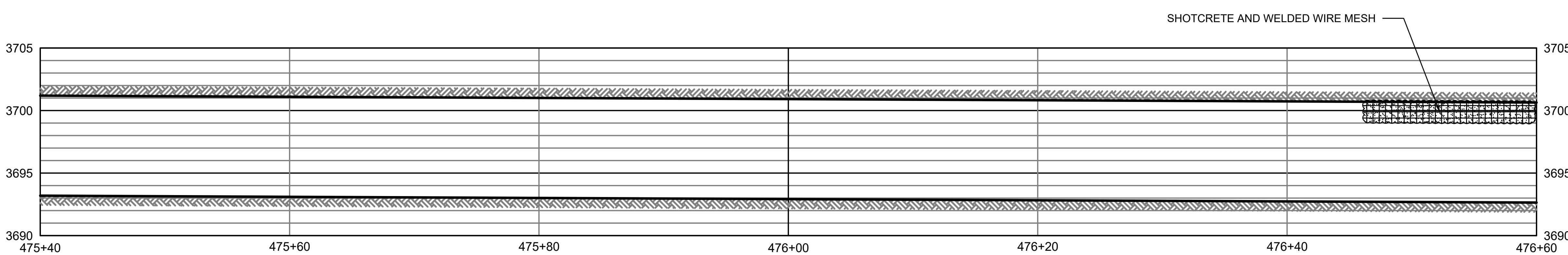
FIGURE NUMBER

FIG-06

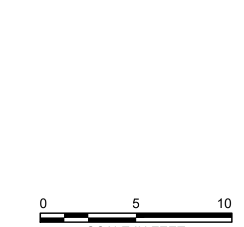
6 OF 13

Published: 12/10/2024 2:01:28 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg





Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
23	473+30.00	473+50.00	IMG_5005.HEIC _145236	Car pass - tunnel widened on south wall up to approximately 12 feet. Observed sediment (clay/sand) deposition at the tunnel floor
24	476+45.00	476+60.00	IMG_4997.HEIC _143713	Incomplete shotcrete with 4 inch WWM. WWM exposed in many areas. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some efflorescence and thin light colored stalactites, likely from leaching of shotcrete. Mine straps in crown.



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

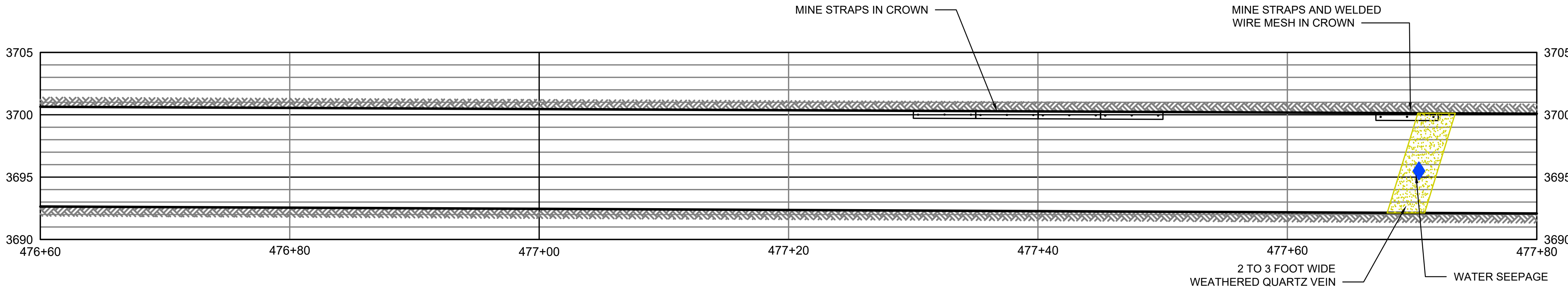
FIGURE TITLE

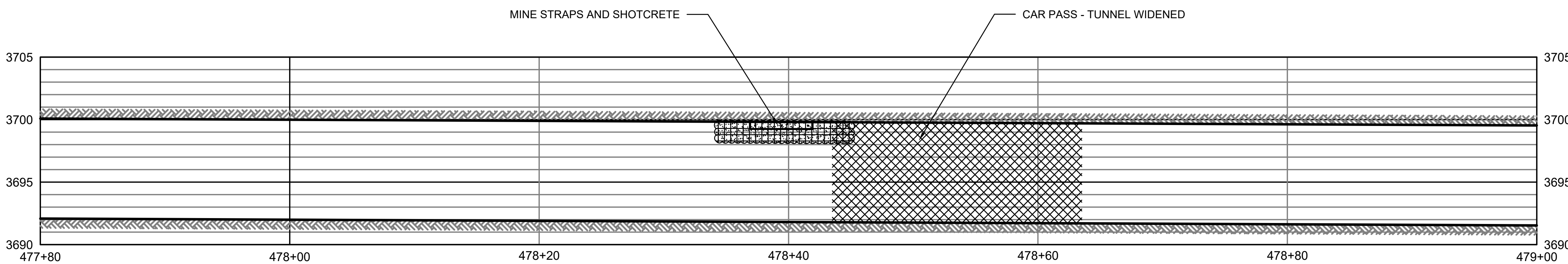
TUNNEL INSPECTION PROFILES

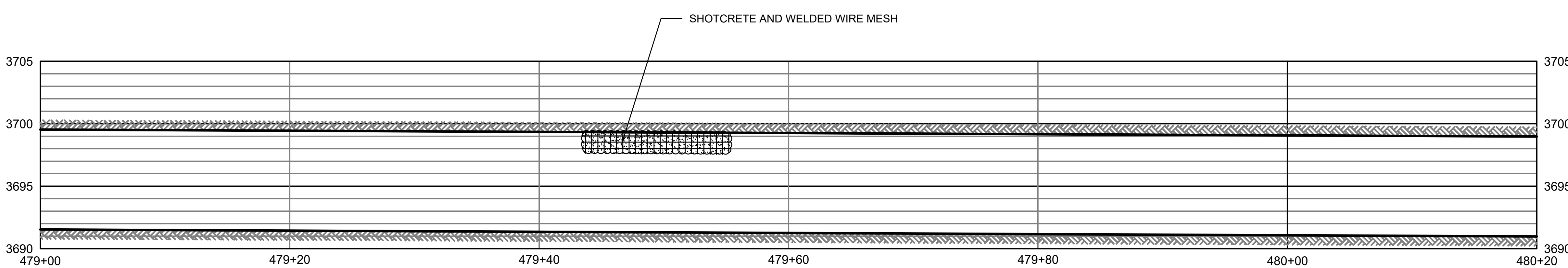
FIGURE NUMBER

FIG-07

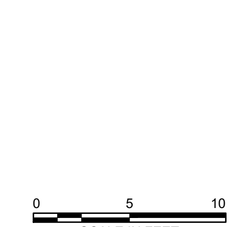
Published: 12/10/2024 2:01:33 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
25	477+35.00	477+50.00	_143433	Single mine strap installed in crown
26	477+70.00	-	IMG_4988.HEIC _143353	0.5 inch WWM and mine straps in crown. Water seep with iron oxide discoloration; tunnel walls wet; 2 to 3 foot wide quartz vein, vertical
27	478+35.00	478+45.00	IMG_4985.HEIC _142810	Incomplete shotcrete with 4 inch and 0.5 inch WWM. WWM exposed in many areas. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some efflorescence and thin light colored stalactites, likely from leaching of shotcrete. Mine straps in crown.
28	478+45.00	478+65.00	IMG_4980.HEIC _142617	Car pass - tunnel widened on south wall up to approximately 12 feet. Shotcrete and mine straps installed in the crown. Observed sediment (clay/sand) deposition at the tunnel floor
29	479+50.00	-	IMG_4977.HEIC _142322	Shotcrete and 0.5 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed.Some efflorescence and thin light colored stalactites, likely from leaching of shotcrete. Some iron oxide staining from water inflow and corrosion of WWM.



