Groundwater Reinjection System
Combined Sewer Flow Diversion

Amtrak Lancaster Station, Lancaster, Pennsylvania

November 1-2, 2016

Presented by:

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Craig Caldwell - National Railroad Passenger Corporation (Amtrak)

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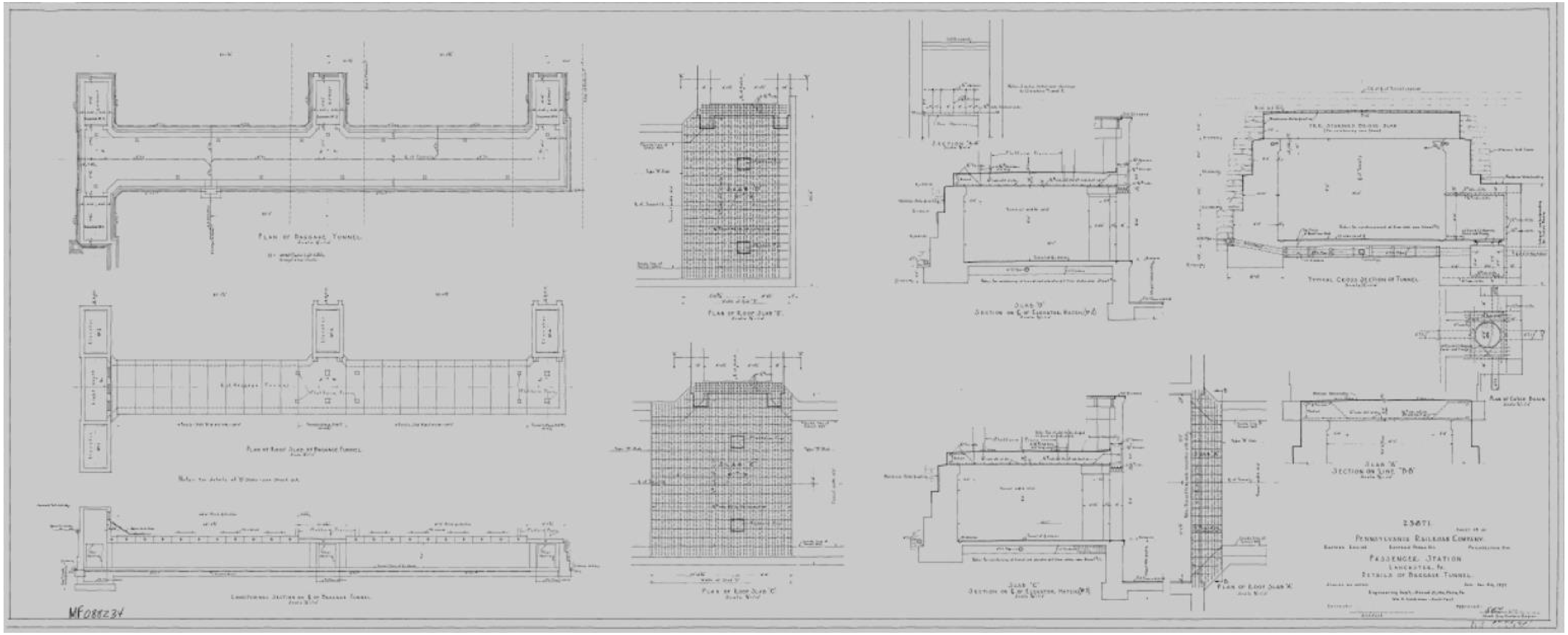
Tunnel Foundation Drain Details

- Station constructed in 1929 with four Elevators & Tunnel for mail and baggage handling
- Tunnel Floor is 20' below tracks
- Foundation drains divert groundwater to LCSA via Catch basin and 8" Combined Sewer



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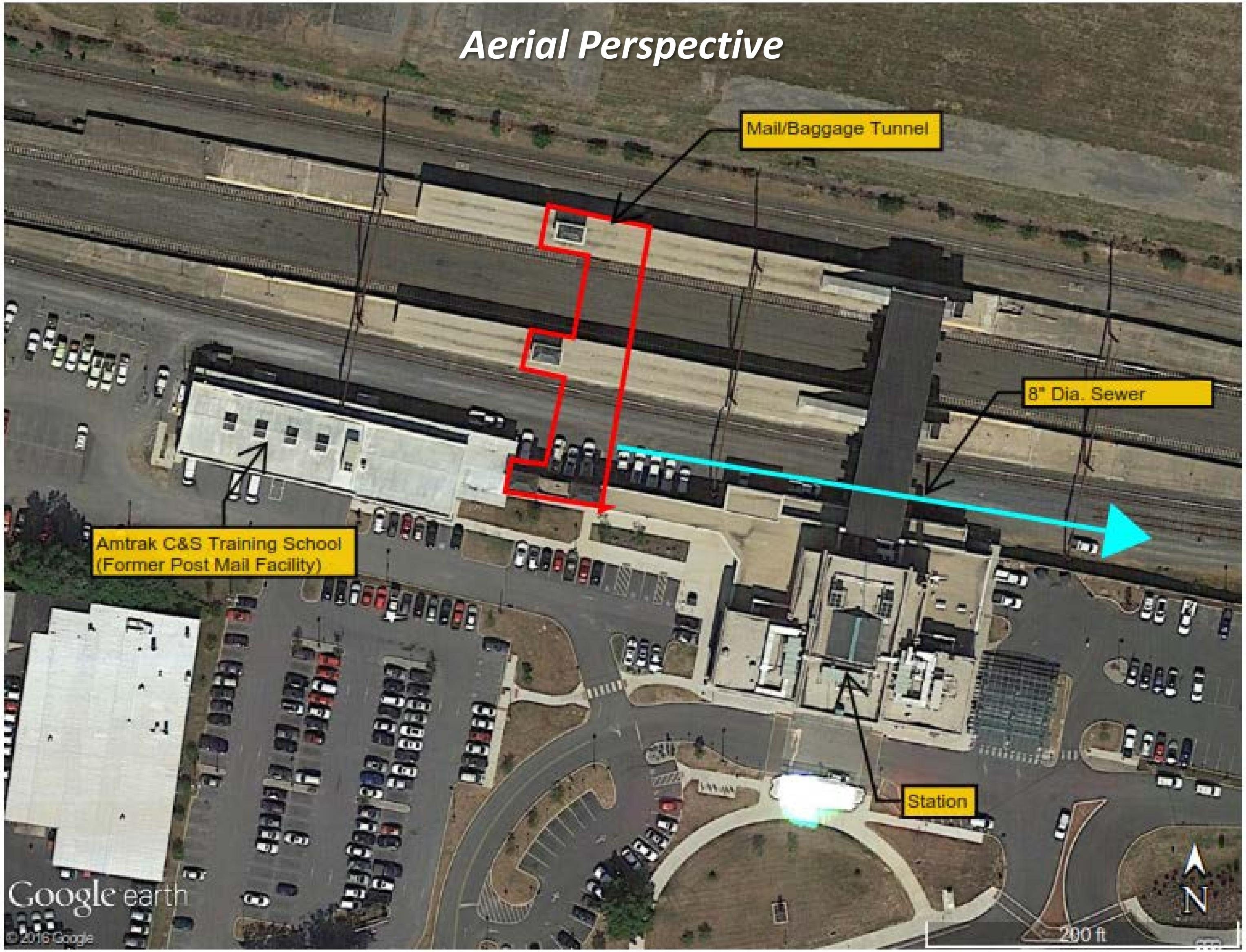

