

**MEMORANDUM**

TO: Perry Park Water and Sanitation District Board of Directors

FROM: TST Infrastructure, LLC

CC: TST Infrastructure, LLC File

SUBJECT: Water and Sewer Service Feasibility Study for a portion of Bannock Drive, Quivas Road, and a portion of Delaware Drive

DATE: October 8, 2020

This study summarizes the potential impacts to Perry Park Water and Sanitation District's (PPWSD's) system by providing water and sanitary sewer service to 41 currently undeveloped, single-family lots on Bannock Drive east of Cheyenne Drive and west of Red Rock Drive.

**I. General:**

The study area consists of 41 single-family lots, with sizes of approximately 1.0 acre. These lots are located in the Perry Park West region on Bannock Drive east of Cheyenne Drive, along Quivas Road, and Delaware Drive southwest of Elati Road. The lots are distributed between Blocks 7 and 12 in Perry Park Filing #5, with eleven lots in Block 7 (Lots 1 through 3 and Lots 28-35), nine lots in Block 8 (Lots 10 through 18), twelve lots in Block 9 (Lots 1 through 12), one lot in Block 10 (Lot 10), four lots in Block 11 (Lot 11 through 14) and four lots in Block 12 (Lots 25-28). The study area also includes two tracts of land belonging to Perry Park Metropolitan District. Currently all lots are undeveloped.

Figure A shows the boundaries of the study area and lot lines of the 41 lots. The study area is located in the current district service boundary and is considered part of the Current Service Area per the District's April 2016 Master Plan. Water service provisions are described in Section II of this Study, and wastewater service provisions are described in Section III. For a vicinity map of the study area, please reference Figure A.

**II. Water:**

**Current Water System in the Vicinity of the Study Area:** (Please reference Figure B.) Per the current PPWSD Master Plan, this area is planned to be split between Perry Park West Region, Pressure Zone 5 and Pressure Zone 3, with the existing nearby water distribution pipes are in Pressure Zone 3. At full buildout, Pressure Zone 5 will be served by the future Pressure Zone 5 water storage tank and associated distribution piping, neither of which are currently constructed. This evaluation focuses on the feasibility of providing water service to the study area by completing water and sewer main extensions as shown in Figure A without first constructing the future Pressure Zone 5 water storage tank and distribution piping.

Water modeling analysis was performed to determine the level of service which can be provided to the lots in the study area using the existing infrastructure of Pressure Zone 3 and extending

Memorandum  
October 8, 2020  
Page 2

the water line to serve the study area. Water service can be provided to the study area by extending an 8-inch diameter waterline piping west from the existing waterline in Bannock Drive to the existing waterline at the intersection of Bannock Drive and Crow Drive. Additional connections to the existing water line would be made at the intersection of Delaware Drive and Elati Road. Dead end waterlines are required at 10-inch diameter.

**Summary of Required Water System Improvements:** All proposed waterlines, appurtenances, water services, and fire hydrants shall be installed in accordance with the Perry Park Water and Sanitation District's Rules and Regulations. The spacing of all proposed fire hydrants, hydrant valves, and main line valves will need to meet current Perry Park Water and Sanitation District's Rules and Regulations. Prior to installation, developers and contractors should submit final sizing of all water services to the District for approval.

In evaluation of the improvements required to provide adequate fire protection and domestic water service to the study area it was determined that an 8-inch diameter waterline extended from the existing waterline in Bannock Drive to the west end of the study area could provide adequate fire protection and water service to the study area. In areas where the water line does not complete a loop, 10-inch diameter water line should be used. For water service to be provided to the study area, it is recommended that the water lines be installed as described in this study.

Per the current PPWSD Master Plan, a pressure reducing valve is planned to be installed at the intersection of Bannock Drive and Crow Drive. This PRV would reduce the water pressure from the future Zone 5 Tank. Although this evaluation does not include the installation of a PRV at this time, it is recommended that measures be taken to reduce the construction and service impact when the PRV is installed.

**1. Water System and Service:** Please reference Figure C. Fire protection and domestic water service could be provided to the study area by completing the following improvements:

- Approximately 4,000 linear feet of 8-inch diameter waterline extending from the existing 10-inch diameter waterline located at Block 8, Lot 10 and extending west on Bannock Drive to the intersection of Crow Drive, north on Quivas Road to Delaware Drive, and from the intersection of Quivas Road and Delaware Drive to the intersection of Delaware Drive and Elati Road.
- Approximately 1,000 linear feet of 10-inch diameter water line extending from the intersection of Bannock Drive and Crow Place south on Crow Place, from the intersection of Crow Drive and Bannock Drive west on Bannock Drive to the western lot line of Block 9, Lot 12, and from the intersection of Quivas Road and Delaware Drive west on Delaware Drive to the western lot line of Block 11, Lot 11.
- 13 fire hydrants installed at approximately 500 feet of spacing within the Bannock Drive, Delaware Drive, and Quivas Road ROW .
- 41 water service stubs.

Memorandum  
October 8, 2020  
Page 3

- Two manholes or vaults for future PRV installation. One at the intersection of Crow Place and Bannock Drive and the other at the intersection of Delaware Drive and Elati Road.
- District policy requires installation of water improvements in roadways when applicable.

**Fire Protection:** One of the primary concerns when considering development within the District is the water system's capabilities of providing fire protection. Adequate fire protection is defined as the capability of the system to furnish 1,000 gallons per minute (gpm) with a minimum residual pressure of 20 pounds per square inch (psi) for a period of two (2) hours at any single location. Per the 2016 Master Plan, the minimum system pressure for domestic water service is 35 psi and design maximum pressure guideline is 150 psi.

To evaluate the adequacy of the water system to provide fire protection to the study area, the current system water model was run assuming complete occupancy of the study area with the 8-inch water main extending from the existing 10-inch water main located at the east end of the study area to Crow Drive, north on Quivas Road to Delaware Drive, and from the intersection of Quivas Road and Delaware Drive to the intersection of Delaware Drive and Elati Road. A 10-inch waterline will need to be installed where the waterline does not complete a loop. It was assumed that each of the residential lots evaluated would be developed for single family residential use.

**Fire Flow Scenario:** A fire flow model run was evaluated at several locations within the study area. The model run assessed the expected available fire flow at each location during system-wide max day demand conditions, while maintaining at least 20 psi residual pressure at all other locations in the distribution system.

Based on the result of modeling this scenario, fire protection can be provided to the study area by installing water system improvements as described above and shown in Figure C. Figure D shows the expected available fire flow during max day demand conditions (worst case scenario) ranges from 1,033 gpm to 1,489 gpm while maintaining 20 psi residual at all other points in the distribution system.

**Domestic Water Service:** To study the domestic water service capabilities of the District's system to the study area, a single peak-hour demand scenario was completed. The current system water model was run with the study area added and assuming complete occupancy of the study area.

**Domestic Water Service Scenario:** A model run was performed with a peak-hour demand applied to the distribution system. The results indicate that the available domestic service pressures within the study area range from 35 to 104 psi. The District's requirements for domestic water service requires that a minimum water pressure of 35 psi to each lot. Based on the result of modeling this scenario, domestic water service can be provided to the study area by installing water system improvements as described above and shown in Figure C. Please reference Figures C-E for the information for the anticipated domestic service pressures.

Memorandum  
October 8, 2020  
Page 4

### **III. Water Availability:**

Note: In the preparation of this study, water demand and supply district-wide are considered, as the West Region consumes more water than can be generated in the West region. Also, the East Region supply and treatment infrastructure is capable of providing water to both the East and West service regions of PPWSD.

**Current Water Demand:** The District defines water demand based on Equivalent Residential Units (EQRs). EQRs are defined based on meter size. The following table shows the number of EQRs represented by each meter size.

Meter Size	Corresponding EQRs
5/8"	1
3/4"	1.5
1"	2.5
1 1/2"	5
2"	8

Referencing the June 2020 Systems Report, prepared by SEMOCOR, Inc., and discussions with District Staff, the District provides water service to a total of 1,497 taps, of which 837 are located in the West region and 660 are located in the East region. Converting taps to EQRs using the table above results in 1,653 EQRs. The difference between the number of taps (1,497) and the number of EQRs (1,653) can be accounted for by the taps in service equating to more than one EQR. Water to the study area would be provided by the West Region Water Treatment and Supply System under normal operating conditions.

