STUDY & RECOMMENDATIONS OF DRAINAGE IMPROVEMENTS TO THE GLENVIEW ROAD DRAINAGE DITCH & CULVERT

SUBMITTED TO:

THE BOROUGH OF NORTH CALDWELL

SUBMITTED BY:

PETRY ENGINEERING, LLC

155 PASSAIC AVENUE

FAIRFIELD, NEW JERSEY 07004

JANUARY 10, 2019

PETRY ENGINEERING, LLC

January 10, 2019

Mr. Frank Zichelli, PE
Borough Administrator
Borough of North Caldwell
141 Gould Avenue
North Caldwell, New Jersey 07006

RE: Study and Recommendation of
Drainage Improvements to the Glenview
Road Drainage Ditch and Culvert

Dear Mr. Zichelli:

Pursuant to our proposal and your authorization, our firm has completed the Study and Recommendation of Drainage Improvements to the Glenview Road Drainage Ditch and Culvert.

Our investigation included studies of the hydrologic and hydraulic conditions within the tributary area and the culvert itself, as well as the evaluation of alternatives for the various options for the improvements. The studies comprise a total of three binders of technical information, a full copy of which has been provided as part of this submittal. We have chosen to separate the report and recommendations from the technical data in order to not over-burden the reader with information that can only be expertly interpreted by those who fully understand the programs.

This report includes the results of the study to allow for a complete understanding of the work performed. We trust that you will find the information comprehensive and we are available to answer any questions the municipal officials may have.

We thank you for the opportunity to be of service to the Borough of North Caldwell.

Very truly yours,

PETRY ENGINEERING, LLC

J. Michael Petry, PE, PP, AIA

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HYDROLOGIC ANALYSIS

Our first step of the analysis was to develop sufficient mapping from the data gathered to establish an overall drainage area that is tributary to the culvert. Utilizing survey information, along with both the County topo mapping and the development plans, we established an overall drainage area of 84.71 acres. This drainage area exceeds the 50-acre NJDEP threshold for regulations, officially classifying the watercourse as a requested stream. Therefore, any work performed on the culvert or the stream itself will require NJDEP review and approval.

Based upon our field observations, we established the various ground covers and development patterns that effect stormwater runoff within the study area. This analysis allows our team to determine how stormwater runs off each of the various areas within the drainage study area. We did this for conditions both prior to and after the development of the Hilltop parcels so that we could provide an understanding of the impacts of those developments on the culvert and stream. We also evaluated the construction records from HEP SCD to determine the conditions during the August 11, 2018 storm event, as this event occurred while the second project was under construction and the drainage improvements were not completed and functioning as designed.

Our study was performed using Technical Release 55 – Urban Hydrology for Small Watersheds (TR-55) which is an industry standard for drainage studies such as this. We also utilized the most recent NRCS storm types, which differ slightly from what was utilized in the previous evaluations. Our study determined that the pre-construction peak flows into the culvert were higher for each and every storm analyzed when compared to the post-construction peak flows, due to the stormwater management systems that were proposed as part of those developments. We also established the overall flows, since the post-construction condition does increase the total volume of runoff.

Comparison of Pre- and Post-Development peak flows

Flood Event	Pre-Development Peak Flows (cfs)	Post Development Peak Flows (cfs)
2-Year Flood	60.99	44.62
5-Year Flood	101.08	75.91
10-Year Flood	137.95	105.09
25-Year Flood	195.50	154.28
50-Year Flood	246.61	204.91
100-Year Flood	304.52	263.66

We utilized the flow information from the pre-development and post-development conditions to route the stream and culvert for a comparative analysis. Our initial findings indicated that the culvert crossing Glenview does not have the capacity to handle flows greater than a 2-year storm. The lack of capacity in the culvert to handle even the smaller storms, such as a 2-year, is significant as much of the older drainage infrastructure was sized for at least a 10-year storm and more recently a 25-year storm.

As part of any analysis developed for NJDEP, the flood hazard elevation needs to be analyzed. This is developed by increasing the flows from the 100-year flood event by 25% to establish the regulated flood area (referred to as the New Jersey Flood Hazard Area Design Flood or NJFHADF). Again, our team implemented this flow for both the pre-Hilltop and post-Hilltop development conditions. Details of all of this information are contained in the Hydrologic Study that is included in this submittal.

HYDRAULIC ANALYSIS

Existing Conditions

Utilizing the flow data established in our hydrologic study, our team walked the entire reach of the stream corridor study area to determine the conditions within the channel itself. These conditions affect the flow rate within the stream.

