Norwood Lake Storm Sewer Outlet Improvements

Cherry Lane and Beechwood Drive

Northfield Center Township, Summit County

DRAINAGE MEMO

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Executive Summary

This drainage study evaluates the condition and performance of the Norwood Lake Storm Sewer Outlet System, which serves more than 130 properties in Northfield Center Township. The purpose of this analysis is to determine the most appropriate strategy for ensuring the long-term serviceability of the sewer system.

Constructed in the 1950s, the system includes approximately 1,220 linear feet (LF) of storm sewer conveying flow from Norwood Lake and the surrounding subdivision to the ODOT drainage system along State Route 82 (SR 82). Pipe materials vary and sizes range from 12 to 24 inches. Currently, ownership of the system is divided into three segments: Part A (HOA), Part B (Northfield Center Township), and Part C (private property extending to the ODOT outlet.

A closed circuit television (CCTV) inspection performed in October 2025 found that upstream segments between the lake and the central access point at Cherry Lane/Beechwood Drive are generally in serviceable condition but contain isolated structural issues such as cracking, deformation, joint separation, and irregular alignment. Downstream of this access point, the storm sewer could not be inspected due to persistent standing water, root blockage and/or silt accumulation, and a blocked connection at SR-82. Subsequent review of plans and field observations revealed that the original connection to the ODOT system had been rerouted.

Based on these findings, there is likely a loss of hydraulic connectivity in Part C (the private property portion of the system). If left in its current condition, the system poses an increased risk of localized ponding, property impacts, and escalating future repair costs.

Three alternatives were evaluated for each section: **Rehabilitation, Full Replacement,** and **No-Build.**

Introduction

The purpose of this drainage study is to assess the condition and performance of the Norwood Lake Storm Sewer Outlet System in Northfield Center Township and determine the most appropriate strategy for ensuring the long-term serviceability of the sewer system.

This system plays a critical role in conveying stormwater from Norwood Lake and adjacent streets - Beechwood Drive, Cherry Lane, and portions of Olde Eight Road and Aurora Rd (SR-82) - into the state owned drainage system along the north side of SR-82.

Installed in the 1950s, the existing storm sewer system consists of approximately 1,220 LF of pipe constructed from various materials, such as High-Density Polyethylene (HDPE), reinforced concrete (RCP), corrugated metal (CMP), and clay. Pipe diameters range from 12 to 24 inches. The system has been identified as undersized, with shallow slopes, and appears to experience hydraulic discontinuity in sections. Over time, aging infrastructure and sediment accumulation have created concerns regarding its structural integrity and hydraulic capacity.

The scope of this drainage memo includes:

- Reviewing historical information and maintenance records
- Performing and reviewing results of CCTV inspection to evaluate structural condition
- Conducting a preliminary hydraulic assessment
- Identifying and examining feasibility of repair or replacement
- Providing recommendation based on cost, reliability, and long-term performance

Existing Conditions

System Overview

- Installation Date: 1950s
- Total Length: Approximately 1,220 Linear Feet
- Pipe Materials: High-Density Polyethylene (HDPE), Reinforced Concrete Pipe (RCP), Corrugated Metal Pipe (CMP), and Clay
- Diameter Range: 12 to 24 Inches
- Rehabilitations: No Official Records; however, the presence of HDPE pipe suggests a previous replacement under Cherry Lane

The existing storm outlet system extends from Norwood Lake to the State Route 82 drainage system. **Appendix A** illustrates the alignment of the existing system. The following descriptions and inspection finding utilize the structure ID nomenclature from **Appendix A – Map of Norwood Lake Storm Sewer Outlet System**.

Alignment Description

The system is divided into three sections, as described below.

SECTION A: Extending from the lake outlet (D0) to junction box D1, near the westerly right-of-way line of Cherry Lane. This section of pipe is within sublot 81, Northfield Homes Subdivision No 2.

- Inlet Location D0: Southeast corner of Norwood Lake, consisting of a 15-inch reinforced concrete pipe inlet situated in a wooded area behind 8080 Cherry Lane (PPN 4002506). A metal cage has been placed over the inlet to prevent debris entry. The invert elevation of the inlet is 973.17 feet. The inlet is located on private property; Northfield Center Township does not have a maintenance agreement for access.
- From the inlet: The pipe runs east beneath a shed and near the foundation of 8080 Cherry Lane, then connects to a grateless junction box (D1) just inside the Northfield Township right-of-way. CCTV inspection revealed several irregular bends in the alignment of the pipe along this segment.

SECTION B: Extending from junction box D1 through the right-of-way of Cherry Lane to the east right-of-way of Beechwood Drive (just west of Catch Basin D4). This segment is owned and maintained by Northfield Center Township.

- From D1: The pipe heads SE to a manhole (D2), then continues east under Cherry Lane pavement to a large double catch basin (D3) located in the intersection radius of Cherry Lane and Beechwood Drive. Settlement was observed in the pavement along this stretch.
- From this catch basin: Pipe turns SE to a catch basin (Type CB-2-2A) in the roadside ditch (D4) in front of 363 Beechwood Dr (PPN 4002167).

SECTION C: Extending from the east right-of-way of Beechwood Drive to the ODOT storm sewer on SR-82 (Catch Basin D4 to Catch Basin D7).

- The sewer then exits township ROW, traversing SE through parcels 4002167, 4001456, 4001381, and 4004471, crossing under multiple driveways and a parking lot, and running close to several structures.
- The system ultimately discharges into the state-owned drainage system on the north side of SR-82 at Basin D7. Palmer Engineering Company (PEC) and the Summit County Engineer's Office (SCEO) initially believed that D6 flowed directly into D8, the basin across SR-82 from Calumet Drive and the Crossings at Golden Links Shopping Center. However, the northern-facing pipe inside Basin D8 has been intentionally blocked. Upon further investigation, existing plans SUM-82-3.20 (1952) and field observations revealed the existence of Junction Basin D7, which connects Basin D6 to the state owned system. The connection between D7 and D8 was grouted and bypassed by ODOT to continue on to Basin D9, where flow continues east along SR-82 before reaching a box culvert on the east side of the Aldi property.

Inspection Findings

In October 2025, PEC and GPRS performed a CCTV inspection of the system. The full report prepared by GPRS can be found in **Appendix B – GPRS Storm Sewer Inspection Report (OCT '25)**. A summary of key findings and inspection operations is included in this memo.

- Access was obtained through a central access point - the double catch basin at the intersection of Cherry Lane and Beechwood Drive (D3).
- From D3 west to the lake inlet D0, the HDPE and corrugated metal pipe segments are generally in good condition, with isolated areas of structural deterioration, cracking, deformation, silt deposits, and joint separation. Pipe diameters along this stretch vary between 15 to 18 inches. HDPE, RCP, and CMP material were noted. The alignment of the pipe was traced using GPRS pipe navigation equipment and a metal detector. The pipe along this corridor has several irregular bends and size changes. The following photos show some typical defects found in the inspection.

Figure 1: Broken Section of Pipe under Cherry Lane

Figure 2: Longitudinal Crack in Pipe under Cherry Lane

Figure 3: Perforation of corrugated metal pipe section

- East of D3, high standing water levels prevented GPRS equipment from accessing downstream pipes. Standing water was also observed in the next downstream catch basin (D4) located in the roadside ditch. Silt build-up exceeding 4 inches was noted in the sump of both D3 and D4.
- GPRS attempted to access the pipe from its SR-82 connection, however, that connection has been blocked off (see Figure 4).

Figure 4: Blockage of storm sewer connection to the ODOT system at D8 (looking north towards D7)

As discussed in Part C of *Alignment Description*, PEC staff conducted a supplemental site visit to identify a previously undocumented catch basin (D7) and further assess basins D5 and D6 between Beechwood Dr. and SR-82. The following provides a brief assessment of Basins D5 through D7.

Junction Basin D7

- Located in brushy area, buried, approx. 17.5-ft north of basin D8.
- Structure: 28" x28" square junction box with grateless lid.
- Located on ODOT drainage easement; end of Norwood Lake storm sewer system
- Current condition: Connection to D8 has been blocked (Figure 4); flow has been bypassed via 18" pipe southeast toward ODOT Basin D9.

Catch Basin D6

- Condition: Completed silted in; SCE records indicate original depth was approx. 3 ft.
- Observations: Standing water with clay residue; large piles of fallen timber debris surrounding the basin

Figure 5: Basin D6 (shown in the foreground), looking NW.

Node D5

- Issue: Discovered an opening in the pipe. Material is clay pipe. Approximately a 6” gap between pipe segments, open to air.
- 4” pipe from 363 Beechwood Dr. outlets at this gap.
- Water level inside pipe: approx.: 9 inch deep.

Figure 6: Gap in Pipe (denoted as Node D5), looking NW.

Connectivity Concerns: There is likely a discontinuity or blockage in the pipe between D5 and D7. Water level between D4 and D7 did not correlate. Basin D6 is silted in, suggesting water may be diverting into the surrounding soil or elsewhere.

Inspection Findings Summary: The inability to access downstream segments due to standing water, combined with observed silt accumulation and damaged pipe, indicates the system is experiencing severe hydraulic and structural deficiencies. SCE has indicated there is likely a blockage located along this corridor, upstream from where a previous blockage was cleared on the Spitzer parcel (PPN 4004471). There is likely a lack of hydraulic connectivity between basin D5 and D7. These conditions increase the risk of localized ponding and further deterioration. Therefore, full replacement of this section is warranted necessary and has been incorporated into the proposed alternative to ensure long-term reliability and performance.

Hydrologic and Hydraulic Analysis

Watershed Characteristics

The Norwood Lake Storm Sewer Outlet System serves a mixed residential watershed that includes the Norwood Lake watershed, the watershed of the pond to the northwest connected to Norwood Lake, along with surrounding streets Cherry Lane, Beechwood Drive, and portions of E Aurora Road, Olde Eight Road, Toth Drive, Leonard Drive, Vest Avenue and Forestwood Drive.

The total contributing drainage area is 112.3 acres, divided into three subsections:

1. Drainage to Norwood Lake – 50.9 Acres
2. Drainage to Pond connected to Norwood Lake – 19.5 Acres
3. Drainage to Outlet Storm Sewer Network prior to connection to State Route 82 – 41.9 Acres

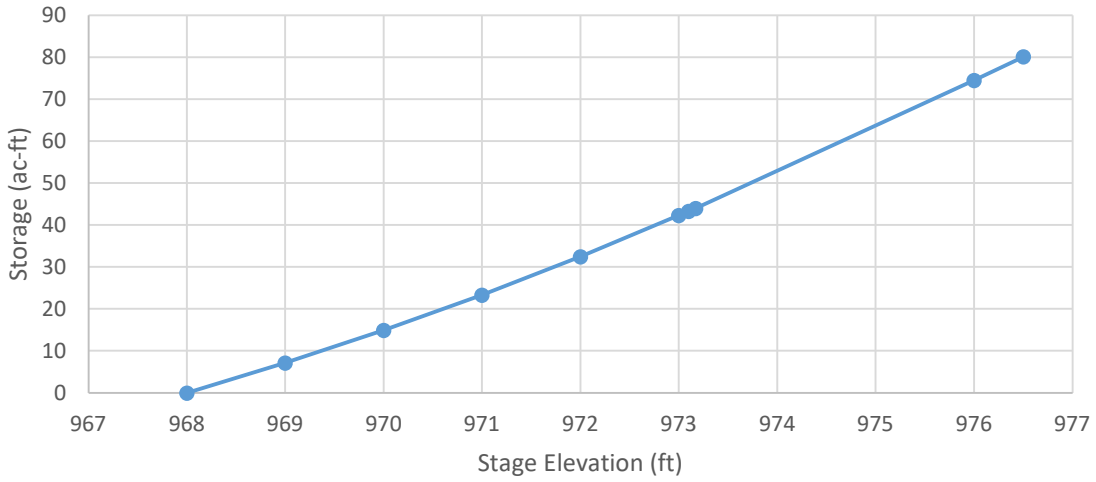
Land use within the watershed is primarily residential and wooded, with some commercial development. Impervious coverage consists of rooftops, driveways, and local roadways.

Hydrologic Analysis

Hydrologic methods were applied to evaluate Norwood Lake and estimate discharge rates and flow depths entering the storm sewer outlet system during the 10-year (10%) design storm. A summary of key finding is provided below; full calculations are included **in Appendix C – Hydrologic and Hydraulic Calculations**.

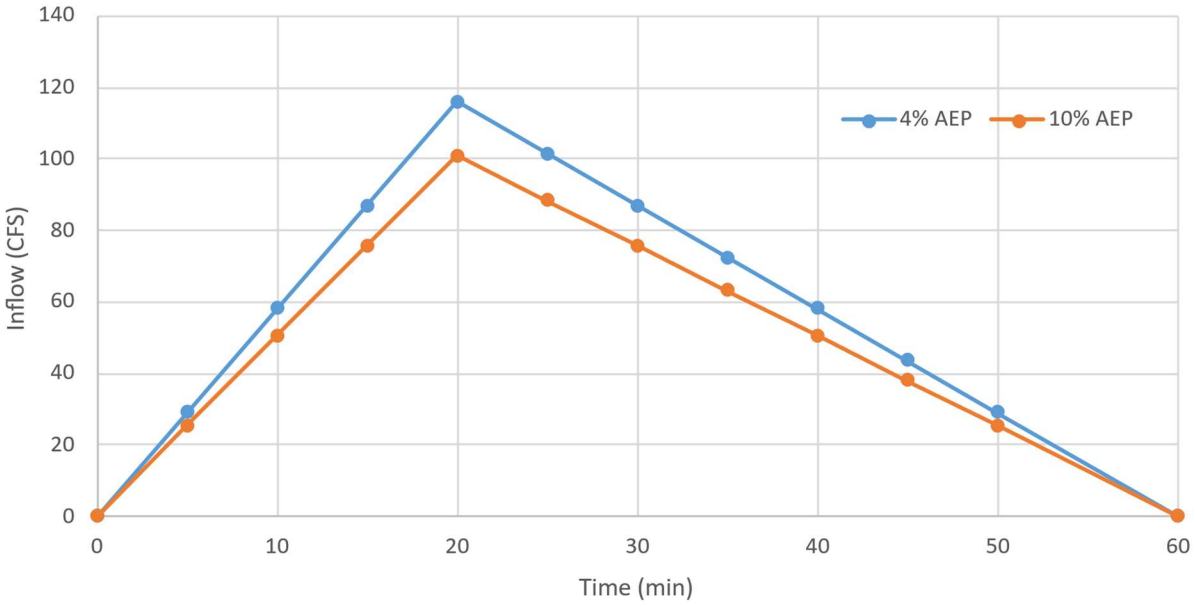
- The lake's normal pool elevation is approximately 973.10 ft, encompassing an area of 10.24 acres. The existing 15-inch storm sewer outlet has an invert elevation of 973.17 ft, meaning it conveys flow only during storm events when the lake rises above normal pool.
- Because Norwood Lake's actual depth is unknown, a typical peat bog lake depth range (3-10 ft) was considered. For this analysis, a depth of 5 feet was assumed, corresponding to a bottom elevation of 968.0 ft. This results in an estimated storage volume of 43.3 acre-feet at normal pool.
- A stage-storage curve was developed to support routing and discharge calculations (see Figure 7). The assumed depth was used to establish the curve.
- The top-of-bank elevation, beyond which overtopping would impact adjacent neighborhoods, is approximately 976.50 ft.

