Chaffee Road Watershed Study Memo

Sustainable Streams LLC
Science · Service · Solutions

Prepared for
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Overview

This memorandum provides a summary of the findings related to the watershed study completed in the vicinity of Chaffee Road, in Sagamore Hills Township, Summit County, Ohio. Specifically, the focus of the study was the functionality of two existing culverts: the 53" x 34" elliptical concrete culvert under Chaffee Road (adjacent to 7570 Chaffee Road) as well as the 42" concrete driveway culvert at 7565 Chaffee Road, located just upstream of the roadway culvert.

Project Background

Summit County Engineer's Office (SCE) hired Sustainable Streams in September 2024 to complete a watershed assessment/study of the Chaffee Road Area and a concept plan of the recommended solutions to address conveyance limitations at the two above-referenced culverts. Numerous evaluations by others have been previously completed, with the area being studied as early as 2013 by SCE.

The primary goal of this project is to develop solutions that manage stormwater in order to provide the target level of service for the roadway and driveway culverts, as stated below. Level of service was informed by SCE's Stormwater Drainage Manual, dated 1/1/2020, and the Ohio Department of Transportation's Location & Design Manual, Vol. 2 Drainage design, dated 1/19/2024, along with direct input from SCE.

1) Chaffee Road Culvert (Figure 1): The headwater depth below the near, low edge of the pavement at the culvert does not exceed one foot in the 25-year design storm.
2) 7565 Chaffee Road Driveway Culvert (Figure 2): The headwater depth at the inlet of each roadway driveway culvert shall be at or below the near edge of pavement for driveway culverts conveying runoff along roadside ditches during the design storm.
    a. This criterion is assumed to apply to the 25-year event.
3) 7565 Chaffee Road Driveway Culvert (Figure 2): The peak headwater depth during the 100-year frequency event shall be one foot below the finished grade adjacent to any existing or proposed building.

A secondary goal of the project is that proposed stormwater intervention(s) should also help to protect public assets and improve water quality to the extent feasible.

Figure 1. 53" x 34" elliptical concrete culvert under Chaffee Road, looking at upstream end of culvert (left) and downstream end of culvert (right)

Figure 2. 42" concrete culvert under the driveway of 7565 Chaffee Road, looking at upstream end of culvert

Existing Watershed

The drainage area to the Chaffee Road culvert was delineated as 312.6 acres. Nearly all soil in the watershed is either hydrologic soil group C/D or hydrologic soil group A: 49% and 39% of the watershed, respectively (Soil Survey Staff, 2024). According to the National Land Cover Database (NLCD) 2021 Land Cover dataset, 53% of the land is classified as developed, open space (i.e., impervious cover less than 20%) and 20% of the land is classified as developed, low intensity (i.e., impervious cover between 20% and 49%). Deciduous forest (14%) and pasture/hay (10%) are the next two most common land types (Dewitz, 2023). Refer to Map 1 through Map 3 in Appendix A.

As evidenced in the land cover classifications, development in the watershed is comprised of mostly large-lot residential homes, with one subdivision apparent in aerial mapping. Based on the as-built mapping provided by SCE, the Red Hawk Reserve subdivision, located near the intersection of Merrit Drive and Nakita Court, was constructed in ~2005. At the time of development, the basin was designed to meet the County's stormwater management criteria, which was that the 25-year developed site peak runoff is released below the 2-year peak runoff for the undeveloped site. All storms larger than the 25-year storm must have a developed peak runoff lower than the undeveloped peak runoff for the same storm (Fultech Consulting Engineers, 2004).

Field Assessment

In mid-2024, Sustainable Streams visited the area to complete a watershed assessment. The watershed assessment targeted the existing streams and culverts, the Red Hawk Reserve detention basin, and potential areas for proposed detention or wetland areas. Additionally, the field assessment task included documentation of visibly evident illicit discharges, drainage and erosion concerns, debris and blockages in the drainage network, and encroachments into existing easements, if any existed within the extents visited.

An inventory of the streams did not identify extensive erosion in the network. The majority of the evaluated stream segments had ample herbaceous vegetation and/or rock armoring. One exposed gas main was found in the watershed, located in the back property of 7529 Chaffee Road, which does indicate some erosion in this vicinity. It is recommended that SCE reach out to the local utility representative to relay this observation related to the exposed gas line.

A total of four pedestrian bridges were identified within the project area. The culverts in the project area ranged in size and conveyance capacity. A few of the culverts had silty deposits partially clogging them. Only three of the culverts showed signs of erosion: a scour hole downstream of the Chaffee Road culvert, erosion evident on the upstream side of the 7565 Chaffee Road driveway culvert, and erosion and a lack of rock armoring on the upstream side of the double HDPE culverts at a utility corridor crossing at 7495 Chaffee Road. None were extreme.

Three existing basins were visited during the field assessment. The existing detention basin in the Red Hawk Reserve subdivision (Figure 3) found a basin that is well-vegetated but requires some maintenance. The standpipe in the northeast corner of the basin, a part of the outlet structure, was visibly cracked and should be repaired and/or replaced. The other two basins are open water ponds that do not appear to provide detention for the watershed.

No illicit discharges were visibly evident in the portions of the watershed evaluated with this study. Dumping of waste and debris into the drainage system was not evident. There may be a shed and one or two homes within a 30-foot utility easement that runs along the property line between 7555 and 7565 Chaffee Road. However, this was a computer-generated assessment and has not been evaluated by a licensed professional land surveyor (PLS), as that is beyond the scope of this project.

Documentation from the field assessment was shared with SCE in October 2024. These slides have been included in Appendix B of this memo.

Potential Improvement Alternatives

To understand the potential benefits and limitations of potential improvements that may address the capacity discrepancies in the culverts included in this study, Sustainable Streams completed a cursory evaluation of a gradient of solutions ranging from holistic watershed-based opportunities for flood attenuation to more traditional flood mitigation and stormwater conveyance alternatives. Refer to Appendix B for a complete presentation on this initial effort, including mapping, alternative details, easement considerations, and a conceptual-level decision matrix.

The following alternatives were identified by SCE and listed in the Request for Proposals (RFP) on this project. They were evaluated at a cursory level.

- ***Alternative A: Nakita Ct Bankfull Wetlands –*** Up to three bankfull wetlands totaling ~2.2 ac-ft of storage would be located in a heavily wooded area of the Red Hawk Reserve subdivision. The wetlands would be designed to offload flows that contribute to peak discharges at the Chaffee Road culvert. Due to the nature of these wetlands, these features would have a high probability of improving water quality in the watershed. However, the location of these wetlands is relatively high in the watershed and would only be able to intercept ~50% of the drainage area to the culvert, thus they are anticipated to have a low chance of attenuating flow at the Chaffee Road culvert.
- ***Alternative B: Detention within Red Hawk HOA Depression –*** This heavily wooded area adjacent to the existing detention basin in the Red Hawk Reserve subdivision collects flow from ~70% of the drainage area to the Chaffee Road culvert. The footprint of a potential detention-type feature in this location could be expansive (preliminary volume = 8.1 ac-ft), providing a high probability of attenuating flow at the Chaffee Road culvert. However, the location likely contains a jurisdictional stream, which could result

in the payment of mitigation fees if water was detained/impounded here. Additionally, the historic railroad embankment on the downstream end of the depression would require geotechnical investigations prior to fully understanding the feasibility of this solution.

- ***Alternative C: Existing Detention within Red Hawk Reserve*** – This existing detention basin was found to already provide appreciable flow attenuation and water quality benefits for the receiving channel, discussed in detail in the "Additional Modeling" section, such that additional modifications would not be anticipated to have a significant impact to the flows at Chaffee Road.
- ***Alternative D: Storage within Small Depression between Bike Path & Carter Rd*** – Another potential opportunity for storage in the watershed was a depression between the existing bike path and Carter Road. Preliminary estimates show ~2.1 ac-ft of storage volume would be possible here. Unfortunately, this location appears to also have a jurisdictional stream, which could potentially require mitigation fees if water was impounded here, and there are also existing utilities that would either need to be relocated or limit the size of the storage area. Furthermore, ponding water immediately adjacent to a roadway increases risks to the public traveling on that roadway.
- ***Alternative E: Stream Restoration on Private Property at 7720 Carter Rd*** – This private property alternative would focus on restoration of ~410 linear feet of stream that does not presently have a forested riparian buffer. Although the majority of the watershed's drainage area flows through this stream segment and although minor locations of erosion may be stabilized via this solution, stream restoration strategies at this scale would not be anticipated to attenuate peak discharges at meaningful enough levels to substantially improve conveyance capacity issues at the downstream culvert.
- ***Alternative F: Stream Restoration on Private Property at 7760 Carter Rd*** – This private property alternative would focus on restoration of ~630 linear feet of stream that is mostly within a forested area. This section of stream does not appear to drain to the Chaffee Road culverts and was not evaluated further.
- ***Alternative G: Storage near CEI Property at 1063 W Aurora Rd*** – Another potential opportunity for storage in the watershed is a potential bankfull wetland on private property, just upstream of the utility-owned property. Preliminary estimates show ~1.1 ac-ft of storage volume would be possible here. The wetland would be designed to offload flows, thus reducing the peak flows at the Chaffee Road culvert. With such a large drainage area and a relatively small storage volume, this wetland location is predicted to have only a moderate probability for flow attenuation at Chaffee Road and a moderate probably for water quality benefits.
- ***Alternative H: Stream Restoration near Gas Main*** – As discussed with Alternative E, stream restoration alternatives are unlikely to provide the flow attenuation that this project targets. However, this ~300-foot restoration would provide the benefit of protecting the currently exposed gas main in this section of stream.
- ***Alternative I: Pond on Private Carter Rd Parcel / Past NEORSD Project*** – This small pond, completely contained on private property, controls less than 1% of the watershed drainage. As such, a solution utilizing this pond was not further evaluated.

During the field assessment, additional areas for potential flow attenuation concepts were identified. These potential opportunities were evaluated at a cursory level and are summarized below.

- ***Alternative J: Bankfull Wetlands on Private Parcels next to Carter Rd*** – This potential solution is a large bankfull wetland located on two private properties that are currently unforested. The space is expansive

enough that there is a high likelihood that flow attenuation at the Chaffee Road culvert could be achieved (anticipated storage = ~8.2 ac-ft), and water quality benefits would be high as well. However, conveyance to and from the stream would require more complex avenues, such as pipes, since at least one driveway would need to be crossed. Additionally, the privately-owned parcels would need to be purchased or easements obtained.

- ***Alternative K: Bankfull Wetlands on Private Parcels next to CEI Parcel*** – This potential solution is a large bankfull wetland (~5.8 ac-ft) located on two private properties that are currently unforested, farther downstream compared to Alternative J. The space is expansive enough that there is a high likelihood that flow attenuation at the Chaffee Road culvert could be achieved, and water quality benefits would be high as well. The connection to the stream would be less complex than Alternative J (i.e. open conveyance), although property acquisition or easements would still be necessary.

Additional alternatives exist for the watershed as well. The alternatives presented below focus on potential improvements at or near the Chaffee Road culvert itself and are more in line with traditional engineering solutions than watershed-based, holistic solutions.