The majority of the channel within the study area, both upstream and downstream of the culvert, is in its natural state. However, the area between 17 and 19 Glenview shows signs of man-made changes, likely due to the tight proximity of the improvements within those two properties. Within this reach, the channel is primarily stone-lined and shows a reduced cross-section. The stone lining within the channel reduces its capacity.

Similarly, the flood area outside of the channel is primarily lawn and wooded areas, with the exception of the area immediately around the Glenview crossing. Within this area, the surrounding homes include standard improvements such as paved driveways, walkways, patios and (in some instances) pools. These improvements affect the runoff conditions within the flood area.

The culvert itself consists of two pipes in series, a 36-inch reinforced concrete pipe (RCP) followed by a 60-inch by 41-inch corrugated metal elliptical pipe (CMEP). The 36-inch pipe is the more restrictive of the two and, therefore, it was utilized in the modeling of the conditions. The existing 36-inch RCP does not have a headwall, which impacts the modeling of the culvert conditions.

Approximately 1300 linear feet downstream of the Glenview culvert is the Ferndale Culvert. This culvert is a 42-inch RCP. The upstream face of the culvert includes a headwall. The stretch of stream between the two culverts is somewhat steeper than the stream approaching the Glenview Culvert. As such, the downgradient reach of the stream is less prone to flooding.

The first part of the hydraulic report presents details of the various storm events and the models associated with those storm events. For purposes of giving the reader a general understanding of the flooding conditions, our overall report here focuses on the NJDEP Flood Hazard Event (NJFHADF). Figures 4 and 5 show the flooding conditions based upon the pre-development and

post-development conditions of the Hilltop properties to allow for an understanding of their impact on flooding.

We note that the flooding limits shown on these studies are in keeping with the information gathered from the municipal officials and the neighbors as it related to the August 11, 2018 storm event. While this storm event did not produce rainfall to the level of the NJDEP Flood Hazard Event storm, the flash-flooding associated with that storm produced significant flood events within the surrounding communities.

Our analysis shows that virtually every storm event overtops the Glenview roadway, thereby flooding the adjacent homes and the yards of several nearby homes. The following chart shows the water surface elevations associated with the various storms in the existing conditions. Please note that the curb at the roadway crossing is at elevation 549.3, so every elevation above that would overtop the roadway at the crossing location.

Water Surface Elevation (WSEL) at the Culvert

Percent Chance Flood	Pre-Development WSEL (ft)	Post Development WSEL (ft)
2-Year Flood	549.5	548.9
5-Year Flood	549.5	549.7
10-Year Flood	549.3	549.4
25-Year Flood	549.9	549.5
50-Year Flood	549.9	549.9
100-Year Flood	549.9	549.9
NJFHADF	549.9	549.9

NJDEP regulations require that we evaluate the NJFHADF for any culvert replacement. It does allow for consideration of a lesser storm event (25-year) in the event that the work associated with the regulatory storm is overly burdensome or requires more work within the stream than is practical.

We note in our studies that the Ferndale Road Culvert, located approximately 1,300 feet downstream of the Glenview Culvert, can only convey flows from the 10-year storm. In a similar fashion, when this culvert fails, it also overtops the roadway. Any modifications to the Glenview Culvert need to be modeled to Ferndale to ensure that the changes do not exacerbate flooding at Ferndale.

Proposed Solutions

Our analysis shows that, while the culvert is undersized and causes back-up to occur, the modified channel between #17 & #19 does not have adequate capacity to convey the higher storms to the culvert. As such, just replacing the culvert will not solve the problem. The channel between these two homes needs to be modified in order to alleviate the flooding conditions.

The evaluation of the channel as it approaches the culvert requires a modification that includes widening the bottom of the channel and changing the side slopes. Because the slopes will need to be steeper, the entire channel will need to be constructed of rip-rap at a minimum from the rear of the 17/19 properties and up to the culvert. In order to convey the NJFHADF, the channel located between the two houses will need to have vertical walls

Option #1

Given the elevation of the existing roadway, along with the elevation of the streambed, there is no real alternative that can accommodate the NJFHADF within these two constraints. Without changes to the streambed, the best solution we have found would accommodate the 25-year storm event.

This option incorporates a 3-feet high by 10-feet wide box culvert at the Glenview crossing. The 3-foot high culvert allows for the channel bottom to remain at its current invert elevation. We do, however, require that the channel bottom along the stretch of stream that runs between the #17 & #19 properties to be widened to eight feet, and the side slopes constructed at a 1:1 slope. The entire modified section of the stream will need to be grouted rip-rap in order to hold the slopes. Figure 6 includes mapping of the flood conditions for the 25-year storm if Option #1 is implemented. Please note that all other flood figures are developed utilizing the NJFHADF flows, while this particular figure is developed for a lesser storm.