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WODDLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

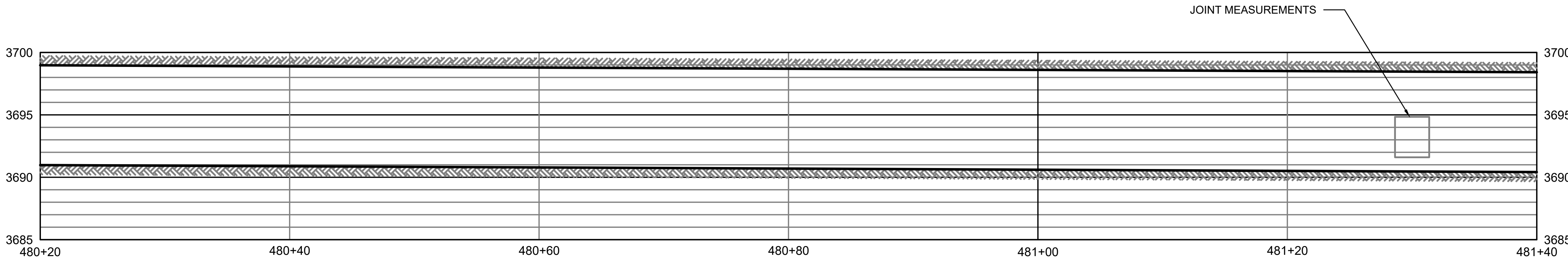
FIGURE TITLE

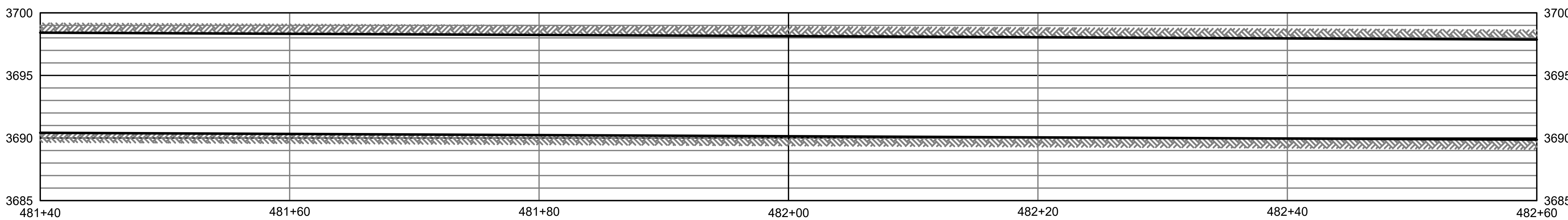
TUNNEL INSPECTION
PROFILES

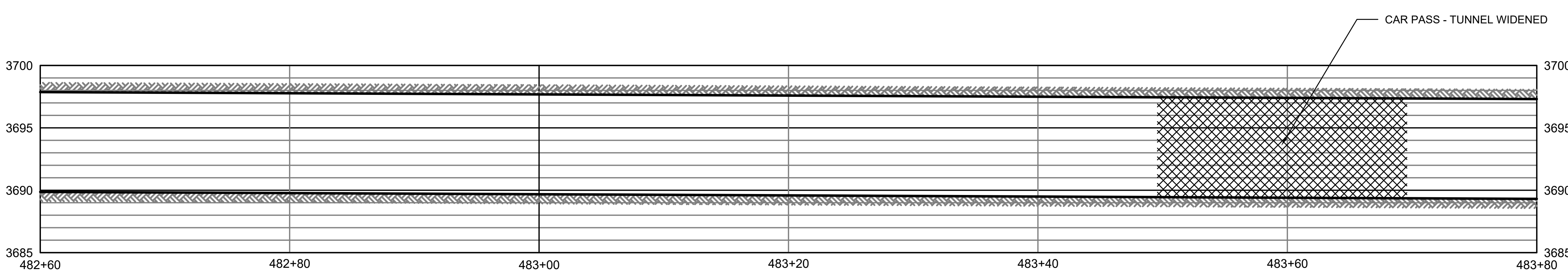
FIGURE NUMBER

FIG-08

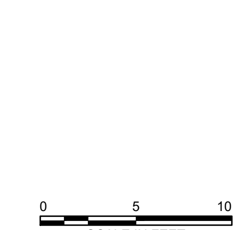
Published: 12/10/2024 2:01:38 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
30	480+20.00	-	_142142	Small breakout on north wall with dimensions of 5 x 5 x 5 feet
31	481+30.00		IMG_4970.HEIC _141534	Geologic measurements - refer to Appendix E
32	483+50.00	483+70.00	IMG_4965.HEIC _141123	Car pass - tunnel widened on south wall up to approximately 12 feet. Observed sediment (clay/sand) deposition at the tunnel floor