- ***Alternative L: Upsizing the Chaffee Road Culvert*** – One option to improve the capacity issues at the Chaffee Road culvert is to upsize the Chaffee Road culvert. This solution would not attenuate flow, nor would there be appreciable water quality benefits. However, the desired level of service for the culvert's conveyance capacity could be achieved.
- ***Alternative M: Upsizing the Chaffee Road & Driveway Culverts*** – Based on past analyses by others, it is understood that increasing the Chaffee Road culvert alone may not achieve the desired level of service related to headwater depths relative to the adjacent driveway and finished floor elevation. As such, one alternative would be to increase the size of not only the Chaffee Road culvert, but also the private culvert at the driveway of 7565 Chaffee Road.
- ***Alternative N: Property Acquisition of 7555 Chaffee Road*** – Based on a review of USGS topographic mapping, the stream in this watershed historically flowed through the structure location at 7555 Chaffee Road and was moved when the home was built in the late 1990's (see Appendix B). To address reported flooding of this structure, the property could be acquired by the County and the house demolished.
- ***Alternative O: Property Acquisition of 7555 Chaffee Road with Storage*** – Taking Alternative N one step farther, the parcel could be utilized for storage after demolition of the structure. The narrow nature of the parcel limits the amount of potential storage here.

After presenting the list of 15 potential alternatives for this watershed, SCE requested that Sustainable Streams focus on understanding the existing conditions via modeling.

Existing Conditions Modeling

Hydrologic Modeling of the Watershed

Sustainable Streams built a watershed model in HydroCAD to generate discharge estimates for a range of design storms at multiple locations within the Chaffee Road watershed. The model includes 18 drainage areas that are conveyed to the Chaffee Road culvert. Data used in the model were generated from a range of available sources. Drainage areas were delineated based on 1-foot LiDAR-based contours, generated by Sustainable Streams from Ohio Geographically Referenced Information Program (OGRIP) data (referred to herein as LiDAR and LiDAR contours), as well as storm sewer infrastructure, which was informed by SCE data and a field visit by Sustainable

Streams. The curve number calculations utilized hydrologic soil group data from the Web Soil Survey as well as land use data from the NLCD 2021 Land Cover dataset. Times of concentration were manually delineated using the best-available data in GIS (e.g., culvert and ditch locations, contours, etc.). Refer to Map 4 in Appendix A for a map of the modeled drainage areas with times of concentration paths. A summary of the drainage areas, curve numbers, times of concentration, and select flows have been included in Appendix C.

The existing detention basin within Red Hawk Reserve (Figure 3) was included in the existing conditions model. The drainage area to the basin, 16.0 acres, was delineated in the same manner as the above-mentioned methods and is relatively close to the original delineation by the design engineer (i.e., 15.77 acres). The basin was modeled with ~3.14 ac-ft of storage below the spillway elevation of 884.11. The stage-storage table for the basin utilized the design engineer's stage-storage table provided in their stormwater calculations (Fultech Consulting Engineers, 2004). Measurements of the various orifices and openings on the outlet structure were measured in the field and incorporated into the model. Details on the storage and outlet of this basin have been included in Appendix C.

Figure 3. Existing Red Hawk Reserve basin

Modeled rainfall events include the 1-year to 100-year events over a 24-hour duration. Rainfall depths were informed by NOAA (Bonnin et al., 2006), and the SCS Type II distribution was used (USDA NRCS, 1986; SCE, 2020). Refer to Table 1 for a summary of the rainfall depths for each event modeled as well as the peak flow at both study culverts.

Table 1. Existing Conditions Hydrologic Modeling Results

Event	*Rainfall Depth (in)*	*Peak Flow at 7565 Chaffee Rd. Culvert (cfs)*	*Peak Flow at Chaffee Rd. (cfs)*
1-yr, 24-hr	2.04	17.41	20.72
2-yr, 24-hr	2.44	28.40	33.03
5-yr, 24-hr	3.03	49.58	56.24
10-yr, 24-hr	3.52	71.14	79.51
25-yr, 24-hr	4.24	108.96	119.86
50-yr, 24-hr	4.85	145.46	158.49
100-yr, 24-hr	5.50	194.73	204.03

Hydraulic Modeling of the Culverts

Sustainable Streams built a hydraulic model in HEC-RAS to understand the existing capacity at the Chaffee Road culvert as well as the driveway culvert at 7565 Chaffee Road. This hydraulic model was informed by cross-sectional channel surveys and culvert data collected by SCE both prior to the start of this contract and also during

summer 2024. SCE surveys were completed in 2012 and 2024. The 2012 SCE survey extents included Chaffee Road, both culverts of interest, and the channel upstream of the driveway culvert until its confluence with a side channel behind 7555 Chaffee Road. The 2024 SCE survey included select cross sections and several culverts within the modeled reach. The upstream end of the model is the downstream side of Carter Road, downstream of the 3'x3' culvert. The downstream end of the model is ~100 feet downstream of the Chaffee Road culvert. Map 5 in Appendix A includes the locations of the cross sections and culverts in the HEC-RAS model.

Figure 4. Looking upstream towards channel and corner of 7555 Chaffee Road

Flows in the HEC-RAS model were generated in HydroCAD. The flow rate for each event changed four times along the modeled alignment due to the addition of new drainage areas (Map 4 in Appendix A), with the Chaffee Road culvert having the largest flows in the model. Manning's n values in the channel ranged from 0.030 to 0.040, and Manning's n values in the floodplain ranged from 0.035 to 0.050.

For the 42" concrete driveway culvert at 7565 Chaffee Road, the existing conditions results are included in Table 2. It is noted that the lowest elevation along the driveway, from the 2012 survey, is 789.30, although this location is at the edge of the surveyed area and may not capture the lowest point along the driveway. LiDAR indicates that the driveway may continue to drop in elevation beyond the extents of the survey (moving east away from Chaffee Rd.) and could be as low as 788.4 per LiDAR data. In the 25-year event, the model indicates that there is only 0.01 feet of freeboard above the surveyed lowest driveway elevation. Should the driveway elevation continue to decrease, as indicated by the LiDAR, the driveway would be overtopped in the 25-year event.

Table 2. Existing Conditions Hydraulic Modeling Results – Upstream Side of 42" Driveway Culvert

Event	*Peak Flow at Culvert [1] (cfs)*	*Water Surface Elevation [1] (ft)*	*Depth of Water [1] (ft)*	*Freeboard Below Surveyed Portion of Driveway [1, 2] (ft)*	*Freeboard Below Windowsill [3] (ft)*
2-yr, 24-hr	28.40	786.69	2.54	2.61	6.43
25-yr, 24-hr	108.96	789.29	5.14	0.01	4.36
100-yr, 24-hr	194.73	789.22	5.07	0.08	4.07

[1] Modeling results from the cross section at station 1665.95 reported (the cross section at the upstream side of the 7565 Chaffee Rd. driveway culvert).
[2] Driveway elevation of 789.30 informed by survey and used in calculation. It is noted that the survey may not have captured the lowest point in the driveway (LiDAR indicates the driveway could be as low as ~788.4).
[3] Water surface elevations associated with the modeling results were interpolated at windowsill location with surveyed elevation of 793.46. It is unknown if the basement is finished. A positive freeboard value indicates space between the water surface elevation and the top of the driveway, whereas a negative freeboard value indicates that water is overtopping the driveway.

Beyond the 25-year freeboard at the driveway, the results also compared the 100-year water surface elevation to the surveyed elevations along the house at 7555 Chaffee Road (Figure 4). The finished ground floor elevation of 7555 Chaffee Road, surveyed along the back of the house, was 795.54, and two basement windowsills along the side of the house closest to the channel were surveyed at 793.47 and 793.46. In the 100-year event, modeling shows that the water surface is 4.07 feet below the lowest windowsill. The basement floor elevation is unknown, and it is unknown if the basement is finished. A survey shot of the ground at the windowsill was not available. Assuming a standard cinder block height of eight inches and that there are three cinder blocks exposed between the windowsill and the ground elevation (Figure 4), it can be assumed that there is ~2.07 feet of freeboard between the water surface elevation in the 100-year event and the ground elevation along this side of the house.

Based on this analysis, it appears that the driveway culvert may meet both design criteria stated at the beginning of this memo, provided that there is not a finished basement at 7555 Chaffee Road and the lowest elevation of the driveway at 7565 Chaffee Road is not lower than the lowest point within the extents of the SCE 2012 survey. If the lowest elevation of the driveway is lower than the lowest driveway elevation within the 2012 survey extents, the 7565 Chaffee Road driveway culvert would not meet the 25-year driveway freeboard requirement. Furthermore, it is restated that the basement floor elevation is unknown. As such, the basement at 7555 Chaffee Road could potentially be impacted by the adjacent water table or ponding elevations during large events, despite having apparent freeboard below the surveyed windowsill elevations.

For the 53" x 34" elliptical concrete culvert under Chaffee Road, the existing conditions results are presented in Table 3. The results from the Chaffee Road culvert indicate a lack of capacity to meet the 25-year level of service required in the existing regulations. Specifically, the lowest elevation along the roadway is 788.22, which is 0.19 feet lower than the 25-year water surface elevation at the cross section upstream of the roadway.

Table 3. Existing Conditions Hydraulic Modeling Results – Upstream Side of 53"x34" Chaffee Rd. Culvert[1]

Event	*Peak Flow at Culvert (cfs)*	*Water Surface Elevation (ft)*	*Depth of Water (ft)*	*Freeboard Below Roadway* [2] *(ft)*
2-yr, 24-hr	33.03	786.11	2.33	2.11
25-yr, 24-hr	119.86	788.41	4.63	-0.19
100-yr, 24-hr	204.03	788.70	4.92	-0.48

[1] Modeling results from the cross section at station 1589.09 reported (the cross section at the upstream side of the Chaffee Rd. culvert).

[2] Roadway elevation of 788.22 informed by survey and used in calculation. A positive freeboard value indicates space between the water surface elevation and the top of the roadway, whereas a negative freeboard value indicates that water is overtopping the roadway.

It is noted that the 25-year headwater elevation at the existing driveway culvert at 7655 Chaffee Road is slightly higher than the 100-year headwater elevation in the backwater zone of the submerged driveway culvert (stations 1666 and 1742.3). These subtle differences in the water surface (< 2 inches) are artifacts of the multiple submerged culverts, entrance/exit losses, the driveway elevation relative to the headwater depth, and hydraulic jumps that result in slight changes in the transition location between subcritical flow and rapidly varied flow in the relatively coarse, 1-dimensional hydraulic model. Such minor differences in the backwater elevation should be considered immaterial in the broader context of the hydraulic results that show the 100-year water surface

is anticipated to be deeper than the 25-year water surface for all areas outside of this unique backwater condition at the submerged driveway culvert.

Upstream of the culverts are numerous channels with varying slopes, shapes, and bed material. The capacity of these channels varies and is not easily indexed in this memo. Refer to Figure 5 for a profile of the existing conditions model results near the culverts of interest and 7555 Chaffee Road for the 2-, 25-, and 100-year events and Figure 6 for a cross section adjacent to 7555 Chaffee Road. Map 6 in Appendix A identifies the locations from the Figure 5 profile. A tabular summary of the hydraulic results for the existing conditions HEC-RAS model are included in Appendix D.