Groundwater Reinjection System Design
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Project Drivers

- Lancaster's CSO were overflowing due to capacity limits and polluting the Conestoga River.
- The Lancaster City Sewer Authority (LCSA) complied with USEPA by developing a Long-Term Control Plan to reduce untreated sewage from discharging to the river. The LTCP includes enforcement actions if the City does not meet certain milestones for reduction of CSOs.
- Lancaster has moved away from additional storage capacity and towards green infrastructure to reduce stormwater into the CSO.
- LCSA imposed Stormwater Fee in 2014 ($30.98/1,000 sf impervious).
- LCSA also needed to identify and eliminate clean groundwater discharges into the CSO.
- LCSA goal to remove 750 MGY of clean groundwater discharges from the CSO.
- LCSA looking at ways to impose fees for clean groundwater discharges.
- LCSA approached Amtrak to identify options to eliminate the groundwater discharge from the tunnel.
- **Amtrak estimated potential usage fees of $67,000 annually**
- Amtrak budget $219,000 over past 3 years for study/design/construction
- **Return on Investment 3.5 Years**

Groundwater Reinjection System - Access Issues
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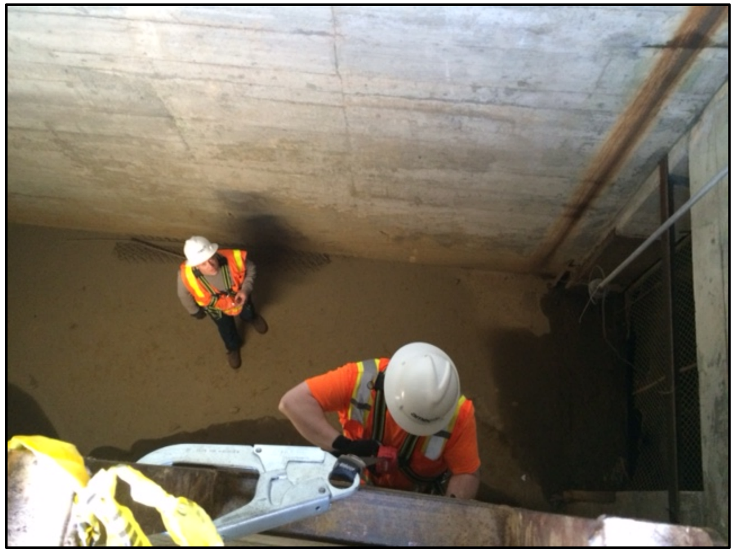
Safe Tunnel Entry

- Considered Non-Permit Confined Space
  - Only means of access through window down ladder
  - Elevators no longer in operation
  - Approx. 20 foot drop
- Requires use of harness, fall restraint, and retrieval system
- City of Lancaster Fire Department called and on standby



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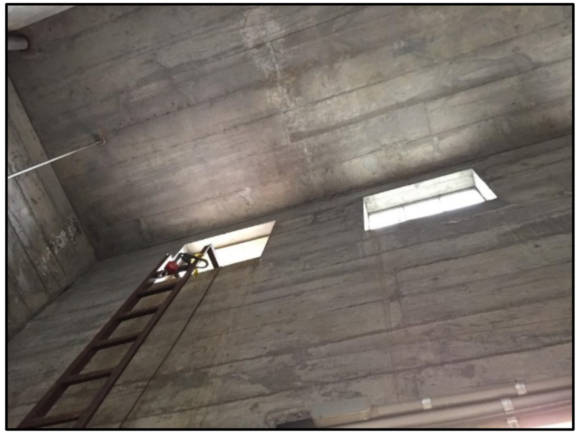
Preliminary Study

- Purpose was to evaluate the tunnel conditions and evaluate up to 5 Conceptual Alternatives
- Pre-design Investigation, Flow was speculated to be about 1-Million Gallons per year (<2-GPM)





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Preliminary Investigation Results

- The tunnel is no longer in use, sump pumps in the elevator shafts taken out of service in 1980.
- Continuous flow of clear water into catch basin and out to sewer.
- Horizontal stains on tunnel walls up 8' indicating past flood level.
- During significant rain events the tunnel would flood with backflow from the Combined Sewer.
  - Muddy, silty water
  - No apparent raw sewerage
  - Floor covered in 1"-2" layer of silt/mud
- Visible cracks in wall with some evidence of water intrusion through walls.

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Preliminary Investigation

- Five Conceptual Groundwater Management Alternatives Were Identified:
  - Perforate The Tunnel Floor
  - Discharge to Surface Water
  - Groundwater Reuse
  - Evaporative Elimination
  - Class V Injection Well

- Additional Recommendations
  - Assess water quality
  - Conduct Expanded Desktop Study (Geotechnical, hydrogeological, other)

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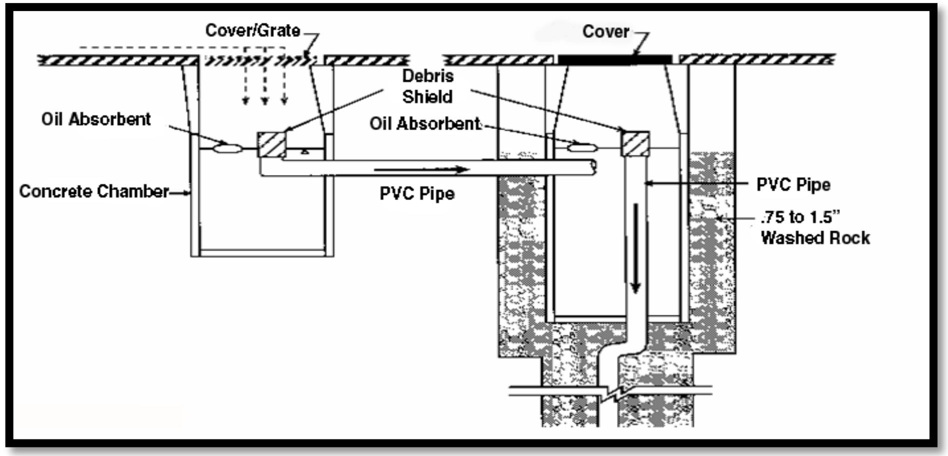
Evaluation of Alternatives – Class V Injection Well