**Potential of Immediate Demand:** In addition to the 1,653 EQRs currently served, the District has accepted a number of main line extensions and development projects (completed water infrastructure installation) which could potentially require immediate demand. The District has 251 EQRs which fall into this category. These projects were previously platted lots within the current District service boundary and, because of the current availability of service infrastructure, could add to the immediate demand. Of these 251 additional EQRs, 171 EQRs are located within the West Region.

**Potential Demand, Approved Construction Plans (waiting for construction):** The District has approved construction plans that are the final step for provisions of water service and fire protection. These areas could create demand on the system following completion. A summary of the approved construction plans, their system location, and their potential demand are as follows:

Memorandum  
 October 8, 2020  
 Page 5

Study Area	Type of Lots	No. of EQRs
Country Club	Residential	3 EQRs
Bannock Drive 2018*	Residential	10 EQRs
Poncho Drive*	Residential	14 EQRs
<b>Total</b>	<b>Residential</b>	<b>27 EQR's</b>

*\*Construction plans are being finalized*

**Potential of Approved Feasibility Studies:** There are currently two approved feasibility studies, as shown in the table below.

Study Area	Type of Lots	No. of EQRs	Approved Date
DGKS	Residential	17 EQRs	Mar 20, 2019
7100 Fox Circle	Residential	1 EQR	Feb 21, 2018
<b>Total</b>	<b>Residential</b>	<b>18 EQRs</b>	

**Total Potential Immediate Demands:** The district-wide potential immediate demand - considering areas with approved feasibility studies, areas that the District has already committed service to, and areas with approved construction plans - total 296 EQRs.

**Treated Water Capacity (Treatment Capacity and Treated Water Storage):** As previously mentioned, the District currently provides water service to 1,653 EQRs. This equates to a max-day demand of 926 gpm (1,653 EQRs x 0.56 gpm/EQR).

The District has two water treatment plants (WTPs). The Glen Grove WTP (GGWTP) is located in the District's West Region and the Sageport WTP (SWTP) is located in the District's East Region.

The district-wide water treatment infrastructure (East and West Regions) is capable of providing approximately 1,032 gpm. The East Region's Sageport WTP provides 910 gpm assuming all filters are operating and in service and a well capacity of 812 gpm. The District's West Region's GGWTP provides 220 gpm.

The District has a number of treated water storage tanks. A description of their storage capacities is as follows:

Memorandum  
 October 8, 2020  
 Page 6

Name of Storage Facility	Max Available Storage Vol. 100% Full (gallons)
Hog John Tank No. 1	300,000
Hog John Tank No. 2	150,000
Echo Hills Tank No. 1	500,000
Echo Hills Tank No. 2	333,000
School House Tank	800,000
Sageport WTP Clearwell	100,000
Glen Grove Clearwell	38,000
<b>Total Volume</b>	<b>2,221,000</b>
<b>Required Fire Storage</b>	<b>-240,000</b>
<b>Available Storage for Continuous Max Day Demand Events</b>	<b>1,981,000</b>

When considering available treated water storage, it is important to note that a reserve of water storage equal to 240,000 gallons must be kept for fire protection as indicated in the table above and in the 2016 Master Plan.

During normal operation, WTPs and water storage are utilized to provide water to the District. If the District encounters a problem with one of the WTPs and the treatment capacity is temporarily reduced, the additional treated water is supplied using the District's treated water storage. In order to estimate the water available in storage a conservative factor of safety is applied to the max-day demand to account for unforeseen, short-term shortages in treatment capacity. The District utilizes a factor of safety equal to twenty-five percent (25%) resulting in a treatment capacity equal to 774 gpm (1032 gpm x 75%). In the unforeseen event that the District WTPs are not capable of producing 774 gpm, the difference is subsidized from the District's treated water storage system.

Using the District's max-day demand of 0.56 gpm/EQR, the 41 EQRs proposed in the study area would generate a demand of approximately 23 gpm during a max-day event. These estimates are made by assuming 41 single-family residential lots in the development. The addition of the study area would increase the max-day demand for the District to 949 gpm. This max-day demand can be met by the District using the treatment capacity and the treated water storage.

The following table illustrates the number of days the District could rely on their available treated water storage to supply a district-wide, continuous, max-day demand event. For this analysis, treatment capacity with the safety factor applied was used to determine the amount of water which would need to be subsidized by treated water storage. The District tanks for this scenario were assumed to be full and the days of available storage capacity maintain 240,000 gallons left in reserve for fire protection.

Memorandum  
 October 8, 2020  
 Page 7

	Projected Max-Day Demand	District Wide Treatment Capacity (including safety factor)	Treatment capacity to be subsidized by storage	Available Storage Volume 100% Full Accounting for fire protection	Days of Available Storage from 100% full storages to Cover shortages in treatment capacity during Max-Day Event
	(gpm)	(gpm)	(gpm)	(Gallons)	(Days)
Current Demand	926	774	152	1,981,000	8.76
Current Demand & Study Area	949	774	175	1,981,000	7.86
Current Demand, Study Area, & All Potential Demands	1115	774	341	1,981,000	4.03

As previously stated, the current district-wide treatment capacity is equal to 774 gpm and the current max-day demand is 926 gpm; therefore, the treatment capacity is 152 gpm (774 gpm – 926 gpm) less than the max-day demand. However, as shown in the previous table, when the District's treated water storage is included, the District can meet the max-day demand using the worst-case scenario evaluated (operating at 75% of max capacity) for more than eight days. It should be noted that max-day events occur a limited number of times per year and treated water storage is kept as close to full as possible during load season (typically when max-day events occur).

Based on the analysis, the 41 lots within the study area could be added and the District could meet the associated max-day demands using treatment capacity and treated water storage capacity without the Pressure Zone 5 water storage tank. In the event that all of the lots that could add immediate demands and the study area are developed in the near future, the District can meet the associated max-day demands using treatment capacity and treated water storage capacity.

#### **IV. Sanitary Sewer:**

**Current Sewer System in the Vicinity of the Study Area:** The proposed development is located in Perry Park West and is served by the West Sewer Collection and Waucondah Wastewater Treatment Plant (WWTP). The nearest existing sanitary sewer lines to the study area are located east of the study area in Bannock Drive. The configuration of the existing sewer collection system is shown in Figure F. All required sanitary sewer lines, sanitary sewer manholes, sanitary sewer services, and appurtenances will need to meet current Perry Park Water and Sanitation District's Standards and Specifications.

Memorandum  
October 8, 2020  
Page 8

**Evaluation of Sewer Service:** In order to evaluate existing surface elevations in the study area, the existing sewer main elevations were estimated. Surface elevations were estimated through the use of LiDAR data by Douglas County. Existing sewer main elevations and manhole invert elevations were determined from the District's as-built drawings.

**Summary of Required Sewer System Improvements:** Please reference Figures G and H. In order to provide sewer service to the study area, the following minimum sewer system improvements are required. All proposed sewer services, sewer lines, and appurtenances shall be installed in accordance with PPWSD's Rules and Regulations and Standards and Specifications.

**1. Sanitary Sewer System and Service:** Sewer service to the study area could be provided by completing the following improvements:

- Approximately 5,000 linear feet of 8-inch diameter sewer line installed in Bannock Drive, Quivas Road, and Delaware Drive Right-of-Way. Note that there is a portion of the sewer main in Bannock Drive that requires deep sewer (27 to 42 feet deep) to eliminate a lift station. The final depth will depend on the final road design. Figure H shows Bannock Drive at a 6% maximum road slope which would result an approximately 27 feet deep sewer. If Douglas County allows a steeper road slope, deeper sewer in this area will be required and special considerations may be required.
- 24 sanitary sewer manholes.
- Sewer service stubs and associated cleanouts constructed to serve each of the 41 single-family lots in the study area installed in conformance with the PPWSD Standards and Specifications.
- In the event that a sewer service would require a grinder pump, the installation and maintenance of the grinder pump and service line forcemain will be the responsibility of the builder and subsequent homeowner.