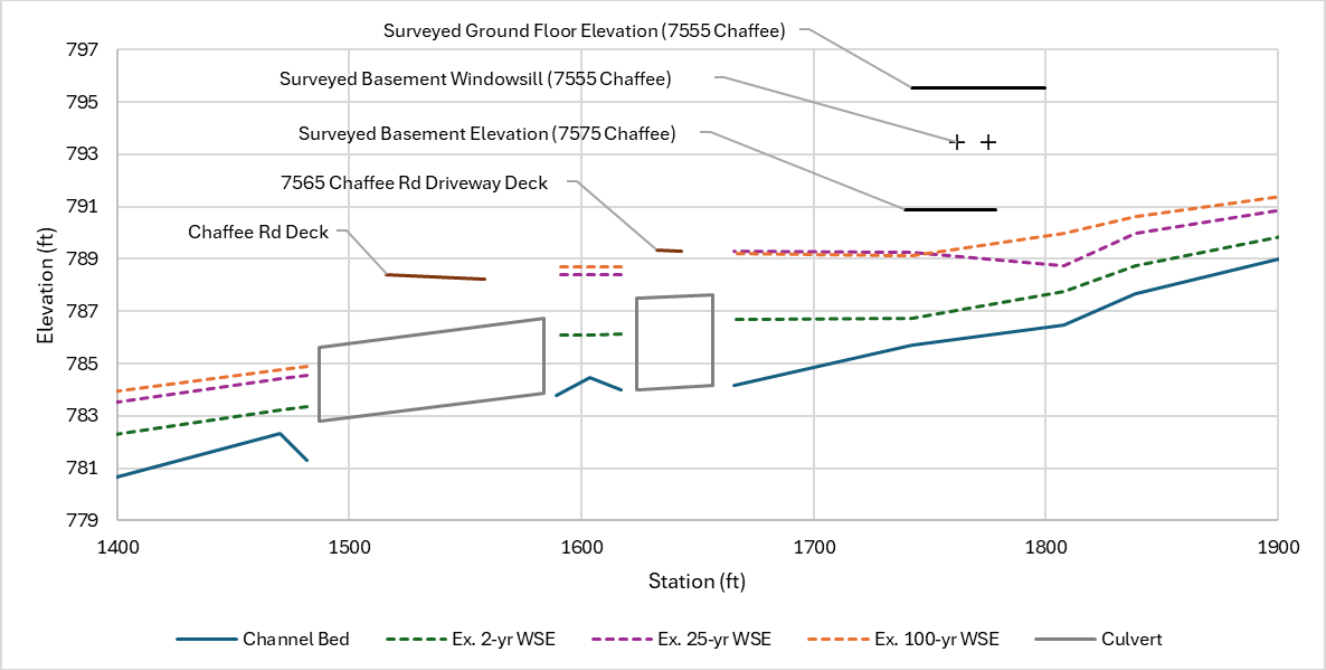


Figure 5. Existing Conditions Hydraulic Modeling Profile of Chaffee Road culvert (near station 1550) and 7565 Chaffee Rd. Driveway Culvert (near station 1650)

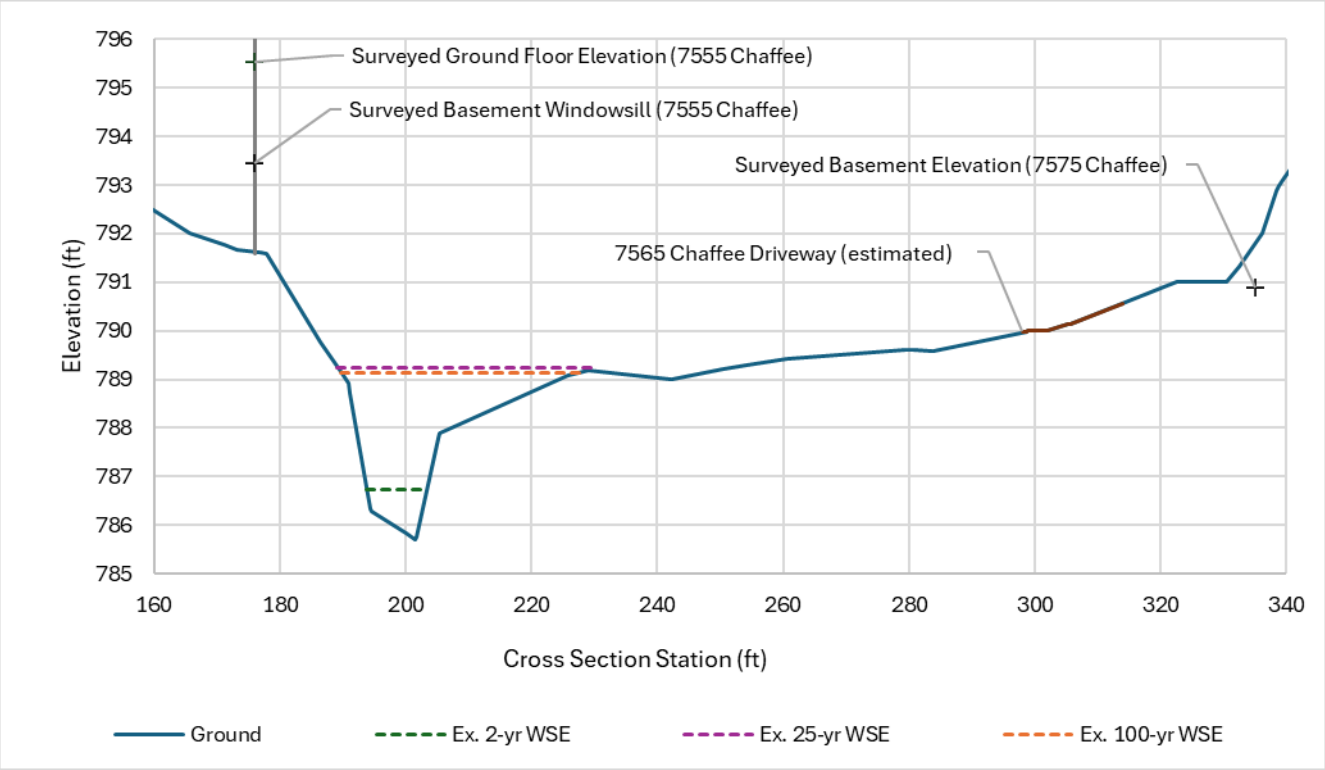


Figure 6. Cross section from Model Station 1742.34, adjacent to 7555 Chaffee Road, showing the existing conditions modeling results relative to the house, surveyed windowsill, and approximate driveway location at 7565 Chaffee Road

Proposed Conditions Modeling

Based on the initial screening-level effort, the opportunities matrix revealed that culvert upsizing was likely the most cost-effective solution to meet the primary goal of the project of improved conveyance. As such, SCE requested proposed conditions modeling to understand the culvert size that would be required to meet the County's standards.

Two proposed conditions scenarios were evaluated and are reported herein. The first scenario, called Scenario A, includes upsizing the Chaffee Road culvert to convey the 25-year design storm with a minimum of one foot of freeboard on the upstream, low edge of the pavement. The second scenario, called Scenario B, is upsizing the Chaffee Road culvert to meet the above-stated requirement and upsizing the 7565 Chaffee Road driveway culvert such that the headwater depth at the inlet of the culvert is at or below the near edge of pavement. As in the existing conditions, the lowest driveway elevation in the proposed scenarios was informed by the survey data (elevation = 789.3), although there is consideration given for the potential for a lower driveway elevation based on the LiDAR data (elevation = ~788.4). These scenarios do not assume to know the floor elevation of the basement at 7555 Chaffee Road or whether it is finished.

For Scenario A, the Chaffee Road culvert was modeled as a 2'(H) x 6'(W) box culvert, with an increased slope of 1.43%, resulting from lowering the downstream invert to 782.50. The existing scour hole at the downstream end of the culvert provides the available fall for this increased slope. Roadway elevations remained the same as existing conditions. The box culvert height of only two feet was chosen to maintain or increase the cover between the top of pipe and roadway compared to the existing condition.

This proposed culvert was found to provide 1.07 feet of freeboard at Chaffee Road in the 25-year event (Table 4). Upsizing the Chaffee Road culvert lowers the water surface in the model upstream until the driveway culvert. Throughout this short segment, the water surface in the 25-year event is ~1.25 feet lower in the proposed conditions model than the existing conditions model.

Table 4. Proposed Conditions (Scenario A and Scenario B) Hydraulic Modeling Results – Upstream Side of Proposed 2' x 6' Chaffee Rd. Culvert[1]

Event	Peak Flow at Culvert (cfs)	Water Surface Elevation (ft)	Depth of Water (ft)	Freeboard Below Roadway [2] (ft)
2-yr, 24-hr	33.03	785.43	1.65	2.79
25-yr, 24-hr	119.86	787.15	3.37	1.07
100-yr, 24-hr	204.03	788.54	4.76	-0.32

[1] Modeling results from the cross section at station 1589.09 reported (the cross section at the upstream side of the Chaffee Rd. culvert).

[2] Roadway elevation of 788.22 informed by survey and used in calculation. A positive freeboard value indicates space between the water surface elevation and the top of the roadway, whereas a negative freeboard value indicates that water is overtopping the roadway.

Across all three modeled storm events, the proposed water surface is lower than existing conditions between the Chaffee Road culvert and the driveway culvert. No changes to the water surface were noted in the modeling results upstream of the driveway culvert, with the exception of the 2-year event. Scenario A was found to increase the depth of water by 0.03 feet in the 2-year event, just upstream of the driveway culvert. Refer to Figure 7. Map 6 in Appendix A identifies the locations from the Figure 7 profile. A tabular summary of the hydraulic results for the Scenario A HEC-RAS model are included in Appendix D.

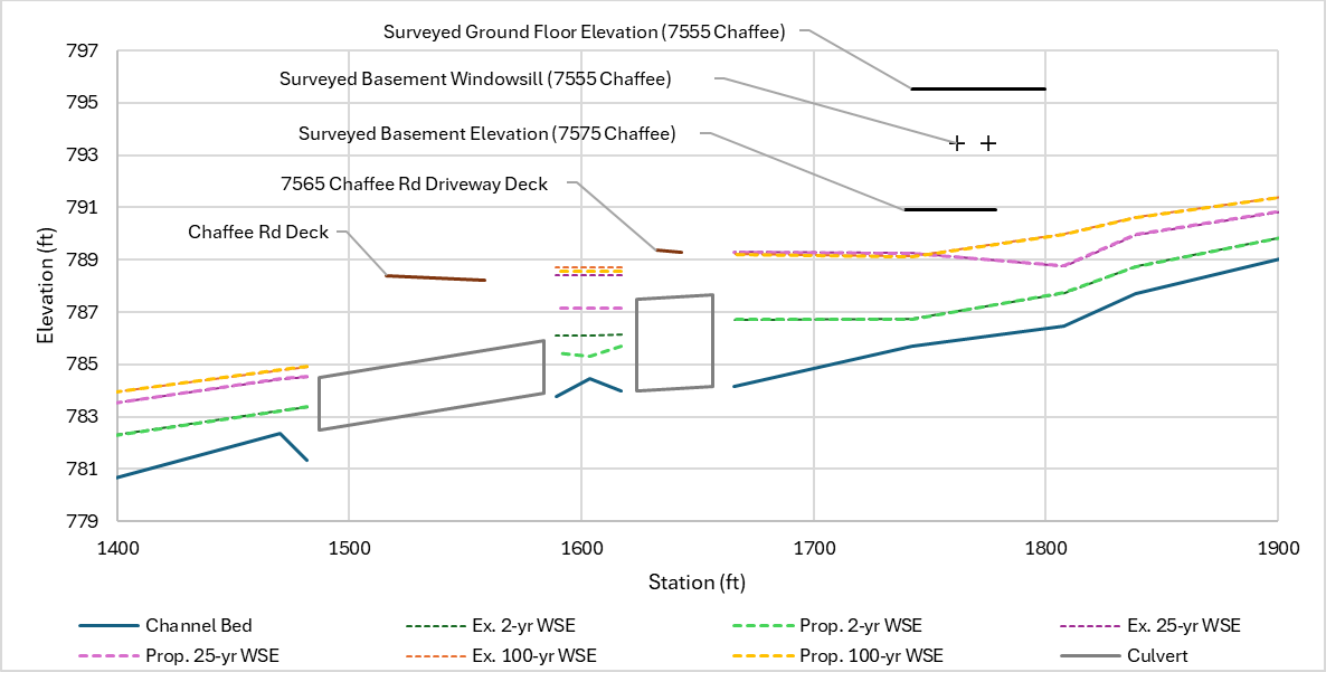


Figure 7. Comparison of existing and proposed conditions (Scenario A) hydraulic modeling profile of Chaffee Road culvert (near station 1550) and 7565 Chaffee Rd. driveway culvert (near station 1650)

For Scenario B, the Chaffee Road culvert was again modeled as a 2'(H) x 6'(W) box culvert with an increased slope of 1.43%. The driveway culvert was increased to a 43"(H) x 68"(W) elliptical concrete pipe, and the slope and inverts were maintained. This elliptical pipe is roughly equivalent to a 54" circular pipe and was selected to approximately maintain the existing cover over the pipe at the driveway.