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

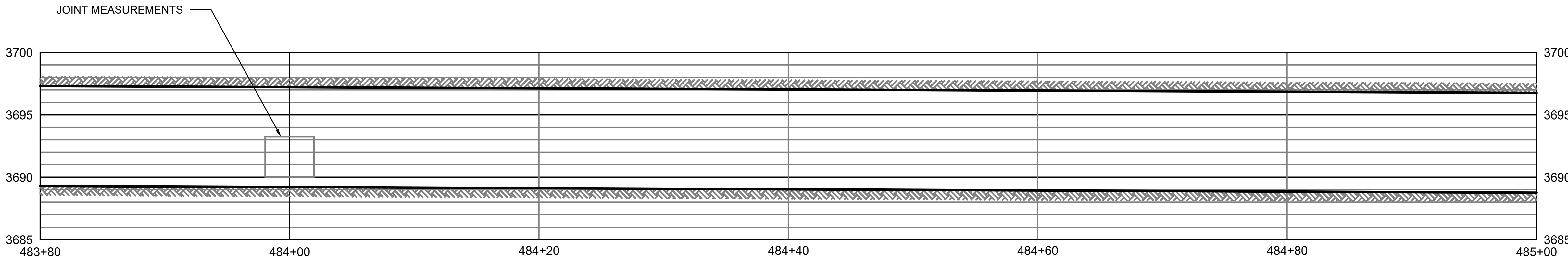
FIGURE TITLE

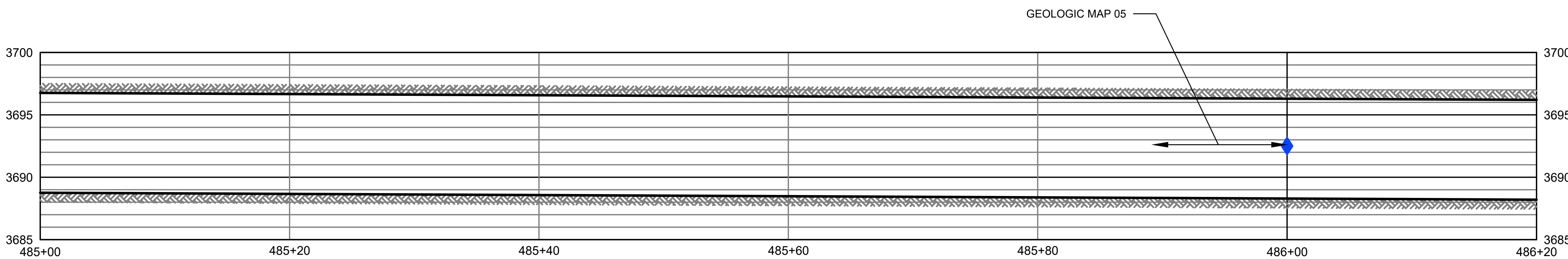
TUNNEL INSPECTION
PROFILES

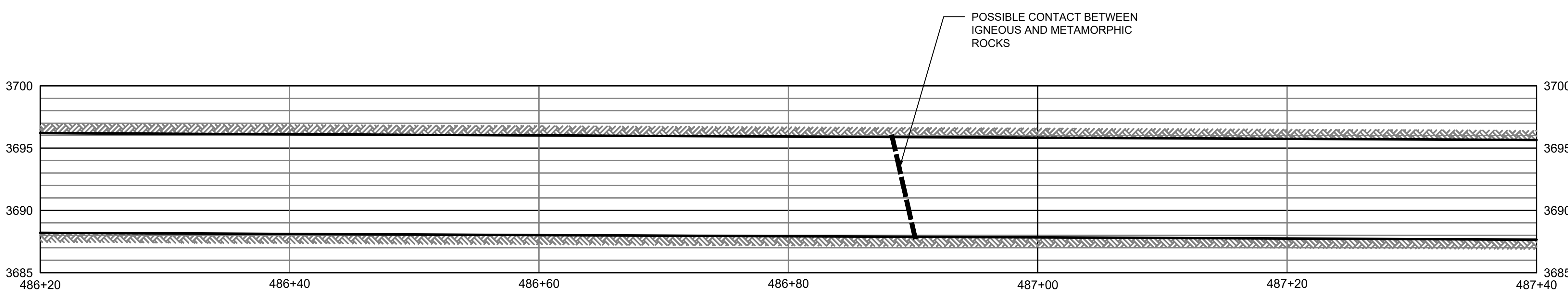
FIGURE NUMBER

FIG-09

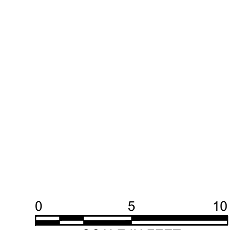
Published: 12/10/2024 2:01:43 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
33	484+00.00	-	_140926	Geologic measurements - refer to Appendix E
34	486+00.00	-	IMG_4956.HEIC	Groundwater flow, <1gpm. 2 inch drain installed and clogged.
35	486+00.00	-	_140656	Geologic Map - see tunnel Geologic Map 05 in Appendix E
36	486+70.00	-	_135253	Possible contact between slate/hornfels(?) and granodiorite



BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE

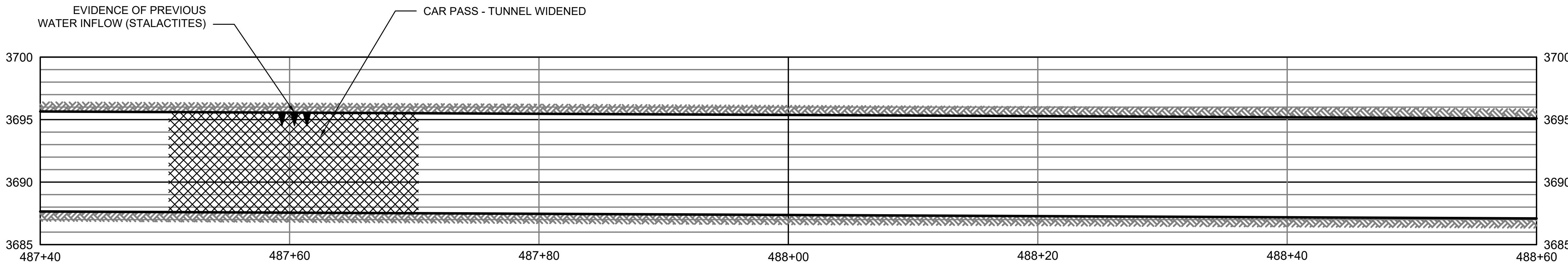
TUNNEL INSPECTION
PROFILES

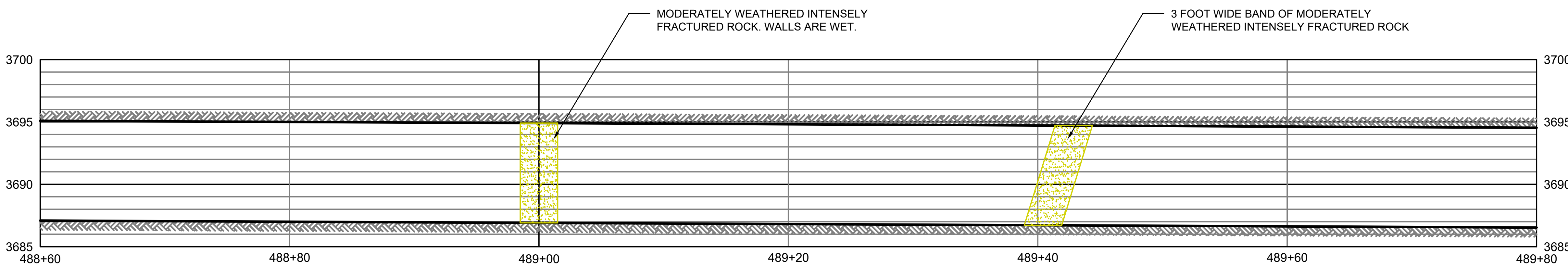
FIGURE NUMBER

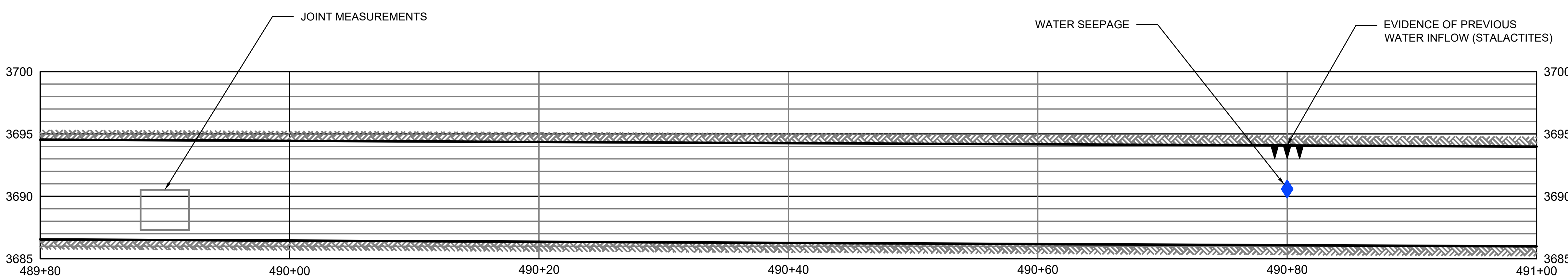
FIG-10

10 OF 13

Published: 12/10/2024 2:01:48 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
37	487+55.00	487+75.00	_132647	Car pass - tunnel widened on south wall up to approximately 14 feet. No shotcrete or other apparent support. Some stalactites showing evidence of previous water inflow.
38	489+00.00		IMG_4945.HEIC	Moderately weathered rock, walls are damp to wet
39	489+40.00	-	_132348	3 foot wide band of moderately weathered highly jointed rock. Joints are vertical
40	489+90.00	-	_131953	Geologic measurements - refer to Appendix E
41	490+80.00	-	_131318	Minor water inflow (<1gpm) and evidence of previous water inflow in additional locations due to existing stalactites. Significant iron oxide discoloration. Stalactites in crown