**V. Wastewater Treatment Capacity:**

**Current Demand:** Referencing the June 2020 Systems Report, prepared by SEMOCOR, Inc, the District provides wastewater collection and treatment services to 806 taps in the West Region. The Wauconda WWTP and Collection System serves the PPWSD West Region and would be utilized to collect, transport, and treat wastewater from the study area.

**Potential of Immediate Demand:** The District has accepted a number of main line extensions and development projects (completed sewer service infrastructure installation) which could potentially add near-term demand. The District has 246 taps which fall into this category. This figure is a district-wide number, with approximately 171 of these lots attributed to the West Region. These projects were previously platted lots within the current service boundary, and, because of the current availability of service infrastructure, could potentially add immediate demand.

Memorandum  
 October 8, 2020  
 Page 9

**Potential Demand, Approved Construction Plans (waiting for construction):** In addition to the 806 sewer taps currently served and the 171 lots which could require service in the immediate future, the District has accepted a construction plan which would increase the demand. This approved construction plan is the final step towards installation of wastewater collection infrastructure. This area could create near-term demand on the system following construction. A summary of the approved construction plans and potential wastewater treatment demands to the Wauconda WWTP and West Collection System are as follows:

Study Area	Type of Lots	No. of EQRs
Country Club (west)	Residential	3 EQRs
Bannock Drive 2018*	Residential	10 EQRs
<b>Total</b>	<b>Residential</b>	<b>13 EQRs</b>

\*Construction plans are being finalized

**Potential of Approved Feasibility Studies:** Currently, there are two approved feasibility studies within the West Collection System area, as shown in the table below.

Study Area	Type of Lots	No. of EQRs	Approved Date
DGKS	Residential	16 EQRs	Mar 20, 2019
7100 Fox Circle	Residential	1 EQR	Feb 21, 2018
<b>Total</b>	<b>Residential</b>	<b>17 EQRs</b>	

**Total Potential Immediate Demands:** The number of sewer taps (EQRs) which could add immediate demand to the system is 201. This is calculated from the number of lots in the West Collection System area that the District has committed service to (171), has approved feasibility studies for (17), or has approved construction plans for (13). The number of EQRs which the District is presently serving (806) plus the number of potential immediate EQRs (201) equals 1,007 EQRs.

**Treatment Capacity:** As previously mentioned, the District currently provides wastewater treatment services to 806 EQRs. The Waucondah WWTP has a permitted capacity of 320,000 gpd. The June 2019 through June 2020 Systems Reports indicated the maximum month average daily flow to the plant was 185,000 gpd in April 2020. Per the maximum month average daily flow, the Waucondah WWTP is at 57.8% of permitted capacity. The remaining 42.2% capacity equals approximately 135,000 gpd.

Using the maximum month average daily flow rate for April 2020 of 185,000 gpd, the average daily flow rate per tap equals approximately 231 gpd per tap (185,000 gpd / 803 taps). The estimated wastewater treatment demand generated by the improvements associated with the study area equals 9,471 gallons per day (gpd) for the 41 lots in the study area. The EQRs associated with the study area improvements would consume 7.02% (9,471 gpd / 135,000 gpd) of the remaining treatment reserve. In the event that all of the lots which could add immediate

Memorandum  
October 8, 2020  
Page 10

demand in the study area are developed in the near future, the treatment capacity would be equal to 61% of permitted capacity, with 39% of treatment capacity available for the future.

Incorporating the total potential immediate demands into the WWTP, there is a total of 242 additional EQRs (201 EQRs from total potential immediate demand + 41 EQRs from the study area). Utilizing the approximately 231 gpd per tap, the demand generated by all immediate demands is 55,902 gpd (231 gpd/tap x 242 EQRs). The EQRs associated with total potential immediate demand plus the study area improvements would consume 41.4% (55,902 gpd/135,000gpd) of the remaining treatment reserve. In the event that all of the lots which could add immediate demand in the study area and potential immediate demand are developed in the near future, the treatment capacity would be equal to 75% of permitted capacity with 25% of the treatment capacity available for the future.

While the potential immediate demands and the study area have shown they could be constructed and still meet permit limits, the District is currently completing a thorough evaluation of all processes at the Wauconda WWTP to confirm the actual capacity of each process meets the permitted capacity. There is potential that the study would show that improvements are required to the Wauconda WWTP to allow additional demands. Based on the results of the permitted treatment capacity, the District can provide treatment services to the study area including all potential immediate demands included, but some processes within the Wauconda WWTP may require upgrades to accommodate the study area.

**Lift Station Capacity:** All wastewater from the study area could flow to the Red Rock Lift Station. Red Rock Lift Station serves approximately 342 lots. The permitted hydraulic capacity for Red Rock Lift Station is 0.25 MGD with a max day of 0.40 MGD. The June and July Lift Station Log Sheets indicated an average daily flow of 21,000 gpd or 0.021 MGD. On average the lift station services 8.4% of its permitted capacity. The remaining 91.6% capacity equals approximately 0.229 MGD. The max daily flow from the lift station was approximately 41,000 gallons. On max day events, the lift station operates at 10.3% of its permitted capacity.

The estimated wastewater flow increase generated by the improvements associated with this study equals approximately 9,471 gpd. The EQRs associated with the study area improvements would consume 4.1% of the remaining hydraulic design capacity.

**Sanitary Sewer Collection System:** As part of the evaluation for the proposed improvements, sewer line capacities were verified to confirm adequate capacity for the additional flow from the study area. Currently, the West Collection System provides services to 806 taps (per the June 2020 Systems Report). With the additional 41 lots being evaluated for sewer service, the West Collection System will provide services to 847 taps (806 existing taps + 41 new taps). The capacity of the last segment of sewer pipe prior to entering the Wauconda WWTP, between manhole A-2 and A-1, was of greatest concern. At peak flow the sewer line segment of most concern is at 64% of full flow capacity; therefore, no sewer lines approach full flow capacity with the additional flow from the study area. With existing demand, the potential immediate demand and the study area, there are a total of 1,048 EQRs. At peak flow the sewer line segment of the most concern is at 80% of full flow capacity. In the event that all of the lots which could add immediate demands

Memorandum  
October 8, 2020  
Page 11

and the study area are developed in the near future, no sewer lines approach full flow capacity even with the additional flow from the study area and all potential immediate demands included.

Based on the results of the collection system capacity evaluation, the District can provide wastewater collection services to the study area including all potential immediate demands included.

## **VI. Conclusion:**

After reviewing the current system including the study area, the following summarizes the recommended improvements to the District infrastructure to provide water and sewer service to the study area:

### **1. Fire Protection and Domestic Water Service:**

- Approximately 4,000 linear feet of 8-inch diameter waterline extending from the existing 10-inch diameter waterline located at Block 8, Lot 10 and extending west on Bannock Drive to the intersection of Crow Drive, north on Quivas Road to Delaware Drive, and from the intersection of Quivas Road and Delaware Drive to the intersection of Delaware Drive and Elati Road.
- Approximately 1,000 linear feet of 10-inch diameter water line extending from the intersection of Bannock Drive and Crow Place south on Crow Place, from the intersection of Crow Drive and Bannock Drive west on Bannock Drive to the western lot line of Block 9, Lot 12, and from the intersection of Quivas Road and Delaware Drive west on Delaware Drive to the western lot line of Block 11, Lot 11.
- 13 fire hydrants installed at approximately 500 feet of spacing within the Bannock Drive, Delaware Drive, and Quivas Road ROW .
- 41 water service stubs.
- Two manholes or vaults for future PRV installation. One at the intersection of Crow Place and Bannock Drive and the other at the intersection of Delaware Drive and Elati Road.
- District policy requires installation of water improvements in roadways when applicable.

### **2. Treated Water Capacity:**

- The District currently uses treatment capacity and treated water storage to meet the max-day demands. With the construction of the 41 lots in the study area, the District max-day demand is estimated to increase by 23 gpm and can be met by the District. As shown in this feasibility study the District has adequate treated water storage, while still providing fire protection, to subsidize the treatment capacity during a max-day event for the current water services and the addition of the study area.