For the Chaffee Road culvert, the results of Scenario B are consistent with the results reported in Table 4, which improve the 25-year freeboard and meet the freeboard requirement. For the driveway culvert, the increased culvert size in Scenario B facilitates improved driveway freeboard. In the 25-year event, the freeboard above the lowest surveyed driveway elevation is increased to 0.85 feet (Table 5).

This increase in freeboard depth nearly facilitates the freeboard requirement being met with a lower driveway elevation (assumed at ~788.4 per LiDAR contours), with ~0.05 feet of water overtopping the assumed lower driveway elevation. Due to the limited extents of the survey-grade elevation data on the driveway and the considerations for budget on this project, it is strongly recommended that the survey extents be expanded to capture the lowest elevation of the driveway at 7565 Chaffee Road prior to any additional driveway culvert size increase. At the size presently proposed (i.e., 43"(H) x 68"(W) elliptical concrete pipe), the elevation between the top of the pipe and the driveway deck is approximately consistent with the existing conditions. Should a larger pipe be needed to meet the driveway freeboard requirement, a box culvert may be necessary to maintain the cover to the driveway deck.

The freeboard to the windowsill is increased for the 25-year storm in Scenario B (Table 5). Freeboard depths for the 2-year and 100-year events remain consistent with the existing conditions model due to the free-flowing and backwater conditions, respectively as indicated in Figure 8.

Table 5. Proposed Conditions (Scenario B) Hydraulic Modeling Results – Upstream Side of 43" x 68" Elliptical Driveway Culvert

Event	*Peak Flow at Culvert [1] (cfs)*	*Water Surface Elevation [1] (ft)*	*Depth of Water [1] (ft)*	*Freeboard Below Surveyed Portion of Driveway [1, 2] (ft)*	*Freeboard Below Windowsill [3] (ft)*
2-yr, 24-hr	28.40	786.05	1.90	3.25	6.43
25-yr, 24-hr	108.96	788.45	4.30	0.85	4.96
100-yr, 24-hr	194.73	789.22	5.07	0.08	4.07

[1] Modeling results from the cross section at station 1665.95 reported (the cross section at the upstream side of the 7565 Chaffee Rd. driveway culvert).
[2] Driveway elevation of 789.30 informed by survey and used in calculation. It is noted that the survey may not have captured the lowest point in the driveway (LiDAR indicates the driveway could be as low as ~788.4).
[3] Water surface elevations associated with the modeling results were interpolated at windowsill location with surveyed elevation of 793.46. It is unknown if the basement is finished. A positive freeboard value indicates space between the water surface elevation and the top of the driveway, whereas a negative freeboard value indicates that water is overtopping the driveway.

Figure 8 displays the results of hydraulic modeling for both the existing conditions and proposed Scenario B in profile format. Map 6 in Appendix A identifies the locations from the Figure 8 profile. A tabular summary of the hydraulic results for the Scenario B HEC-RAS model are included in Appendix D.

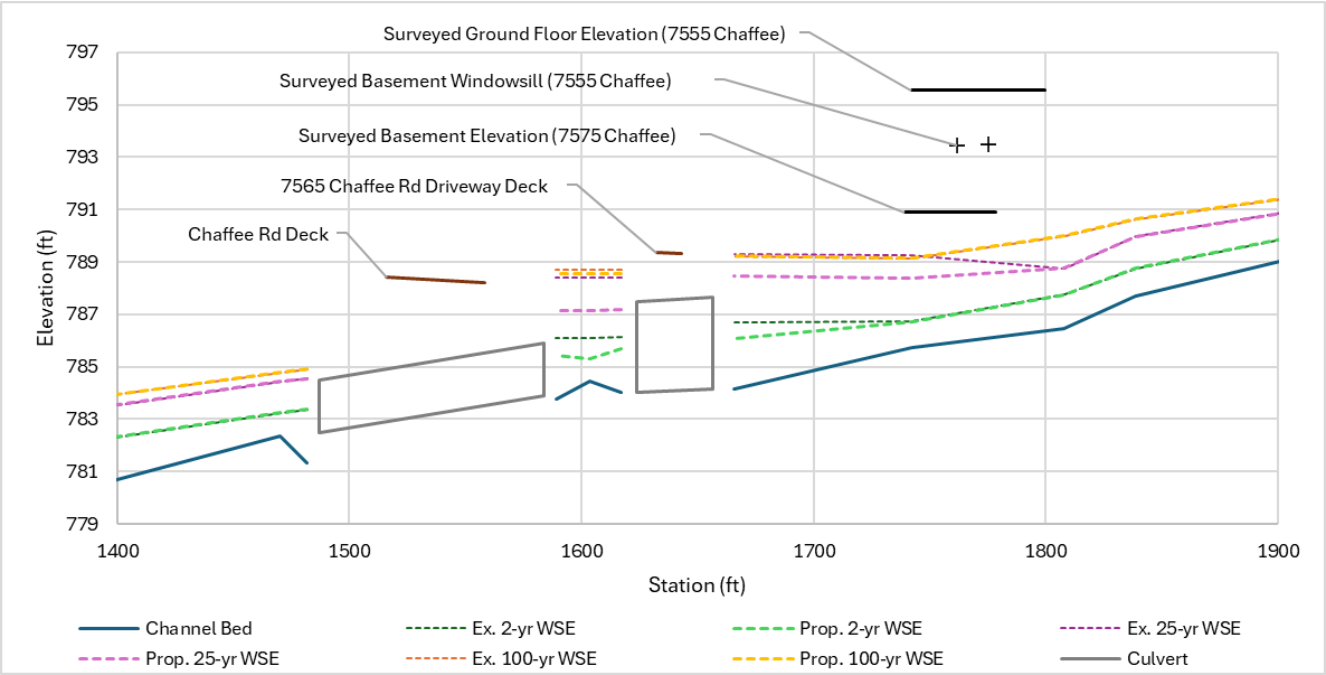


Figure 8. Comparison of existing and proposed conditions (Scenario B) hydraulic modeling profile of Chaffee Road culvert (near station 1550) and 7565 Chaffee Rd. driveway culvert (near station 1650)

Additional Modeling

At the request of SCE, Sustainable Streams completed an analysis to understand how the Red Hawk Subdivision stormwater basin impacts downstream flows. For this analysis, hypothetical scenarios were evaluated and compared to current conditions both at the discharge point of the basin as well as at the Chaffee Road culvert. Hypothetical scenarios included:

- Prior to Subdivision Development: Due to the majority of the impervious surface within the Red Hawk Subdivision draining to the stormwater basin, this scenario evaluated pre-development conditions within the basin's drainage area and maintained the existing conditions in all other drainage areas in the model. This scenario does not include a basin and could be considered "undeveloped".
- Subdivision Development without Basin: This scenario maintains the current drainage patterns and land cover as existing conditions both within the basin's drainage area and in all other drainage areas in the model. This scenario excludes the basin and could be considered "developed and undetained".

Table 6 summarizes the peak flow results leaving the discharge point from the basin (or equivalent location in the scenarios without a basin), and Table 7 summarizes the peak flow results at the Chaffee Road culvert. It is clear from these results that the detention basin was sized and constructed to attenuate the excess runoff generated by the impervious surfaces in the Red Hawk Subdivision.

Table 6. Comparison of Peak Flows at Discharge Point from Basin (i.e. 16-acre drainage area)

Event	*Existing Conditions (Basin in Place and Functioning) (cfs)*	*Prior to Subdivision Development (cfs)*	*Subdivision Development Without Basin (cfs)*
2-yr, 24-hr	0.54	15.54	19.41
10-yr, 24-hr	1.89	30.61	37.85
25-yr, 24-hr	2.52	41.48	50.99
100-yr, 24-hr	5.59	61.05	74.70

Table 7. Comparison of Peak Flows at Chaffee Road Culvert (i.e. 312.6-acre drainage area)

Event	*Existing Conditions (with Basin in Place and Functioning) (cfs)*	*Prior to Subdivision Development (cfs)*	*Subdivision Development Without Basin (cfs)*
2-yr, 24-hr	33.03	47.90	51.98
10-yr, 24-hr	79.51	109.42	114.75
25-yr, 24-hr	119.86	159.58	165.30
100-yr, 24-hr	204.03	262.47	267.86

Furthermore, the flows leaving the detention basin in the 2-year storm are small enough that they are released below $Q_{critical}$, which is the threshold for erosive flows. Based on data collected across Ohio, as well as in the Yellow Creek Watershed within Summit County, the threshold for erosive flows is ~40% of the undeveloped 2-year flow (i.e., Q_2). As calculated via the USGS Regional Equation, Q_2 for the 16 acres entering the basin is 7.58 cfs, resulting in a $Q_{critical}$ threshold of 3.03 cfs. The modeled 2-year peak flow from HydroCAD is only 0.54 cfs (Table 6), indicating that the developed areas of the Red Hawk Subdivision that drain to the basin are not contributing to excess downstream erosion compared to the undeveloped condition.

Conclusion

Sustainable Streams has completed a detailed watershed inventory and evaluation of numerous alternatives for flow attenuation throughout the Chaffee Road watershed, with the ultimate goal of meeting conveyance standards for the Chaffee Road culvert and the upstream driveway culvert at 7565 Chaffee Road. Watershed-based solutions tailored to this location exceed the budgetary restrictions of this project and include numerous considerations that result in culvert upsizing as the logical solution in this location.

The increased culvert sizes identified in the memo present an option to resolve the inadequate conveyance under Chaffee Road, with a consideration of additionally improving conveyance through the 7565 Chaffee Road driveway culvert. Preliminary engineer's opinions of probable construction cost (OPCCs) have been developed for both Scenario A and Scenario B. The construction cost of Scenario A is estimated as ~$400,000 and the construction cost of Scenario B is estimated as ~$475,000. These preliminary engineer's OPCCs should be further refined using recent and relevant bid tab data from comparable culvert replacement and transportation infrastructure projects (Sustainable Streams maintains a large inventory of bid tabs related to stream, wetland, and stormwater construction projects but does not have readily accessible transportation project bid tabs).

Itemized OPCCs are included in Appendix E. Prior to implementation, it is recommended that additional survey of the driveway, farther to the east, be conducted to understand the lowest elevation where stormwater may spill over the driveway embankment and if additional culvert size increase is necessary to meet the regulations.

An upsized culvert would also reduce the scouring forces on the downstream side of Chaffee Rd. relative to the existing conditions, thereby having a slight benefit to water quality.

References

Bonnin, G.M., Martin, D., Lin, B., Parzybok, T., Yekta, M., and Riley, D. 2006. Point Precipitation Frequency Estimates for Akron, Ohio, USA. NOAA Atlas 14, Volume 2, Version 3. NOAA, National Weather Service, Silver Spring, Maryland. https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html?bkmrk=oh [Accessed July 19, 2022].

Dewitz, J., 2023. National Land Cover Database (NLCD) 2021 Products: U.S. Geological Survey data release, https://doi.org/10.5066/P9JZ7AO3.