Figure 7: Norwood Lake Stage-Storage Curve (10% Design Storm)



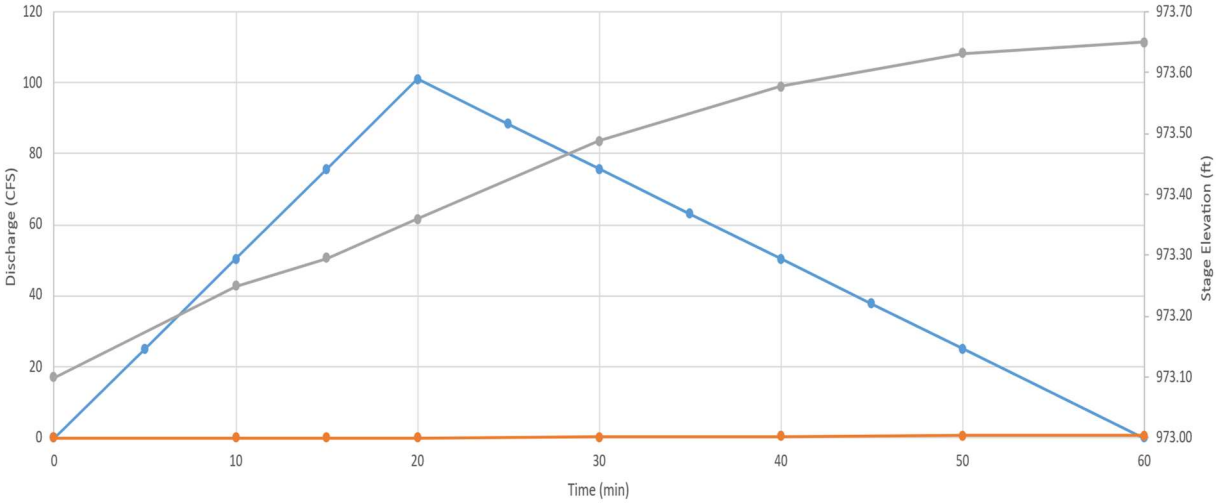
An inflow hydrograph was developed for the lake using the 10-year design storm. Summit County is located in ODOT Rainfall Intensity Zone A. A time of concentration (t_c) of 20 min and a runoff coefficient (C) value of 0.4 were assumed. Intensity (i) for the 10% storm at 20 minutes is 3.56 in/hr. based on L&D Figure 1101-2. The contributing drainage area of the lake and connected pond is 70.4 acres. Based on these parameters, the inflow hydrograph shown in Figure 8 was generated:

Figure 8: Inflow Hydrographs for Norwood Lake (Existing Conditions)



Hydrologic level-pool routing was performed using the developed inflow hydrograph. Outflow discharge was computed using the Manning's equation for Steady Uniform Flow, updating based on the stage elevation. During the 10-year storm, Norwood Lake reaches a peak elevation of 973.71 ft. At its peak, the outlet pipe conveys only 0.95 CFS, which is negligible compared to the lake's inflow rate. Due to low outflow discharge rates, drawdown time for the lake through the sewer system is lengthy.

Figure 9: Level-Pool Routing Analysis (10% Design Storm)



A similar analysis was conducted for the check storm (4% AEP). For this event, the lake reaches a stage elevation of 973.83 ft, with a max discharge rate of 1.97 CFS.

Hydraulic Analysis

A hydraulic analysis of the existing storm sewer system was performed following ODOT storm sewer computation methods. Detailed calculations are provided in **Appendix C – Hydrologic and Hydraulic Calculations**. The system currently exhibits shallow slopes, averaging 0.34% (approximately 4.17 feet of fall over 1220 LF).

The hydraulic analysis confirms that the existing storm sewer is severely limited by its shallow slopes and undersized pipes. While the initial segments provide adequate conveyance, capacity deficiencies become critical beyond the Beechwood-Cherry catch basin, where additional flow from the Beechwood Drive storm sewer network enters the system. This junction substantially increases the contributing drainage area, resulting in flow rates that exceed the system's capacity. These conditions create an elevated risk of surcharge and localized ponding during design storm events. Given the structural and hydraulic constraints, targeted repairs alone would not resolve the underlying capacity issues. Upsizing and reconstruction of the system is necessary to achieve compliance with design standards and ensure long-term performance.

Alternatives Analysis

An alternatives analysis was performed for the three sections of the Norwood Lake Storm Sewer Outlet System. For each section, three alternatives were considered: Trenchless Rehabilitation, Full Replacement, or No-Build. The following sections discuss some of the advantages and challenges of Full-Replacement versus Rehabilitation, then examine each section to determine a recommended alternative.

Preliminary cost estimates have been prepared for each section and are included in Appendix E – Preliminary Cost Estimates.

Repair Method 1: Trenchless Rehabilitation through Cured-in-Place Pipe (CIPP)

This alternative rehabilitates the existing storm sewer through trenchless installation methods.

CIPP installation involves inserting a resin-impregnated liner into the existing pipe, expanding it to fit the host pipe, and curing it using heat or light to form a structurally independent liner. Prior to installation, the storm sewer must be thoroughly cleaned using high-pressure jetting to ensure proper adhesion and curing.

Table 1: Advantages and Disadvantages of CIPP

Pros / Advantages	Cons / Challenges
CIPP installation results in minimal disruption to nearby homes and roadway surfaces along Cherry Lane and Beechwood Drive.	Installation requires continuous water diversion, typically lasting 1–30 hours depending on length and curing method.
Faster construction timeline	Slight reduction in pipe diameter after lining
Compatible with most existing pipe materials	Small pipes or pipes with bends can make liner inversion or curing difficult.
Extends the service life of the existing pipe	Service life, while improved, is shorter than a completely new pipe system, and warranties may vary compared to full replacement.
Lower cost than full replacement (subject to final cost estimating analysis)	There are potential health and odor hazards associated with CIPP resin and curing emissions.
CIPP reduces excavation needs, lowering surface restoration risk	Requires adequate entry points for liner installation
Shorter permitting timeline	Post-installation inspection can be challenging, and some defects may be harder to detect.
Improved hydraulic performance relative to host pipe conditions	There is a risk of curing failure, particularly if humidity, temperature, or flow conditions are not properly controlled.

Repair Method 2: Full Replacement

This alternative replaces the existing storm sewer infrastructure with new pipe. The design includes upsizing select pipe segments where necessary and incorporating elliptical pipe sections in locations with limited cover. These improvements increase hydraulic capacity while maintaining the existing lake outlet invert elevation and preserving the required tie-in elevation at ODOT's Basin D7.

Construction will require open-cut excavation, which may involve pavement removal and temporary lane closures along Cherry Lane and Beechwood Drive. Restoration activities will follow installation, including pavement replacement and surface repairs.

Table 2: Advantages and Disadvantages of Full Replacement

Pros / Advantages	Cons / Challenges
Provides a completely new system with full structural integrity and an extended service life.	Significant surface disruption along Cherry Lane and Beechwood Drive, several driveways.
Substantially improves hydraulic performance by increasing pipe diameter and available flow area.	Excavation near several structures presents risks; the shed near the lake inlet will require removal.
Reduces long-term maintenance needs and lowers the risk of future failures.	Longer construction duration than CIPP rehabilitation.
Maximizes service life and may include manufacturer or contractor warranties.	Higher environmental impacts associated with excavation; may require environmental permitting.
Construction cost is expected to be within approximately 15% of the CIPP option	Potential utility conflicts require careful coordination with existing sanitary sewer and water lines to avoid damage and ensure service continuity.

Section A: Lake Outlet (D0) to West Right of Way Line of Cherry Lane

Length: ~146 feet - Ownership: Likely HOA/Lake Association

Limits: Lake outlet (D0) to westerly R/W line of Cherry Lane (near Junction Box D1)

The existing conduit is a 15-inch corrugated metak pipe from the lake outlet (D0) to the right of way line near junction box D1. Based on CCTV observations, this reach is generally in good condition with adequate hydraulic capacity, though the alignment contains several irregular bends and the run is in close proximity to the residence at 8080 Cherry Lane. The inlet D0 sits on private property with a debris cage; no Township maintenance agreement currently exists for access.

Because the outlet invert is above the lake's normal pool, this segment primarily conveys event flows rather than continuous discharge; no upsizing is indicated by the study's hydraulic findings for this reach.

CIPP Performance and Limitations

If Section B is rehabilitated via CIPP, lining Section A provides material and maintenance continuity across the upstream corridor. CIPP here would likely be feasible from a capacity standpoint; however, alignment irregularities and tight access adjacent to the home may complicate installation/curing and require careful staging. Any CIPP installation would still require thorough pre-cleaning and bypass control during curing.

Full Replacement Considerations

Full replacement in Section A would require open-cut excavation immediately adjacent to the residence, removal of a shed and generator, and close coordination with the homeowner due to proximity to the foundation. If Sections A and B are both reconstructed, rerouting to tie directly into Manhole D2 should be evaluated to pull the storm line away from the house; design must confirm clearance with nearby utilities and structural features.

Utilities and Alignment Constraints - There is a possibility of private utilities near the residence. In addition, alignment alteration may be constrained by the existing sanitary sewer, limiting reroute options and dictating minimum horizontal / vertical separations.

Coordination With Residents and Access - Work in this area will occur within a yard setting immediately behind/alongside the home. If construction is pursued, advanced homeowner coordination will be required for temporary removals, access, and restoration, including any temporary relocation of small appurtenances.

Surface and Site Restoration - If disturbed, restoration should return lawn/landscaping and any hardscape features to pre-construction condition. If the shed/generator is removed for access, plan/permit temporary relocation and reset in coordination with the owner.

Long-Term Maintenance (No-Build Scenario)

Even if no construction occurs, establish a drainage maintenance agreement for access to D0 and periodic debris cage cleaning/inspection to maintain conveyance and reduce blockage risk during storm events.

Risks of No-Build

- Debris/Blockage at D0: Accumulation at the caged inlet could reduce conveyance during events and elevate localized water levels at the shoreline.
- Access & Responsibility: Without a maintenance agreement, response to future blockages or homeowner complaints may be delayed or disputed.
- Hidden Condition Progression: While current condition is serviceable, unseen bedding/void issues near the foundation could evolve, increasing the complexity and cost of future emergency work.

Given the current condition and the balance of cost, **No-Build is preferred for Section A, with the caveat that a drainage maintenance agreement be put in place for access and routine upkeep**. If Section B proceeds with CIPP, consider CIPP lining of Section A for continuity; if Section B proceeds with open-cut replacement, consider rerouting Section A to D2 to reduce risk near the home—subject to utility constraints and easement feasibility.

Table 3: Section A Alternatives - Estimated Costs

Alternative Method	*Estimated Construction Cost*	*Surface Disruption*	*Preferred Alternative*	*Notes*
CIPP Rehab	$48,200	LOW		
Full Replacement	$55,630	HIGH - STRUCTURE REMOVAL		Requires shed removal and air condition relocation
No-Build	$3,700	N/A	X	Northfield Center Twp. should acquire drainage easement.

Section B: Basin D1 to East Right-of-Way Beechwood Drive

This section includes approximately 545 feet of storm sewer under the jurisdiction of Northfield Center Township. The existing CMP and HDPE 18-inch pipe is generally in serviceable condition with isolated structural and joint-related defects documented in the CCTV inspection (see *Inspection Findings* and ***Appendix B – GPRS Storm Sewer Inspection Report (OCT '25***)). Hydraulic analysis confirms that the pipe size in this section is adequate and no upsizing is required to meet design capacity through Node D3. Capacity limitations begin beyond D3 and become more severe after the connection from the neighborhood storm sewer at Node D4.

Pavement settlement has been observed along Cherry Lane within this segment. This settlement suggests that the minor deficiencies noted during the CCTV inspection may be allowing infiltration/exfiltration; or historical trench settlement may be contributing to surface instability. Addressing the pipe defects now would help reduce the potential for worsening settlement, localized pavement failures, or increased future maintenance costs—particularly given the shallow cover over portions of the sewer.

CIPP Performance and Limitations in Section B

A trenchless Cured-in-Place Pipe (CIPP) liner could be installed along Section B; however, its effectiveness is moderated by several project-specific constraints:

- Existing bends and alignment irregularities may make liner installation difficult, increasing risk of wrinkles, incomplete curing, or liner bridging over joints.

- Isolated defects such as joint separations or voids beneath the pipe may not be fully addressed by CIPP, since lining does not correct external soil loss or pre-existing structural voids.
- Minor diameter reduction inherent to CIPP would not create a hydraulic problem in this segment, but it does slightly reduce available cross-sectional area and may reduce future maintenance access.
- CIPP installation requires full cleaning of the pipe and a dry environment. Bypass pumping would be required regardless of repair method but can be more continuous/intensive for CIPP to ensure a dry substrate for proper curing.
- Structural enhancement is moderate: CIPP adds significant internal strength but does not replace bedding, nor does it correct settlement-related problems.

While CIPP could extend the useful service life of the existing pipe, it would not address subsurface issues contributing to pavement settlement and would not resolve external defects that may worsen over time.

F*ull Replacement Considerations*

The full replacement alternative requires pavement removal along both Cherry Lane and Beechwood Drive. Driveway access must be maintained throughout construction, likely via steel plating and staged excavation. Pavement restoration quantities have been estimated using the minimum removal widths necessary for safe open-cut installation.

Utility conflicts are a likely consideration, as existing sanitary and water lines run in close proximity to portions of the storm sewer alignment. These factors limit adjustments to the horizontal and vertical alignment of the system. Field verification and design coordination will be necessary to avoid conflicts.

Coordination With Residents and Driveway Access

Construction will occur directly in front of several homes; therefore, driveway access must be maintained during all phases of the work. Temporary access measures and advanced communication with residents will be essential to reduce impacts.

Pavement Restoration Scope

Replacing the storm sewer will require full-depth pavement removal within trench limits. Restoration will include full-depth asphalt replacement within the trench and surface course replacement extending to lane lines or intersections where necessary to ensure long-term pavement performance and uniform ride quality.

Integration With Hydraulic Analysis

Hydraulic modeling indicates that although the existing 18-inch HDPE pipe in Section B is adequate to Node D3, hydraulic deficiencies begin at D3 and amplify when inflow from the Beechwood Drive storm sewer system enters at Node D4. As a result, the portion of the sewer between D3 and D4 is a candidate to be upsized to improve overall system performance.

Risks of No-Build

Choosing not to rehabilitate or replace Section B carries several risks:

- Progressive Pipe Deterioration - Existing structural and joint defects may worsen, leading to voids, pipe failures, or additional roadway instability.
- Worsening Pavement Settlement - Existing settlement along Cherry Lane may progress, increasing the likelihood of roadway failure, sinkholes, or emergency repairs.
- Surcharge and Localized Ponding - Capacity becomes deficient downstream of Node D3; deferring improvements increases the risk of street ponding and overflow during storm events.
- Utility Impact Risks - Continued ground movement near sanitary and water lines increases the risk of unplanned conflicts, service disruptions, and emergency utility work.
- Higher Long-Term Costs - Delaying repairs typically expands the future scope of work and increases total project cost due to larger excavations, more pavement replacement, and more complex utility coordination.

Summary: The no-build option heightens operational, hydraulic, and structural risks and is likely to increase long-term repair costs compared to a planned, coordinated improvement project.

Summit County has indicated that improvements within Section B must be funded independently by Northfield Center Township and cannot be included in the Drainage Petition assessment. Given this funding constraint and considering the documented structural deficiencies, observed pavement settlement, and the long-term hydraulic limitations downstream of Node D3, Palmer recommends pursuing the **full replacement alternative** for this section.

Full replacement provides a comprehensive solution that corrects existing defects, addresses the underlying causes of surface settlement, and minimizes future maintenance risk—benefits that CIPP rehabilitation cannot fully achieve in this corridor. Replacement also offers the greatest opportunity to manage utility coordination proactively, improve long-term system reliability, and stabilize the roadway where settlement has already been observed. Although more disruptive during construction, full replacement delivers the most durable and cost-effective long-term outcome for the Township given the system's age, condition, and shallow cover.