- The EPA has defined six classes of injection wells. Examples of Class V wells include:
  - Stormwater drainage wells and septic system leach fields.
- An injection well for the Lancaster Station site would be classified as a Class V well.
- Most of these Class V wells are unsophisticated shallow disposal systems.
- There are over 14,350 Class V wells in Pennsylvania and over 248,000 in the United States.
- Class V wells are "authorized by rule,"
  - They may be operated without an individual permit so long as the injection does not endanger an underground source of drinking water
  - The owner and/or operator of the well submits basic inventory information about the well to their permitting authority (USEPA)
  - PADEP does not regulate

- This Alternative selected for further evaluation.
  - Least Investment Cost
  - Quicker ROI – 3.5 Years



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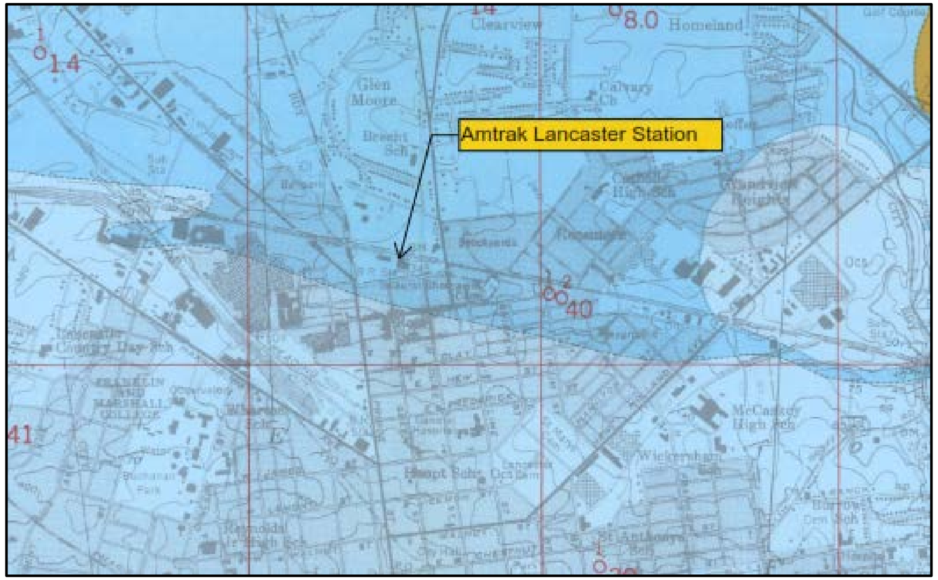
Water Quality Evaluation to Support Class V Injection Well

- Collection of water samples
  - Analyzed for a full suite of parameters - Target Compound List (TCL), Volatile Organic Compounds (VOCs) + 20 compound library search (+20), TCL Semivolatile Organic Compounds (SVOCs)+20, TCL Pesticides, Polychlorinated Biphenyls (PCBs), Target Analyte List (TAL) Metals, pH and Total Suspended Solids (TSS).
  - Compared to Pennsylvania Land Recycling Program Medium Specific Concentrations (MSCs) for groundwater based on a residential and non-residential site use for water with Total Dissolved Solids ≤2500 milligrams per Liter (mg/L).
  - Analysis demonstrated that the water is “clean” and suitable for reinjection.
- Local Geology and geomorphology evaluated – no immediate issues identified related to local karst geology.



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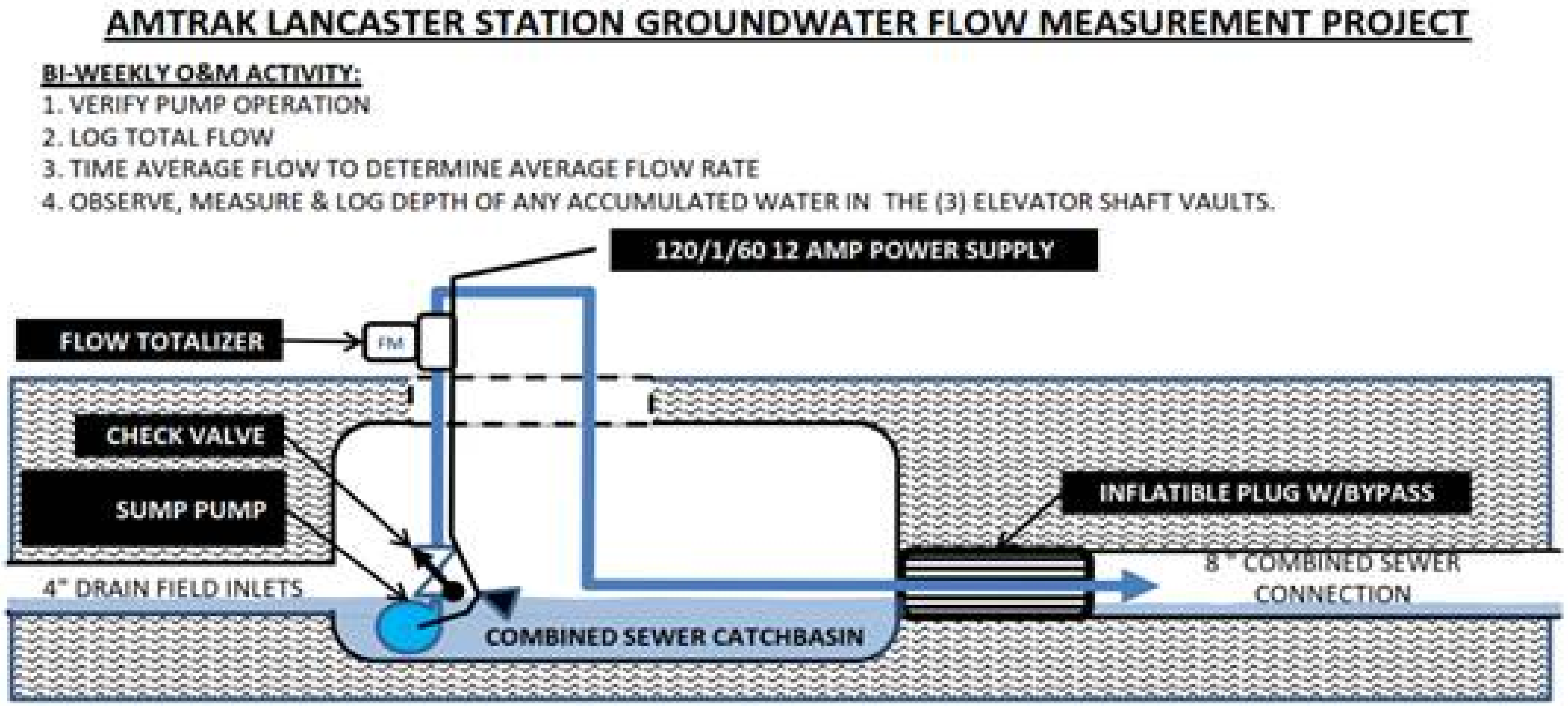
Mini-Pilot Test to Determine Flow and Support Class V Injection Well Design

- Measurement of flow rate from catch basin into Combined Sewer
  - Flow ranged from 26 GPM to 50 GPM (26 M GPY) during a limited Month-long test period
  - Test stopped and Design expedited for complete system installation by end of August 2015 (FY2015).