### **3. Sewer System and Service:**

- Approximately 5,000 linear feet of 8-inch diameter sewer line installed in Bannock Drive, Quivas Road, and Delaware Drive Right-of-Way. Note that there is a portion

Memorandum  
October 8, 2020  
Page 12

of the sewer main in Bannock Drive that requires deep sewer (27 to 42 feet deep) to eliminate a lift station. The final depth will depend on the final road design. Figure H shows Bannock Drive at a 6% maximum road slope which would result an approximately 27 feet deep sewer. If Douglas County allows a steeper road slope, deeper sewer in this area will be required and special considerations may be required.

- 24 sanitary sewer manholes.
- Sewer service stubs and associated cleanouts constructed to serve each of the 41 single-family lots in the study area installed in conformance with the PPWSD Standards and Specifications.
- In the event that a sewer service would require a grinder pump, the installation and maintenance of the grinder pump and service line forcemain will be the responsibility of the builder and subsequent homeowner.

**4. Sewer Treatment:**

- Based on the information and analysis presented, the District has adequate permitted capacity at the Wauconda WWTP to treat the additional wastewater from the improvements associated with the study area. The District is undertaking a study of the Wauconda WWTP that may show that upgrades are required to meet the permitted capacity. Additionally, the existing sewer collection system was determined to have adequate capacity to serve the lots from the study area.

**5. Red Rock Lift Station Capacity**

- Based on the information and analysis presented in this study, the District has adequate capacity at the Red Rock Lift Station to pump the additional wastewater due to the improvements within the study area

Based on the analysis performed in this study, and assuming that items 1 – 5 listed above are included, it is recommended that the study area as described for fire protection, domestic water service, and sewer service be accepted. The approved study area improvements must meet the District's requirements for installation of sewer and water infrastructure.

Other items to note, it is the responsibility of the applicant to satisfy the County's requirements for road improvements to the study area.

This Feasibility Study will expire two years from the date of acceptance by the Perry Park Water and Sanitation District Board.

Sincerely,  
TST Infrastructure, LLC



Michael Gerstner, P.E.  
Principal

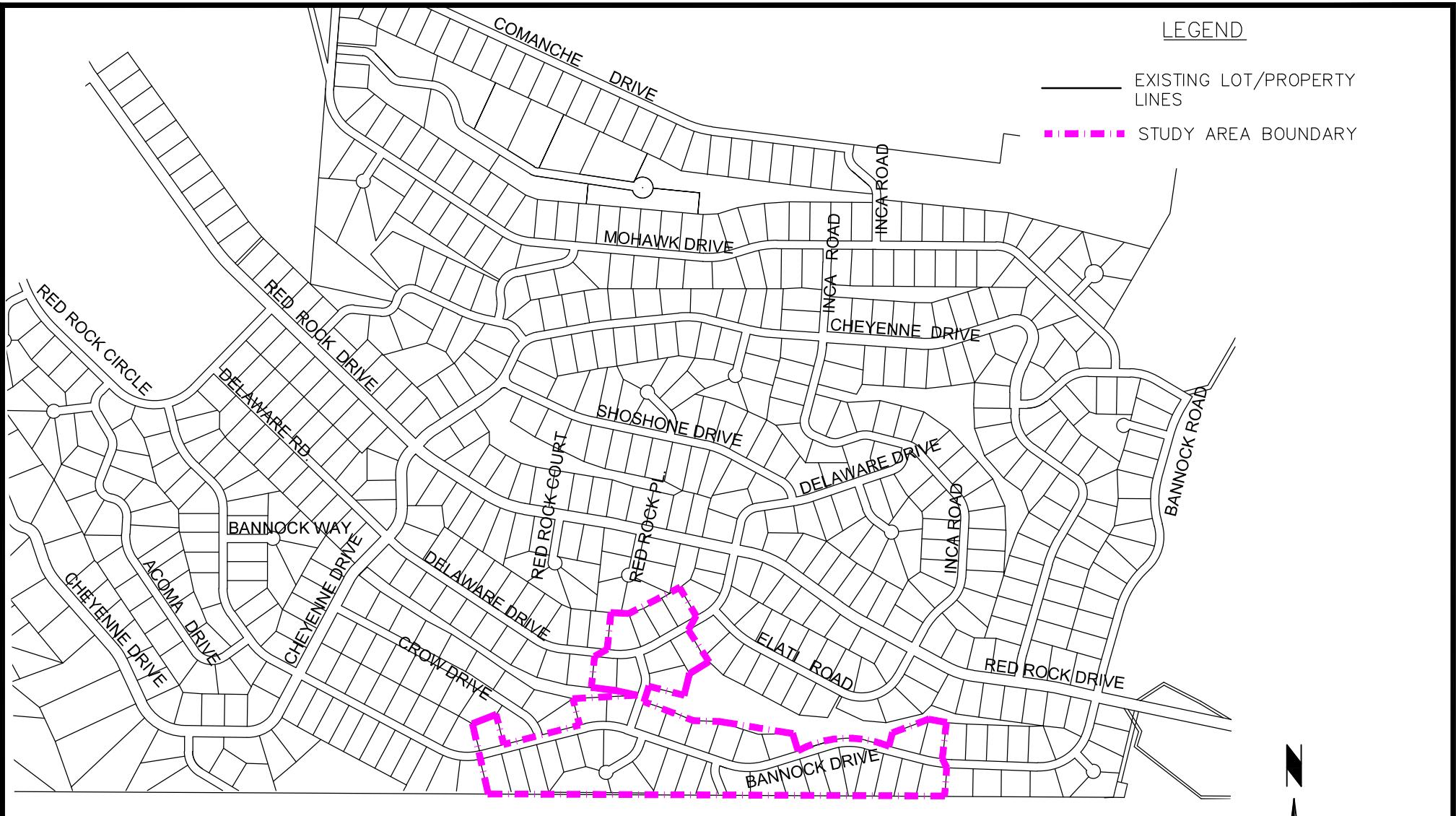


FIGURE A - VICINITY MAP OF STUDY AREA - PERRY PARK WEST

1" = 1000'