Fultech Consulting Engineers, 2004. Storm Water Management Report & Hydrologic Study for the Red Hawk Residential Development. Township of Sagamore Hills, Summit County, Ohio. August 2004.

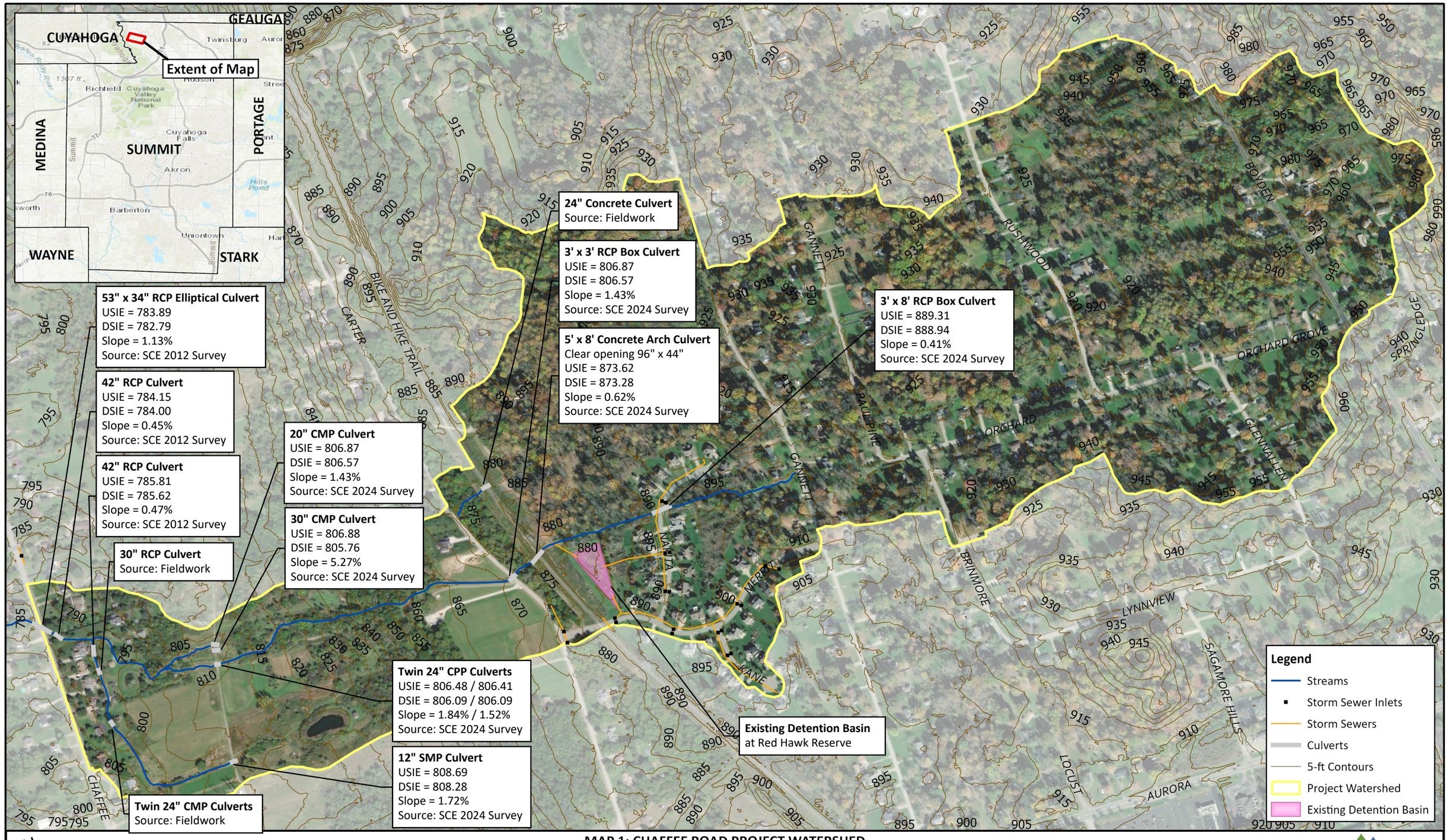
SCE (Summit County Engineer). 2020. Stormwater Drainage Manual. Summit County, Ohio. January 2020.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. 2024 Web Soil Survey. Available online at the following link: https://websoilsurvey.sc.egov.usda.gov/. [Accessed November 22, 2024].

USDA (United States Department of Agriculture) NRCS (Natural Resources Conservation Service) Conservation Engineering Division. 1986. Urban Hydrology for Small Watersheds. Technical Release No. 55 (TR-55). June 1986.

APPENDIX A

Maps



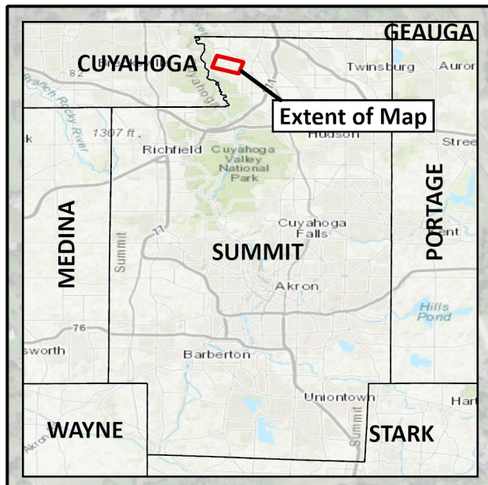
MAP 1: CHAFFEE ROAD PROJECT WATERSHED OVERVIEW

CHAFFEE ROAD WATERSHED STUDY MEMO

SUMMIT COUNTY ENGINEER'S OFFICE

Sustainable Streams LLC

Last Updated On: Tuesday, January 21, 2025



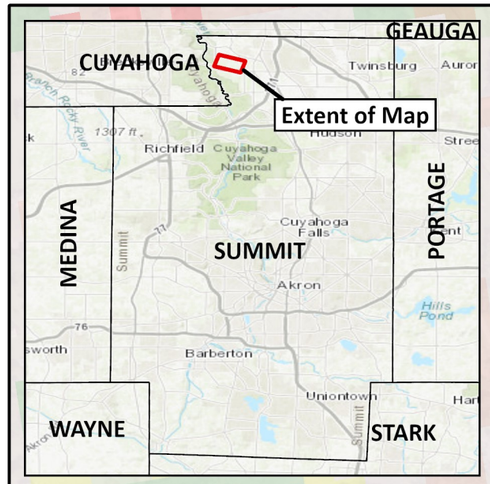
N

0 500 1,000 Feet

MAP 2: CHAFFEE ROAD PROJECT WATERSHED
SOIL TYPE AND HYDROLOGIC SOIL GROUP
CHAFFEE ROAD WATERSHED STUDY MEMO
SUMMIT COUNTY ENGINEER'S OFFICE

Sustainable Streams LLC

Last Updated On: Tuesday, January 21, 2025



CARTER
BIKE AND HIKE TRAIL
GANNETT
RUSHWOOD
BOYDEN
ORCHARD GROVE
SPRINGLEDGE
PAUL PINE
ORCHARD
GLENNALLEN
GANNETT
NANITA
MERRIT
KANE
BRINMORE
LYNNVIEW
CHAFFEE

Legend

Land Cover Type

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Herbaceous
- Hay/Pasture
- Cultivated Crops
- Woody Wetlands
- Streams
- Storm Sewer Inlets
- Storm Sewers
- Culverts
- Project Watershed

N

0 500 1,000 Feet

MAP 3: CHAFFEE ROAD PROJECT WATERSHED
NLCD 2021 LAND COVER TYPE
CHAFFEE ROAD WATERSHED STUDY MEMO
SUMMIT COUNTY ENGINEER'S OFFICE

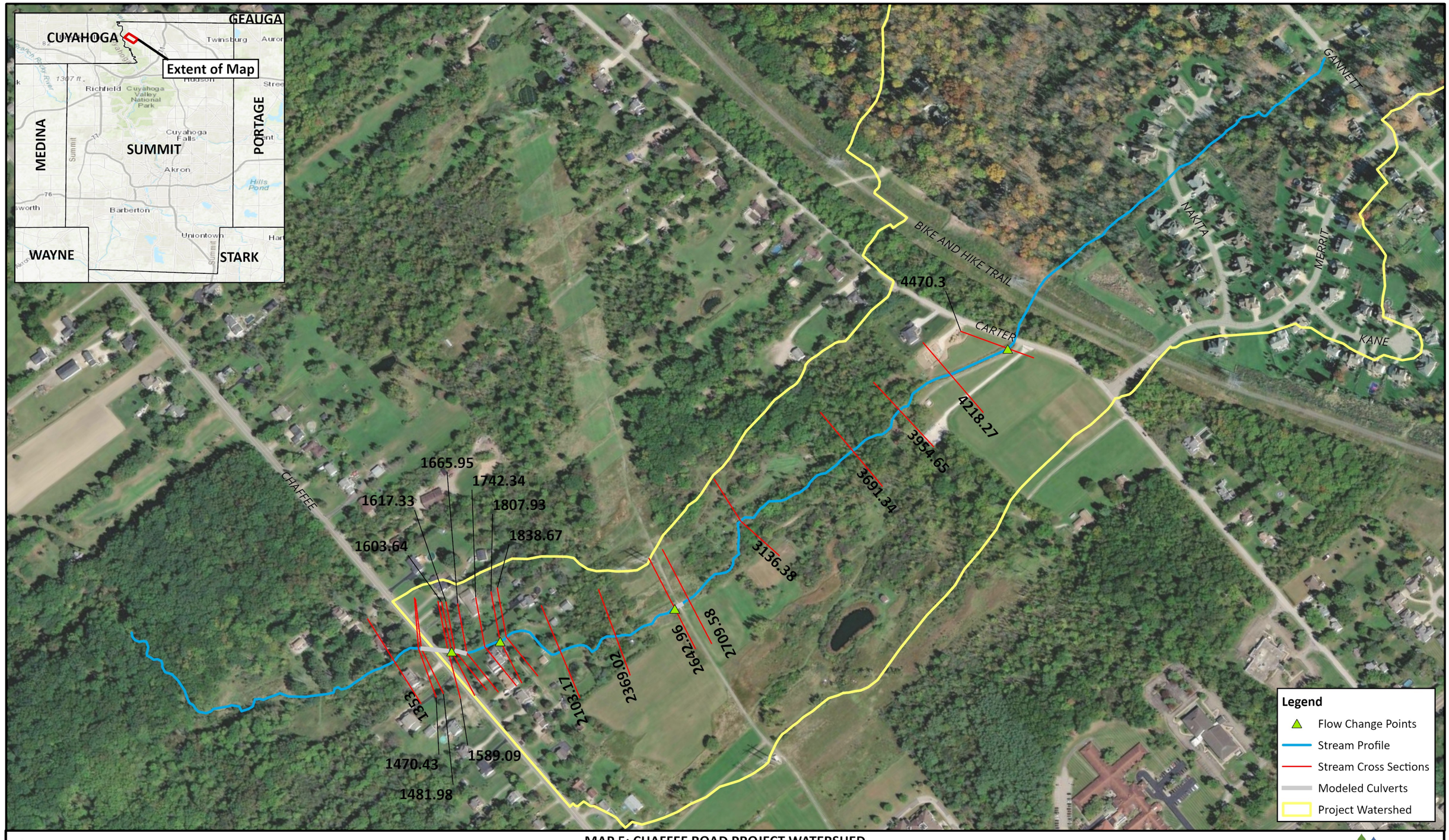
Sustainable Streams LLC

Last Updated On: Tuesday, January 21, 2025

MAP 4: CHAFFEE ROAD PROJECT WATERSHED
HYDROLOGIC MODELING DRAINAGE AREAS AND TIMES OF CONCENTRATION
CHAFFEE ROAD WATERSHED STUDY MEMO
SUMMIT COUNTY ENGINEER'S OFFICE