Storms greater in intensity than a 25-year storm will continue to overtop the road and cause flooding within the abutting roadways. The flooding would continue to impact the homes at #17 and #19, as both properties have conditions within the front yards that are lower than the roadway elevation.

Option #2

In order to accommodate the NJFHADF, the invert of the culvert on the upgradient side of the crossing will need to be lowered. This will allow us to limit the disturbance to the downstream section of the channel. Since the upstream section is being reconstructed at a lower elevation, our recommendation is to include walls on the sides of the channel between the two homes and utilize the same rip-rap sides within the rear portion of the lots. The walls will help to ensure that the structures are not undermined as the channel bottom is lowered.

The required box culvert increases to a 4.5-feet by 10-feet structure at the Glenview crossing. In both instances, the culvert will be constructed with a headwall in order to guide the flow into the

structure. The top of the headwall and the top of the walls that line the stream at the culvert would be constructed at an elevation of 550.0, to allow for flows to enter the culvert and not pass over the roadway. Figure 7 includes the mapping of the proposed flood limits for the NJFHADF if this solution is implemented. The flood surface elevations are included in the following chart:

Water Surface Elevation (WSEL) at the Culvert

Percent Chance Flood	Existing 36" RCP Culvert Pre-Development WSEL (ft)	Proposed 4.5' x 10' Culvert Pre-Development WSEL (ft)
2-Year Flood	549.5	545.4
5-Year Flood	549.5	546.0
10-Year Flood	549.3	546.6
25-Year Flood	549.9	547.4
50-Year Flood	549.9	548.0
100-Year Flood	549.9	548.7
NJFHADF	549.9	549.8

As part of our efforts, our team met with representatives of NJDEP and presented the existing conditions, as well as the two options for the culvert replacement. NJDEP recommended that the Borough pursue the proposed project as a Flood Improvement Project, as this will allow for certain requirements for net fill to be eliminated. It is anticipated that either Option #1 or Option #2 would be required to be submitted for Individual Permits for both Flood Hazard Area permits and Freshwater Wetland Permits.

We note that the Borough will either require an easement within the limits of the work area or the abutting homeowners will be required to sign-off as property owners on any application made to the State.

FINAL RECOMMENDATIONS

It is in the best interest of the Borough to secure approval for the Option #2 solution to ensure that the flooding in the area is addressed to the current State standard. However, this solution will require the most significant channel modifications and will, therefore, be scrutinized by the Wetlands group at NJDEP. It is possible that the DEP could force the Borough to reduce the scope to Option #1 in order to limit the stream disturbance.

Please note that any Individual Permit requires an alternatives analysis. This analysis will need to include the potential of purchasing the existing homes that are impacted so as to limit the required stream disturbance. Additionally, wetland mitigation will be required. The rate for mitigation varies dramatically from 2:1 to as high as 8:1 based upon the disturbed areas. Mitigation can be performed within municipally-owned land (such as parks) or by the purchase of credits. The purchase of credits is limited and quite expensive. However, any private

mitigation will require the submittal of a plan, along with a five-year maintenance program that includes inspections and reports filed with DEP each year.

Based upon the current regulations, either option would be subject to NJDEP review of:

The Flood Hazard Area and Floodway Limits established under Method 6
Individual FHA Permit for Channel Modifications/Culvert Replacement
Freshwater Wetlands Determination & LOI
Freshwater Wetlands Individual Permit for Channel Modifications

Subtotal NJDEP Fees Budget $ 27,000.00

Hudson-Essex-Passaic Soil Conservation District approval of a Soil Erosion & Sediment Control Plan would be required for any project undertaken at this location.

HEP SCD Permit Fees Budget $ 1,000.00

Wetlands Mitigation will be required for the stream disturbance. The cost of the mitigation is directly related to the area of disturbance and the ratio that DEP requires. Since this is a flood control project in a disturbed stream corridor, we suggest that the mitigation could likely be considered at a 2:1 ratio. On-site mitigation (within a municipally-owned property) would be at the lower end of the scale and mitigation banks would be at the upper end of the scale.

Mitigation Costs Budget $220,000 to $550,000

Subtotal Mitigation Budget $250,000

Establishing Easements within the affected properties (either temporary or permanent) would require establishing the property boundaries and developing metes and bounds descriptions of the affected areas. Most of this work would be survey, the balance would be legal costs. Negotiation of the purchase of the easements has been valued at zero, since both property owners want the project to move forward.