PERRY PARK WATER AND SANITATION DISTRICT

BANNOCK DRIVE FEASIBILITY STUDY

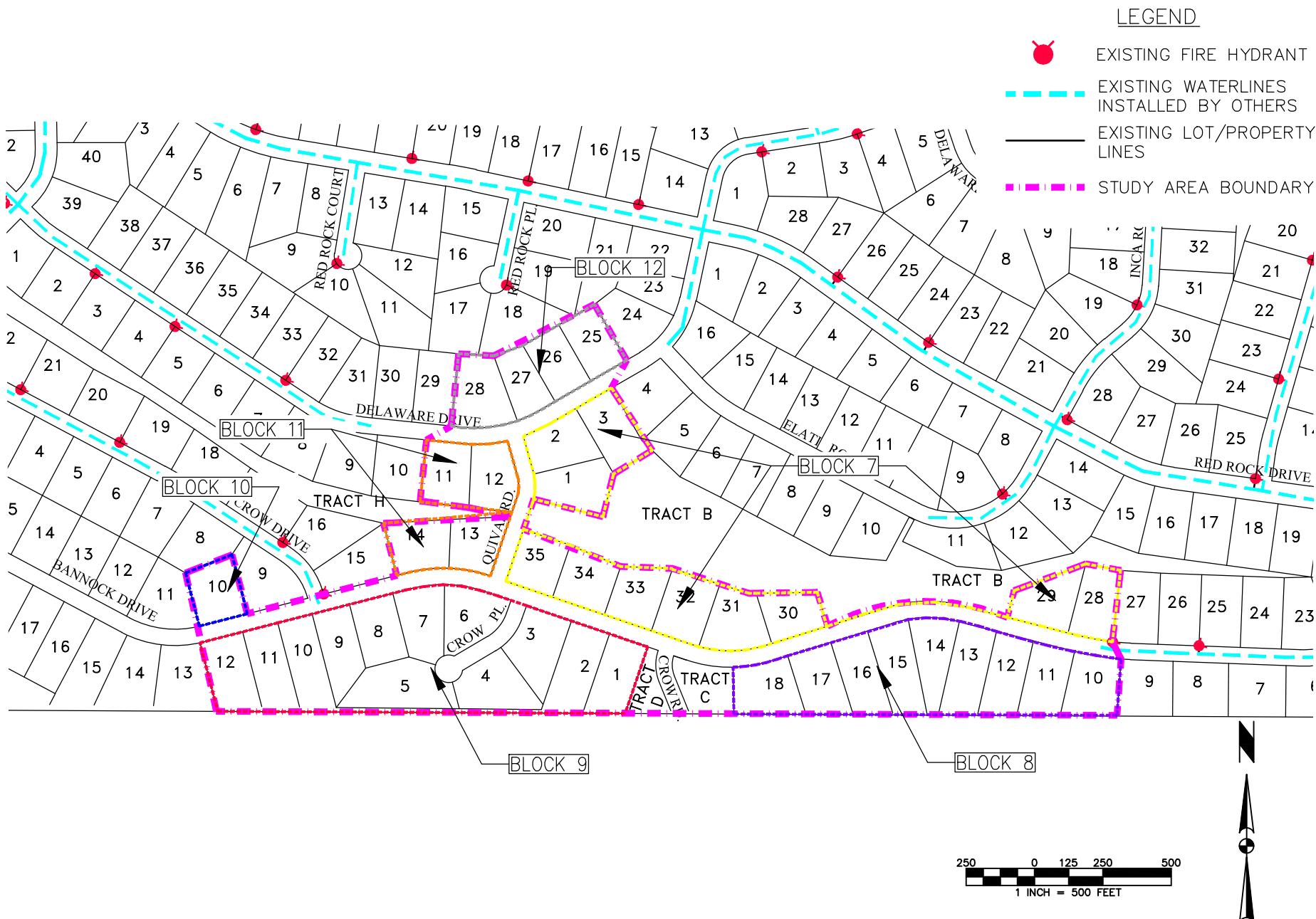
TST INFRASTRUCTURE, LLC

#### FIGURE A - VICINITY MAP OF STUDY AREA

**FIGURE A - VICINITY MAP OF STUDY AREA**

JOB NO.

DATE



**FIGURE B- EXISTING WATER SYSTEM**

1" = 500'

PERRY PARK WATER AND SANITATION DISTRICT

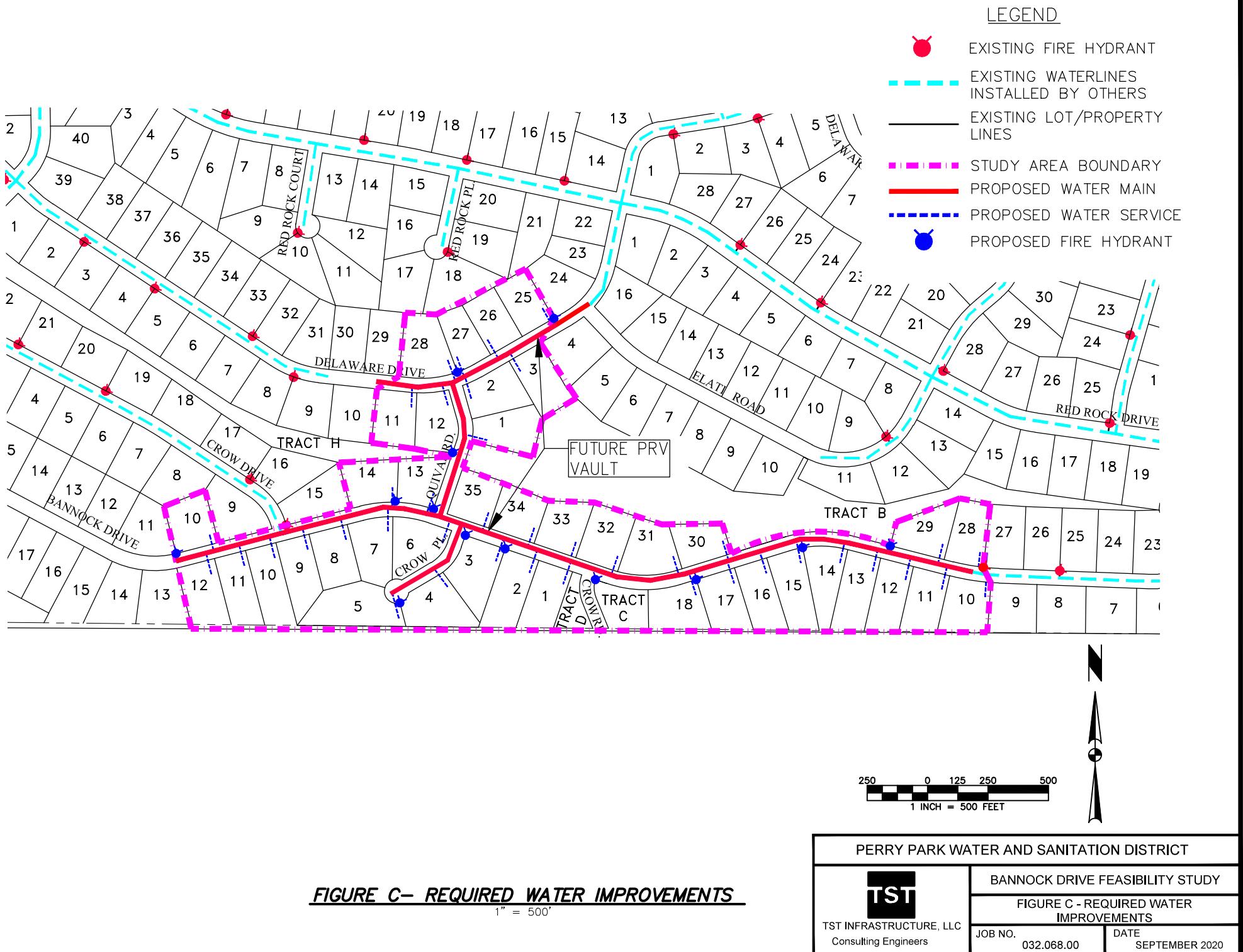


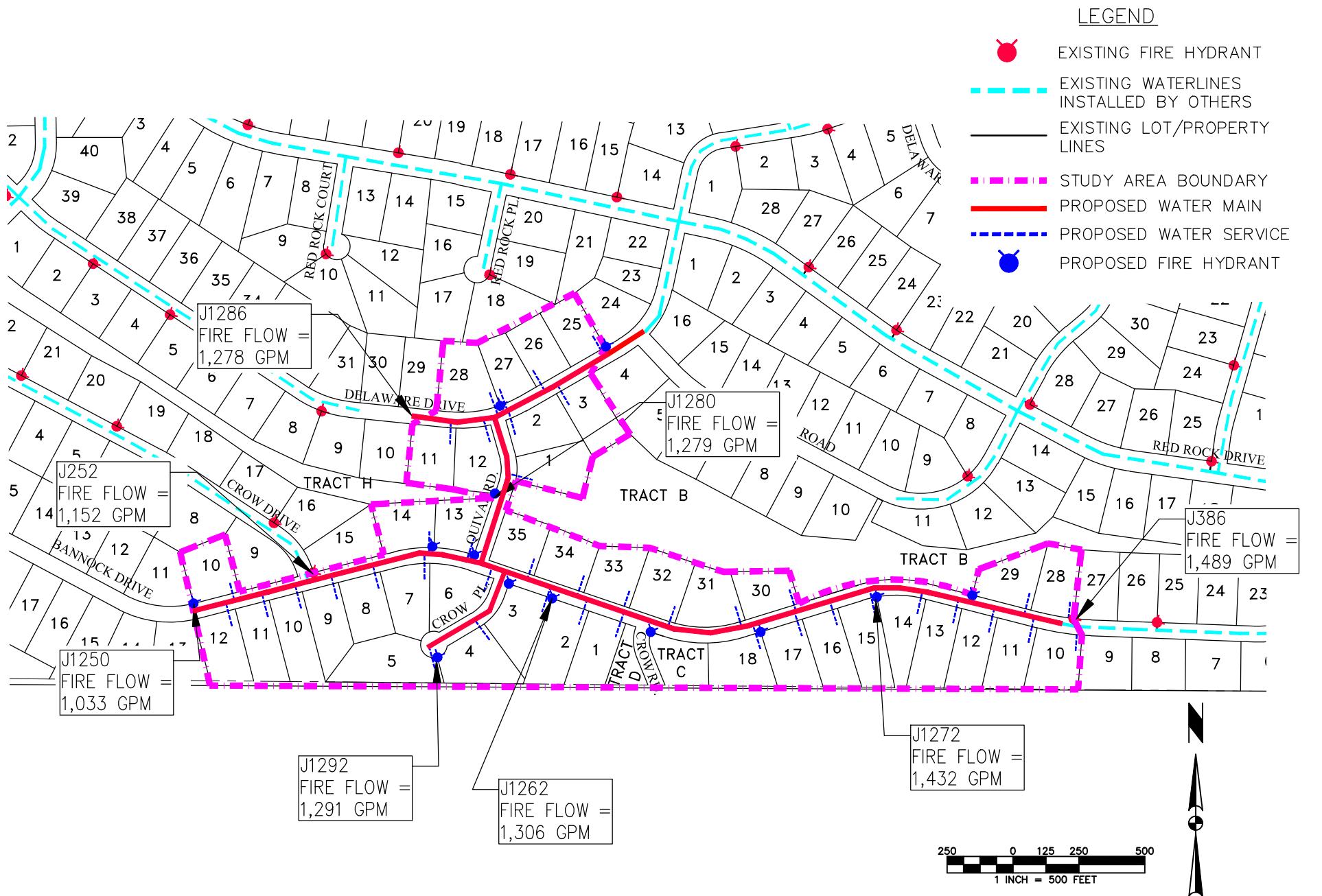
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BANNOCK DRIVE FEASIBILITY STUDY