Table 4: Section B Alternatives - Estimated Costs

Alternative Method	*Estimated Construction Cost*	*Surface Disruption*	*Preferred Alternative*
CIPP Rehab	$185,740	LOW	
Full Replacement	$212,473	HIGH – Pavement Removal	X

Section C: East Right-of-Way Beechwood Drive to ODOT System

Section C encompasses the downstream portion of the Norwood Lake Storm Sewer Outlet System (510 feet), extending from the east right-of-way of Beechwood Drive (Basin D4) to the ODOT-owned storm sewer located at Basin D7 along State Route 82. This segment crosses multiple private parcels, traverses beneath driveways and a parking lot, and runs in close proximity to several structures. No existing drainage easement is present along this corridor; therefore, construction of this segment will require a temporary construction easement and a drainage maintenance agreement with the affected property owners.

Existing Conditions and Deficiencies

CCTV inspection of Section C was not achievable due to persistent standing water, silt accumulation, pipe blockages, and structural discontinuities downstream of Basin D4. These conditions represent the most severe deficiencies in the entire system. Without intervention, the downstream blockage will continue to impede outlet performance and increase upstream surcharge and ponding risk.

Horizontal and Vertical Alignment Considerations

To reduce impacts to homes and structures along the corridor, the horizontal alignment will be slightly altered where necessary from the existing path. This adjustment will maintain function while improving constructability on private property. The final vertical elevation is fixed due to the required tie-in to ODOT's Basin D7. Consequently, design opportunities for grade adjustment are limited.

Given the shallow cover and hydraulic demands, the replacement design will increase capacity using elliptical pipe, which provides greater flow area without raising the finished surface grade or requiring excessive excavation.

CIPP Limitations

Although the downstream portion of the system could technically be jetted to remove silt and clear blockages, the underlying structural condition of the pipe is still expected to be unsuitable for successful CIPP rehabilitation. Field observations indicate hydraulic discontinuity, standing water, joint separation, and potential void formation, meaning that even after cleaning, the host pipe would not provide the stable, continuous conduit required for inversion, curing, or long-term liner performance. Additionally, the cost of jetting, debris removal, and post-cleaning inspection—combined with the uncertainty of whether CIPP would even be feasible afterward—would exceed or closely approximate the cost of full replacement while still offering far greater risk of future failure. For these reasons, pursuing CIPP in Section C is considered impractical and unreliable compared to full reconstruction.

Full Replacement Considerations

Construction Access - Construction access will primarily be from Beechwood Drive, as the remaining corridor is constrained by private property boundaries. Staging areas will be limited, and equipment access may need to be sequenced or restricted based on property layout.

Restricted Working Corridor - The construction corridor is narrow and located behind several properties. This will require:

- Careful planning for excavation widths
- Coordination with homeowners for access and mobility
- Use of smaller or specialized construction equipment where necessary

Utility Coordination - Private and public utilities may be present behind homes, including:

- Private drains, including the known 4-inch line at D5
- Gas or communication lines
- Water services
- Sanitary laterals

Pavement and Surface Restoration - Construction will require disturbance to:

- Residential driveways
- A commercial or shared parking lot area
- Lawn and landscaped surfaces

All surfaces will be restored to match existing materials and conditions, including asphalt, concrete, gravel, or vegetation.

Environmental and BMP Considerations - Given the saturated conditions and proximity to drainage features, temporary stormwater BMPs (silt fence, inlet protection, sediment traps, stabilization) will be required to control sediment transport during construction.

Bypass and Temporary Flow Management - Because the system receives flow from Norwood Lake and its subdivision, a bypass system will be required during construction. The bypass may need:

- Multiple control points
- Pump-around systems
- Redundant capacity during storm events
- Stabilized discharge locations

Given the degraded condition of the existing pipe, bypassing all flows around active construction zones is necessary to prevent ponding or further deterioration.

Full Replacement is the preferred alternative for this section.

Jetting this section to remove blockages and then reassessing the pipe for potential rehabilitation was considered. If post-cleaning inspection showed the pipe to be in serviceable condition, CIPP rehabilitation could be evaluated further. However, this approach is entirely dependent on the existing pipe remaining structurally intact after cleaning. Field observations indicate that the pipe has already experienced hydraulic discontinuity, making extensive cleaning neither practical nor cost-effective. When combined with the uncertainty of the pipe's condition after cleaning, the cost of blockage removal followed by CIPP installation would exceed the cost of full replacement and still carry a higher risk of future failure.

Risks of No-Build in Section C

Choosing not to reconstruct Section C will result in significant consequences:

- Continued loss of hydraulic connectivity, restricting outflow from Norwood Lake and prolonging drawdown times.
- Increased risk of localized standing water along Beechwood Drive, Cherry Lane, and adjacent private properties.
- Worsening structural deterioration in the already compromised pipe segments.
- Potential development of sinkholes or ground settlement on private property.
- Impact to private structures and yards due to saturated soils.
- Increased surcharge risk upstream at D4 and further into Section B.
- Future repairs will become more complex, costly, and disruptive.

Table 5: Section C Alternatives – Estimated Costs

Alternative Method	*Estimated Construction Cost*	*Surface Disruption*	*Preferred Alternative*
Full Replacement	$217,030	HIGH	X

Conclusion and Recommendations

Inspection and field observations confirm that while upstream segments remain generally serviceable, the system as a whole is constrained by shallow slopes, undersized pipes, and a loss of hydraulic connectivity in the downstream reach, increasing the risk of surcharge, localized ponding, and progressive deterioration under design storm conditions.

Recommended Improvements (by Section):

- Section A: No-Build with Maintenance Agreement — Maintain access to D0 for periodic debris-cage cleaning/inspection to preserve event-flow conveyance and reduce blockage risk.
- Section B: Full Replacement — Address observed structural/joint defects and settlement, reduce long-term maintenance risk, and coordinate utilities.
- Section C: Full Replacement — Restore hydraulic connectivity to the ODOT system and correct the most severe structural and hydraulic deficiencies.

Preferred Alternative (Total).
Adopting the preferred options above yields a **subtotal construction cost of $433,203** (Table 6).

Table 6: Preferred Alternative Estimated Cost Summary

Storm Sewer Section	*Alternative Method*	*Estimated Construction Cost*
A	No-Build w/ Maintenance Agreement	$3,700
B	Full Replacement	$212,473
C	Full Replacement	$217,030
PREFERRED ALTERNATIVE SUBTOTAL		**$433,203**

Appendix A – Map of Norwood Lake Storm Sewer Outlet System

MAP OF EXISTING NORWOOD LAKE STORM SEWER OUTLET SYSTEM

EXISTING SYSTEM LENGTH IS 1220 LF ± FROM NODE D0 TO D7

LEGEND:

- *SECTION A*
- *SECTION B*
- *SECTION C*

HORIZONTAL SCALE IN FEET
0 15 30 60

APPENDIX A
MAP OF EXISTING DRAINAGE NETWORK

NORWOOD LAKE STORM SEWER OUTLET IMPROVEMENTS

DESIGN AGENCY
Palmer ENGINEERING
3745 MEDINA ROAD
SUITE A
MEDINA, OH 44256
(330) 952-1464

DESIGNER

REVIEWER

PROJECT ID
N/A

SHEET A.1 | TOTAL 1

MODEL: Appendix A Plan Sheet PAPERSIZE: 17x11 (in.) DATE: 2/19/2026 TIME: 7:50:02 AM PLTDRV: OHDOT_PDF_Color.pltcfg PENTBL: OHDOT_PenC.tbl USER: vdragich@palmernet.com WORKSPACE: OHDOTCEv02 WORKSET: SCE Norwood Lake Outlet Storm Water Improvements PRODUCT: OpenRoadsDesigner 24.00.00.205
pw:\\pewinpw-int01.pewin.private.palmernet.com:Palmer Engineering\Documents\Ohio\Non_ODOT\SCE Norwood Lake Outlet Storm Water Improvements\400-Engineering\Drainage\Sheets\SCE Norwood Lake Outlet Storm Water Improvements_DD001.dgn

Appendix B – GPRS Storm Sewer Inspection Report (OCT ’25)

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WEB PROJECT
CLICK TO OPEN

Project

Project	827119_Cherry Lane Storm Line
	10/10/2025

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nate.johnson@gprsinc.com

Table of Contents

Project		
827119_Cherry Lane Storm Line		**10/10/2025**

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Section Summary

Project	
827119_Cherry Lane Storm Line	**10/10/2025**

Number of sections	4
Total length of sewer network	585.80 ft
Inspected length of sewer network	585.80 ft
Not inspected length of sewer network	0.00 ft
Total abandoned inspections	2
Number of section inspection photos	40
Number of section inspection videos	4
Number of section inspection scans	0
Number of section inclination measurements	0

Pipe Segment Reference	**Inlet 03-Inlet 04**	Lateral Upstream Access Point	**Inlet 03**
City	**Northfield**	Lateral Downstream Access Point	**Inlet 04**
Street	**Cherry Lane**	Profile	**Circular 18inch**
Total Length	**456.0**	Material	**Polyethylene**

	Distance	PACP Code	Observation
1	0.0	ACB	Catch Basin / Inlet 04
2	0.0	MWL	Water Level, 5% of the vertical dimension
3	236.0	DFE	Deformed Flexible Elliptical, 5%
4	246.9	TBI	Tap Break-In Intruding at 12 o'clock, dia/height: 6inch, intruding: 1inch
5	257.0	DSF	Deposits Settled Fine, 5% of cross sectional area at 7 o'clock
6	281.5	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start
7	345.8	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish
8	356.6	B	Broken from 6 o'clock to 7 o'clock, within 8 inch / Inner wall
9	356.7	B	Broken at 12 o'clock, within 8 inch
10	372.8	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start
11	395.5	CL	Crack Longitudinal at 11 o'clock, within 8 inch
12	395.6	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish
13	414.3	CL	Crack Longitudinal at 11 o'clock, within 8 inch
14	414.3	ISB	Infiltration Stain Barrel at 11 o'clock, within 8 inch
15	432.6	DFE	Deformed Flexible Elliptical, 5%
16	456.0	AMH	Manhole / Inlet 03

Pipe Segment Reference	**Inlet 02-Inlet 03**	Lateral Upstream Access Point	**Inlet 02**
City	**Northfield**	Lateral Downstream Access Point	**Inlet 03**
Street	**Cherry Lane**	Profile	**Circular 18inch**
Total Length	**51.3**	Material	**Polyethylene**

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Section Summary

Project	
827119_Cherry Lane Storm Line	**10/10/2025**

		Distance	PACP Code	Observation
1		0.0	AMH	Manhole / Inlet 03
2		0.0	MWL	Water Level, 5% of the vertical dimension
3		30.2	MWLS	Miscellaneous Water Level, Sag, 10% of the vertical dimension, Start
4		46.8	MMC	Miscellaneous Material Change, Reinforced concrete pipe / HDPE to RCP
5		46.8	MSC	Miscellaneous Shape or Size Change / 18" to 15"
6		46.8	LL	Line Left, 5%
7		51.3	MWLS	Miscellaneous Water Level, Sag, 10% of the vertical dimension, Finish
8		51.3	AMH	Manhole / Inlet 02

Pipe Segment Reference	**Inlet 01-Inlet 02**	Lateral Upstream Access Point	**Inlet 01**
City	**Northfield**	Lateral Downstream Access Point	**Inlet 02**
Street	**Cherry Lane**	Profile	**Circular 18inch**
Total Length	**78.5**	Material	**Corrugated Metal Pipe**

		Distance	PACP Code	Observation
1		0.0	AMH	Manhole / Inlet 01
2		0.0	MWL	Water Level, 5% of the vertical dimension
3		0.0	HVV	Hole Void Visible at 4 o'clock, within 8 inch
4		0.0	MGO	Miscellaneous General Observation / Bottom if line missing
5		19.5	MMC	Miscellaneous Material Change, Reinforced concrete pipe / CMP to RCP
6		19.5	JOM	Joint Offset Medium, Start
7		20.7	DAE	Deposits Attached Encrustation, 5% of cross sectional area from 12 o'clock to 5 o'clock, within 8 inch
8		23.4	DAE	Deposits Attached Encrustation, 5% of cross sectional area from 8 o'clock to 4 o'clock, within 8 inch
9		30.6	DSF	Deposits Settled Fine, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start/Mud/silt
10		35.1	DSZ	Deposits Settled Other, 5% of cross sectional area from 5 o'clock to 7 o'clock / Pipe
11		65.3	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start
12		75.1	DSZ	Deposits Settled Other, 5% of cross sectional area at 6 o'clock / Pipe
13		78.5	JOM	Joint Offset Medium, Finish
14		78.5	DSF	Deposits Settled Fine, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish/Mud/silt
15		78.5	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish
16		78.5	MSA	Miscellaneous Survey Abandoned / Debris in line preventing further inspection

Pipe Segment Reference	**Inlet 04A-Inlet 05**	Lateral Upstream Access Point	**Inlet 04A**
City	**Northfield**	Lateral Downstream Access Point	**Inlet 05**
Street	**Cherry Lane**	Profile	**Circular 18inch**
Total Length	**0.0**	Material	**Reinforced Concrete Pipe**

		Distance	PACP Code	Observation
1		0.0	ACB	Catch Basin / Inlet 05
2		0.0	MWL	Water Level, 5% of the vertical dimension
3		0.0	MSA	Miscellaneous Survey Abandoned / 100% silt and mud

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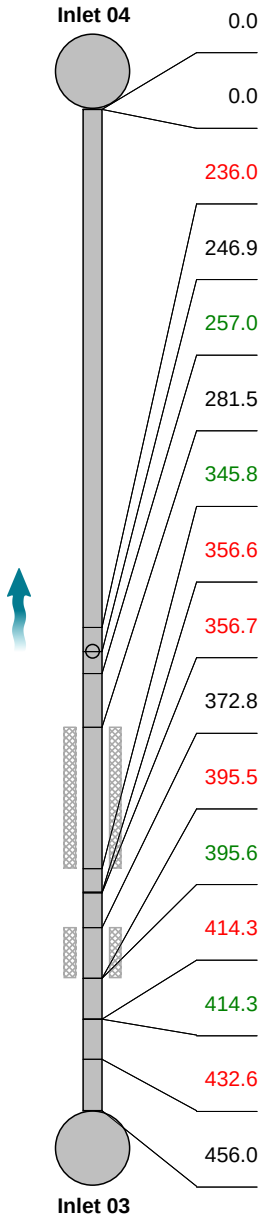
Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
10/10/2025			**Nate Johnson**	**P0052605-022025**	**Inlet 03-Inlet 04**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**456.0 '**	**456.0 '**

City:	**Northfield**	Drainage Area:		Upstream MH:	**Inlet 03**
Street:	**Cherry Lane**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**Inlet 04**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**18 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Polyethylene**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