Easements Budget $ 5,000.00

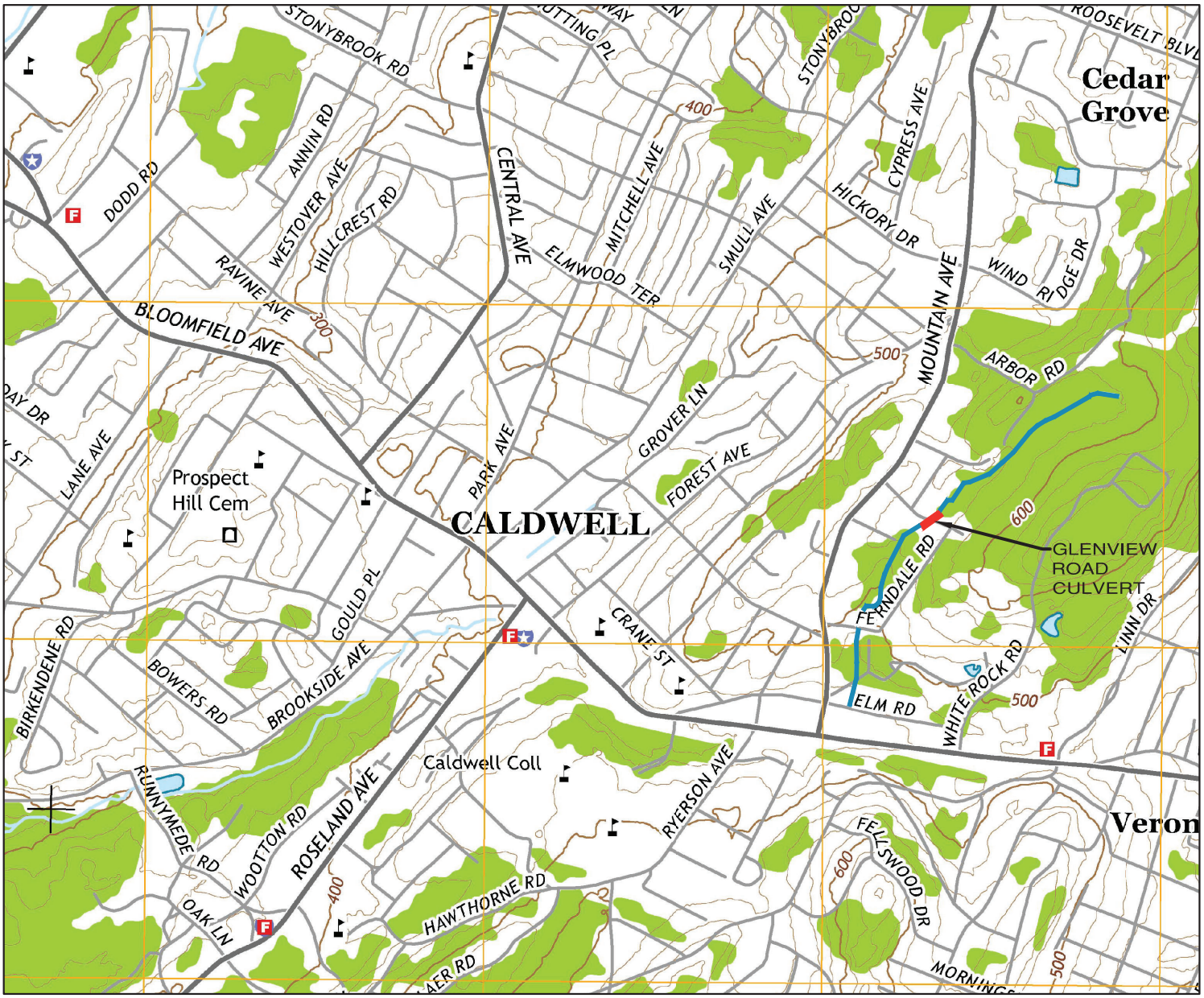
Design & Permitting Fees will include the necessary work to develop the plans, reports, and supporting data to secure NJDEP and HEP SCD approval of the project and to then prepare construction documents. We have assumed that the Borough would want the design engineer to be responsible for the overseeing of the construction as part of the contract.

Engineering/Permitting Budget $50,000.00

Construction Costs include a broad range of items. We have attempted to establish a cost for the construction based upon the conceptual plan, a 4.5' x 10' box culvert.