FIGURE B - EXISTING WATER SYSTEM

JOB NO. 032.068.00 DATE SEPTEMBER 2020





**FIGURE D - FIRE FLOW AT MAX DAY DEMAND AND AT LEAST 20 PSI RESIDUAL PRESSURE**

1" = 500'

PERRY PARK WATER AND SANITATION DISTRICT

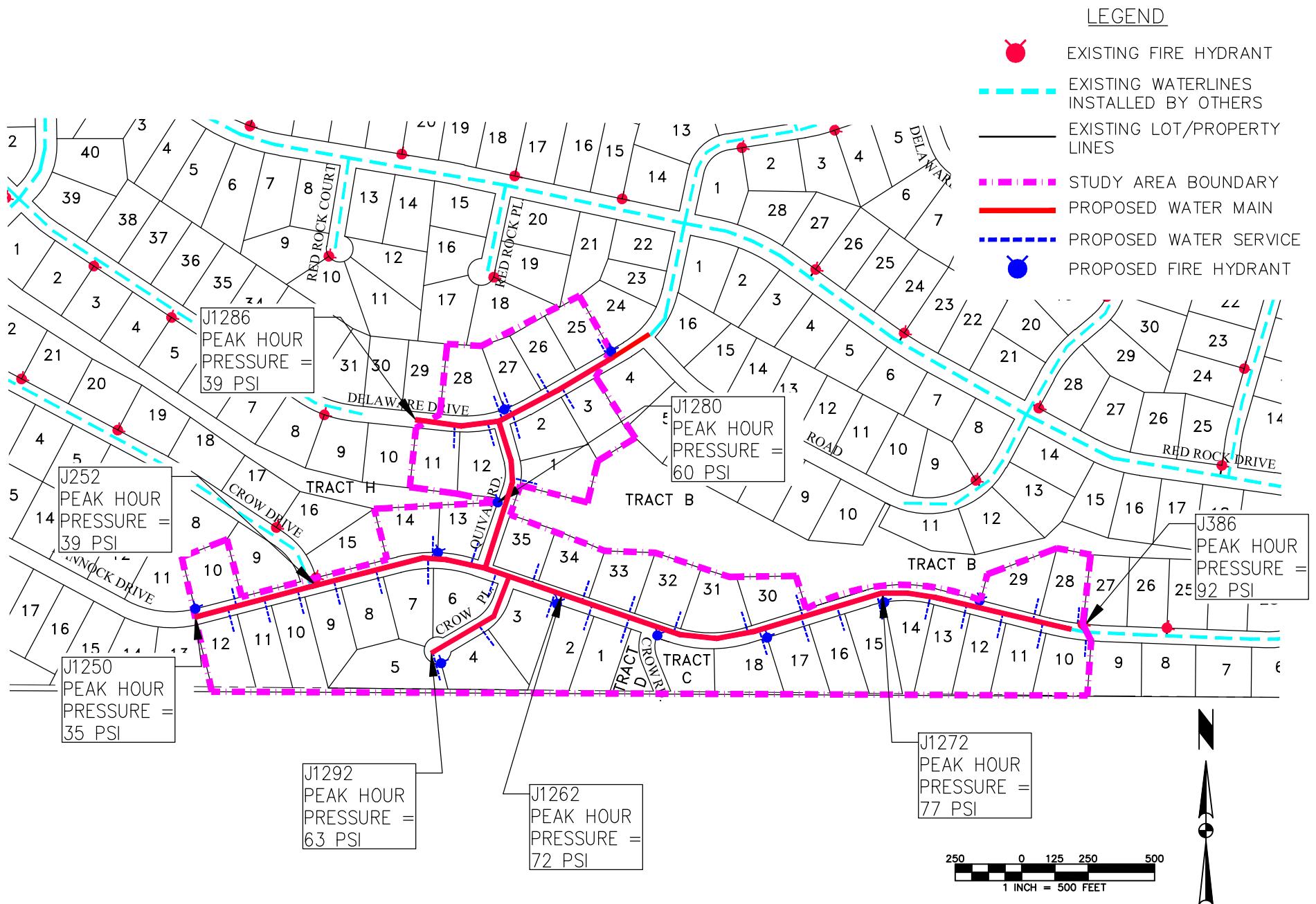


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BANNOCK DRIVE FEASIBILITY STUDY

FIGURE D - FIRE FLOW AT MAX DAY DEMAND & AT LEAST 20 PSI RESIDUAL PRESSURE

JOB NO. 032.068.00 DATE SEPTEMBER 2020



**FIGURE E - SERVICE PRESSURES AT PEAK HOUR DEMAND**

1" = 500'