Sustainable Streams LLC

Last Updated On: Tuesday, January 21, 2025



MAP 5: CHAFFEE ROAD PROJECT WATERSHED
HYDRAULIC MODELING PROFILE AND CROSS SECTIONS
CHAFFEE ROAD WATERSHED STUDY MEMO
SUMMIT COUNTY ENGINEER'S OFFICE

Sustainable Streams LLC

Last Updated On: Tuesday, January 21, 2025

MAP 6: CHAFFEE ROAD PROJECT WATERSHED
EXTENTS OF HYDRAULIC MODELING PROFILE FROM MEMO
CHAFFEE ROAD WATERSHED STUDY MEMO
SUMMIT COUNTY ENGINEER'S OFFICE

Sustainable Streams LLC

Last Updated On: Wednesday, January 22, 2025

APPENDIX B

Field Summary and Cursory Evaluation of Watershed-based Solutions

Chaffee Rd. Watershed Evaluation

Field Assessment Summary & Cursory Alternatives for Discussion with SCE

Completed for Summit Co Engineer

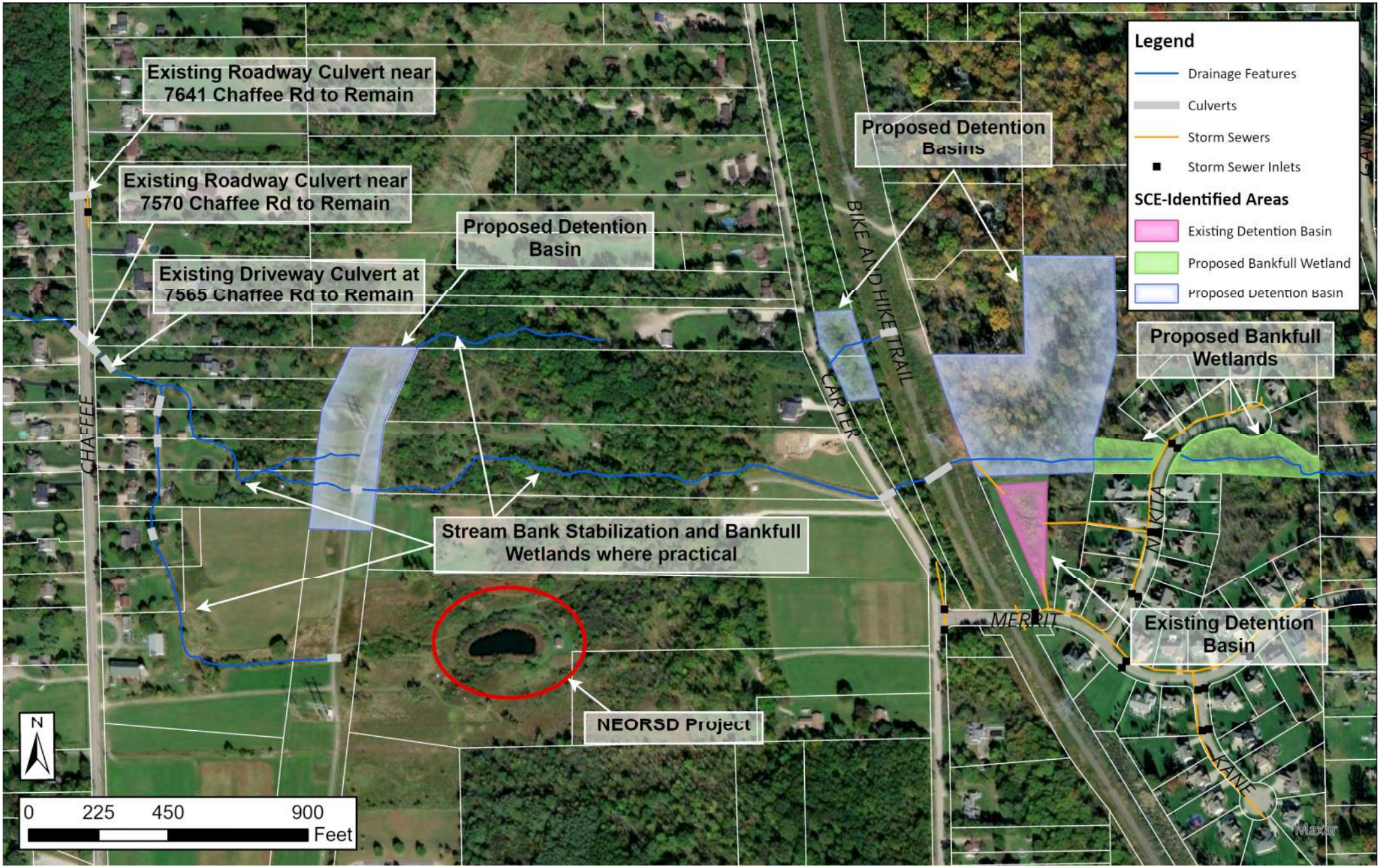
Sustainable Streams, LLC

October 24, 2024

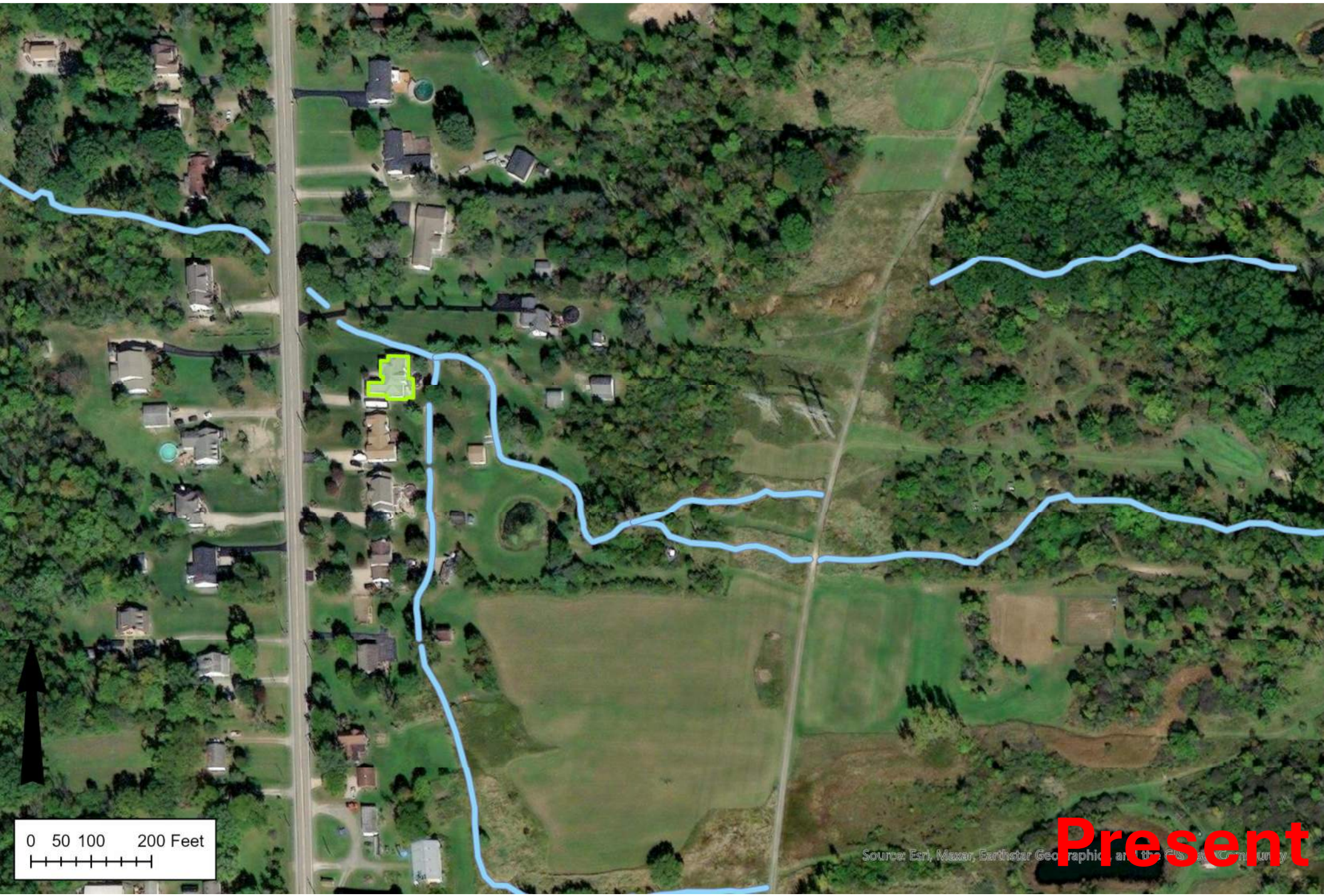
Agenda

- Share existing conditions assessment
- Share analysis of historic watershed changes
- Present cursory ideas of potential improvements for discussion
- Discuss next steps regarding conceptual effort