Construction Costs	Budget	$500,000 to $650,000
Subtotal Construction	**Budget**	**$575,000**

Project Total	**Budget**	**$908,000**
Contingency 10%		**$ 90,800**
Total Budget Estimate		**$1,000,000**



SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2

1000 500 0 METERS 1000 2000

1 0.5 0 1

MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

FEET

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

USGS LOCATION MAP

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BOROUGH OF NORTH CALDWELL

DRAINAGE AREA STUDY
BOROUGH OF NORTH CALDWELL
ESSEX COUNTY NEW JERSEY

REFERENCES: PORTION OF THE CALDWELL NJ QUADRANGLE MAP, DATED 2014
SITE COORDINATES: E (X) 558,877.73 N (Y) 731,737.85
CONTOUR INTERVAL : 20 FT. NAVD 1988 TO CONVERT FROM METERS TO FEET, MULTIPLY BY 3.28

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Draftsman: CVF
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Project No.: 18-0216
Scale: 1" = 1500'
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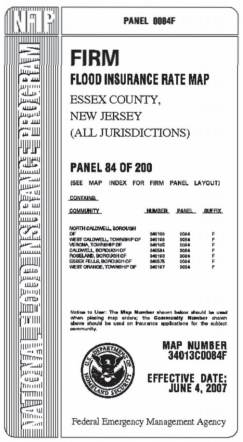
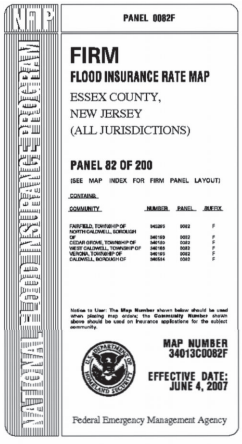
Fig. No.1





FEMA FLOOD INSURANCE RATE MAP

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BOROUGH OF NORTH CALDWELL

DRAINAGE AREA STUDY
BOROUGH OF NORTH CALDWELL
ESSEX COUNTY NEW JERSEY

REFERENCES:
PORTION OF THE FEDERAL EMERGENCY MANAGEMENT AGENCY NATIONAL FLOOD INSURANCE PROGRAM. FLOOD INSURANCE RATE MAP, ESSEX COUNTY, CONTAINING BOROUGH OF NORTH CALDWELL.
MAP No. 34013C0084F: EFFECTIVE DATE JUNE 4, 2007.
ALSO INCLUDED IS:
MAP No. 34013C0082F: EFFECTIVE DATE JUNE 4, 2007.

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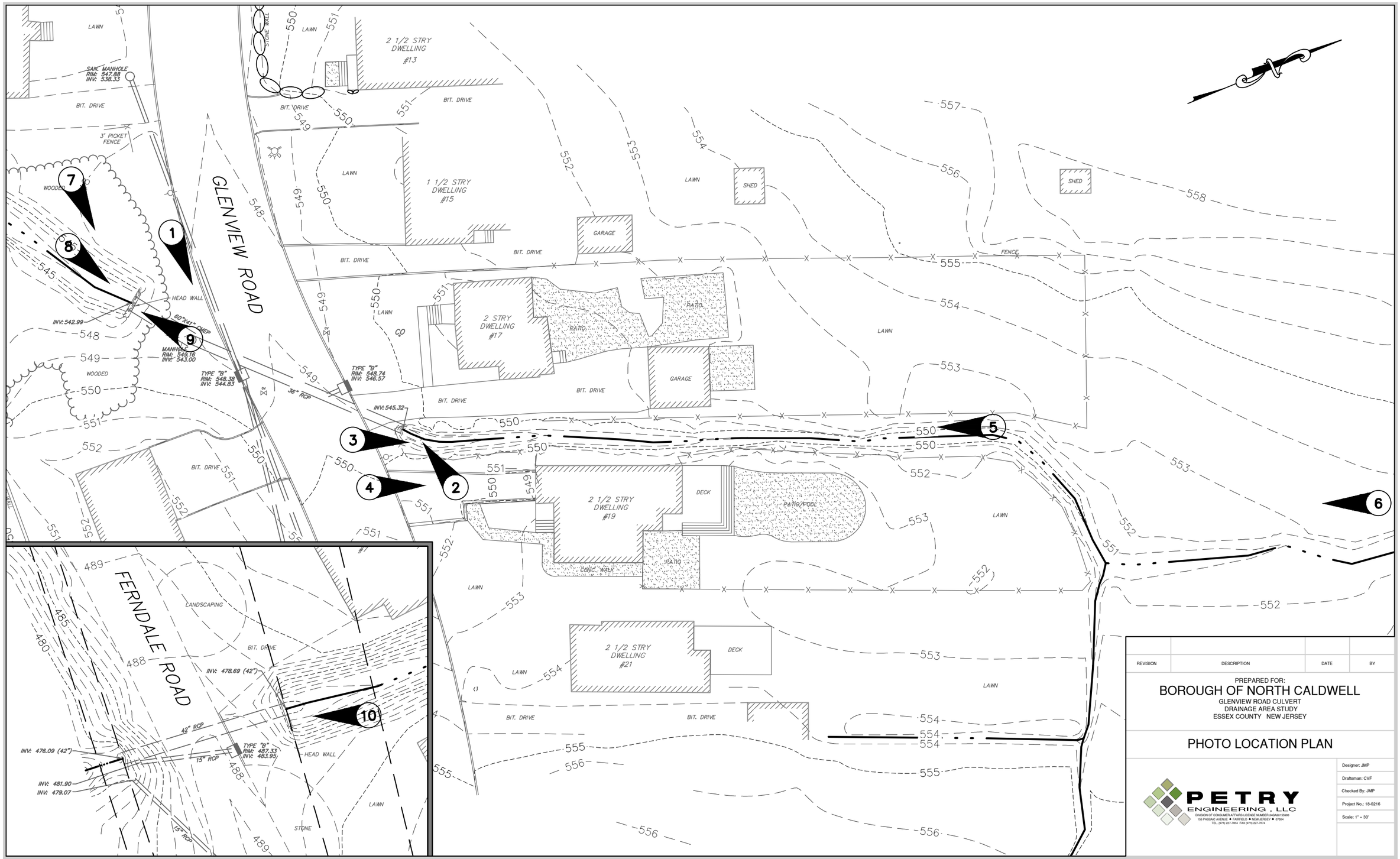
Appendix A