PERRY PARK WATER AND SANITATION DISTRICT

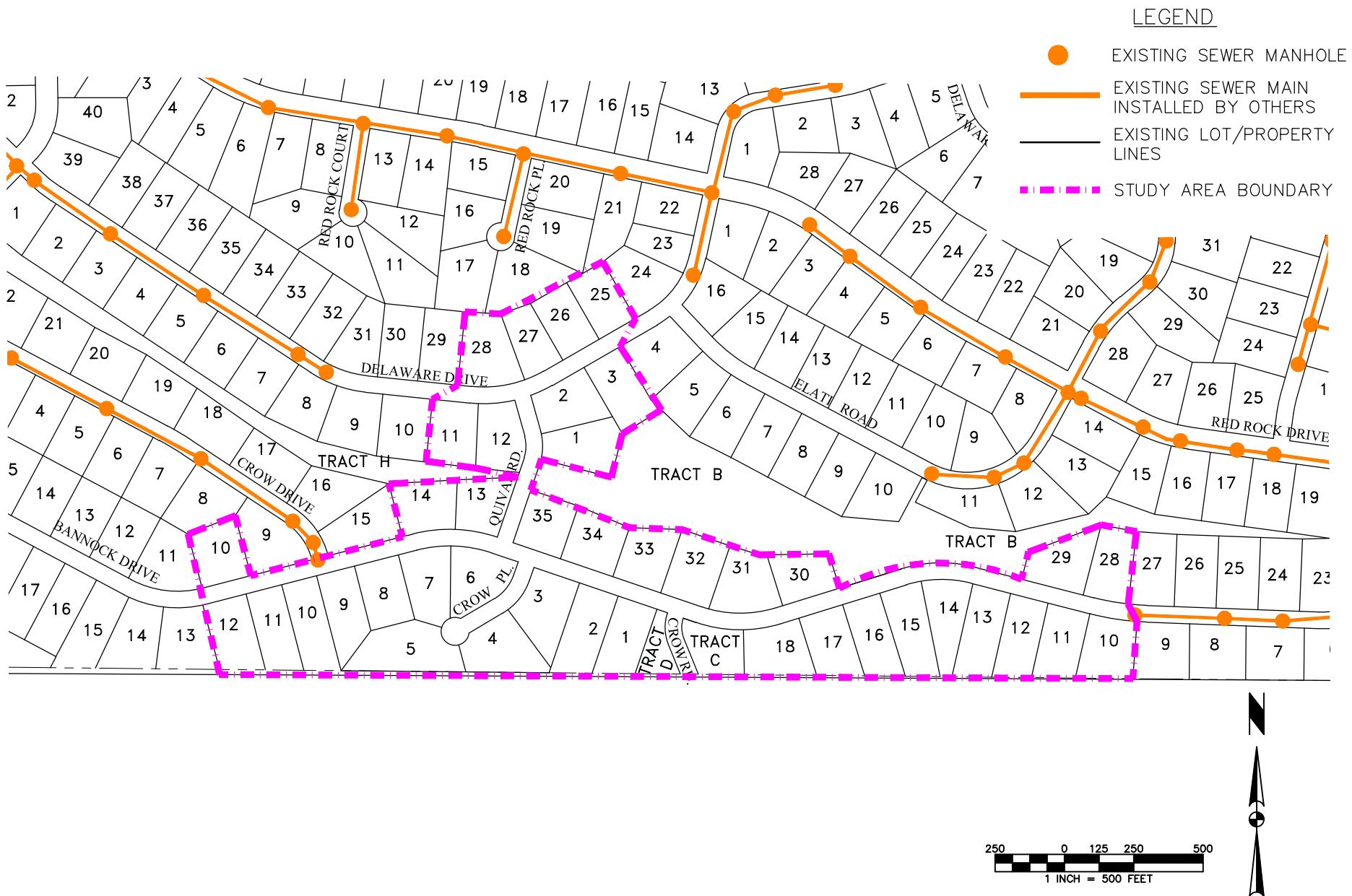


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BANNOC DRIVE FEASIBILITY STUDY

FIGURE E - SERVICE PRESSURES AT  
PEAK HOUR DEMANDS

JOB NO. 032.068.00 DATE SEPTEMBER 2020



**FIGURE F- EXISTING SEWER SYSTEM**

1" = 500'