0 5 10
SCALE IN FEET

BRIERLEY
ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

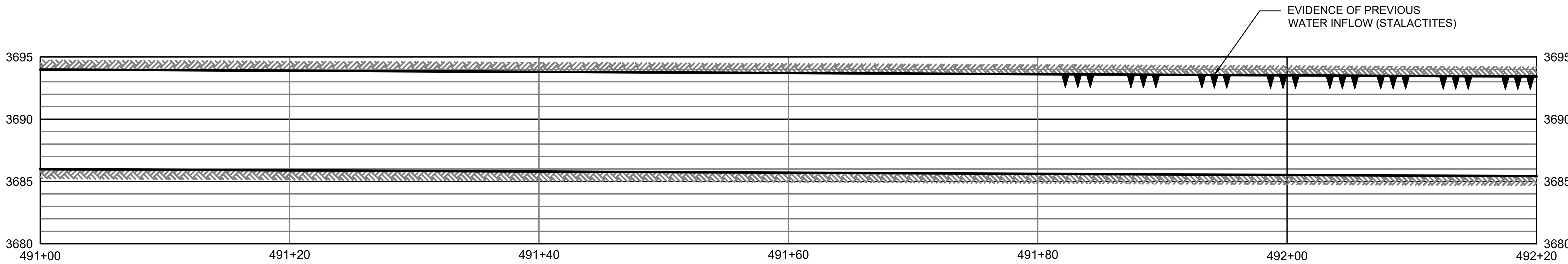
FIGURE TITLE

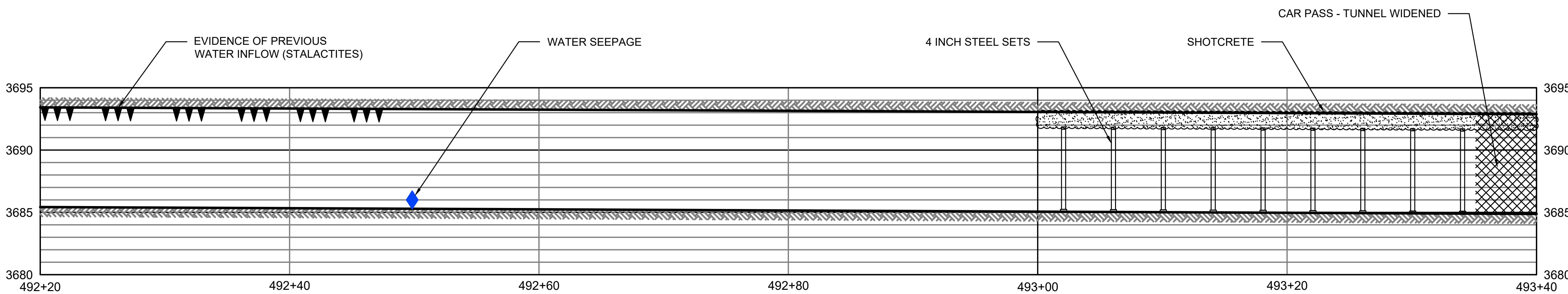
TUNNEL INSPECTION
PROFILES

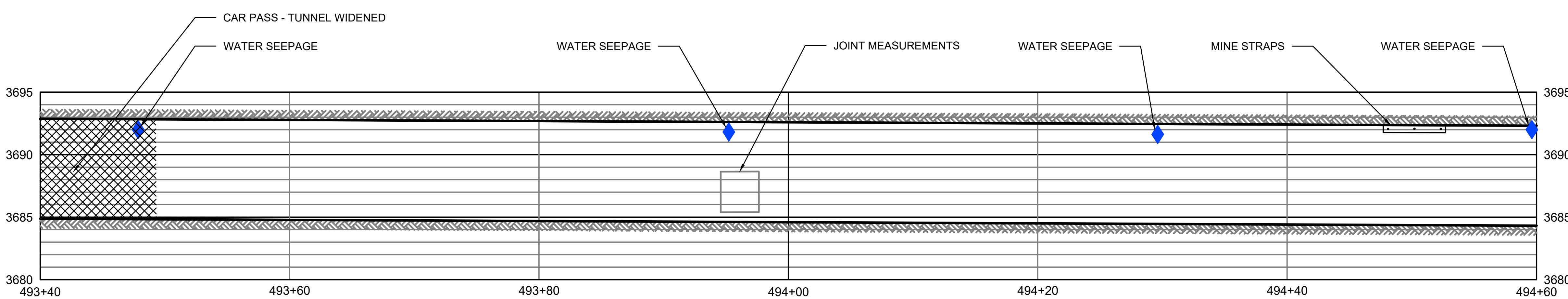
FIGURE NUMBER

FIG-11

Published: 12/10/2024 2:01:53 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
42	491+85.00	492+50.00	_130751	Water inflow and evidence of previous water inflow in additional locations due to existing stalactites. Single seepage point near invert under slight pressure (artesian) at Sta. 492+50. Significant iron oxide discoloration
43	493+00.00	493+55.00	_105650	Shotcrete and 0.5 inch WWM. Shotcrete up to 1 inch thickness with few cracks, with possible demalination or non-contact with tunnel walls. No spalling observed. Some thin light colored stalactites, likely from leaching of shotcrete.
44	493+10.00	493+34.00	_130107	A total of 8 steel ribs (between #74 and #82) spaced at 4.0-ft were observed. This area is the previous fallout zone. There were about six drainpipes to collect or divert groundwater discharge at several locations within this interval. The wood blocking and timbers between the steel ribs and rock surface were missing at the roof. Steel ribs and tie-bars were covered with shotcrete. Some tie-bars were missing.
45	493+34.00	493+50.00	_130038	Car pass - tunnel widened on south wall up to approximately 14 feet

Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
46	493+50.00	-	_125849	Water inflow of 2-3gpm. Several small seepage points at springline under slight pressure (artesian) at Sta. 493+50.
47	493+95.00	-	_125016	Geologic measurements - refer to Appendix E
48	494+30.00	-	_124830	Water inflow of approximately 1-2gpm
49	494+50.00	464+60.00	_124705	Significant iron oxide discoloration; water inflow of approximately 1-2gpm
50	494+50.00			Mine straps in crown moderately corrdoded and held with 0.75 inch pins of unknown length

0 5 10
SCALE IN FEET

BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER TUNNEL INSPECTION

PROJECT NO 124141-000

FIGURE TITLE

TUNNEL INSPECTION PROFILES

FIGURE NUMBER

FIG-12

Published: 12/10/2024 2:01:58 PM C:\Users\bconnelly\DC\ACCDocs\Brierley Associates\GEORGETOWN RAW WATER RAW WATER TUNNEL INSPECTION\Project Files\DOCUMENT\FIGURES\124141-000_FIGURES.dwg

BRIERLEY ASSOCIATES
Creating Space Underground
6355 TOPANGA CANYON BLVD, STE 502
WOODLAND HILLS, CA 91367
PH: 818.835.9554