1:3442 Distance		Code	Observation	Counter	Photo	Grade
0.0		ACB	Catch Basin / Inlet 04	00:00:00	Inlet 03-Inlet 04_98847	
0.0		MWL	Water Level, 5% of the vertical dimension	00:00:02	Inlet 03-Inlet 04_14fd7f	
236.0		DFE	Deformed Flexible Elliptical, 5%	00:09:19	Inlet 03-Inlet 04_301b1	S3
246.9		TBI	Tap Break-In Intruding at 12 o'clock, dia/height: 6inch, intruding: 1inch	00:09:52	Inlet 03-Inlet 04_e4ceac	M2
257.0		DSF	Deposits Settled Fine, 5% of cross sectional area at 7 o'clock	00:10:26	Inlet 03-Inlet 04_9a3dac	M2
281.5	S01	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start	00:11:26	Inlet 03-Inlet 04_bf9a59	
345.8	F01	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish	00:14:10		M2
356.6		B	Broken from 6 o'clock to 7 o'clock, within 8 inch / Inner wall	00:15:21	Inlet 03-Inlet 04_22499	S4
356.7		B	Broken at 12 o'clock, within 8 inch	00:14:47	Inlet 03-Inlet 04_e6c106	S4
372.8	S02	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start	00:16:12	Inlet 03-Inlet 04_ab22c8	
395.5		CL	Crack Longitudinal at 11 o'clock, within 8 inch	00:17:23	Inlet 03-Inlet 04_1620e	S2
395.6	F02	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish	00:17:42	Inlet 03-Inlet 04_14c9d8	M2
414.3		CL	Crack Longitudinal at 11 o'clock, within 8 inch	00:18:36	Inlet 03-Inlet 04_d4728	S2
414.3		ISB	Infiltration Stain Barrel at 11 o'clock, within 8 inch	00:18:41	Inlet 03-Inlet 04_e2809	M1
432.6		DFE	Deformed Flexible Elliptical, 5%	00:19:44	Inlet 03-Inlet 04_7b49c6	S3
456.0		AMH	Manhole / Inlet 03	00:21:13	Inlet 03-Inlet 04_d446c0	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
4232	2C11	4232	18.0	41.0	59.0	3.0	2.0	2.2

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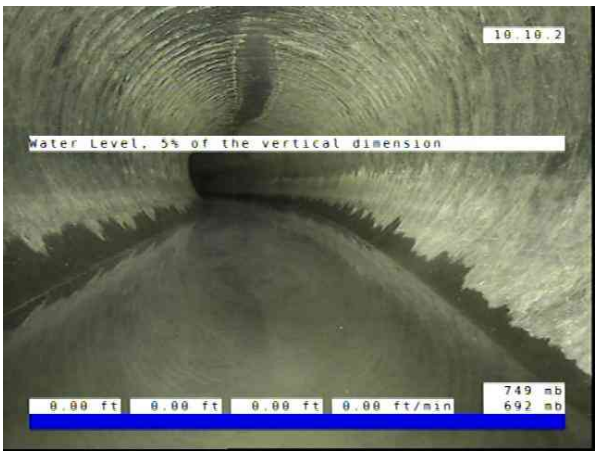
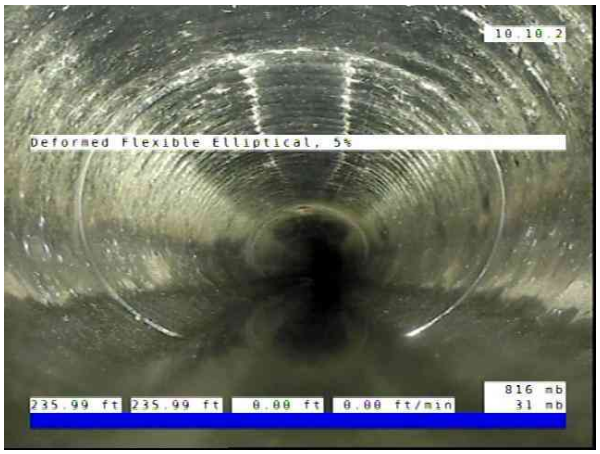
Section Pictures - 10/10/2025 - Inlet 03-Inlet 04

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 03-Inlet 04**	**1**

Inlet 03-Inlet 04_98847996-b37f-4dea-af19-56fe634cb99e_20251010_082215_261.jpg, 00:00:00, 0.00ft
Catch Basin / Inlet 04



Inlet 03-Inlet 04_14fd7f9a-5e35-4ba4-ade9-3bffd7f86d69_20251010_082223_298.jpg, 00:00:02, 0.00ft
Water Level, 5% of the vertical dimension



Inlet 03-Inlet 04_301b1426-a370-405d-bf88-4df1a5b1fa77_20251010_083152_618.jpg, 00:09:19, 235.99ft
Deformed Flexible Elliptical, 5%

Inlet 03-Inlet 04_e4ceac8e-e1ce-4ae5-bc7d-48c141ca7f75_20251010_083238_056.jpg, 00:09:52, 246.87ft
Tap Break-In Intruding at 12 o'clock, dia/height: 6inch, intruding: 1inch

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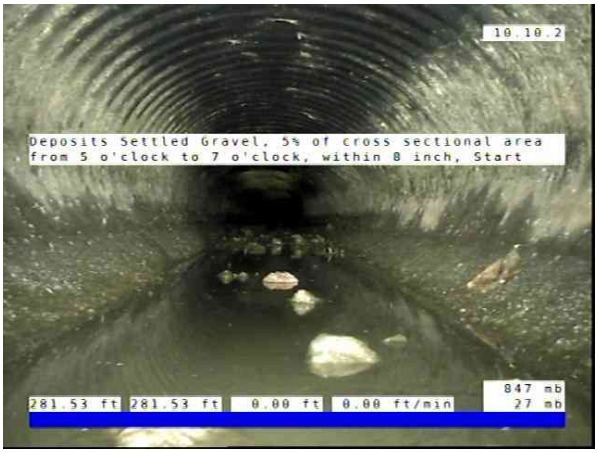
Section Pictures - 10/10/2025 - Inlet 03-Inlet 04

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 03-Inlet 04**	**1**

Inlet 03-Inlet 04_9a3dac02-c805-4a2b-acf4-5ed19167fc32_20251010_083825_603.jpg, 00:10:26, 257.00ft
Deposits Settled Fine, 5% of cross sectional area at 7 o'clock



Inlet 03-Inlet 04_bf9a5931-bfff-40e0-b26e-9b6862334d95_20251010_083937_187.jpg, 00:11:26, 281.53ft
Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start

Inlet 03-Inlet 04_2249918f-bb70-4c64-bd79-ce2412f1396b_20251010_084357_045.jpg, 00:15:21, 356.58ft
Broken from 6 o'clock to 7 o'clock, within 8 inch / Inner wall

Inlet 03-Inlet 04_e6c106fa-ce9d-409c-b7eb-d8a09dee563b_20251010_084311_167.jpg, 00:14:47, 356.74ft
Broken at 12 o'clock, within 8 inch

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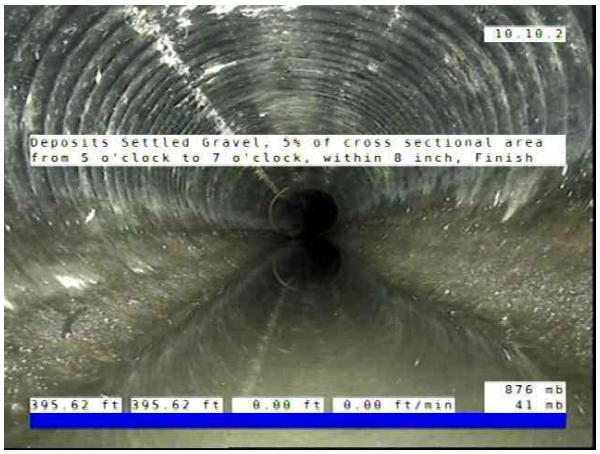
Section Pictures - 10/10/2025 - Inlet 03-Inlet 04

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 03-Inlet 04**	**1**

Inlet 03-Inlet 04_ab22c8df-7f35-4172-bfd6-4f8122662604_20251010_084500_792.jpg, 00:16:12, 372.76ft
Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start

Inlet 03-Inlet 04_1620e0c9-613f-49ce-823f-d7f66df169a2_20251010_084620_301.jpg, 00:17:23, 395.54ft
Crack Longitudinal at 11 o'clock, within 8 inch



Inlet 03-Inlet 04_14c9d8de-826d-41d1-a7b7-b5afc1421f57_20251010_084645_089.jpg, 00:17:42, 395.62ft
Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish

Inlet 03-Inlet 04_d4728e8b-59c1-45ec-acbb-4fb24ba5e040_20251010_084748_747.jpg, 00:18:36, 414.31ft
Crack Longitudinal at 11 o'clock, within 8 inch

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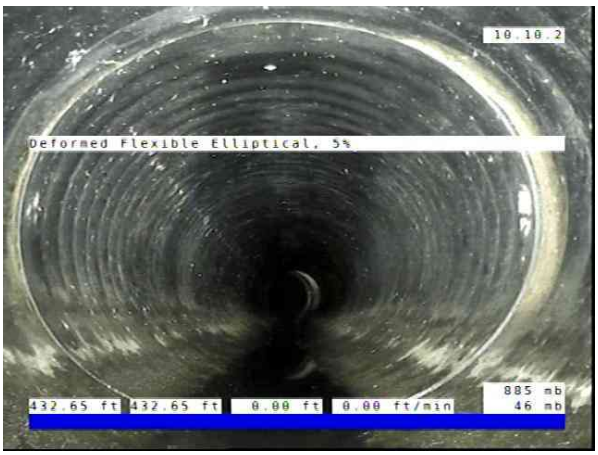
Section Pictures - 10/10/2025 - Inlet 03-Inlet 04

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 03-Inlet 04**	**1**

Inlet 03-Inlet 04_e2809933-88e8-42e6-9239-637797dbe4f1_20251010_084801_425.jpg, 00:18:41, 414.31ft
Infiltration Stain Barrel at 11 o'clock, within 8 inch



Inlet 03-Inlet 04_7b49c65a-3867-4ab5-b404-749a917ac628_20251010_084920_317.jpg, 00:19:44, 432.65ft
Deformed Flexible Elliptical, 5%

Inlet 03-Inlet 04_d446c0f7-ca37-43ab-8d3c-f7ff7cd21453_20251010_085059_820.jpg, 00:21:13, 456.02ft
Manhole / Inlet 03

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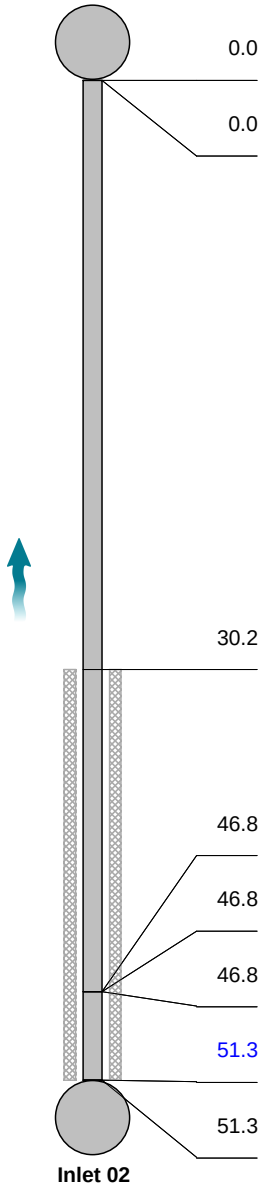
Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
10/10/2025			**Nate Johnson**	**P0052605-022025**	**Inlet 02-Inlet 03**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**51.3 '**	**51.3 '**

City:	**Northfield**	Drainage Area:		Upstream MH:	**Inlet 02**
Street:	**Cherry Lane**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**Inlet 03**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**18 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Polyethylene**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



1:388	Distance		Code	Observation	Counter	Photo	Grade
	0.0		AMH	Manhole / Inlet 03	00:00:00	Inlet 02-Inlet 03_bf241c	
	0.0		MWL	Water Level, 5% of the vertical dimension	00:00:03	Inlet 02-Inlet 03_6cd411	
	30.2	S01	MWLS	Miscellaneous Water Level, Sag, 10% of the vertical dimension, Start	00:01:45	Inlet 02-Inlet 03_8d970	
	46.8		MMC	Miscellaneous Material Change, Reinforced concrete pipe / HDPE to RCP	00:03:08	Inlet 02-Inlet 03_3e24ec	
	46.8		MSC	Miscellaneous Shape or Size Change / 18" to 15"	00:03:11	Inlet 02-Inlet 03_27a9f9	
	46.8		LL	Line Left, 5%	00:03:25	Inlet 02-Inlet 03_790d8	M1
	51.3	F01	MWLS	Miscellaneous Water Level, Sag, 10% of the vertical dimension, Finish	00:04:40	Inlet 02-Inlet 03_b95ad	S2
	51.3		AMH	Manhole / Inlet 02	00:04:43	Inlet 02-Inlet 03_aa854	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
2400	1100	2411	8.0	1.0	9.0	2.0	1.0	1.8

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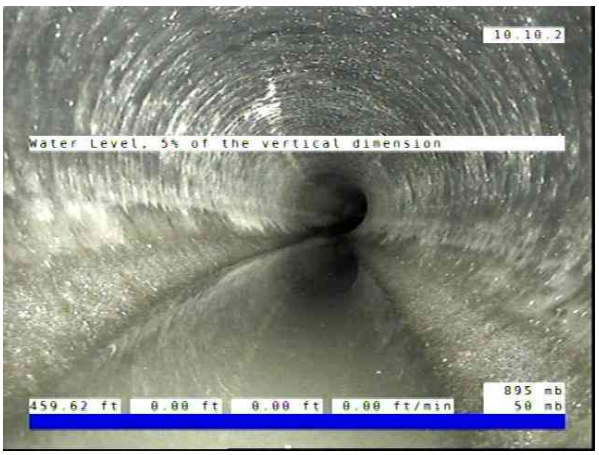
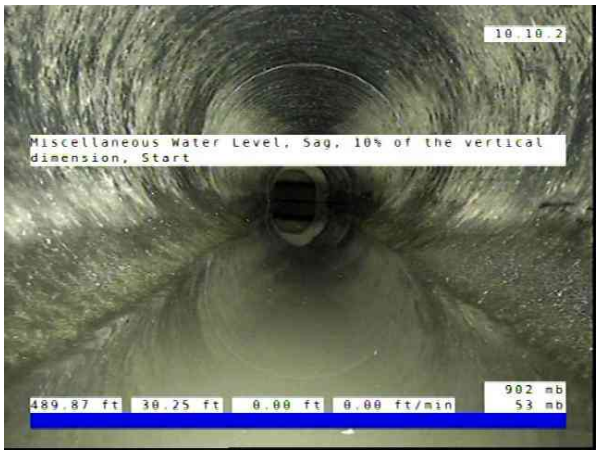
Section Pictures - 10/10/2025 - Inlet 02-Inlet 03

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 02-Inlet 03**	**2**

Inlet 02-Inlet 03_bf241c86-e28c-4c86-b9c5-b242dc8ddb64_20251010_085213_290.jpg, 00:00:00, 0.00ft
Manhole / Inlet 03



Inlet 02-Inlet 03_6cd41142-0efb-4015-8b6c-2e067fc3128f_20251010_085219_792.jpg, 00:00:03, 0.00ft
Water Level, 5% of the vertical dimension



Inlet 02-Inlet 03_8d970817-64fb-49c6-9842-ee47ccf6d737_20251010_085415_887.jpg, 00:01:45, 30.25ft
Miscellaneous Water Level, Sag, 10% of the vertical dimension, Start

Inlet 02-Inlet 03_3e24ec0e-4f99-405f-947d-06956c2e0b8c_20251010_085551_095.jpg, 00:03:08, 46.79ft
Miscellaneous Material Change, Reinforced concrete pipe / HDPE to RCP

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Section Pictures - 10/10/2025 - Inlet 02-Inlet 03

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 02-Inlet 03**	**2**

Inlet 02-Inlet 03_27a9f95b-5a43-46f0-9739-0911ed2e6077_20251010_085624_226.jpg, 00:03:11, 46.79ft
Miscellaneous Shape or Size Change / 18" to 15"

Inlet 02-Inlet 03_790d8dd9-b9b3-4802-9c19-c5307b0a59d7_20251010_085636_937.jpg, 00:03:25, 46.79ft
Line Left, 5%