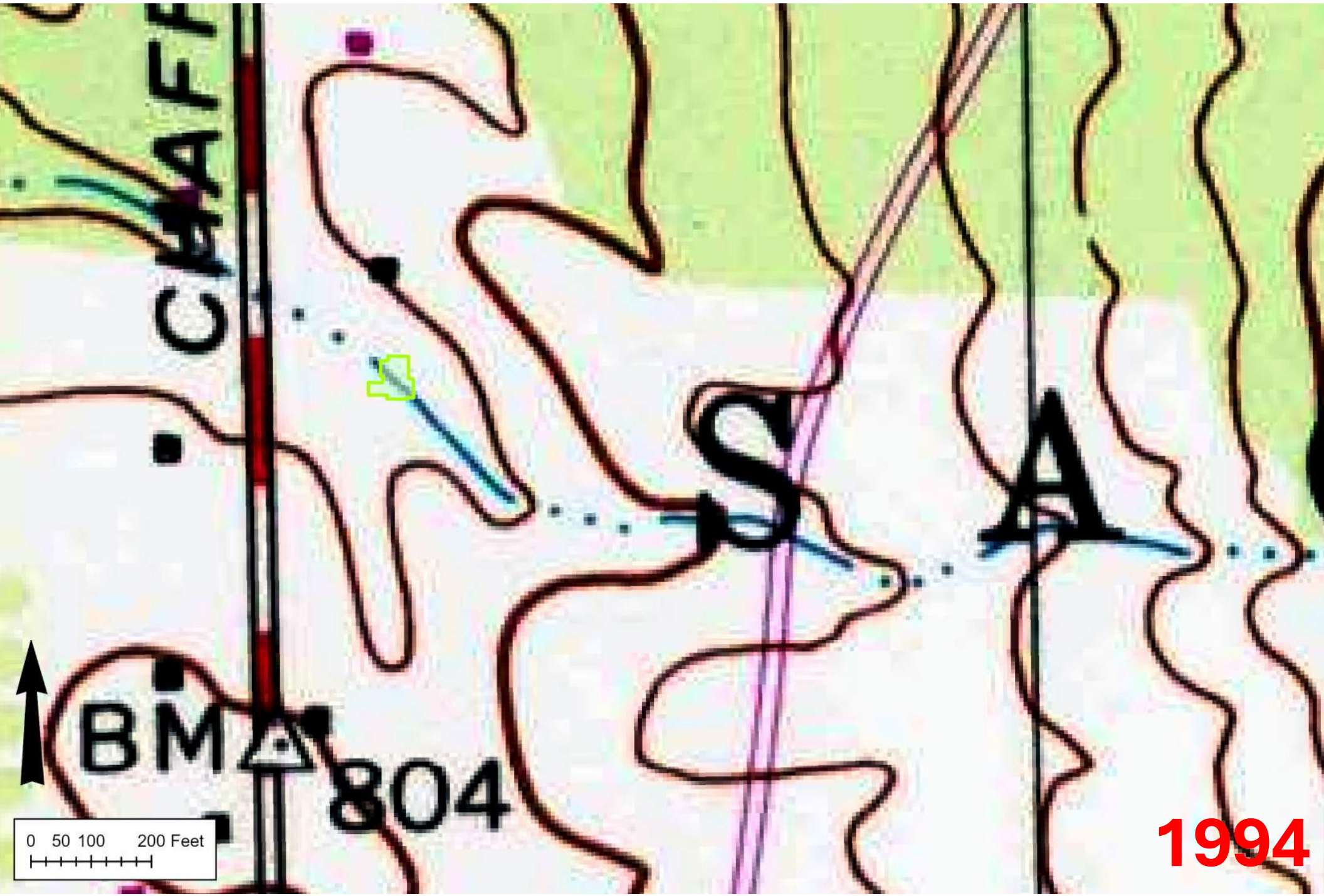
Project Evaluation Area



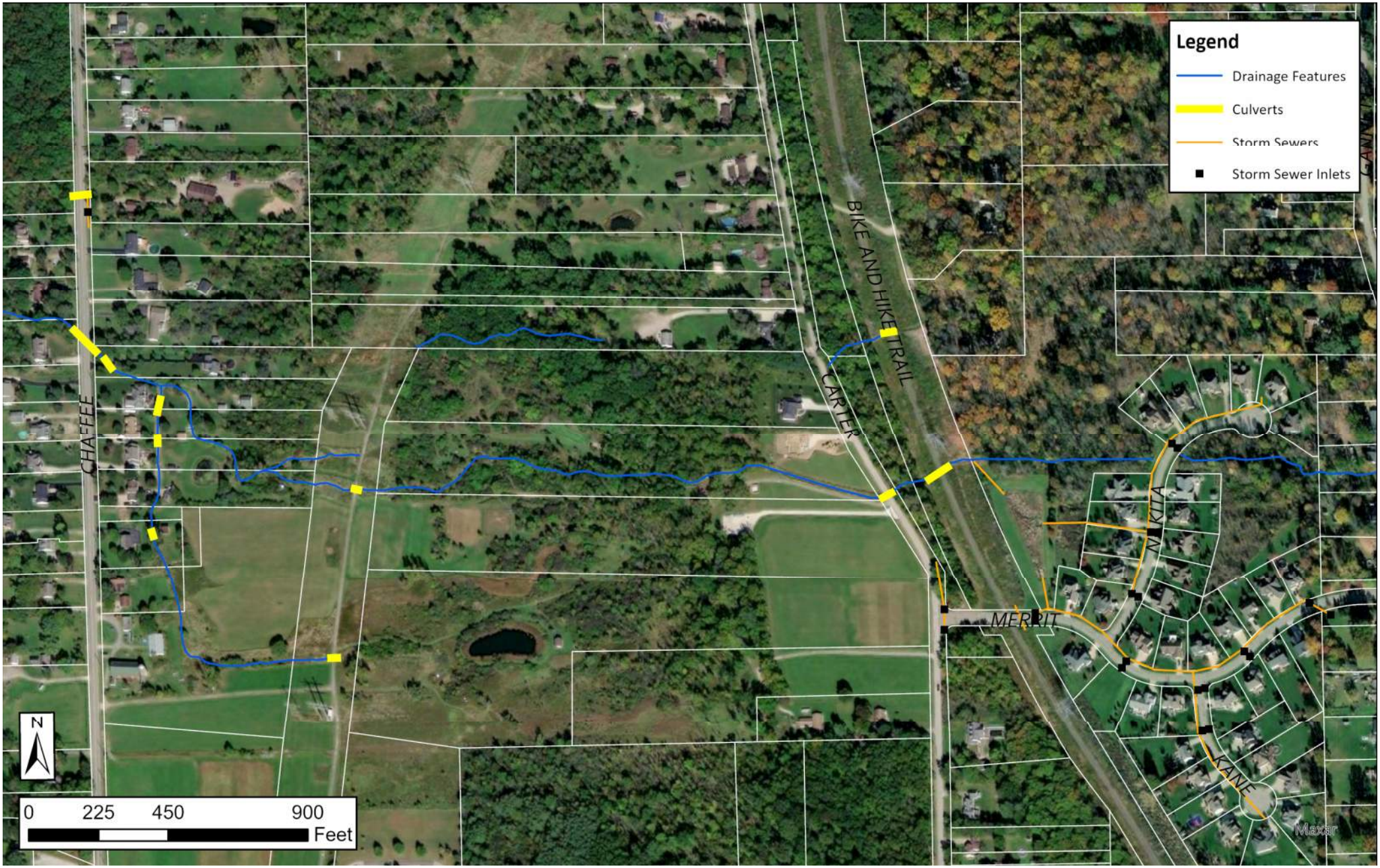
Current Stream Alignment near 7555 Chaffee Rd.



Previous Stream Alignment near 7555 Chaffee Rd.



Project Field Notes - Culverts



Project Field Notes - Culverts

Chaffee Rd Culvert = 53”x 34” (elliptical)
U/S end

Chaffee Rd Culvert = 53”x 34” (elliptical)
Scour hole present
D/S end

7565 Chaffee Rd driveway culvert = 42”
Erosion evident around sides
U/S end

Project Field Notes - Culverts

Project Field Notes - Culverts

7525 Chaffee Rd backyard culvert = Two 24”
D/S end

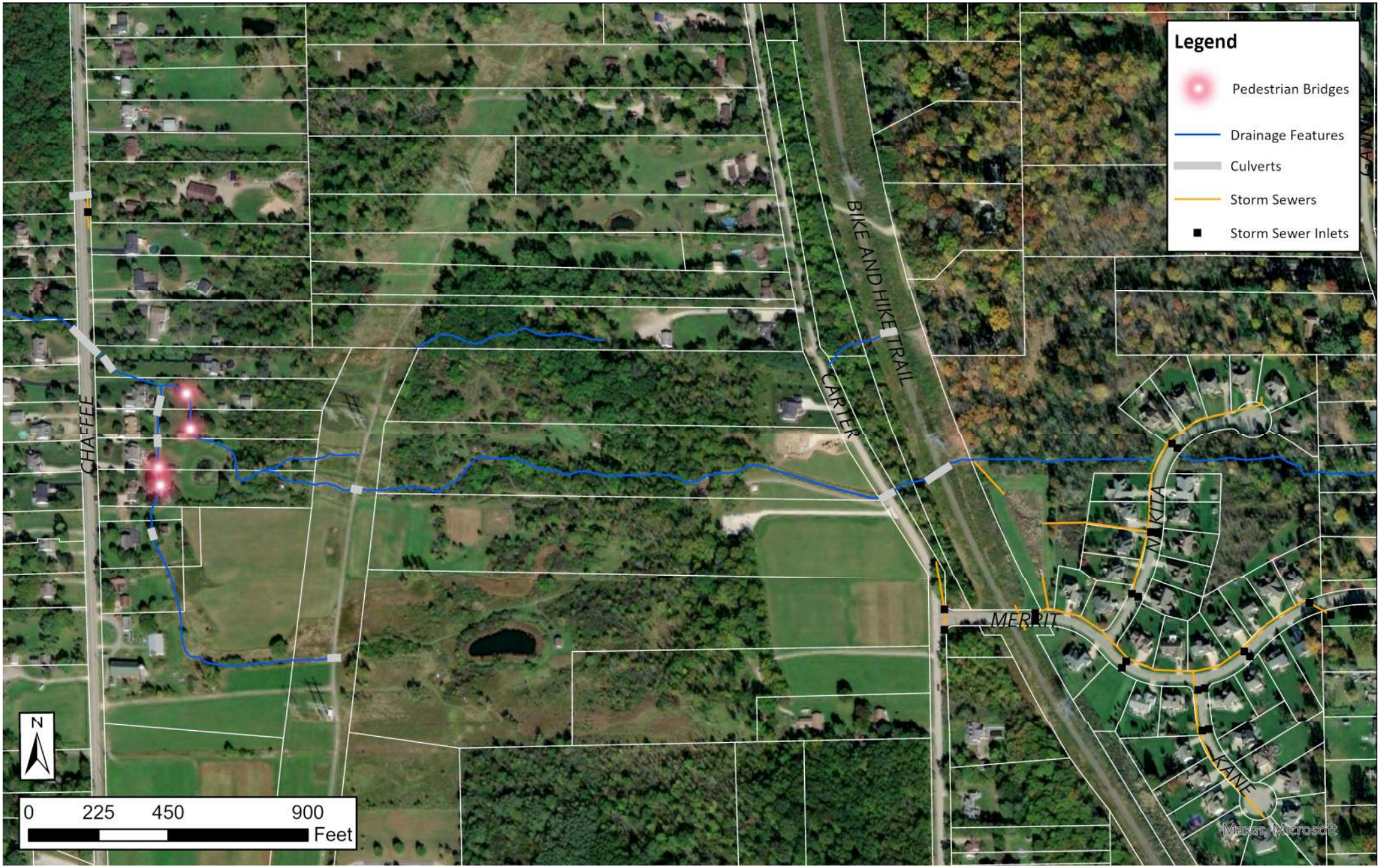
7495 Chaffee Rd culvert (CEI parcel) = 12”
D/S end