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Design Assessments

- Assess tunnel or additional infiltration
  - Pumped out elevator shafts and observe for GW infiltration
    - None observed
  - Indication of minor infiltration from tunnel wall/ceiling
  - Concluded that tunnel flooding primarily the result of backflow from combined sewer

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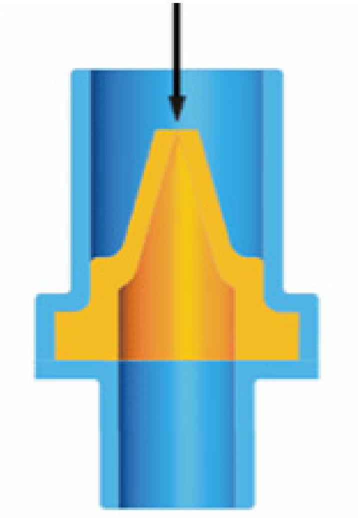
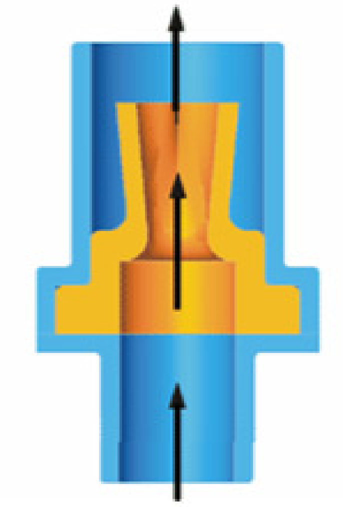
Duckbill Check Valve Installed in Combined Sewer to Prevent Backflow/Surcharge

- A “Duck-Bill Check Valve” was installed in the 8” combined sewer discharge line prevent backflow during sewer surcharge events, and to allow forward flow in the event of the groundwater injection system shutdown due to power outages or maintenance.

  - Internal seated version of the Duck Bill Check Valve
  - No reported tunnel flooding since installation





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Further Evaluation to Support Class V Injection Well

- Drill Bedrock Well
  - Conduct geophysical survey
  - Pump testing

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Class V Injection Well Details

- The regional Karst Geology was researched and evaluated
- Well Construction
  - 182.6 feet total depth
  - Casing 7.75" I.D Steel to 26.5 feet
  - Open hole to bottom
- Steel Casing set 5-ft into Bedrock
- Geophysical survey located significant bedrock fracture zones at 96.5-103 ft. and 167.5-169.5 ft.
- Pump tests performed to confirm greater than 100 gpm water producing zone with sustainable flow
- The open borehole well was developed
- 4" PVC Slotted Screen extends to the bottom of the well
- Well Seal is Installed between the 8" Steel Casing and the 4" Well Screen, so the well can be pressurized

Groundwater Injection Well - Geophysical Log
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SET GEOPHYSICS

19 Brookside Avenue
Pennington, New Jersey
609-730-0005
609-480-9382

Three-Arm Caliper Log

CO: Amec Foster Wheeler
WELL: IW-1
ADD: 53 E. McGovern Avenue
CITY: Lancaster
STATE: Pennsylvania
ZIP CODE: 83101

CLIENT: Amec Foster Wheeler
WELL ID: IW-1
SITE: 53 McGovern Avenue
CITY: Lancaster
STATE: Pennsylvania

LOCATION
SEC TWP RGE

OTHER SERVICES
None

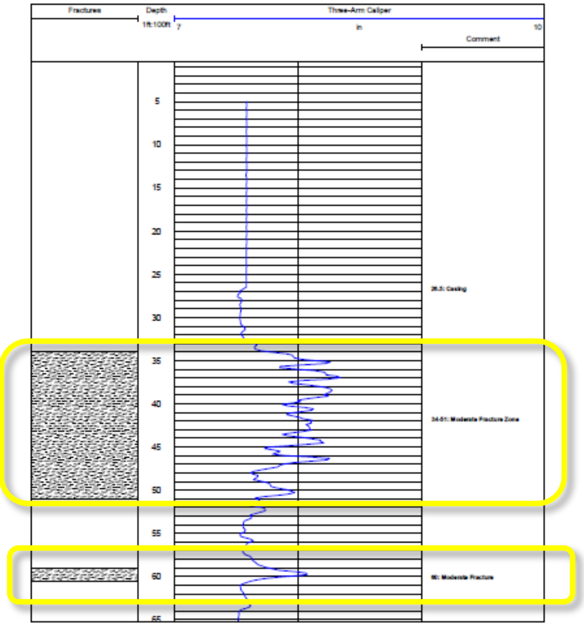
PERMANENT DATUM: Ground Surface ELEVATION: K.B.
LOG MEAS. FROM: Ground Surface ABOVE PERM. DATUM: D.F.
DRILLING MEAS. FROM: Ground Surface G.L.

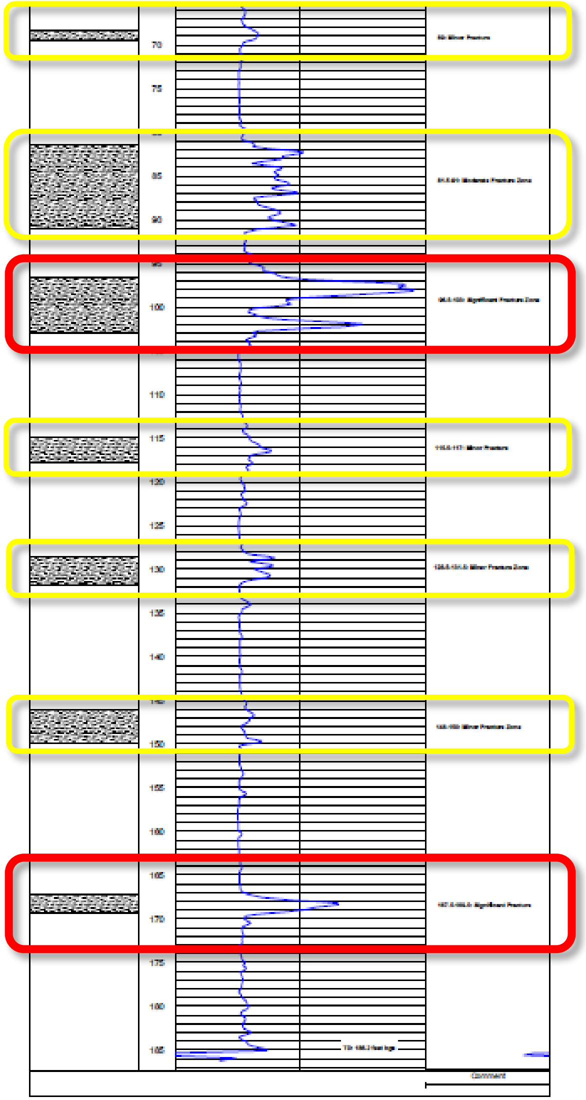
DATE	July 10, 2015	TYPE FLUID IN HOLE	Groundwater
RUN No	1	SALINITY	
TYPE LOG		DENSITY	
DEPTH-DRILLER		LEVEL	
DEPTH-LOGGER	186.2 feet	MAX. REC. TEMP.	
BTM LOGGED INTERVAL	186.2 feet bgs		
TOP LOGGED INTERVAL	5 feet		
OPERATING RIG TIME			
RECORDED BY	P. Miller		
WITNESSED BY	Steve Tanen, P.G.		