Inlet 02-Inlet 03_b95ad3d4-e88c-4833-9959-994b44d98212_20251010_085759_394.jpg, 00:04:40, 51.32ft
Miscellaneous Water Level, Sag, 10% of the vertical dimension, Finish

Inlet 02-Inlet 03_aa85427d-9380-416e-bf6a-99993cae7bd0_20251010_085809_833.jpg, 00:04:43, 51.32ft
Manhole / Inlet 02

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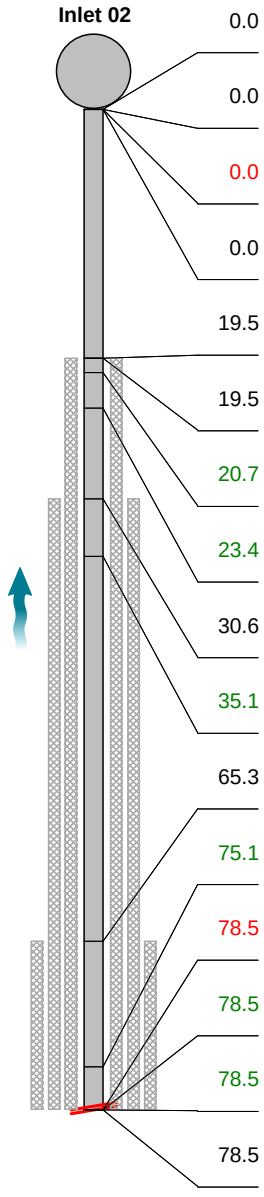
Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
10/10/2025			**Nate Johnson**	**P0052605-022025**	**Inlet 01-Inlet 02**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Upstream**		**78.5 '**	**78.5 '**

City:	**Northfield**	Drainage Area:		Upstream MH:	**Inlet 01**
Street:	**Cherry Lane**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**Inlet 02**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**18 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Corrugated Metal Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					



1:593 Distance		Code	Observation	Counter	Photo	Grade
0.0		AMH	Manhole / Inlet 01	00:00:00	Inlet 01-Inlet 02_0e558	
0.0		MWL	Water Level, 5% of the vertical dimension	00:00:03	Inlet 01-Inlet 02_4f6d9d	
0.0		HVV	Hole Void Visible at 4 o'clock, within 8 inch	00:00:27	Inlet 01-Inlet 02_6184e	S5
0.0		MGO	Miscellaneous General Observation / Bottom if line missing	00:00:42	Inlet 01-Inlet 02_1412f4	
19.5		MMC	Miscellaneous Material Change, Reinforced concrete pipe / CMP to RCP	00:02:14	Inlet 01-Inlet 02_5e12a	
19.5	S01	JOM	Joint Offset Medium, Start	00:02:20	Inlet 01-Inlet 02_b087f7	
20.7		DAE	Deposits Attached Encrustation, 5% of cross sectional area from 12 o'clock to 5 o'clock, within 8 inch	00:02:40	Inlet 01-Inlet 02_e20c1c	M2
23.4		DAE	Deposits Attached Encrustation, 5% of cross sectional area from 8 o'clock to 4 o'clock, within 8 inch	00:03:05	Inlet 01-Inlet 02_5a08e	M2
30.6	S02	DSF	Deposits Settled Fine, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start / Mud/silt	00:03:45	Inlet 01-Inlet 02_78bfb4	
35.1		DSZ	Deposits Settled Other, 5% of cross sectional area from 5 o'clock to 7 o'clock / Pipe	00:04:15	Inlet 01-Inlet 02_8d540	M2
65.3	S03	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start	00:06:29	Inlet 01-Inlet 02_2e780	
75.1		DSZ	Deposits Settled Other, 5% of cross sectional area at 6 o'clock / Pipe	00:07:37	Inlet 01-Inlet 02_d1fadc	M2
78.5	F01	JOM	Joint Offset Medium, Finish	00:08:59		S3
78.5	F02	DSF	Deposits Settled Fine, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish / Mud/silt	00:08:59		M2
78.5	F03	DSGV	Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish	00:08:59	Inlet 01-Inlet 02_ad0a5	M2
78.5		MSA	Miscellaneous Survey Abandoned / Debris in line preventing further inspection	00:08:59	Inlet 01-Inlet 02_d30c5e	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
513A	2B00	513A	41.0	34.0	75.0	3.2	2.0	2.5

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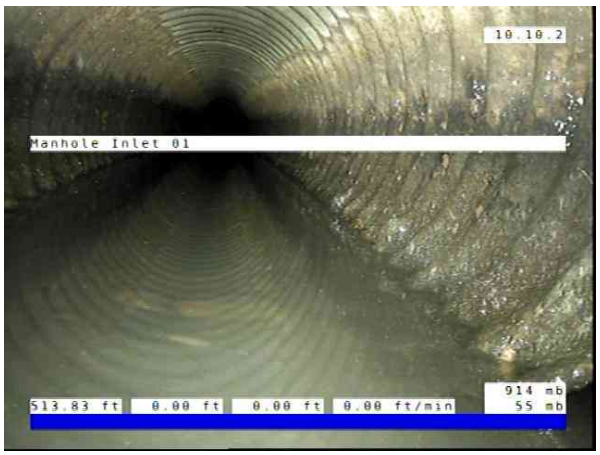
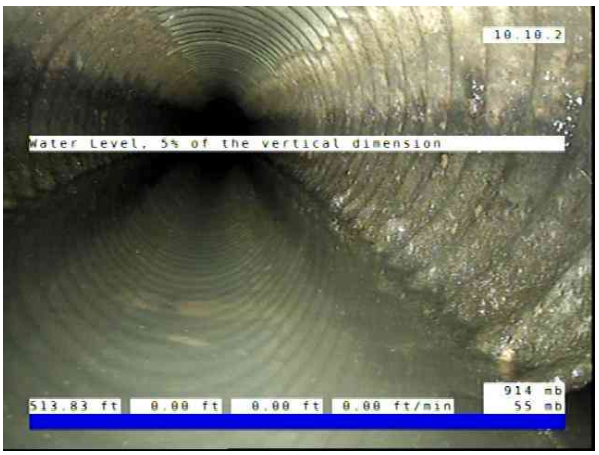
Section Pictures - 10/10/2025 - Inlet 01-Inlet 02

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 01-Inlet 02**	**3**



Inlet 01-Inlet 02_0e558b1c-3f89-4ecb-bb9c-3f87b4d61fc1_20251010_085938_169.jpg, 00:00:00, 0.00ft
Manhole / Inlet 01



Inlet 01-Inlet 02_4f6d9d40-66b9-43d4-a48d-bce40afa5314_20251010_085943_388.jpg, 00:00:03, 0.00ft
Water Level, 5% of the vertical dimension

Inlet 01-Inlet 02_6184eb40-fb5d-40c0-abf2-17b0dc0b82ab_20251010_090023_389.jpg, 00:00:27, 0.04ft
Hole Void Visible at 4 o'clock, within 8 inch

Inlet 01-Inlet 02_1412f4ed-031a-452d-87f4-f99925acb638_20251010_090107_646.jpg, 00:00:42, 0.04ft
Miscellaneous General Observation / Bottom if line missing

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Section Pictures - 10/10/2025 - Inlet 01-Inlet 02

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 01-Inlet 02**	**3**

Inlet 01-Inlet 02_5e12a33c-8def-4af7-947d-3fb8f3a82718_20251010_090251_999.jpg, 00:02:14, 19.55ft
Miscellaneous Material Change, Reinforced concrete pipe / CMP to RCP

Inlet 01-Inlet 02_b087f79d-6333-44a5-aa5c-0431f36e8aa6_20251010_090302_990.jpg, 00:02:20, 19.55ft
Joint Offset Medium, Start

Inlet 01-Inlet 02_e20c1c36-448b-4eb5-b83c-9f6c7296de66_20251010_090334_265.jpg, 00:02:40, 20.66ft
Deposits Attached Encrustation, 5% of cross sectional area from 12 o'clock to 5 o'clock, within 8 inch

Inlet 01-Inlet 02_5a08e344-e137-4ace-adff-32d12ace4808_20251010_090410_146.jpg, 00:03:05, 23.45ft
Deposits Attached Encrustation, 5% of cross sectional area from 8 o'clock to 4 o'clock, within 8 inch

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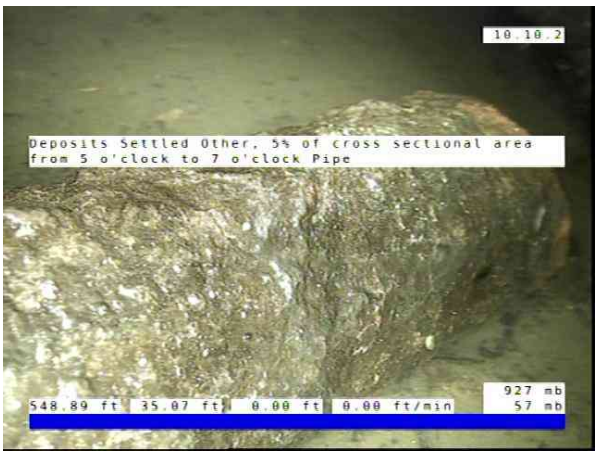
Section Pictures - 10/10/2025 - Inlet 01-Inlet 02

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 01-Inlet 02**	**3**

Inlet 01-Inlet 02_78bfb45a-64ba-49b3-9b29-682460321246_20251010_090502_970.jpg, 00:03:45, 30.59ft
Deposits Settled Fine, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start / Mud/silt



Inlet 01-Inlet 02_8d54024a-3974-45b2-9eba-dbf4e934f909_20251010_090558_813.jpg, 00:04:15, 35.07ft
Deposits Settled Other, 5% of cross sectional area from 5 o'clock to 7 o'clock / Pipe

Inlet 01-Inlet 02_2e7807ff-4cc5-4ebe-9fe1-969bbc6623a5_20251010_090826_600.jpg, 00:06:29, 65.25ft
Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Start

Inlet 01-Inlet 02_d1fadcf8-0bdb-4cb0-9ea1-e30796fcc8aa_20251010_090945_947.jpg, 00:07:37, 75.10ft
Deposits Settled Other, 5% of cross sectional area at 6 o'clock / Pipe

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Section Pictures - 10/10/2025 - Inlet 01-Inlet 02

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 01-Inlet 02**	**3**

Inlet 01-Inlet 02_ad0a5211-56df-4d64-bb13-9cbc7ff451ba_20251010_141901_282.jpg, 00:08:59, 78.46ft
Deposits Settled Gravel, 5% of cross sectional area from 5 o'clock to 7 o'clock, within 8 inch, Finish

Inlet 01-Inlet 02_d30c5ee5-1246-4ddc-a18a-74997edeaa6c_20251010_141924_385.jpg, 00:08:59, 78.46ft
Miscellaneous Survey Abandoned / Debris in line preventing further inspection

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Inspection report

Date:	Work Order:	Weather:	Surveyed By:	Certificate Number:	Pipe Segment Ref.:
10/10/2025			**Nate Johnson**	**P0052605-022025**	**Inlet 04A-Inlet 05**
Year laid:	Pre-cleaning:	Direction:	Pipe Joint Length:	Total Length:	Length Surveyed:
	Not Known	**Downstream**		**0.0 '**	**0.0 '**

City:	**Northfield**	Drainage Area:		Upstream MH:	**Inlet 04A**
Street:	**Cherry Lane**	Media Label:		Up Rim to Invert:	
Location Code:		Flow Control:		Downstream MH:	**Inlet 05**
Location Details:		Sheet Number:		Down Rim to Invert:	
Pipe shape:	**Circular**	Sewer Use:	**Stormwater Pipe**	Total gallons used:	**0.0**
Pipe size:	**18 "**	Sewer Category:	**SEC**	Joints passed:	**0**
Pipe material:	**Reinforced Concrete Pipe**	Purpose:		Joints failed:	**0**
Lining Method:		Owner:			
Additional Info:					

1:50	Distance	Code	Observation	Counter	Photo	Grade
Inlet 04A						
	0.0	ACB	Catch Basin / Inlet 05	00:00:00	Inlet 04-Inlet 05_770bcd	
	0.0	MWL	Water Level, 5% of the vertical dimension	00:00:03	Inlet 04-Inlet 05_0b6b5	
	0.0	MSA	Miscellaneous Survey Abandoned / 100% silt and mud	00:00:44	Inlet 04-Inlet 05_0465d	

QSR	QMR	QOR	SPR	MPR	OPR	SPRI	MPRI	OPRI
0000	0000	0000	0.0	0.0	0.0	0.0	0.0	0.0

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Section Pictures - 10/10/2025 - Inlet 04A-Inlet 05

City	Street	Date	Lateral Segment Reference	Section No.
Northfield	**Cherry Lane**	**10/10/2025**	**Inlet 04A-Inlet 05**	**4**

Inlet 04-Inlet 05_770bcdde-84b8-4ac9-98a4-e624e9c8505c_20251010_100716_451.jpg, 00:00:00, 0.00ft
Catch Basin / Inlet 05

Inlet 04-Inlet 05_0b6b54d4-1ae0-4886-a919-0bd9db447a9c_20251010_100721_453.jpg, 00:00:03, 0.00ft
Water Level, 5% of the vertical dimension

Inlet 04-Inlet 05_0465d8d0-b35e-4f4c-983a-375dfc7bb184_20251010_100823_878.jpg, 00:00:44, 0.00ft
Miscellaneous Survey Abandoned / 100% silt and mud

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nate.johnson@gprsinc.com

WinCan

Notes:

Thank you for choosing to use WinCan to carry out your drainage investigation works.

The results and views carried in this report are those of the engineer(s) appointed to carry out the investigation and are considered relevant on the day of the survey. Drain and sewer performance is known to alter over time, so liability cannot be accepted for differences between the recorded data and the actual data at a time after this report was generated.

This survey has been created in accordance with the drainage standard used in the country and language settings for this PC.

If a DVD has been supplied with this report, please note that it can only be used in a Windows based PC. Please browse the DVD and navigate to the PDF folder to find project-based documents such as drawings, engineer's site notes and survey specifications amongst others.

CCTV subsidence investigations do not account for the water tightness of the pipes and are merely a visual inspection of inside of the drains. CCTV drainage engineers are generally not qualified to comment on the causes of subsidence, and can only suggest required remedial actions for the pipes, and not the affected buildings.

Subsidence is a building structural failure, which can occur for many reasons. Although drainage failures can contribute to subsidence problems, other causes should always be investigated as part of a considered approach. In order to eliminate drains from suspicion, WinCan suggests that all pipes within at least 10m of the subsidence area be pressure tested over and above a CCTV inspection, and remedial suggestions considered based on the findings.

Unless otherwise specified in an associated task order (or similar), the data gathered in this report may not be suitable for use as a pre-lining investigation. We are happy to carry out such surveys, but this must be agreed prior to the commencement of the works, and a the client must specify the data they wish to capture and the acceptable tolerances.

Where GPS coordinates and heights have been issued within this report, they are to 1m accuracy, and 2m accuracy for heights. Greater accuracy can be provided on request.