CLIENT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

PROJECT

GEORGETOWN DIVIDE
PUBLIC UTILITY DISTRICT
GEORGETOWN, CALIFORNIA

GEORGETOWN RAW WATER
TUNNEL INSPECTION

PROJECT NO 124141-000

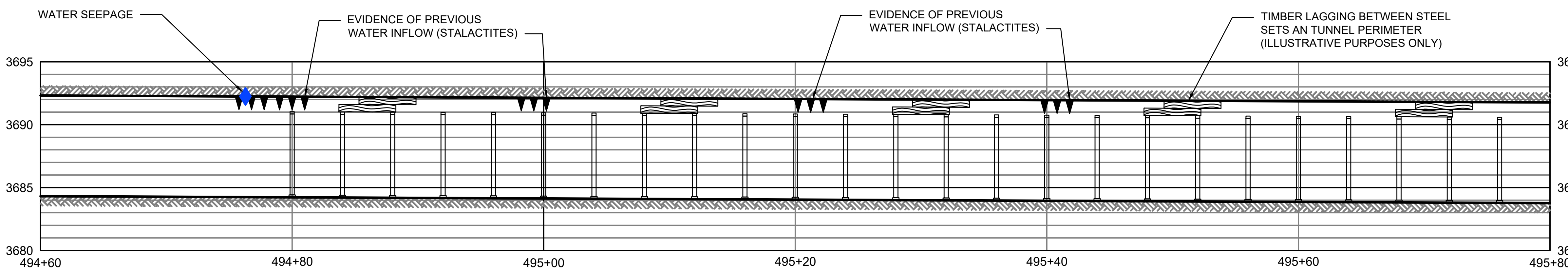
FIGURE TITLE

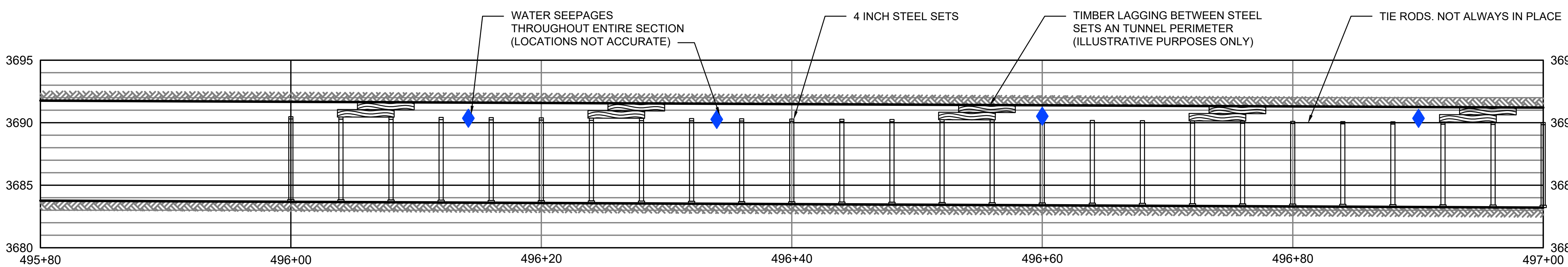
TUNNEL INSPECTION
PROFILES

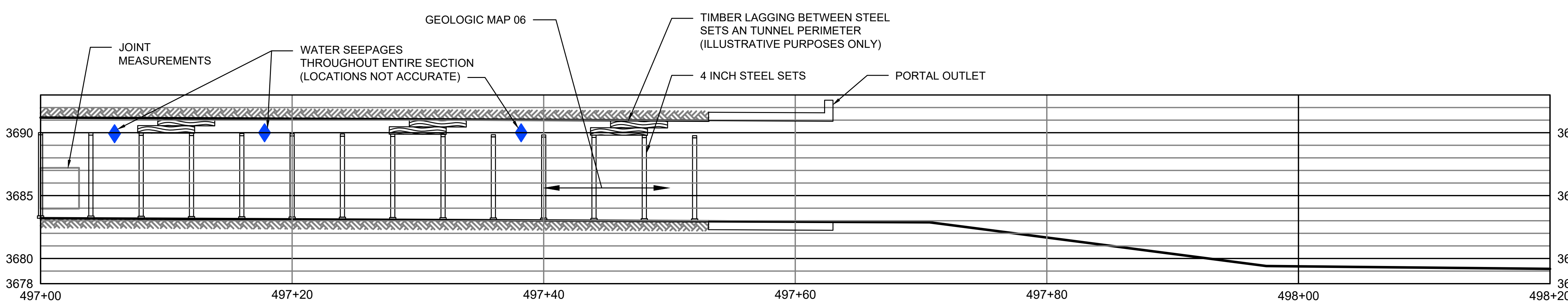
FIGURE NUMBER

FIG-13

13 OF 13







Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
51	494+80.00	495+75.00		A total of 25 steel ribs (between #50 and #74) spaced at 4.0-ft were observed. A tie-bar between the steel rib #53 and #54 were missing on S wall, and some tie-bars were deformed. The wood blocking, shotcrete and timbers were observed to be inadequate at some locations
52	494+80.00	495+75.00	_123028 to _	Iron oxide discoloration and significant stalactites, evidence of previous water inflow throughout section
53	494+30.00	-	_123645	Water inflow of approximately <1gpm and iron oxide discoloration
54	496+00.00	497+50.00	IMG_4926.HEIC	Steel ribs (quantity 49). The first 21 steel ribs (between #49 and #29) were spaced at from 3.0 to 4.0-ft; then, the next 14 steel ribs (between #29 and #14) were spaced at from 2.0 to 3.0-ft; the last 14 steel ribs (between #14 and #1) near the outlet were spaced at approximately 2.0-ft. The steel ribs and tie-bars were not covered with shotcrete, and they appeared to be affected by significant corrosion. Some occasional shotcrete applications were observed on steel ribs closer to the tunnel invert to secure the steel sets. The wood blocking between the steel ribs and rock surface were missing at the shoulders, walls and roof for the first ten steel ribs. Some tie-bars between the steel ribs were missing and deformed.
55	496+00.00	497+53.11	_123124	Significant water inflow throughout entire section. Estimated 10 to 20gpm

Defect No.	2024 Start Station	2024 End Station	Photo Number	Defect/Observation Description
56	497+00.00	-	_120351	Geologic measurements - refer to Appendix E
57	497+40.00	497+50.00	_120109	Geologic Map - see tunnel geologic map 05 in Appendix E
58	497+53.00	497+63.00		The concrete surface of transition structure has some efflorescence especially along some surficial cracks. There was no delamination, scaling, spalling, exposed bar, honeycombing or active leakage. Cracks on the north wall were surficial and very thin between 0.01 and 0.1 inches. A light-colored deposit build-up as in the form of efflorescence was present along a couple cracks that are five to ten inches long. Cracks on the south wall were also surficial and very thin in general. There was a crack extending perpendicular to the tunnel axis and with a light-colored deposit build-up as in the form of efflorescence. It was uncertain how and when this crack had been initiated. Staining was mainly present in light-color and green. Condition State: CS2
59	497+63.00	-		Geologic measurements - refer to Appendix E