Photo Log

Glenview Road Culvert
North Caldwell, New Jersey

Date of Photos: October 19, 2018 & November 20, 2018



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BOROUGH OF NORTH CALDWELL

GLENVIEW ROAD CULVERT
DRAINAGE AREA STUDY
ESSEX COUNTY NEW JERSEY

PHOTO LOCATION PLAN

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Draftsman: CVF	
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Project No.: 18-0216	
Scale: 1" = 30'	

Photo 1 – View looking East at an overview of Glenview Road and location where the culvert (described below) passes beneath Glenview Road.

Photo 2 – View Looking West at the upstream portion of the culvert and northeast of Glenview Road. The Un-Coded Tributary enters here before passing through a 36” RCP pipe which passes beneath Glenview Road. Note the historic channelization of the stream through the placement of rocks along the banks.

Photo 3 – View looking North at the portion of the channel that feeds into the upstream most portion of the culvert, shown in Photo #2. This picture is taken looking upstream and shows the proximity of the stream to the driveway location on 17 Glenview Road and the home of 19 Glenview Road.

Photo 4 – View Looking North. The picture shows the proximity of the stream to the home at 19 Glenview Road. Sandbags were placed at 17 and 19 Glenview Road as a temporary precaution to prevent any future flooding in the respective homes.

Photo 5 – View looking South. This picture was taken looking downstream at the Un-Coded Tributary as it passes between 17 and 19 Glenview Road. The photos location is upstream of Photo #3. There are signs of historic channelization and disturbances along the banks of the stream.

Photo 6 – View looking South. This photo is taken looking downstream, but upstream of Photo #5. This is within the undisturbed wooded portion of the stream. You can see the home located at 19 Glenview Road through the trees in the center of the photo.

Photo 7 – View looking East at the downstream portion of the culvert that passes beneath Glenview Road. Note the material and size of the culvert changes as it passes through Glenview Road. The culvert passing under Glenview Road is comprised of two pipes in series. The first pipe is a 36” reinforced concrete pipe (RCP), followed by a 60”x41” corrugated metal elliptical pipe (CMEP).

Photo 8 – View looking East showing a close-up and more detailed view of the downstream portion of the culvert.

Photo 9 – View looking southwest and downstream at the Un-Coded Tributary after it has completely passed through the culvert beneath Glenview Road.

Photo 10 – View looking South at the upstream portion of the culvert (before it passes beneath Ferndale Road) which is downstream of the Glenview Road culvert. The culvert is comprised of a 42” RCP pipe.