Appendix C – Hydrologic and Hydraulic Calculations

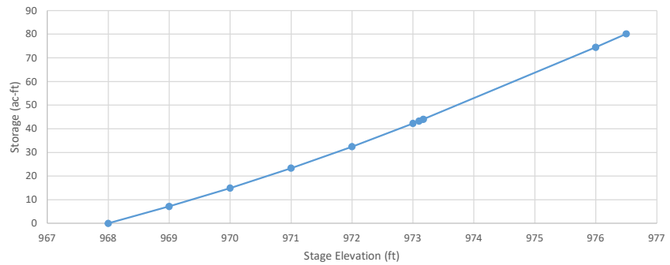
Norwood Lake Hydrologic Analysis

Lake Storage Computations:

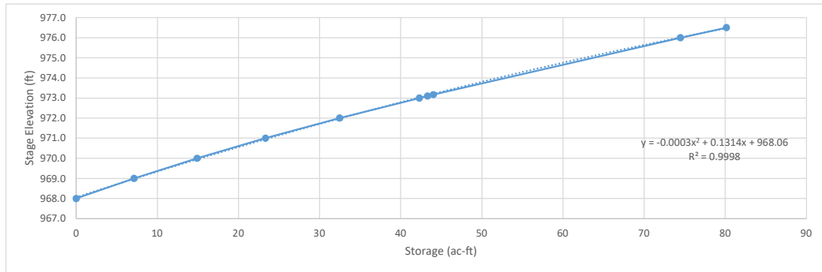
Note	Elevation	Surface Area (SF)	Incremental Volume (CF)	Cum. Vol. (CF)	Cum. Vol. (ac-ft)	Active Storage
Assumed Bottom Elev.	968.0	296,396	0	0	0.000	No
	969.0	324,382	310,389	310,389	7.126	No
	970.0	353,047	338,715	649,104	14.901	No
	971.0	382,358	367,703	1,016,806	23.343	No
	972.0	412,315	397,337	1,414,143	32.464	No
	973.0	442,919	427,617	1,841,760	42.281	No
Estimated Normal Pool Elev.	973.10	446,080	44,450	1,886,209	43.301	No
Bot. of Invert	973.17	448,186	31,299	1,917,509	44.020	Yes
	976	489,400	1,326,684	3,244,193	74.476	Yes
Top of Bank before Overflow	976.5	497,400	246,700	3,490,893	80.140	Yes

Stage-Storage Curve:

Stage-Storage Curve



Inverse Curve Used to Get Stage Elev.

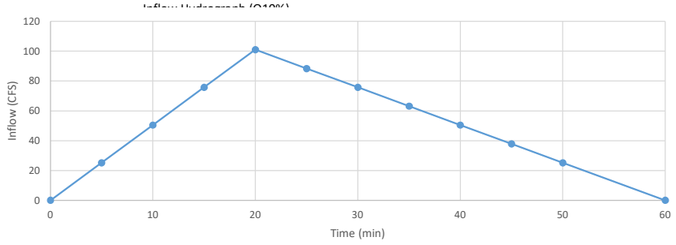


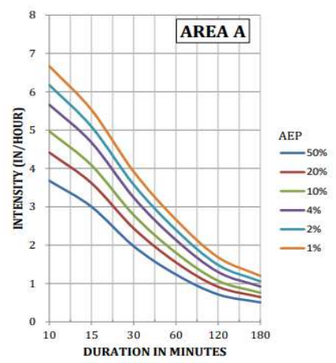
Existing Conditions - 10% Design Storm

Inflow Hydrograph

Variables	Values	Assumptions
Drainage Coefficent C	0.4	estimated, verified
Drainage Area A (ac)	70.4	calc'd
Intensity Zone	A	1102-2
Time of Concentraction Tc (min)	20	assumed
Intensity I (in/hr)	3.56	10% storm - 1101-2
Peak Discharge Q (CFS)	101	
Time of Storm (min)	60	tc + 2*tc

Time (min)	Flow (CFS)
0	0.0
5	25.3
10	50.5
15	75.8
20	101.0
25	88.4
30	75.8
35	63.1
40	50.5
45	37.9
50	25.3
60	0.0





ODOT L&D2 1101-2

$i = a/(t+b)^c$ Where: i = rainfall intensity (inches/hour)
t = time of concentration (minutes)
a = constant
b = constant
c = constant

The IDF Curves can be expressed using the above general equation utilizing the constants shown below.

Intensity Zone	AEP %	Constant a	Constant b	Constant c
A	50	46.184	9.000	0.859
	20	56.985	10.250	0.851
	10	64.167	11.000	0.842
	4	66.528	11.000	0.811
	2	65.702	10.750	0.782
	1	64.489	10.500	0.754

diameter (ft)	n-value	radius (ft)	Slope (ft/ft)
1.25	0.012	0.625	0.0012

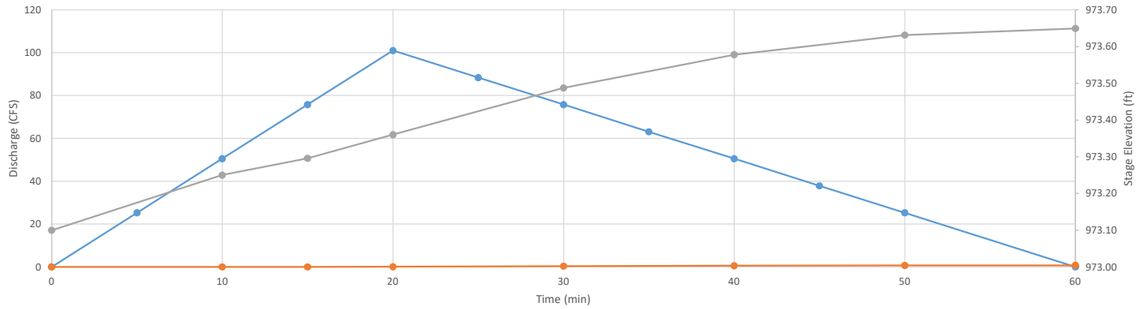
Routing Table

Start with Normal Pool 973.10

Time (min)	Inflow (cfs)	Outflow (cfs)	Elevation (ft)
0	0.0	0.00	973.10
10	50.5	0.02	973.25
15	75.8	0.05	973.30
20	101.0	0.12	973.36
30	75.8	0.34	973.49
40	50.5	0.56	973.58
50	25.3	0.71	973.63
60	0.0	0.76	973.65

Elevation (ft) (Inflow Only)	Inflow Vol Lake (ac-ft)	Inflow Vol (ac-ft)	Total Vol including outfow	Outflow Vol (ac-ft)	Head (ft)	Outflow (CFS)	Area (SF)	Wetted Perimeter (ft)	Hydraulic Radius RH (ft)	theta
973.10	43.30	0		0	0.00	0				
973.25	43.65	0.35	43.65	0.000	0.08	0.02	0.03	0.64	0.05	1.02
973.30	44.08	0.43	44.08	0.000	0.13	0.05	0.06	0.81	0.08	1.29
973.36	44.69	0.61	44.69	0.001	0.19	0.12	0.12	1.00	0.12	1.60
973.49	45.91	1.22	45.91	0.003	0.32	0.34	0.25	1.32	0.19	2.11
973.58	46.78	0.87	46.77	0.006	0.41	0.56	0.35	1.52	0.23	2.43
973.63	47.30	0.52	47.29	0.009	0.46	0.71	0.41	1.63	0.25	2.62
973.65	47.47	0.17	47.46	0.010	0.48	0.76	0.43	1.67	0.26	2.68

Routing Analysis



Drawdown

Volume at End of Inflow (CF)	2,067,569
Drawdown to Pipe Invert	1917509
Volume Difference (CF)	150,061
Average Outflow Discharge	0.70
Time (hour)	60

6.4.5 Steady Uniform Flow

6.4.5.1 Manning's Equation

$$Q = \frac{1.486}{n} A R_H^{2/3} S^{1/2}$$

$$v = \frac{1.486}{n} R_H^{2/3} S^{1/2}$$

where

Q = discharge or flow rate (ft^3/sec)

v = flow velocity (ft/sec)

n = Manning's roughness coefficient

A = cross-sectional area of flow (ft^2)

R_H = hydraulic radius (ft) = $\frac{A}{P}$

P = wetted perimeter (ft)

S = slope (ft/ft)

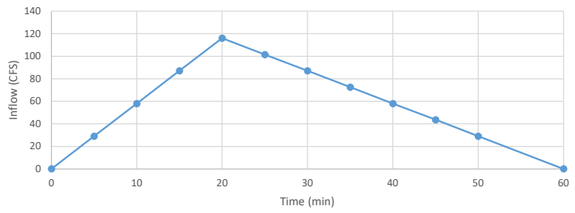
Existing Conditions - 4% Check Storm

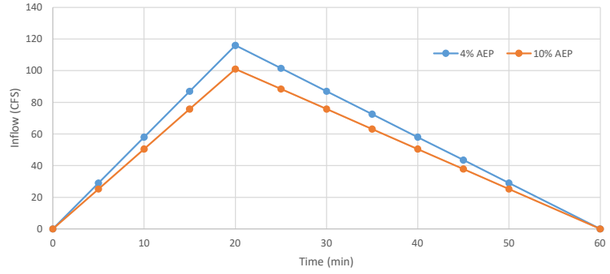
Variables

Drainage Coefficent C		0.4	estimated, verified
Drainage Area A (ac)		70.4	calc'd
Intensity Zone	A		1102-2
Time of Concentraction Tc (min)		20	assumed
Intensity I (in/hr)		4.11	4% storm - 1101-2
Peak Discharge Q (CFS)		116	
Time of Storm (min)		60	tc + 2*tc

Time (min)	Flow (CFS)
0	0.0
5	29.0
10	58.0
15	87.0
20	116.0
25	101.5
30	87.0
35	72.5
40	58.0
45	43.5
50	29.0
60	0.0

Inflow Hydrograph (Q4%)





diameter (ft)	n-value	radius (ft)	Slope (ft/ft)
1.25	0.012	0.625	0.0012

Routing Table

Start with Normal Pool 973.10

Time (min)	Inflow (cfs)	Outflow (cfs)	Elevation (ft)
0	0.0	0.00	973.10
10	58.0	0.02	973.26
15	87.0	0.06	973.31
20	116.0	0.15	973.38
30	87.0	0.43	973.53
40	58.0	0.71	973.63
50	29.0	0.89	973.69
60	0.0	0.95	973.71

Elevation (ft) (Inflow Only)	Inflow Vol Lake (ac-ft)	Inflow Vol (ac-ft)	Total Vol including outfow	Outflow Vol (ac-ft)	Head (ft)	Outflow (CFS)	Area (SF)	Wetted Perimeter (ft)	Hydraulic Radius RH (ft)	theta
973.10	43.30	0		0	0.00	0				
973.26	43.70	0.40	43.70	0.000	0.09	0.02	0.04	0.66	0.06	1.06
973.31	44.20	0.50	44.20	0.000	0.14	0.06	0.07	0.85	0.09	1.36
973.38	44.90	0.70	44.90	0.001	0.21	0.15	0.14	1.06	0.13	1.70
973.53	46.30	1.40	46.29	0.004	0.36	0.43	0.29	1.41	0.21	2.26
973.63	47.30	1.00	47.29	0.008	0.46	0.71	0.41	1.63	0.25	2.61
973.69	47.90	0.60	47.88	0.011	0.52	0.89	0.49	1.76	0.28	2.82
973.71	48.09	0.20	48.08	0.013	0.54	0.95	0.51	1.80	0.28	2.88

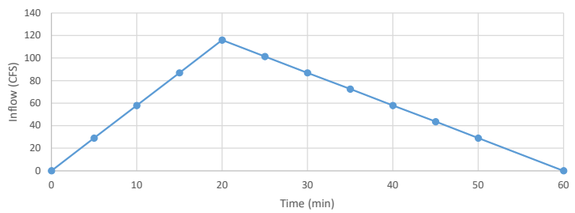
Prop Conditions - 10% Design Storm

Variables

Drainage Coefficent C		0.4	estimated, verified
Drainage Area A (ac)		70.4	calc'd
Intensity Zone	A		1102-2
Time of Concentraction Tc (min)		20	assumed
Intensity I (in/hr)		3.56	10% storm - 1101-2
Peak Discharge Q (CFS)		101	
Time of Storm (min)		60	tc + 2*tc

Time (min)	Flow (CFS)
0	101.0
5	101.0
10	101.0
15	101.0
20	101.0
25	101.5
30	87.0
35	72.5
40	58.0
45	43.5
50	29.0
60	0.0

Inflow Hydrograph (Q4%)



diameter (ft)	n-value	radius (ft)	Slope (ft/ft)
1.25	0.012	0.625	0.0027

Routing Table

Start with Normal Pool 973.10

Time (min)	Inflow (cfs)	Outflow (cfs)	Elevation (ft)
0	101.0	0.00	973.10
10	101.0	0.18	973.36
15	101.0	0.35	973.43
20	101.0	0.57	973.51
30	87.0	1.10	973.64
40	58.0	1.57	973.74
50	29.0	1.87	973.80
60	0.0	1.97	973.82

Elevation (ft) (Inflow Only)	Inflow Vol Lake (ac-ft)	Inflow Vol (ac-ft)	Total Vol including outfow	Outflow Vol (ac-ft)	Head (ft)	Outflow (CFS)	Area (SF)	Wetted Perimeter (ft)	Hydraulic Radius RH (ft)	theta
973.10	43.30	0		0	0.00	0				
973.36	44.69	1.39	44.69	0.001	0.19	0.18	0.12	1.00	0.12	1.60
973.43	45.39	0.70	45.39	0.002	0.26	0.35	0.19	1.19	0.16	1.91
973.51	46.08	0.70	46.08	0.003	0.34	0.57	0.27	1.36	0.19	2.18
973.64	47.38	1.29	47.37	0.012	0.47	1.10	0.42	1.65	0.26	2.64
973.74	48.38	1.00	48.36	0.018	0.57	1.57	0.55	1.86	0.30	2.98
973.81	48.98	0.60	48.95	0.024	0.64	1.87	0.63	1.98	0.32	3.17
973.83	49.18	0.20	49.15	0.026	0.66	1.97	0.65	2.03	0.32	3.24

Existing Storm Sewer Capacity Analysis

1	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
MH CB or I	**Drainage Area (ac)**		**Tc (min)**		Rainfall (in/hr)		Runoff C	CxA		Dischrage (cfs) CA x i		Size of pipe (in)	Length (ft)	Slope (ft/ft)	Inflet FL of Pipe	Outlet Fl	Mean Velocity (fps)	Just Full Capacity	Friction Slope (ft/ft)	Head Loss (ft)	Elev of Hyd. Gradient (for year 25)	Grate or Cover Elev	Cover Elev. - HG elev.
No.	**delta A**	sum A	**delta Tc**	sum Tc	**i10**	i25	**C**	deltaCA	**sumCA**	Q10	**Q25**	D	**L**	S0	**Elev.**	Elev.	**Vm**	cfs	**Sf**	H	Elev.	Elev.	
D0 - Lake Inlet	70.4	70.4	20	20	3.56	4.54	0.4			0.15	0.57												
	^ to Lake		^ Calculated seperately for Lake - does not carry downstream									15	192	0.0012	973.17	973.17	1.98	2.42	0.0012	0.22858	973.767	974.42	0.65
D1 - JCT Box	1.008	1.008	45.0	45.0	2.16	1.97	0.62	0.62	0.62496	1.5	1.8												
												18	54.62	0.0062	973.00	973.00	5.07	8.96	0.0062	0.33598	973.538	976	2.46
D2 MH	2.045	3.053	0.2	45.2	2.16	1.97	0.53	1.08	1.71	3.8	3.9												
												18	459.4	0.0028	972.65	972.65	3.41	6.02	0.0028	1.27619	973.202	977.36	4.16
D3 - DOUBLE CB	10.55	13.6	57.0	57.0	1.84	1.97	0.29	3.06	4.77	8.9	10.0												
												18	41.3	0.0022	970.09	970.00	3.02	5.34	0.0022	0.09014	971.926	975.4	3.47
D4 CB	9.83	23.43	64.0	64.0	1.69	1.97	0.46	4.52	9.29	15.9	18.9												
												18	182.7	0.001	970.00	970.00	2.04	3.60	0.0010	0.18126	971.836	973.53	1.69
D6 CBR	10.42	33.85	1.5	65.5	1.66	1.97	0.34	3.54	12.83	21.5	25.9												
												24	336.5	0.0025	969.00	969.00	3.90	12.25	0.0025	0.83462	971.655	972.05	0.39538
D7 JCT BOX																							
													Existing system does not have sufficent hydraulic capacity to convey design storm to SR-82								970.82	975.36	