REMARKS:
1) SET ran the three-arm caliper log in IW-1. Casing was 7.75 inches I.D.
2) The borehole openings observed on the logs may represent fractures, gouges, or irregularities in borehole size that are due to the drilling process.
3) SET has characterized the borehole openings as minor, moderate, and significant.

Table 2: Fractures or Borehole Openings Observed in Well IW-1 and Comments

Fracture/Borehole Opening Depth (feet)	Comments
26.5	Bottom of Casing
34-51	Moderate borehole opening – possibly related to lithology
60	Moderate borehole opening – individual feature
69	Minor borehole opening
81.5-91	Moderate borehole opening – possibly related to lithology
96.5-103	Significant borehole opening – AMEC noted an increase in water
115.5-117	Minor borehole opening
128.5-131.5	Minor borehole opening
146-150	Minor borehole opening
167.5-169.5	Significant borehole opening – AMEC noted an increase in water
186.2	Bottom of logged interval





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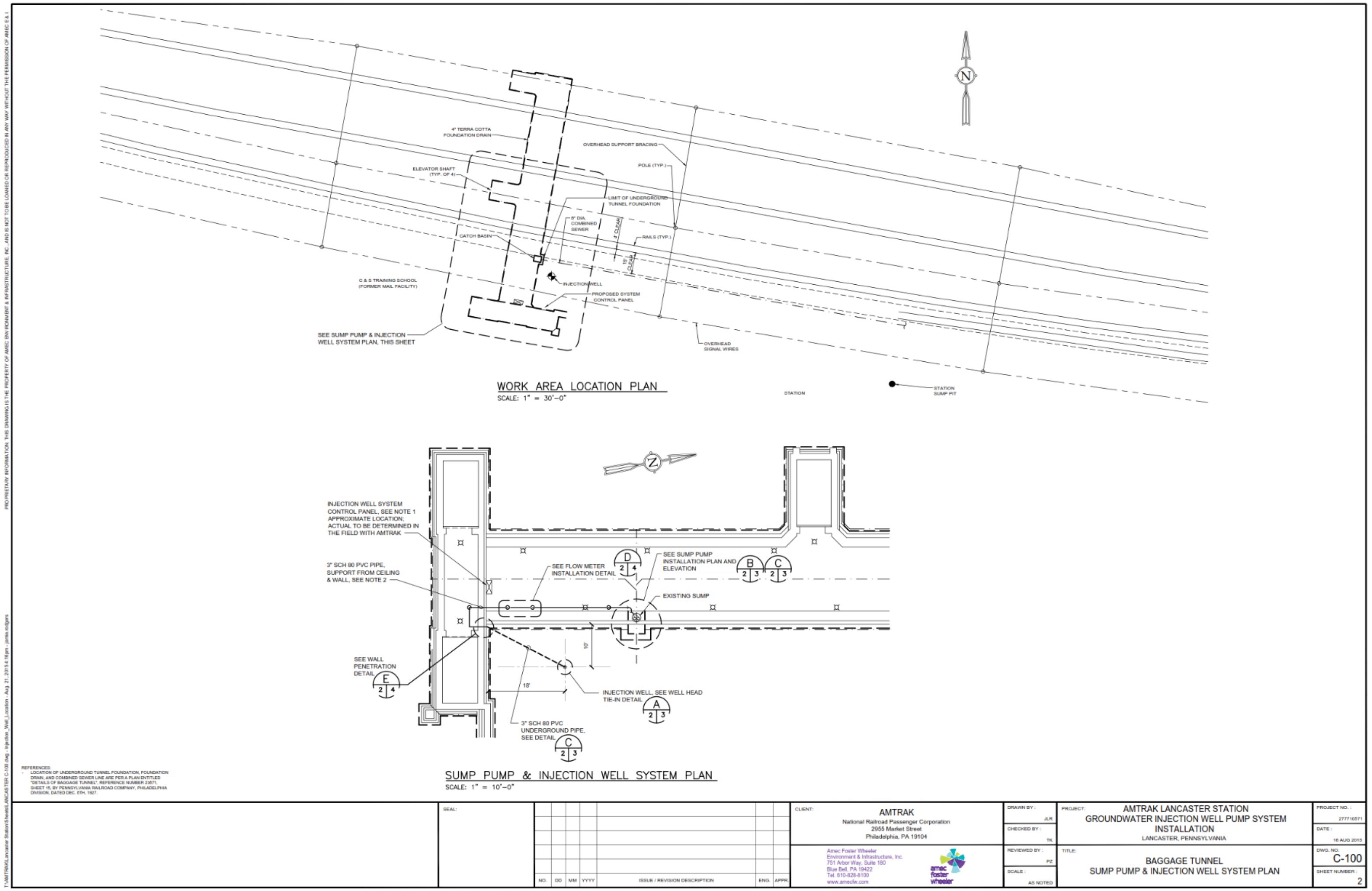
SYSTEM DESIGN



- 100 GPM Peak Flow
- Dual submersible pumps – Lag pump comes on at high level
- PLC Control Panel with wireless remote monitoring and control
- Continuous Level/VFD pump control
- Conductivity Level Sensor Alarms
- Totalizing flow meter/transducer
- Pressure transducer
- 3” In-line strainer w/ Inverted Cone Screen & Bottom Drain
- Wellhead Air Vent
- Sample Ports
- 8” Open Bore Well to 182.6 ft BGS with 4” 0.020 Screen & Well Seal
- Flush-mount well vault

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System Construction






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System Construction

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Initial Startup of the System – August 2015

- **Construction Surprise!!**
  - Catch basin found to not have a solid bottom
  - Bent rebar sand, gravel, and, silt where concrete floor should have been

- Started up and Operated system the last week of August 2015
  - Ran Pumps – for about 30 minutes before the in-line strainer plugged
  - Strainer designed to prevent injection well fouling
  - Pumps started pumping at over 90-GPM, and dropped to a trickle
  - Sediment in the catch basin bottom was being stirred up
  - The clear water discharge was becoming silty
  - Sediment from the tunnel floor was fouling the clear water flow