PERRY PARK WATER AND SANITATION DISTRICT

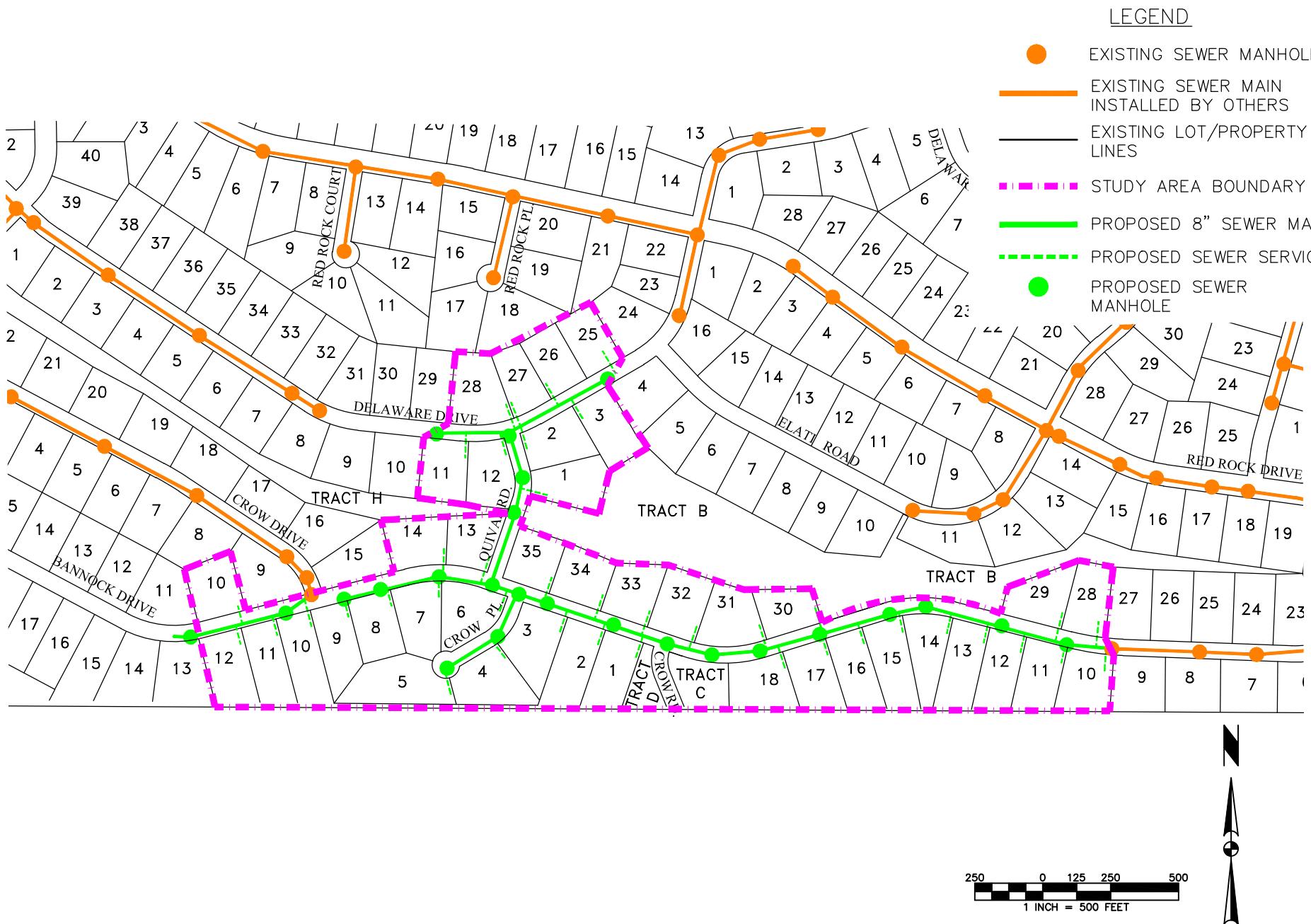


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Consulting Engineers

BANNOCK DRIVE FEASIBILITY STUDY

FIGURE F - EXISTING SEWER SYSTEM

JOB NO. 032.068.00 DATE SEPTEMBER 2020



**FIGURE G – REQUIRED SEWER IMPROVEMENTS**

PERRY PARK WATER AND SANITATION DISTRICT

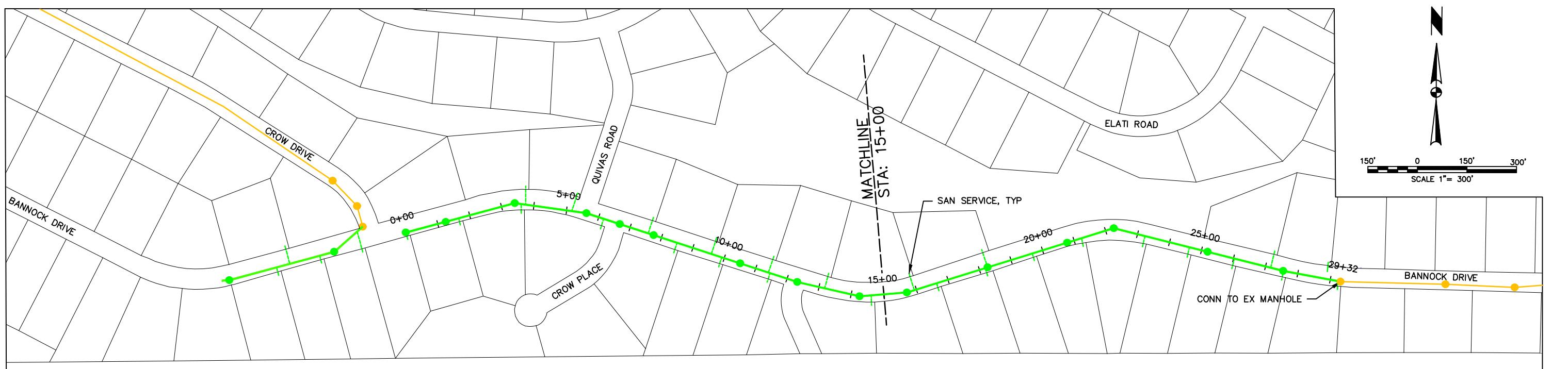


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Consulting Engineers

BANNOCK DRIVE FEASIBILITY STUDY

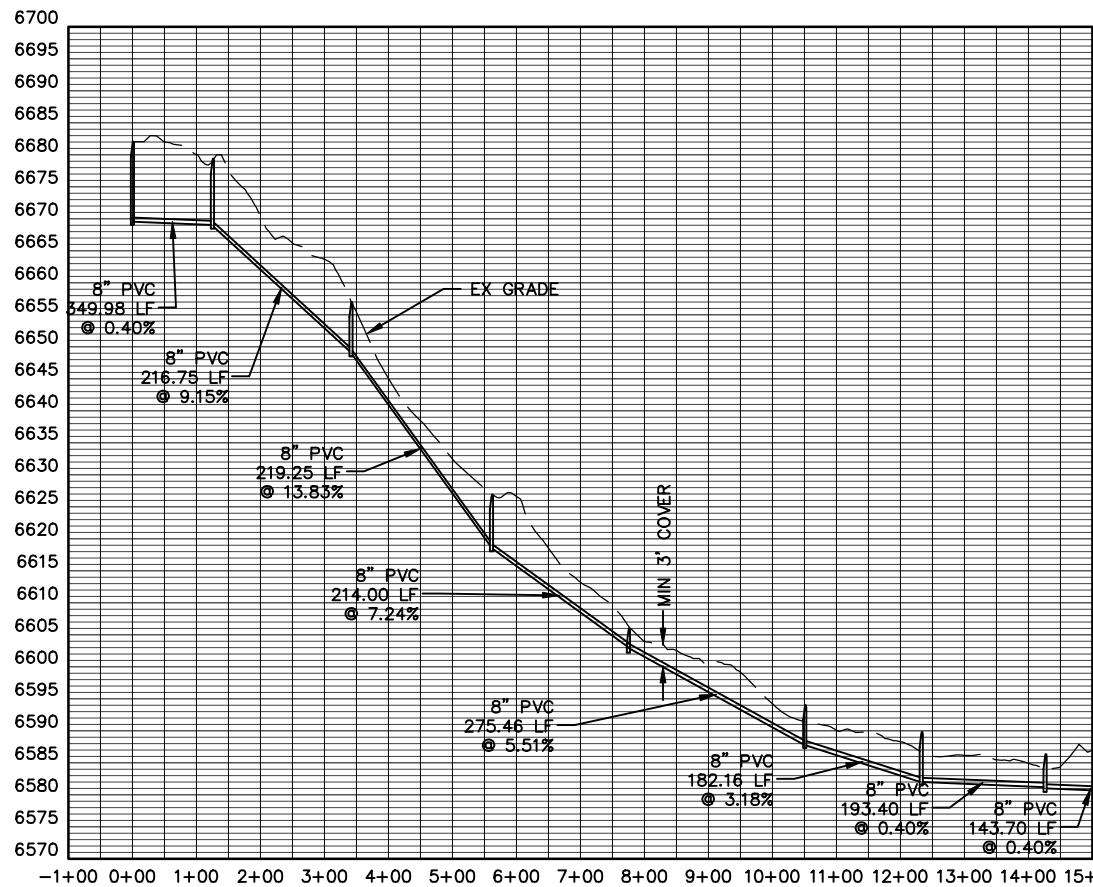
FIGURE G - REQUIRED SEWER IMPROVEMENTS

JOB NO. 032.068.00 DATE SEPTEMBER 2020



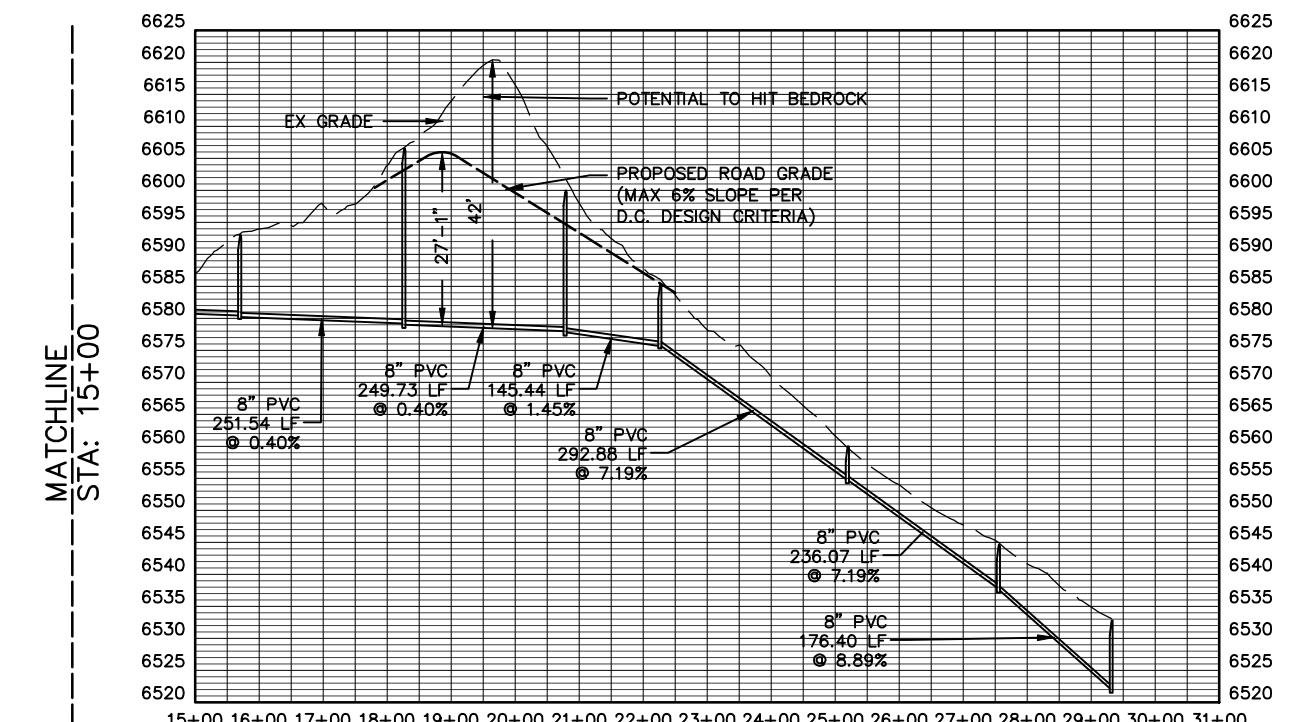
BANNOCK DRIVE SEWER PLAN VIEW

SCALE: 1"=300'



BANNOCK DRIVE SEWER PROFILE

STA 0+00 TO STA 19+00  
HORIZONTAL SCALE: 1"=300'  
VERTICAL SCALE: 1"=10'



BANNOCK DRIVE SEWER PROFILE

STA 19+00 TO STA 36+56  
HORIZONTAL SCALE: 1"=300'  
VERTICAL SCALE: 1"=10'

NOTES:

1. PROFILES WERE DEVELOPED FROM DATA PROVIDED BY DOUGLAS COUNTY AND ARE NOT BASED ON ACTUAL SURVEY
2. ESTIMATED DESIGN FOR ROADWAY MAY NOT REFLECT ACTUAL FUTURE DESIGN OF ROADWAY
3. THE CONNECTION ELEVATION TO EXISTING SEWER WAS DETERMINED FROM INFORMATION PROVIDED BY OTHERS AND MAY NOT ACCURATELY REFLECT THE ACTUAL ELEVATION

CONCEPTUAL

PERRY PARK WATER AND SANITATION DISTRICT



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BANNOCK FEASIBILITY SEWER PROFILE

EXHIBIT H - SEWER FEASIBILITY

JOB NO. 032.068.00 DATE SEPTEMBER 2020