Calculations performed using CDSS methodologies with max discharge added from Norwood Lake

Conceptual Proposed Storm Sewer Analysis

1	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
MH CB or I	**Drainage Area (ac)**		**Tc (min)**		Rainfall (in/hr)		Runoff C	CxA		Dischrage (cfs) CA x i		Size of pipe (in)	Length (ft)	Slope (ft/ft)	Inflet FL of Pipe	Outlet Fl	Mean Velocity (fps)	Just Full Capacity	Friction Slope	Head Loss	Elev of Hyd. Gradient (for year 25)	Grate or Cover Elev	Cover Elev. - HG elev.
No.	**delta A**	sum A	**delta Tc**	sum Tc	**i10**	i25	**C**	deltaCA	**sumCA**	Q10	**Q25**	D	**L**	S0	**Elev.**	Elev.	**Vm**	cfs	**Sf**				
Inlet	70.4	70.4	20	20	3.56	4.54	0.4			0.15	0.57												
	^ to Lake		^ Calculated seperately for Lake - does not carry downstream									15	194.0	0.0027	973.17	973.17	2.95	3.6	0.0027	0.5159	976.017	977.36	1.34
D-1 JCT BOX	1.008	1.008	45.0	45.0	2.16	1.70	0.62	0.62	0.62496	1.5	1.6												
												18	54.62	0.0062	973.00	973.00	5.07	8.96	0.0062	0.33598	975.837	976	0.16
D-2X MH	2.045	3.053	0.18	45.2	2.16	1.70	0.53	1.08	1.71	3.8	3.5												
												18	456.0	0.0028	972.65	972.65	3.39	6.0	0.0027	1.25007	975.501	973.53	-1.97
D-3 Double CB	10.53	13.58	79.0	79.0	1.45	1.70	0.28	2.95	4.66	6.9	8.5												
												19X30	34.0	0.0026	970.09	970.09	3.90	12.1	0.0084	0.28678	974.251	972.85	-1.40
D-4 CB	9.83	23.41	0.1	79.1	1.45	1.70	0.46	4.52	9.18	13.5	16.2												
												24x38	181.0	0.0019	970	970	3.90	19.4	0.0062	1.12283	973.964	972.85	-1.11
D-5 CB	9.0	32.41	0.8	79.9	1.44	1.70	0.34	3.06	12.24	17.8	21.4												
												24x38	188.0	0.0019	969.65	969.65	3.88	19.3	0.0061	1.15491	972.841	975	2.16
D-6 CB	1.5	33.91	0.8	80.7	1.43	1.70	0.4	0.60	12.84	18.5	22.4												
												24x38	140.0	0.0019	969.29	969.29	3.89	19.4	0.0062	0.86619	971.686	975.36	3.67
D-7 ODOT																							
																					970.82	975.36	

Calculations performed using CDSS methodologies with max discharge added from Norwood Lake

Appendix D – Preliminary Plan and Profile – Preferred Alternative

NORWOOD LAKE STORM SEWER OUTLET IMPROVEMENTS

MODEL: OPTION 2 SHEET - 1 PAPERSIZE: 17x11 (in.) DATE: 2/17/2026 TIME: 10:53:12 AM PLTDRV: OHDOT_PDF_Color.pltcfg PENTBL: OHDOT_PenC.tbl USER: vdrajich@palmernet.com WORKSPACE: OHDOTCEv02 WORKSET: SCE Norwood Lake Outlet Storm Water Improvements PRODUCT: OpenRoadsDesigner 24.00.00.205
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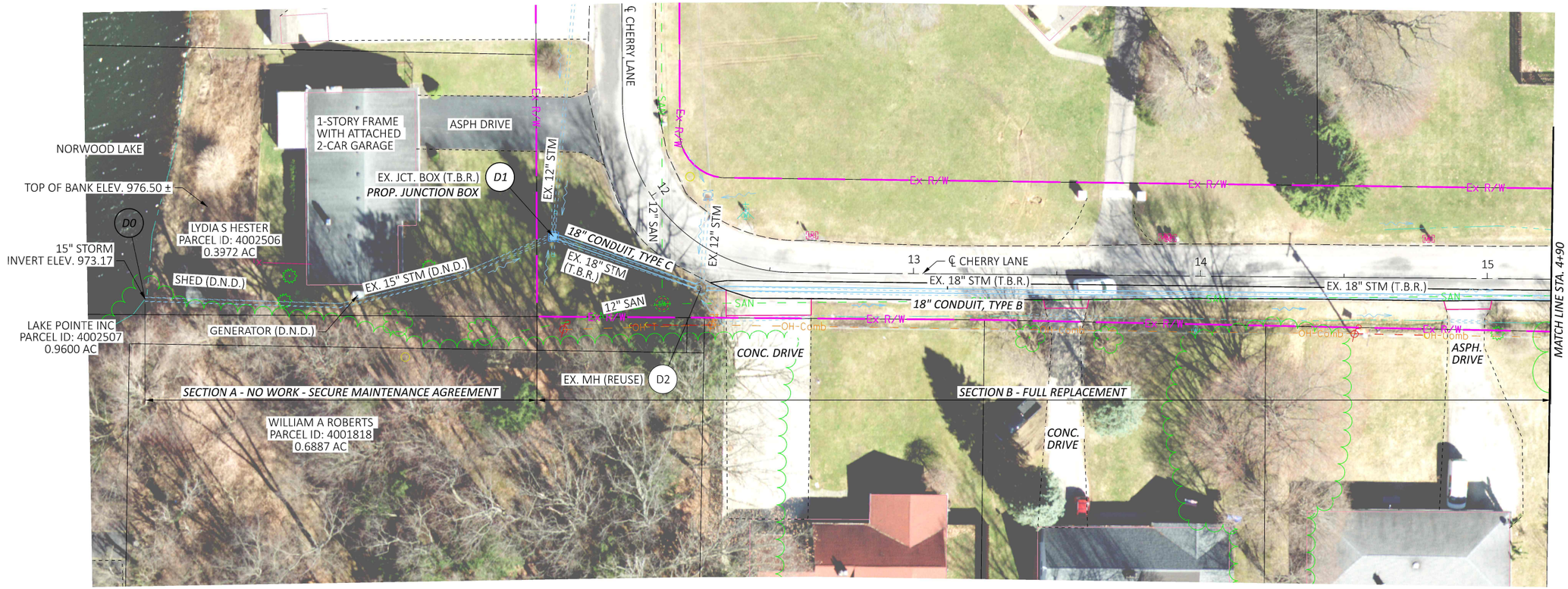

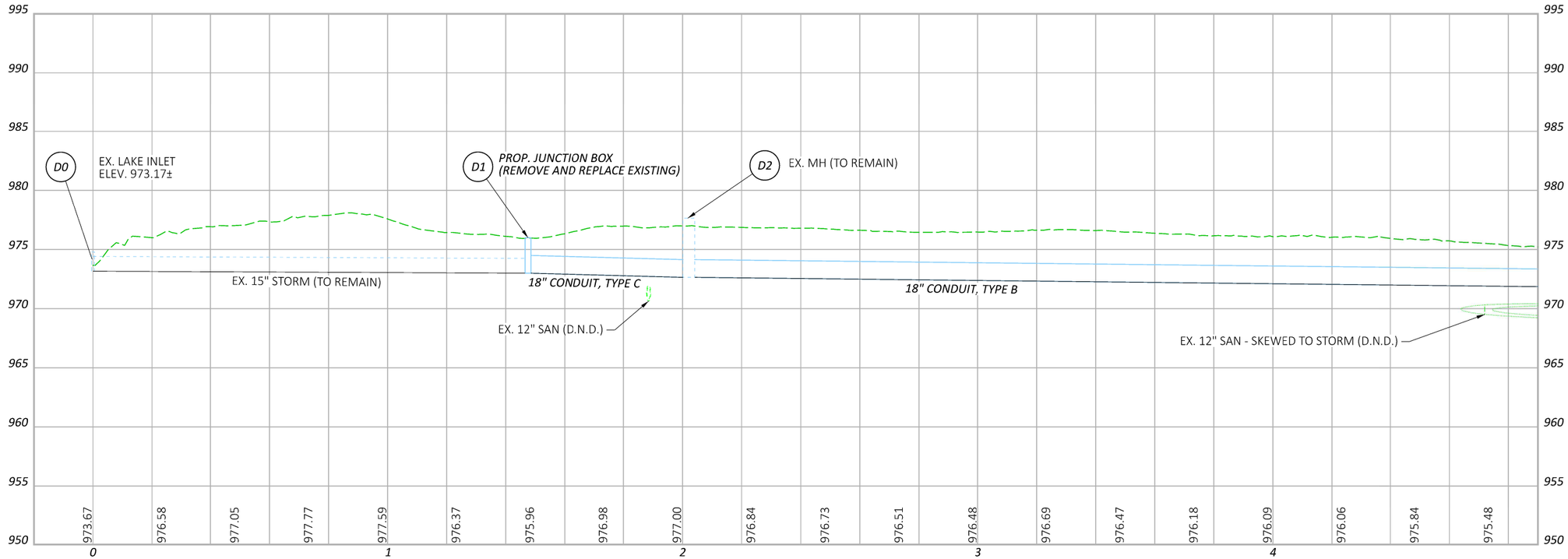

HORIZONTAL SCALE IN FEET
0 10 20 40

APPENDIX D
15% PRELIMINARY PLAN - SHEET 1 OF 3

DESIGN AGENCY
Palmer ENGINEERING
3745 MEDINA ROAD
SUITE A
MEDINA, OH 44256
(330) 952-1464

DESIGNER	VND
REVIEWER	MLJ 02/17/26
PROJECT ID	N/A
SHEET	1
TOTAL	3

NORWOOD LAKE STORM SEWER OUTLET IMPROVEMENTS

MODEL: OPTION 2 SHEET - 2 PAPERSIZE: 17x11 (in.) DATE: 2/17/2026 TIME: 11:31:56 AM PLTDRV: OHDOT_PDF_Color.pltcfg PENTBL: OHDOT_PenC.tbl USER: vdragich@palmernet.com WORKSPACE: OHDOTCEv02 WORKSET: SCE Norwood Lake Outlet Storm Water Improvements PRODUCT: OpenRoadsDesigner 24.00.00.205
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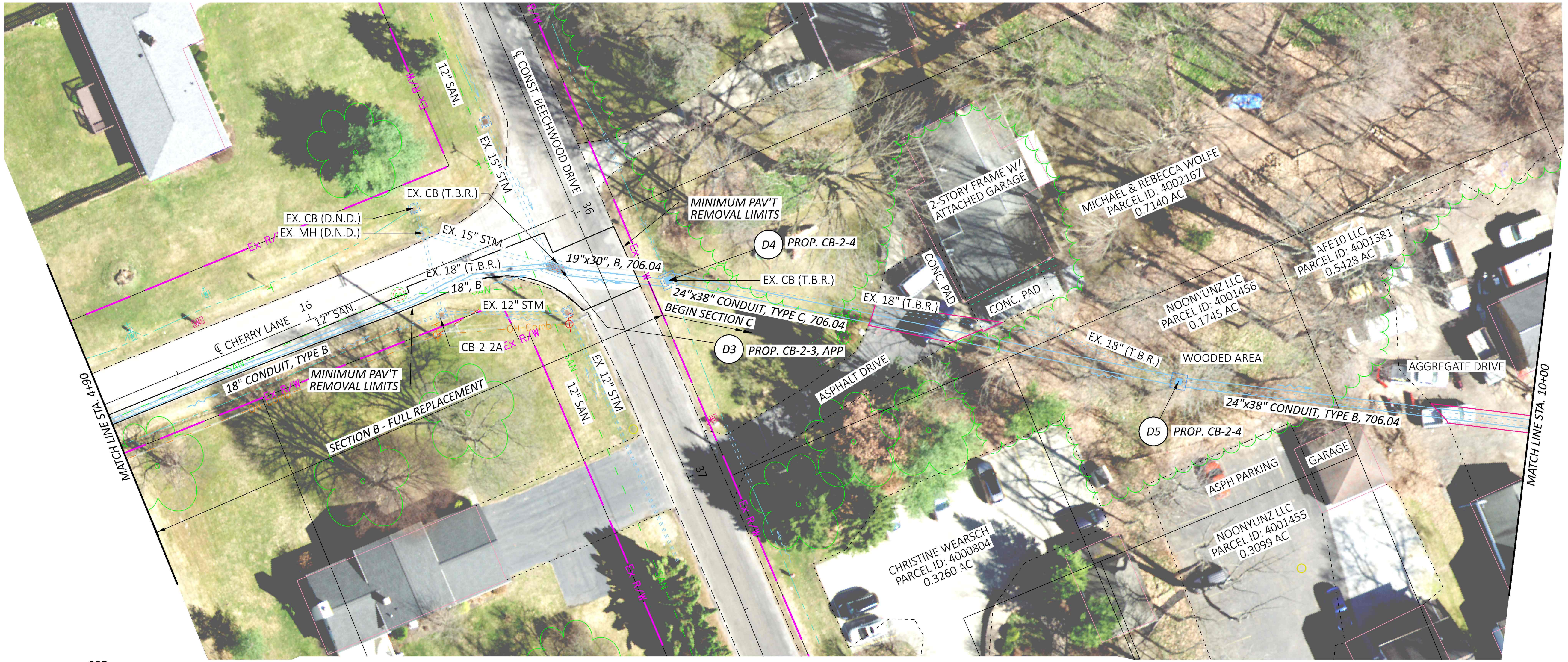

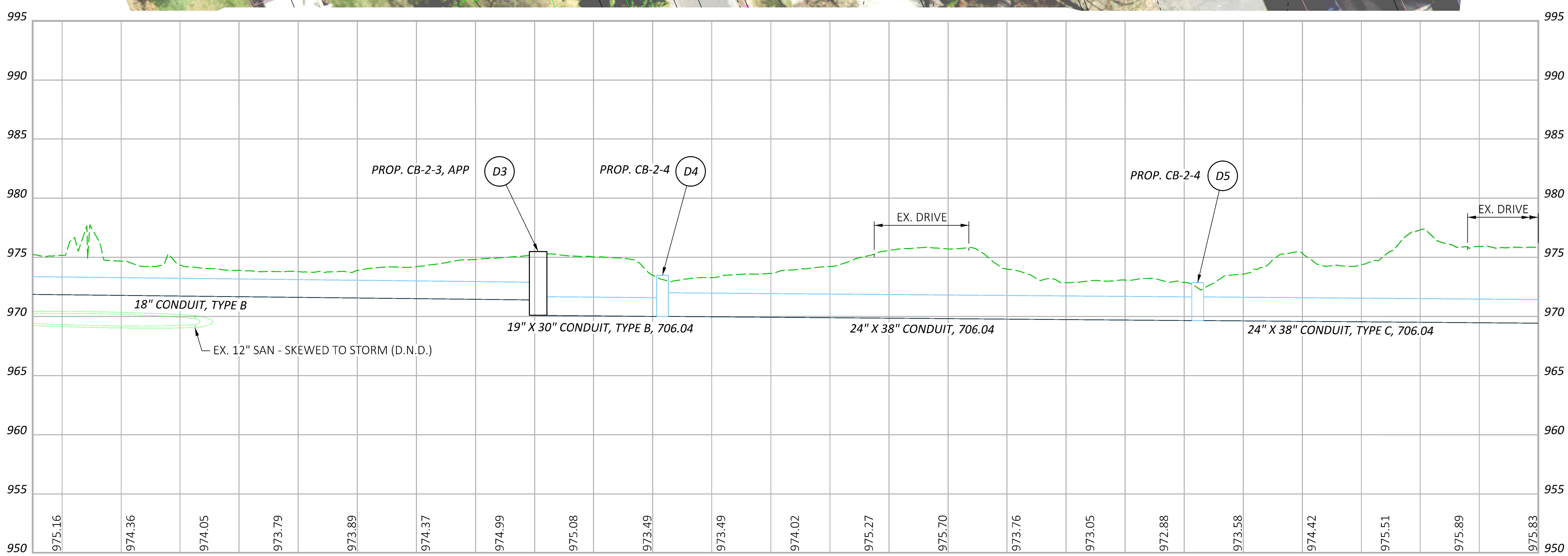

HORIZONTAL SCALE IN FEET
0 10 20 40

APPENDIX D
15% PRELIMINARY PLAN - SHEET 2 OF 3

DESIGN AGENCY
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3745 MEDINA ROAD
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MEDINA, OH 44256
(330) 952-1464