GLENVIEW ROAD

2 STRY DWELLING #14
LAWN
SAN. MANHOLE RIM: 547.88 INV: 538.33
BIT. DRIVE
3' PICKET FENCE
WOODED
1012.30
1012.40
1012.50
HEAD WALL
INV:542.99
60"X41" CMEP
MANHOLE RIM: 545.16 INV: 543.00
TYPE "B" RIM: 548.38 INV: 544.83
36" RCP
WOODED
BLOCK WALL
2 STRY DWELLING #20
LAWN
BIT. DRIVE
STONE WALL
2 1/2 STRY DWELLING #13
1 1/2 STRY DWELLING #15
LAWN
BIT. DRIVE
2 STRY DWELLING #17
LAWN
BIT. DRIVE
TYPE "B" RIM: 548.74 INV: 546.57
INV: 545.32
GARAGE
BIT. DRIVE
2 1/2 STRY DWELLING #19
CONC. WALK
PATIO
DECK
2 1/2 STRY DWELLING #21
LAWN
DECK
BIT. DRIVE
SAN. MANHOLE RIM: 553.27 INV: 544.87
LAWN
SHED
LAWN
SHED
FENCE
PATIO
PATIO/HOT TUB
LAWN
LAWN
1013.00
1013.09
1013.16
1013.30
1013.36
1013.42
1013.48
1013.65
1013.70
1013.90
1014.00
1015.00
1016
1016.30
1016.60

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BOROUGH OF NORTH CALDWELL

GLENVIEW ROAD CULVERT
DRAINAGE AREA STUDY
ESSEX COUNTY NEW JERSEY

EXISTING CONDITIONS
PRE-DEVELOPMENT 100-YEAR FLOOD

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Project No.:	18-0216
Scale:	1" = 30'
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GLENVIEW ROAD

1012.30
1012.40
1012.50
1013.00
1013.09
1013.16
1013.30
1013.36
1013.42
1013.48
1013.65
1013.70
1013.90
1014.00
1015.00
1016
1016.30
1016.60

/2 STRY WELLING #14
LAWN
SAN. MANHOLE RIM: 547.88 INV: 538.33
BIT. DRIVE
3' PICKET FENCE
WOODED
HEAD WALL
INV:542.99
60"X41" CMEP
MANHOLE RIM: 548.16 INV: 543.00
TYPE "B" RIM: 548.38 INV: 544.83
36" RCP
INV:545.32
TYPE "B" RIM: 548.74 INV: 548.57
2 1/2 STRY DWELLING #13
1 1/2 STRY DWELLING #15
2 STRY DWELLING #17
2 1/2 STRY DWELLING #19
2 STRY DWELLING #20
2 1/2 STRY DWELLING #21
GARAGE
SHED
PATIO
DECK
PATIO/HOT TUB
CONC. WALK
FENCE
BLOCK WALL
15" RCP
SAN. MANHOLE RIM: 553.27 INV: 544.87

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GLENVIEW ROAD CULVERT
DRAINAGE AREA STUDY
ESSEX COUNTY NEW JERSEY

EXISTING CONDITIONS
POST-DEVELOPMENT 100-YEAR FLOOD

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Scale:	1" = 30'
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GLENVIEW ROAD

2 STRY DWELLING #14
LAWN
SAN. MANHOLE RIM: 547.86 INV: 538.33
BIT. DRIVE
3' PICKET FENCE
WOODED
STONE WALL
2 1/2 STRY DWELLING #13
1 1/2 STRY DWELLING #15
2 STRY DWELLING #17
2 STRY DWELLING #20
2 1/2 STRY DWELLING #19
2 1/2 STRY DWELLING #21
GARAGE
SHED
PATIO
PATIO/POOL
DECK
CONC. WALK
FENCE
HEAD WALL
60"X41" CMEP
INV:542.99
MANHOLE RIM: 545.00 INV: 543.00
TYPE "B" RIM: 548.38 INV: 544.83
TYPE "B" RIM: 548.74 INV: 546.57
36" RCP
INV:545.32
18" RCP
BLOCK WALL
SAN. MANHOLE RIM: 553.27 INV: 544.87

1012.30
1012.40
1012.50
1013.00
1013.09
1013.16
1013.30
1013.36
1013.42
1013.48
1013.65
1013.70
1013.90
1014.00
1015.00
1016
1016.30
1016.60