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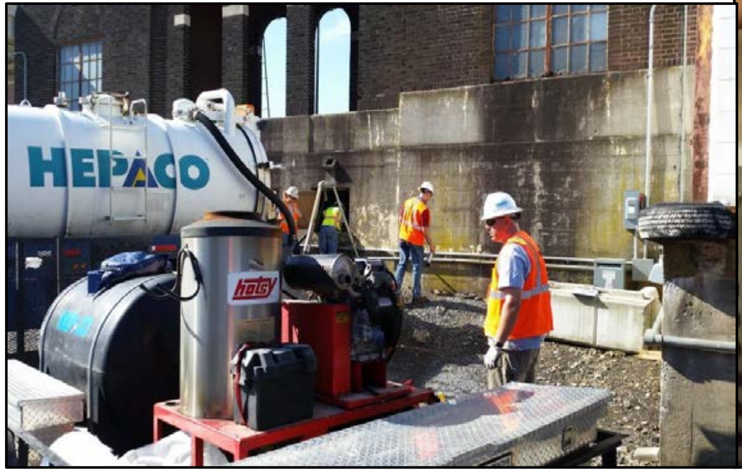
Modification and Restart of the System – July 2016

Modifications to system were designed and completed in July 2016:

- A Miller Lehman "Thompson" Self Cleaning Strainer was installed
- The Catch Basin Bottom was excavated and reconstructed
- The Injection Well Annulus was sealed against the well casing, so the system could achieve higher injection well pressure
- The tunnel floor was cleaned and pressure washed clear of silt and debris
- The System restarted on July 12, 2016
- Continuous operational since then.



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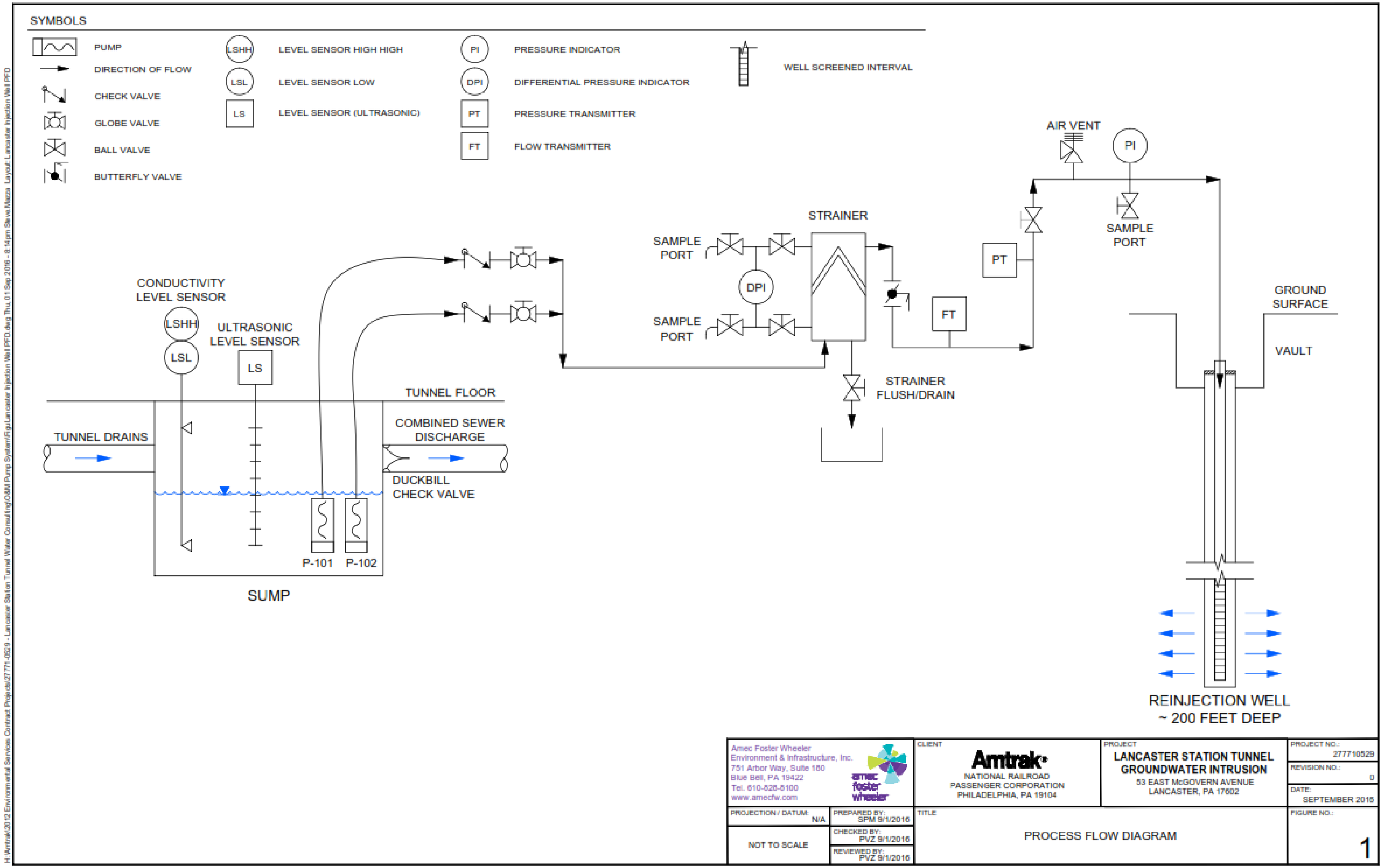
Schematic of the Groundwater Reinjection System