0 5 10
SCALE IN FEET

APPENDIX E

Geologic Maps and RMR Classification

BRIERLEY ASSOCIATES
Creating Space Underground

Rock Mass Characteristics and RMR Classification

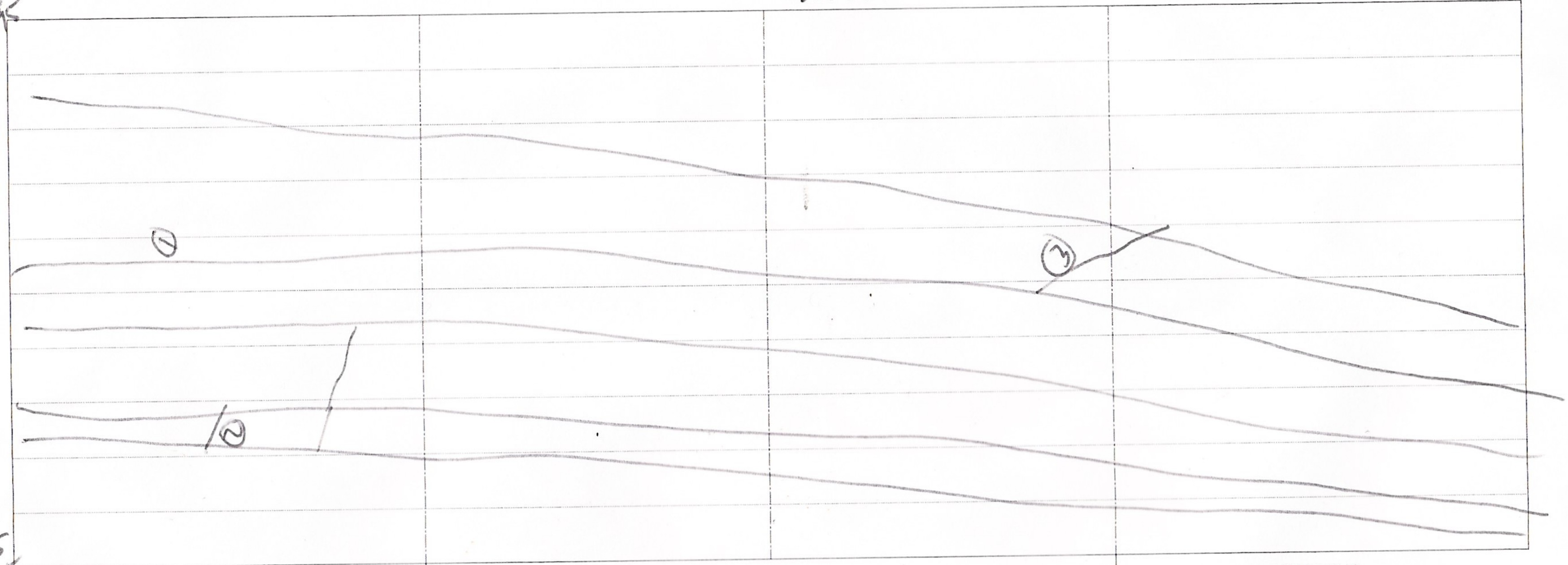
Station	Rock Type	Rock Mass Characteristics												RMR Rating								
		Dip	Direction	Strike	Spacing	Persistence	Opennes	Infill	Weathering	Healing	Planarity	Roughness	Seepage	Strength	RQD	Spacing	Discon.	Inflow	Strike / Dip	Rating	Class	Description
451+50.00	Granodiorite	40	90	360	VW	SC	SO	Cl	HW	-	P	R	None	7	8	8	10	15	0	48	III	Fair
451+50.00	Granodiorite	25	330	240	M-W	MC	SO	Cl	HW	-	P	R	None									
451+50.00	Granodiorite	85	040	310	C	MC	O	Cl	HW	-	P	R	None									
454+95.00	Granodiorite	55	125	035	EW	SC	T	C	SW	-	P	R	None	7	13	10	25	10	0	65	II	Good
454+95.00	Granodiorite	70	305	215	M-VW	MC	T	C	SW	-	P	R	None									
454+95.00	Granodiorite	20	065	335	M	D	T	C	SW	-	P	R	None									
459+90.00	Granodiorite	50	140	050	VC-W	VC	T	C	SW	-	P	R	None	7	13	10	25	15	0	70	II	Good
459+90.00	Granodiorite	60	355	265	EW	HC	T	C	SW	-	P	R	None									
459+90.00	Granodiorite	40	080	350	VC-W	VC	T	C	SW	-	P	R	None									
461+50.00	Granodiorite	35	065	335					SW	-			None									
464+20.00	Granodiorite	55	215	125	EW	MC	T-SO	C	SW	-	P	R	None	7	13	10	25	15	0	70	II	Good
464+20.00	Granodiorite	30	340	250	M	MC	T	C	SW	-	P	R	None									
464+20.00	Granodiorite	40	340	250	EW	MC	T	C	SW	-	P	R	None									
469+90.00	Granodiorite	87	140	050	M	D	T-SO	C	SW	-	P	R	None	7	8	8	25	15	0	63	II	Good
469+90.00	Granodiorite	35	200	110	EW	SC	T-SO	C	SW	-	U	R	None									
469+90.00	Granodiorite	75	220	130	EW	MC	SO	Quartz	SW	-	U	R	None									
469+90.00	Granodiorite	5	055	325	C-M	MC	T	C	SW	-	P	R	None									
481+30.00	Granodiorite	80	320	230	VC	-	-	-	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
481+30.00	Granodiorite	15	025	295	VC	-	-	-	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
484+00.00	Granodiorite	15	290	200	VC	-	-	-	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
486+00.00	Granodiorite	45	115	025	VW	SC	T-SO	C	SW	-	P	R	None	7	13	10	25	15	0	70	II	Good
486+00.00	Granodiorite	65	310	220	EW	SC	T	C	SW	-	P	R	None									
486+00.00	Granodiorite	5	010	280	W-VW	MC	T	C	SW	-	P	R	None									
493+95.00	Slate	60	240	160	VC	MC	T-SO	C-VT	SW	-	P	R	None	4	8	5	20	7	0	44	III	Fair
493+95.00	Slate	90	320	230	M	SC	T	C	SW	-	P	R	None									
493+95.00	Slate	25	080	350	W	SC	-	-	SW	-	-	-	None									
497+00.00	Slate	60	150	050	W	MC	SO	C	SW	-	P	R	None	4	8	5	20	4	0	41	III	Fair
497+00.00	Slate	55	290	200	VC-M	MC-HC	T-SO	C-VT	SW	-	P	SR	None									
497+00.00	Slate	85	320	230	M	SC	T	C	SW	-	P	R	None									
497+40.00	Slate	75	275	185	EW	VC	T-SO	C	SW	-	P	R	Slight	4	8	5	20	7	0	44	III	Fair
497+40.00	Slate	10	030	300	EW	MC	T-SO	C	SW	-	P	SR	Slight									
497+63.00	Slate	50	135	045	M-W	MC	T-SO	C	SW-MW	-	P	R	None	4	8	5	20	15	0	52	III	Fair
497+63.00	Slate	50	260	170	VC-M	VC	T-O	C	SW-MW	-	P	R	None									
497+63.00	Slate	85	320	230	M-W	MC	T-SO	C	SW-MW	-	P	R	None									
497+63.00	Slate	05	085	355	M-W	SC	T-SO	C	SW-MW	-	P	R	None									

Raw Water Conveyance Tunnel

TUNNEL: GDPUD

ØNLET

STA. 454+95



STA. 455+05

SIDEWALL | CROWN | SIDEWALL

OUTLET

DISCONTINUITIES											COMMENTS	GROUNDWATER	
ID	Type	Dip	Dir.	Roughness	Persistance	Aperture	Infill	Spacing	Weathering	Seepage		ID	Flow
1	SJ	70	215	R	>10'	Tight	Clean	6"-10'	SW	None			
2	J	20	335	R	<1'	Tight	None	<1'	SW	none			
3	J	55	035	R	<10'	Tight	clean	>10'	SW	none			

LITHOLOGY					
ID	Lithology	Weathering	Hardness	Color	Coverage

GSI			
ID	Surface Condition	Structure	GSI Value

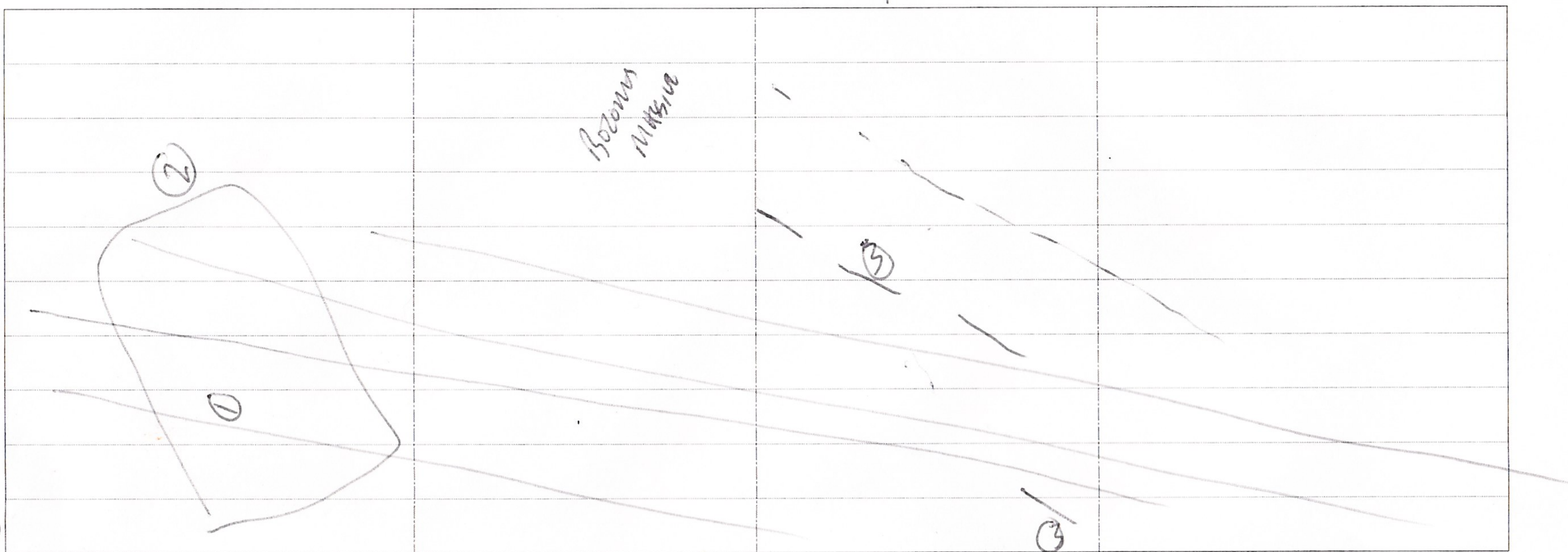
ADDITIONAL SUPPORT

ADDITIONAL COMMENTS

Raw Water Conveyance Tunnel

TUNNEL: GDPUD

STA. 459+00



STA. 460+00

SIDEWALL | CROWN | SIDEWALL

Outlet

DISCONTINUITIES											COMMENTS	GROUNDWATER	
ID	Type	Dip	Dir.	Roughness	Persistance	Aperture	Infill	Spacing	Weathering	Seepage		ID	Flow
1	BJ	40N	350	R	V. cont.	Tight	slight discol.	V. close, W. spac.	S.W.	None			
2	J	60N	265	R	30'	Tight	clean	>10'	S.W.	None			
3	J	50	050	R	V.C.	Tight	S. disc.	V. close-W. spac.	SW	None			