DESIGNER
VND

REVIEWER
MLJ 02/17/26

PROJECT ID
N/A

SHEET 2
TOTAL 3

NORWOOD LAKE STORM SEWER OUTLET IMPROVEMENTS

MODEL: OPTION 2 SHEET - 3 PAPERSIZE: 17x11 (in.) DATE: 2/17/2026 TIME: 11:32:39 AM PLTDRV: OHDOT_PDF_Color.pltcfg PENTBL: OHDOT_PenC.tbl USER: vdragich@palmernet.com WORKSPACE: OHDOTCEv02 WORKSET: SCE Norwood Lake Outlet Storm Water Improvements PRODUCT: OpenRoadsDesigner 24.00.00.205
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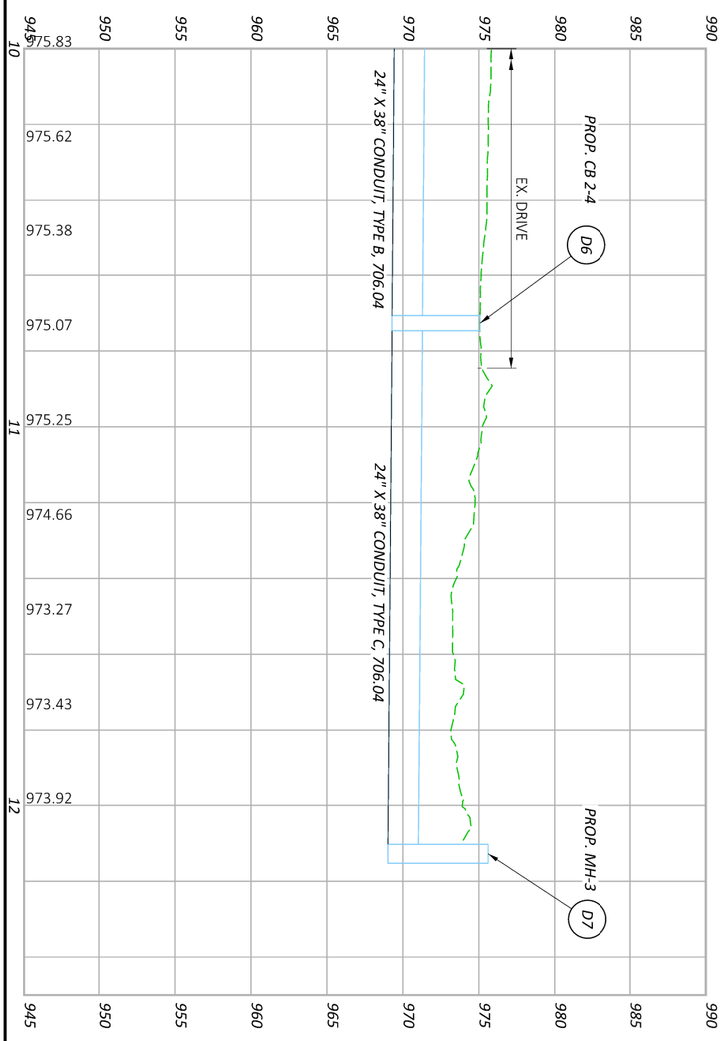

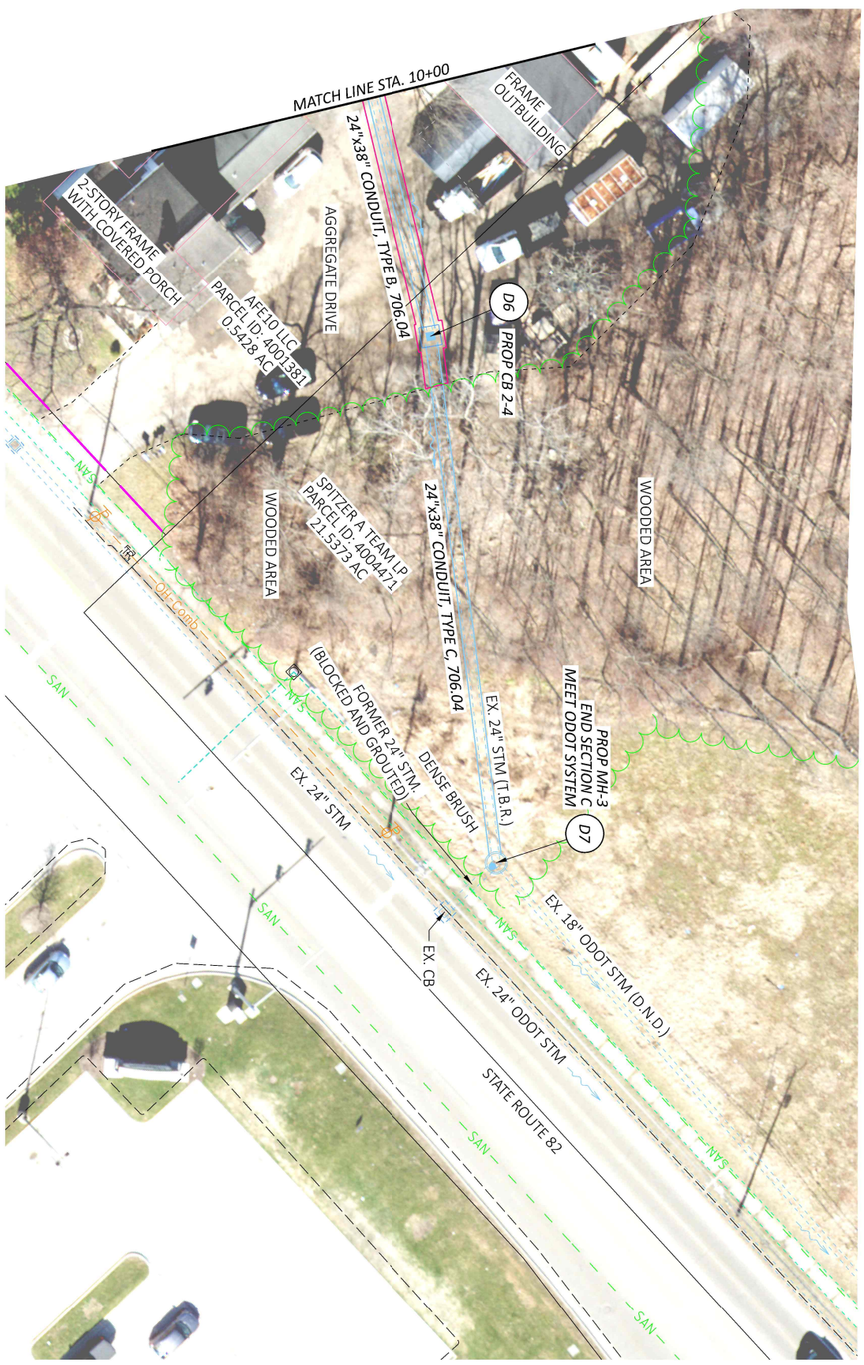

DESIGN AGENCY
Palmer ENGINEERING
3745 MEDINA ROAD
SUITE A
MEDINA, OH 44256
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DESIGNER VND
REVIEWER MLJ 02/17/26
PROJECT ID N/A
SHEET 3 | TOTAL 3

APPENDIX D
15% PRELIMINARY PLAN - SHEET 3 OF 3

HORIZONTAL SCALE IN FEET
0 20
10 40

Appendix E – Preliminary Cost Estimates

SECTION A : ESTIMATES

Section A - Full Replacment - Estimated Cost Summary					
Item No.	*Item*	*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
201E11000	*Clearing and Grubbing*	*LS*	*Lump*	*$ 3,500*	*$ 3,500*
202E35100	*Pipe Removed, 24" and Under*	*146*	*LF*	*$ 20*	*$ 2,920*
611E07400	*15" Conduit, Type C*	*146*	*LF*	*$ 135*	*$ 19,710*
614E11000	*Maintenance of Traffic*	*LS*	*Lump*	*$ 1,500*	*$ 1,500*
623E10000	*Mobilization*	*LS*	*Lump*	*$ 1,600*	*$ 1,600*
624E10000	*Construction Inspection*	*LS*	*Lump*	*$ 2,600*	*$ 2,600*
	Construction Cost Subtotal				*$ 31,830*
	Right-of-Way (includes shed removal and AC relocation)				*$ 18,700*
	Design Contingency (10%)				*$ 3,200*
	Inflation Contigency (6%)				*$ 1,900*
				GRAND TOTAL	***$ 55,630***

Section A - Rehabilitation - Estimated Cost Summary					
Item No.	Item	Quantity	Unit	Unit Cost	Total Cost
201E11000	*Clearing and Grubbing*	*LS*	*Lump*	*$ 1,500*	*$ 1,500*
899E10000	*Cured-In-Place Pipe Liner, 15" Diameter*	*146*	*LF*	*$ 200*	*$ 29,200*
614E11000	*Maintenance of Traffic*	*LS*	*Lump*	*$ 600*	*$ 600*
623E10000	*Mobilization*	*LS*	*Lump*	*$ 1,800*	*$ 1,800*
624E10000	*Construction Inspection*	*LS*	*Lump*	*$ 3,100*	*$ 3,100*
	Construction Cost Subtotal				*$ 36,200*
	Right-of-Way				*$ 6,200*
	Design Contingency (10%)				*$ 3,600*
	Inflation Contigency (6%)				*$ 2,200*
				GRAND TOTAL	***$ 48,200***

Section B - Full Replacment - Estimated Cost Summary					
Item No.	*Item*	*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
201E11000	*Clearing and Grubbing*	*LS*	*Lump*	*$ 1,000*	*$ 1,000*
202E23000	*Pavement Removed*	*355*	*SY*	*$ 25*	*$ 8,875*
202E35100	*Pipe Removed, 24" and Under*	*544*	*LF*	*$ 20*	*$ 10,880*
202E58100	*Catch Basin Removed*	*3*	*EACH*	*$ 660*	*$ 1,980*
301E56000	*Asphalt Concrete Base*	*45*	*CY*	*$ 310*	*$ 13,950*
304E20000	*Aggregate Base*	*55*	*CY*	*$ 90*	*$ 4,950*
441E70000	*Asphalt Concrete Surface Course, Type 1, (449)*	*11*	*CY*	*$ 210*	*$ 2,310*
441E70200	*Asphalt Concrete intermediate Course, Type 1, (449)*	*16*	*CY*	*$ 200*	*$ 3,200*
441E70500	*AC Surface Course, Type 1, 449, (Driveways)*	*0.25*	*CY*	*$ 450*	*$ 113*
452E10050	*6" Non-Reinforced Concrete, Class QC MS*	*26*	*SY*	*$ 110*	*$ 2,860*
611E05900	*15" Conduit, Type B*	*8*	*LF*	*$ 285*	*$ 2,280*
611E07400	*18" Conduit, Type B*	*460*	*LF*	*$ 160*	*$ 73,600*
611E07600	*18" Conduit, Type C*	*55*	*LF*	*$ 115*	*$ 6,325*
611E52302	*19" X 30" Conduit, TYPE B, 706.04*	*34*	*LF*	*$ 275*	*$ 9,350*
611E98511	*Catch Basin, 2-3, As Per Plan*	*1*	*EACH*	*$ 6,000*	*$ 6,000*
614E11000	*Maintenance of Traffic*	*LS*	*Lump*	*$ 8,900*	*$ 8,900*
623E10000	*Mobilization*	*LS*	*Lump*	*$ 8,900*	*$ 8,900*
624E10000	*Construction Inspection*	*LS*	*Lump*	*$ 17,700*	*$ 17,700*
	Construction Cost Subtotal				*$ 183,173*
	Right-of-Way				*$ -*
	Design Contingency (10%)				*$ 18,300*
	Inflation Contigency (6%)				*$ 11,000*
				GRAND TOTAL	***$ 212,473***

Section B - Rehabilitation - Estimated Cost Summary					
Item No.	*Item*	*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
899E10000	*Cured-In-Place Pipe Liner, 18" Diameter*	*556*	*LF*	*$ 240*	*$ 133,440*
614E11000	*Maintenance of Traffic*	*LS*	*Lump*	*$ 2,700*	*$ 2,700*
623E10000	*Mobilization*	*LS*	*Lump*	*$ 10,700*	*$ 10,700*
624E10000	*Construction Inspection*	*LS*	*Lump*	*$ 13,300*	*$ 13,300*
	Construction Cost Subtotal				*$ 160,140*
	Right-of-Way				*$ -*
	Design Contingency (10%)				*$ 16,000*
	Inflation Contigency (6%)				*$ 9,600*
				GRAND TOTAL	***$ 185,740***

SECTION C: ESTIMATE

PART C: Full Replacement - Cost Estimate					
Item No.	*Item*	*Quantity*	*Unit*	*Unit Cost*	*Total Cost*
201E11000	*Clearing and Grubbing*	*LS*	*Lump*	*$ 4,500*	*$ 4,500*
202E23000	*Pavement Removed*	*36*	*SY*	*$ 25*	*$ 900*
202E35100	*Pipe Removed, 24" and Under*	*328*	*LF*	*$ 20*	*$ 6,560*
202E58100	*Catch Basin Removed*	*4*	*EACH*	*$ 660*	*$ 2,640*
304E20000	*Aggregate Base*	*23*	*CY*	*$ 90*	*$ 2,070*
441E70500	*AC Surface Course, Type 1, 449, (Driveways)*	*2*	*CY*	*$ 450*	*$ 900*
611E52502	*24" X 38" CONDUIT, TYPE B, 706.04*	*140*	*LF*	*$ 220*	*$ 30,800*
611E52504	*24" X 38" CONDUIT, TYPE C, 706.04*	*369*	*LF*	*$ 190*	*$ 70,110*
611E98540	*Catch Basin, 2-4*	*3*	*EACH*	*$ 4,750*	*$ 14,250*
611E99574	*Manhole, No. 3*	*1*	*EACH*	*$ 6,000*	*$ 6,000*
614E11000	*Maintenance of Traffic*	*LS*	*Lump*	*$ 4,200*	*$ 4,200*
623E10000	*Mobilization*	*LS*	*Lump*	*$ 8,300*	*$ 8,300*
624E10000	*Construction Inspection*	*LS*	*Lump*	*$ 16,600*	*$ 16,600*
	Construction Cost Subtotal				*$ 167,830*
	Right-of-Way				*$ 22,300*
	Design Contingency (10%)				*$ 16,800*
	Inflation Contigency (6%)				*$ 10,100*
				GRAND TOTAL	***$ 217,030***