REVISION	DESCRIPTION	DATE	BY

PREPARED FOR:
BOROUGH OF NORTH CALDWELL
GLENVIEW ROAD CULVERT
DRAINAGE AREA STUDY
ESSEX COUNTY NEW JERSEY

4.5' x 10' BOX CULVERT
PRE-DEVELOPMENT 100-YEAR FLOOD

PETRY ENGINEERING, LLC
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Designer: JMP
Draftsman: CVF
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Project No.: 18-0216
Scale: 1" = 30'
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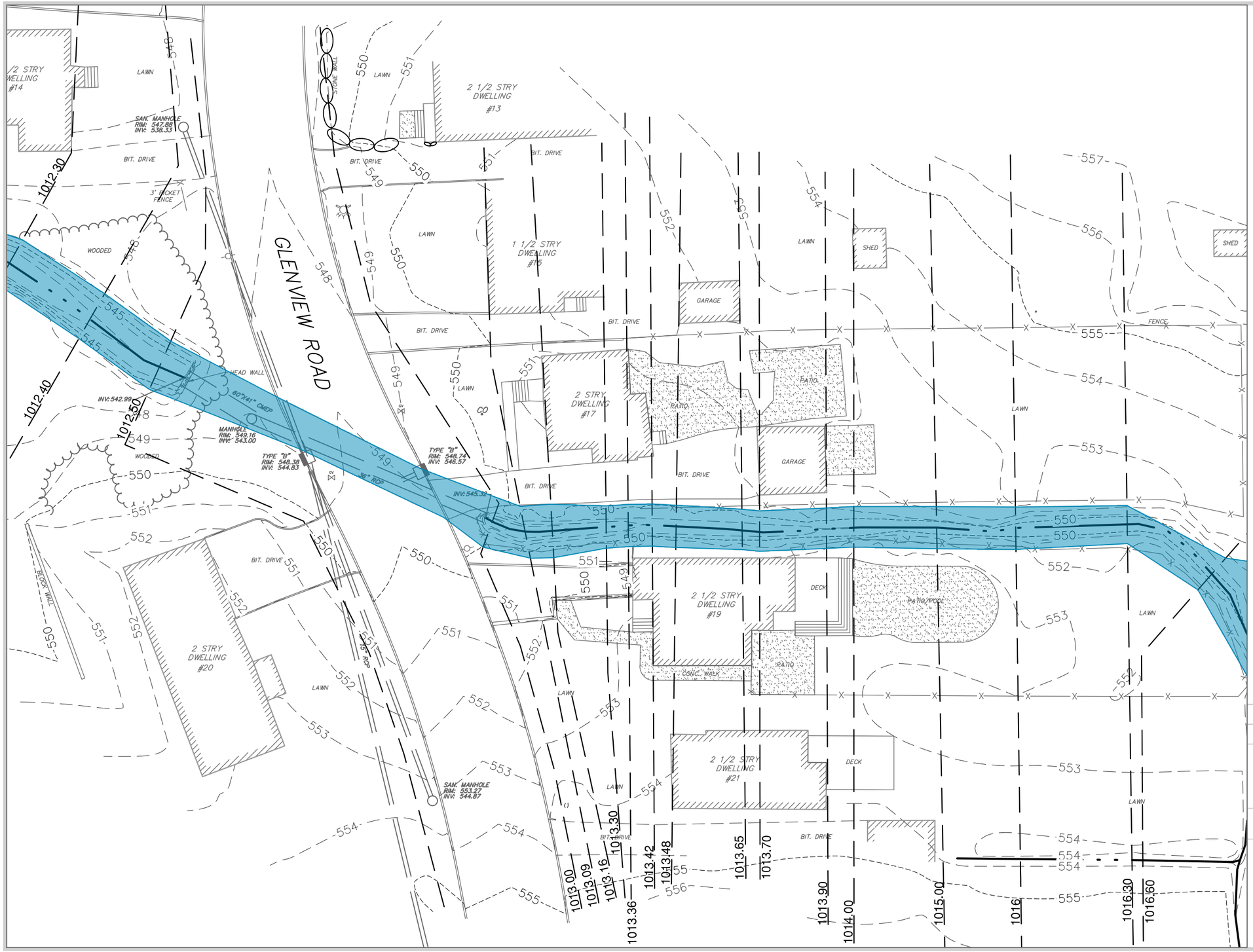
FIG-7



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BOROUGH OF NORTH CALDWELL

GLENVIEW ROAD CULVERT
DRAINAGE AREA STUDY
ESSEX COUNTY NEW JERSEY

3' x 10' BOX CULVERT
PRE-DEVELOPMENT 25-YEAR FLOOD

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Draftsman:	CVF
Checked By:	JMP
Project No.:	18-0216
Scale:	1" = 30'
Sheet:	FIG-6