LITHOLOGY					
ID	Lithology	Weathering	Hardness	Color	Coverage

GSI			
ID	Surface Condition	Structure	GSI Value

ADDITIONAL SUPPORT

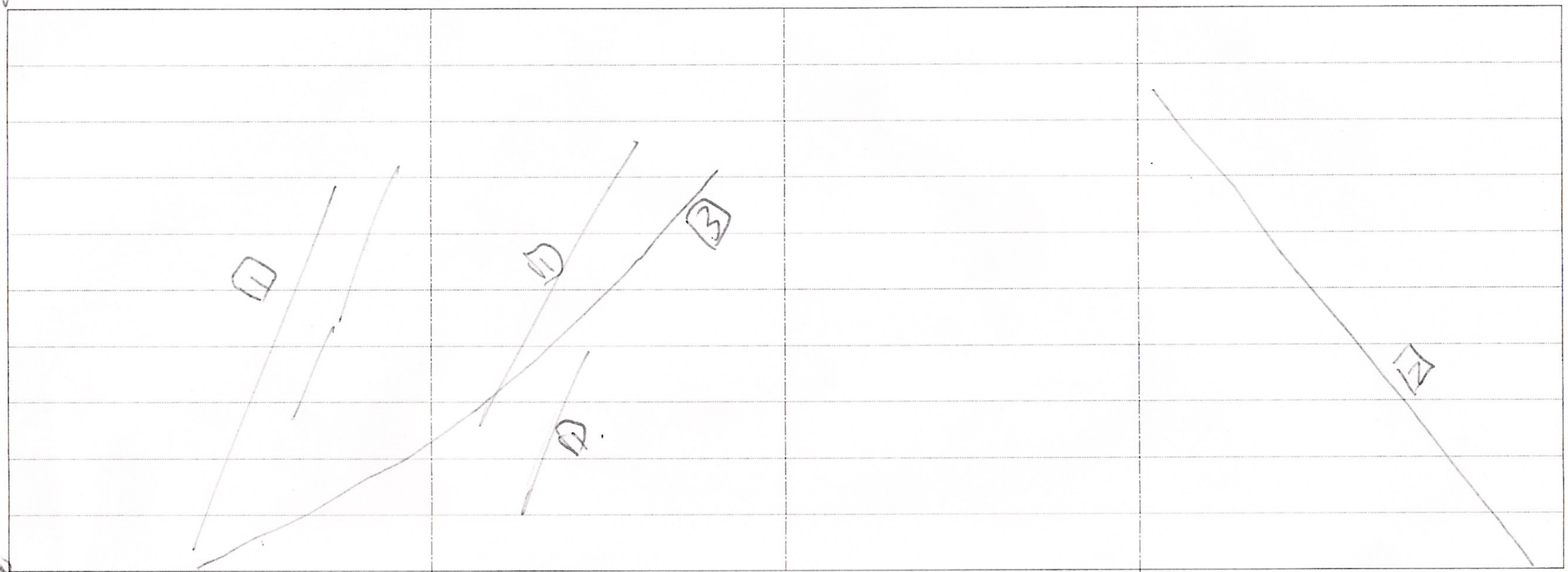
ADDITIONAL COMMENTS

Raw Water Conveyance Tunnel

TUNNEL: GDPUD

Invert

STA. 464+20



STA. 464+30

SIDEWALL CROWN SIDEWALL

OUT

DISCONTINUITIES										COMMENTS	GROUNDWATER	
ID	Type	Dip	Dir.	Roughness	Persistance	Aperture	Infill	Spacing	Weathering	Seepage	ID	Flow
1		30	250	pl-ro	>10ft	tight	Ø	<1ft	Slight	—		
2		55	125	pl-ro	>10ft	tight	Ø	>10ft	Slight	—		
3		40	250	pl-ro	>10ft	tight	Ø	>1ft	sl wx	—		

LITHOLOGY					
ID	Lithology	Weathering	Hardness	Color	Coverage

GSI			
ID	Surface Condition	Structure	GSI Value

ADDITIONAL SUPPORT

ADDITIONAL COMMENTS

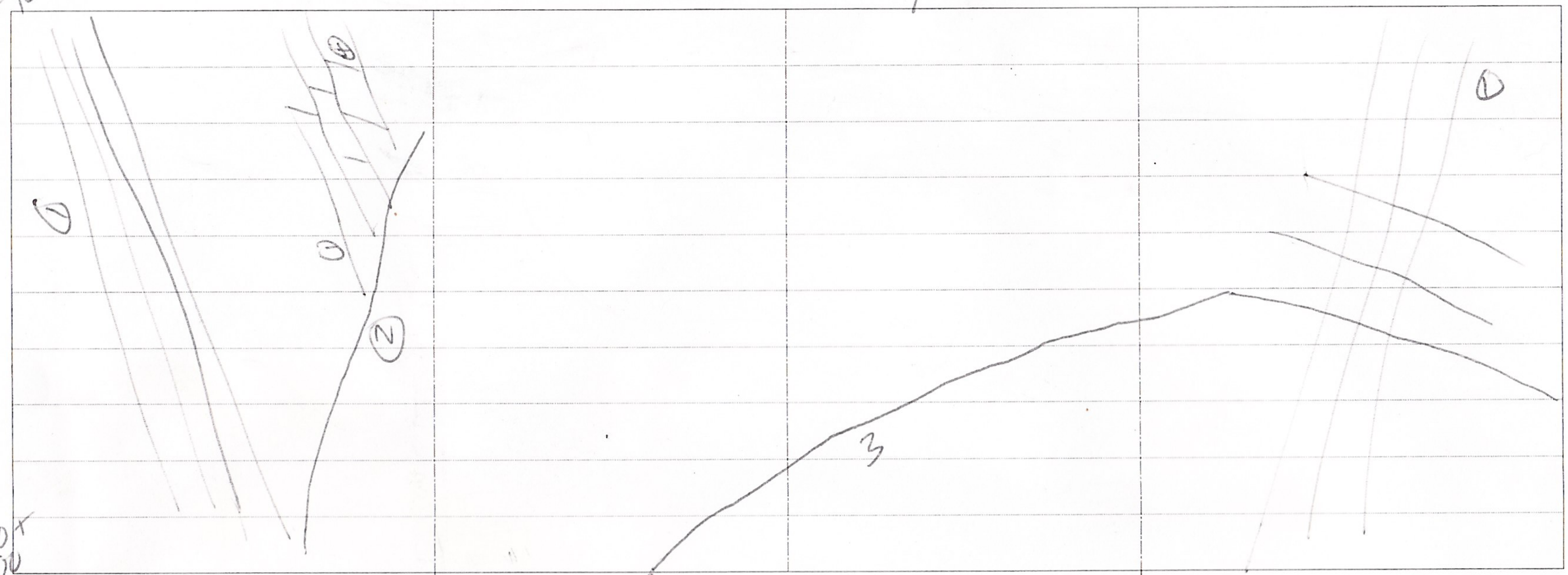
TUNNEL: GDPUD

Raw Water Conveyance Tunnel

φNLSU

STA. 469+90

STA. 470+00



SIDEWALL | CROWN | SIDEWALL

OUTC

DISCONTINUITIES								very closely sp			COMMENTS	GROUNDWATER	
ID	Type	Dip	Dir.	Roughness	Persistance	Aperture	Infill	Spacing	Weathering	Seepage		ID	Flow
1	JC	5°	325	rough	>10	slgt-tgt	Ø	[illegible]ft	sl. wx	—			
2		35 S	110	undulatg	"	"	"			—			
3		75	130	undulat	>10	slop	Qtz	>10ft	mod wx	—			
4		87	050	rough	>1	tight	Ø	<1 ft	sl wx	—			