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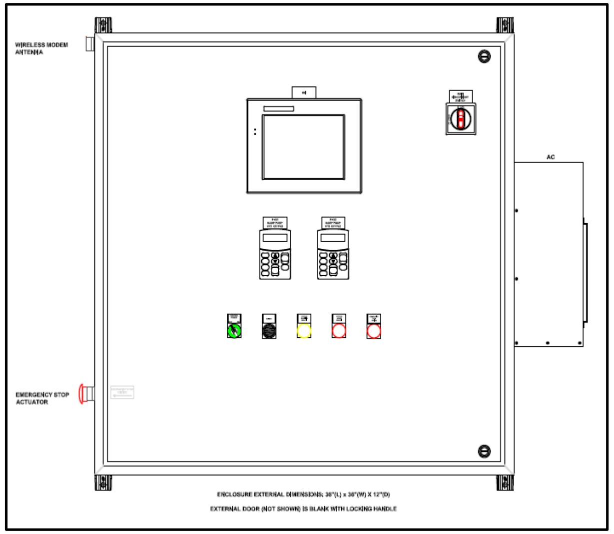
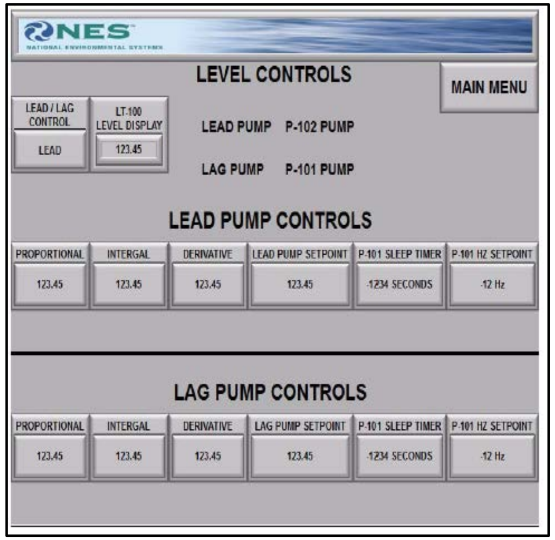
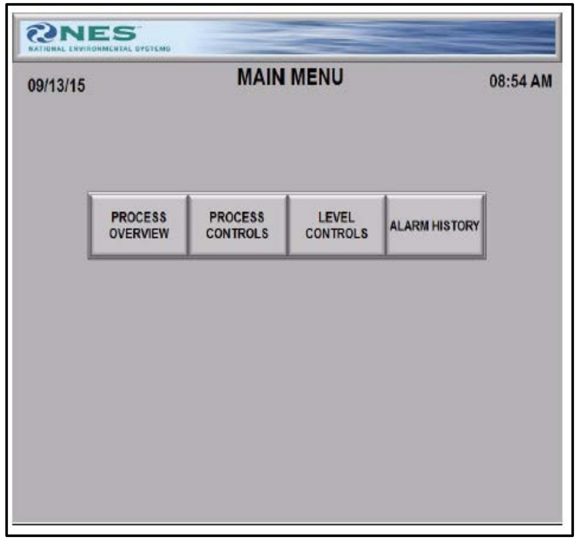
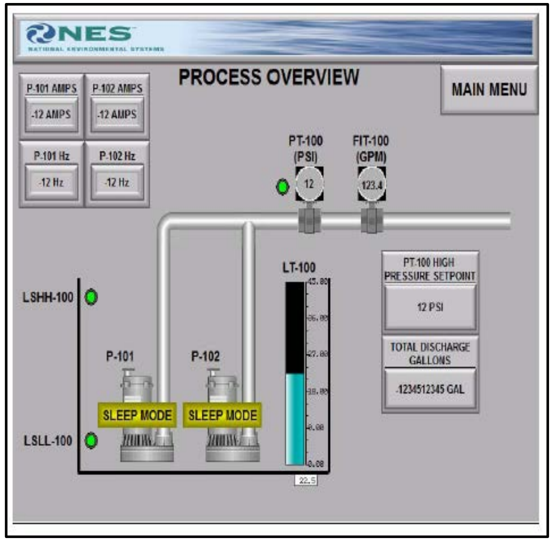
Control Panel Screens

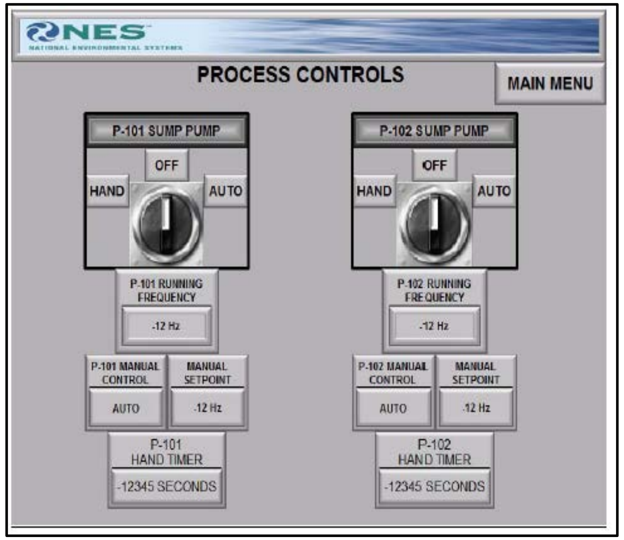


- PLC based Controls
- Enclosed in a NEMA 4X Panel
- Wireless cellular modem (password secured)
- System status outputs for hard wire to Amtrak's centralized monitoring system at the station (Not connected as of September 2016)
- Auto dialer for alarm conditions
- System can be controlled local and remotely









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System Performance Summary

- INITIAL START-UP (*Brief*): **AUGUST 29, 2015**
- SYSTEM RESTART DATE (*Official*): **JULY 12, 2016**
- OPERATING DAYS (*Continuous*): **77** (7/12/16 – 9/23/16)
- GALLONS PUMPED (*7/12 to 9/19/2016*): **4,484,821** (7/16/16 – 9/23/16)
- FLOW - GALLONS PER DAY (GPD AVG): **55,083**
- FLOW - GALLONS PER MINUTE (GPM AVG): **42**

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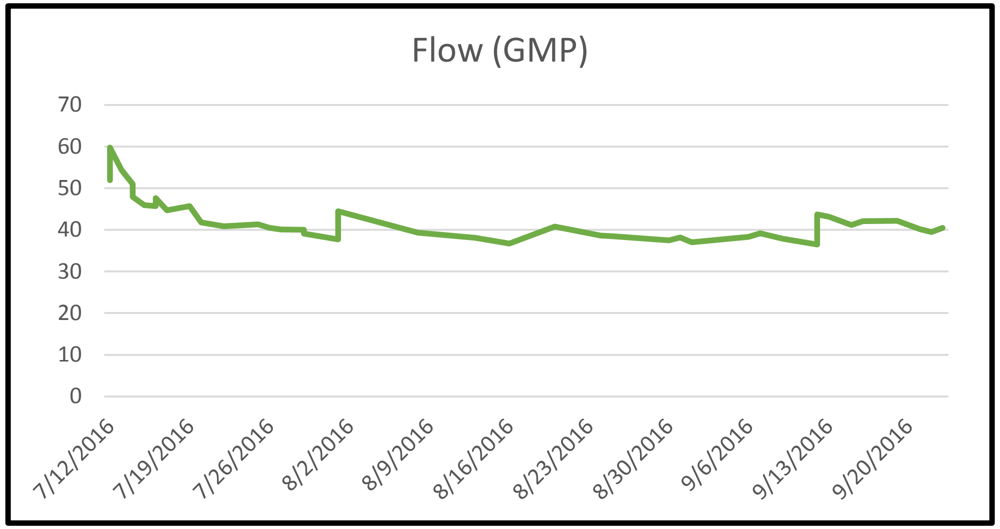
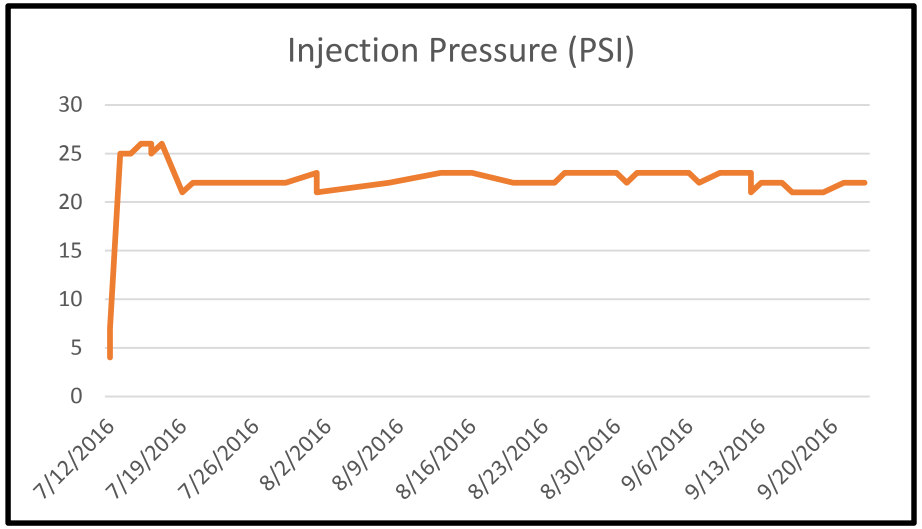
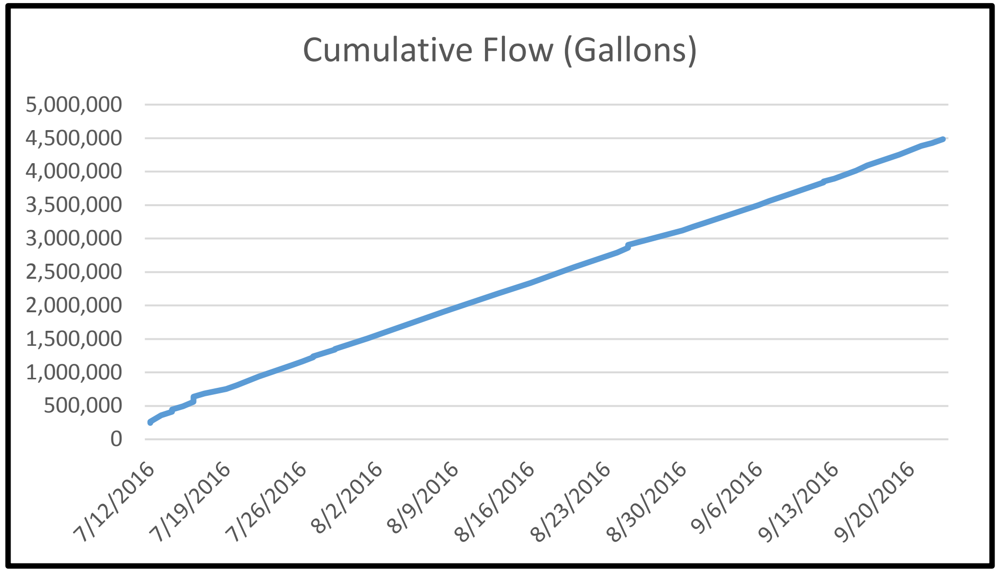
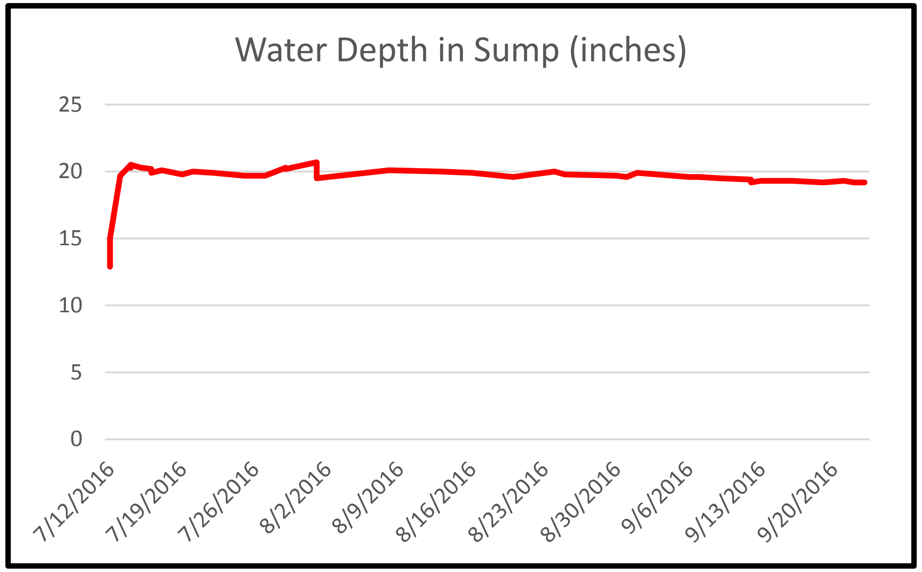
System Performance (as of 9/23/16)









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Potential Future System Optimization

- The strainer requires occasional backwash of the screen; a Manual Process that requires tunnel entry
  - The tunnel is a non-permitted confined space with access issues.
- Design is being prepared to automate the strainer backwash cycle without entering the tunnel:
  - Adjustable automatic timer
  - Blow down the sediment
  - Backwash the strainer
  - Temporarily shut-down the pumps, use static head to backwash the strainer
  - Close the drain valve
  - Restart the pumps.
- The automation upgrade will facilitate remote differential pressure monitoring, remote control of backwash cycles, and/or automatic backwash via programmed time cycle.
- The sediment will be dewatered and accumulate in a silt bag for periodic disposal
  - (i.e. annual due to the clear nature of the water being filtered)
  - Clarified water will drain back to the catch basin.
- A pressure transducer will be added to the strainer inlet to facilitate remote monitoring of differential pressure across the strainer.

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Potential Future System Optimization

The proposed system automation upgrades will:

- Perform automatic strainer backwash, via timer or remote control.
- Minimize the need to access the tunnel, and minimize safety concerns associated with tunnel entry
- Minimize system O&M requirements
- Optimize system performance and process efficiency
- Reduce ongoing O&M cost.

POTENTIAL FUTURE BENEFITIAL WATER REUSE

- *Non-potable clean water Reuse In lieu of reinjection (25-50 Million Gals annual potential benefit)*

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Benefits of the Groundwater Reinjection System

- Diverting **50,000 to 140,000 GPD** from the LCSA Combined Sewer.
- Capable of diverting **25 to 52 MGPY** if operating at maximum design capacity of 100 GPM.
- **Helps** City of Lancaster to **realize their goal** to eliminate 750 MGPY from the combined sewer.
- Will **save** Amtrak **thousands $** per year on potential sewer user fees. **Estimated $67,000 annually.**
- System designed to allow **beneficial re-use** of the water in the future.
- The Duckbill Check Valve appears to have **Resolved the Tunnel Flooding Issue.**
- **Return on Investment – 3.5 Years.**

Groundwater Reinjection System
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Project Acknowledgements

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- HEPACO

City of Lancaster

- Fire Department Rescue Squad

THANK YOU!

QUESTIONS ??