LITHOLOGY					
ID	Lithology	Weathering	Hardness	Color	Coverage

GSI			
ID	Surface Condition	Structure	GSI Value

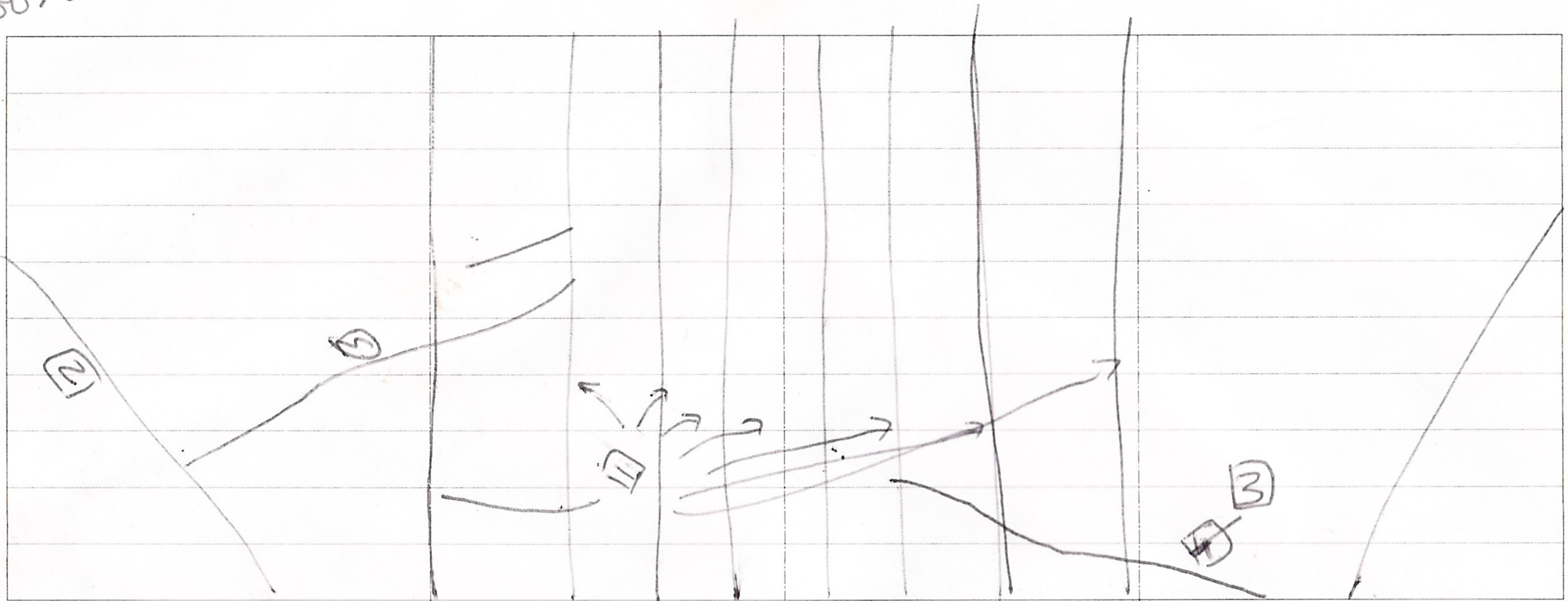
ADDITIONAL SUPPORT

ADDITIONAL COMMENTS

TUNNEL: Inlet GDPUD

Raw Water Conveyance Tunnel

STA. 4186+00



STA. 4186+90

SIDEWALL CROWN SIDEWALL

02/4/K2

DISCONTINUITIES											COMMENTS	GROUNDWATER	
ID	Type	Dip	Strike Dir.	Roughness	Persistance	Aperture	Infill	Spacing	Weathering	Seepage		ID	Flow
1	J	5W	280	R	Ga 30'	Tight	None	1-5'	Slight w.	None			
2	J	45E	025	R	≥30'	Tight	none	5-10'	S.W.	None			
3	J	65W	220	R	<5'	Tight	none	>10'	S.W.	None			

LITHOLOGY					
ID	Lithology	Weathering	Hardness	Color	Coverage

GSI			
ID	Surface Condition	Structure	GSI Value

ADDITIONAL SUPPORT

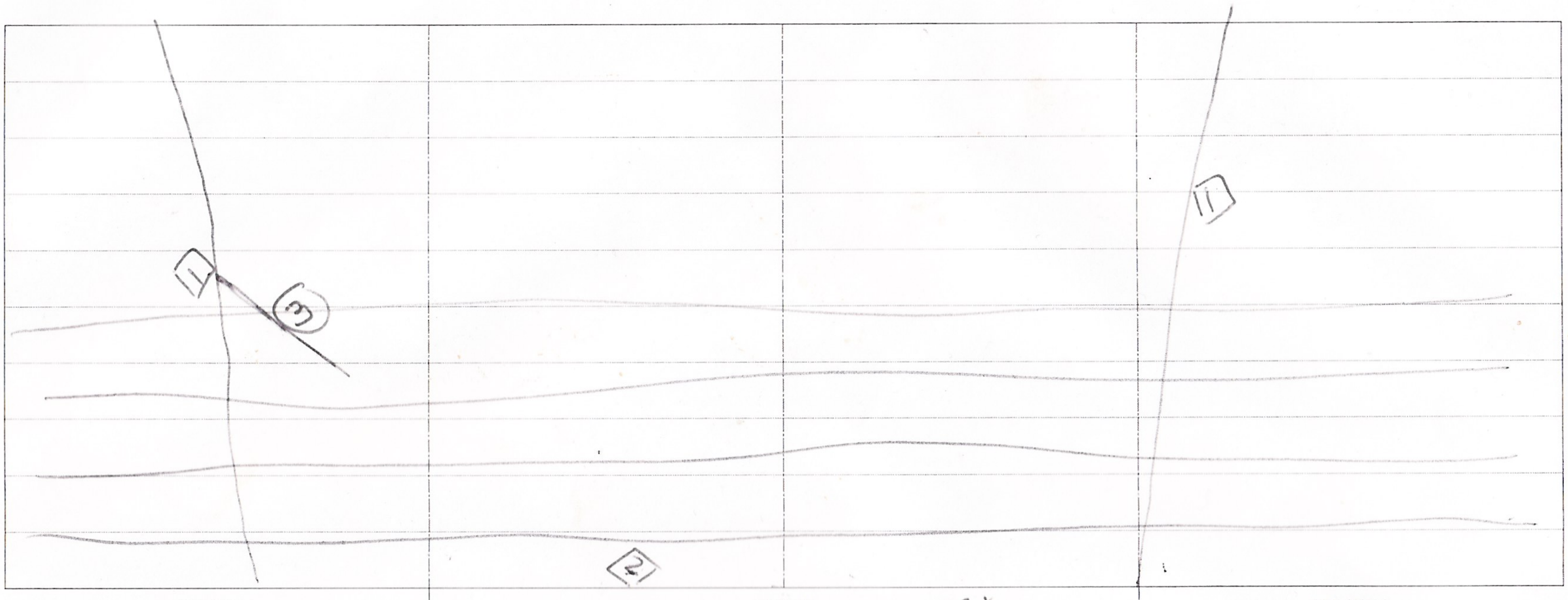
ADDITIONAL COMMENTS

Raw Water Conveyance Tunnel

TUNNEL: GDPUD INLET

STA. 497+40

STA. 497+50



DISCONTINUITIES											COMMENTS	GROUNDWATER	
ID	Type	Dip	Dir.	Roughness	Persistance	Aperture	Infill	Spacing	Weathering	Seepage		ID	Flow
1	Jt	10	300	pl-sm	moderate	tight-slop	∅	7/10	moderate	S/			
2	Jt	75W	135	pl-sm	[illegible]	tight-slop	∅	7/10	slight	S/			
~~3~~	~~Jt~~		~~300~~										
3	Jt	55E	040										

LITHOLOGY					
ID	Lithology	Weathering	Hardness	Color	Coverage

GSI			
ID	Surface Condition	Structure	GSI Value

ADDITIONAL SUPPORT

ADDITIONAL COMMENTS