7495 Chaffee Rd culvert (CEI parcel) = Two 24”
Inlet has erosion and lacks armoring
U/S end

7495 Chaffee Rd culvert (CEI parcel) = 12”
U/S end

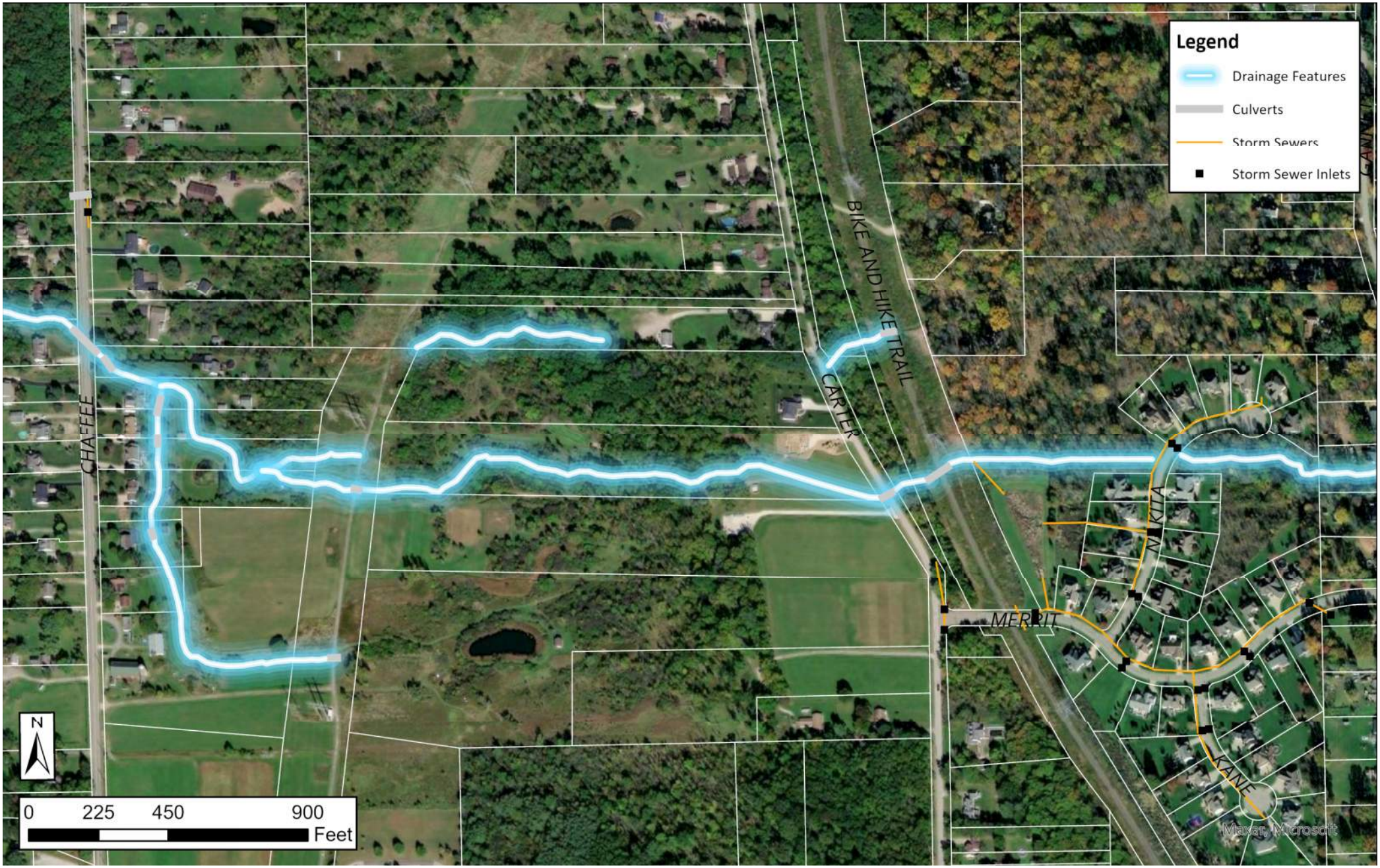
Project Field Notes - Culverts

Project Field Notes – Pedestrian Bridges



Project Field Notes – Pedestrian Bridges

Project Field Notes – Streams



Project Field Notes – Streams

Project Field Notes – Streams

7525 Chaffee Rd
Thick vegetation
Looking U/S

7555 Chaffee Rd
Vegetated buffer through ag land
Looking D/S

Carter Rd
Wetland-like area D/S of small pond
Looking U/S

7495 Chaffee Rd
Heavily vegetated with wetland plants
Looking north

Project Field Notes – Streams

7720 Carter Rd
Limited buffer next to driveway w/ no trees
Looking D/S

S. gap between Carter Rd and bike path
Vegetated with utilities
Looking U/S

Nakita Ct HOA parcel
Large, wooded depression with stream
Looking U/S

Nakita Ct HOA parcel
Large, wooded depression with stream
Looking D/S

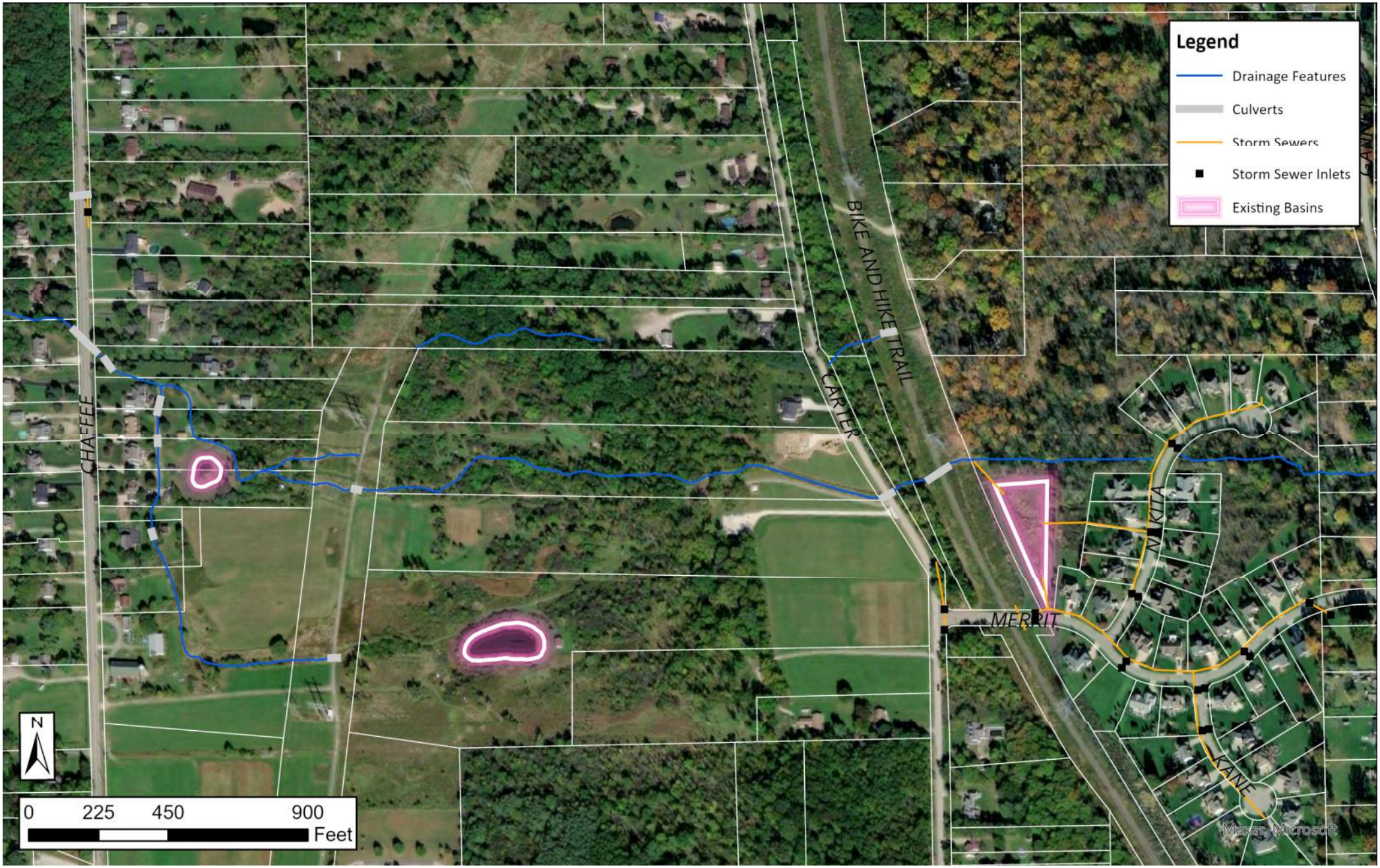
Project Field Notes – Streams

Nakita Ct HOA parcel
US Large, wooded depression with stream
Looking U/S

N. gap between Carter Rd and bike path
Heavily vegetated with stream
Looking D/S

7761 Carter Rd
Recent clearing/grading
Looking U/S

Project Field Notes – Existing Basins



Project Field Notes – Existing Basins

Project Field Notes – Other Notes

Project Field Notes – Other Notes

Project Field Notes – Items to Be on Lookout For

- Dry weather flows or illicit discharges including home sewage treatment systems
  - **None evident.**
- Dumping of waste or debris including yard waste
  - **None evident.**
- Blockage of surface and subsurface drainage
  - **Select private culverts have sediment buildup.**
- Condition of drainage structures (good/fair/failing)
  - **Generally good, one lacking armor on CEI parcel (two 24" HDPE culverts at utility access road).**
- Other drainage or erosion concerns that may be addressed as part of this study
  - **Requires direction from SCE. Stream erosion was worst in the vicinity of CEI parcel (exposed gas line).**

Project Field Notes – Items to Be on Lookout For

- Structures such as decks, sheds, fences, and other improvements that may encroach into existing easements.
  - **Houses and shed appear to be within or adjacent to existing utility easement (7565 & 7555 Chaffee)**

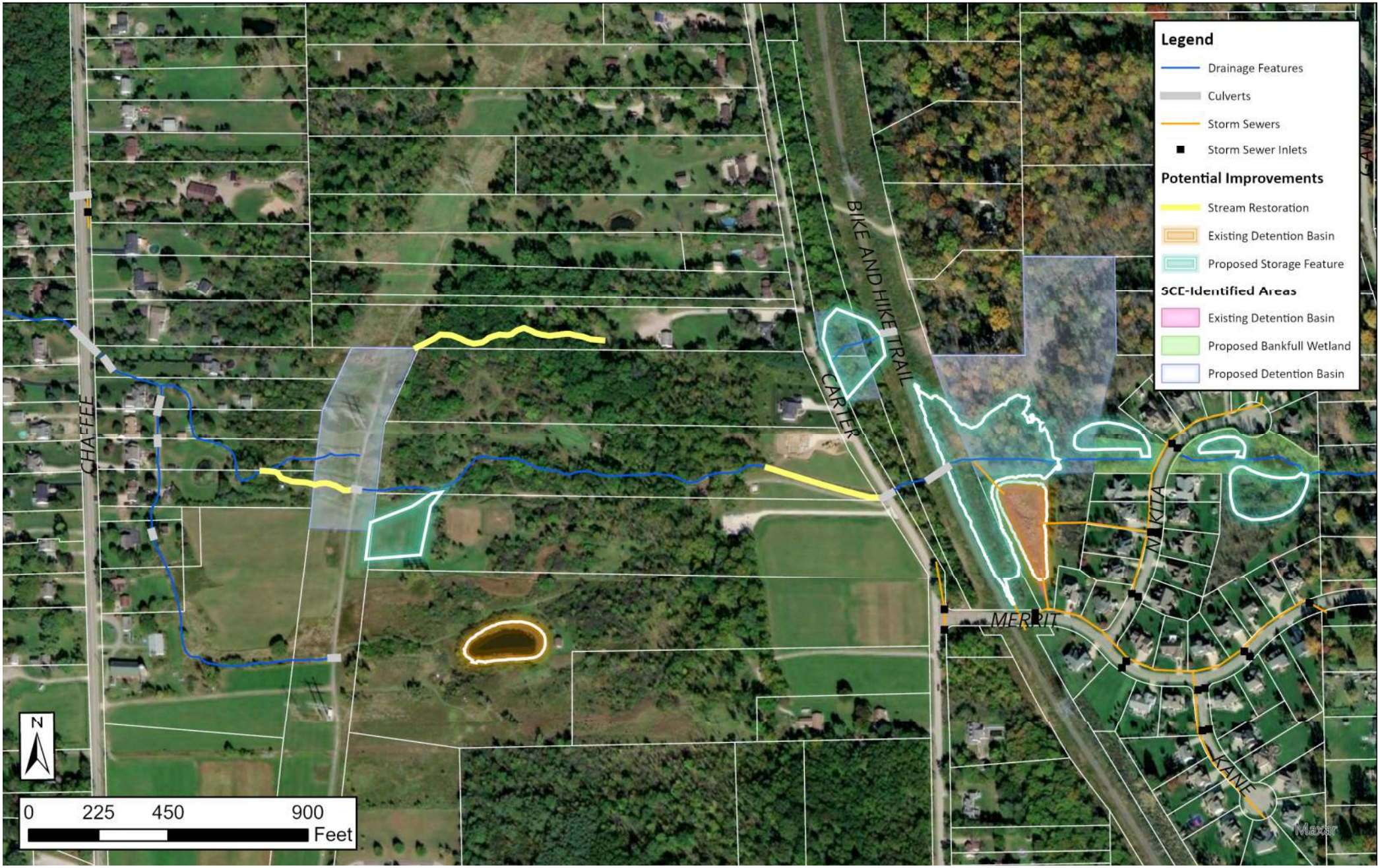
Cursory Alternatives for Discussion with SCE

- Potential Stormwater Improvements to Consider
  - Items from the contract

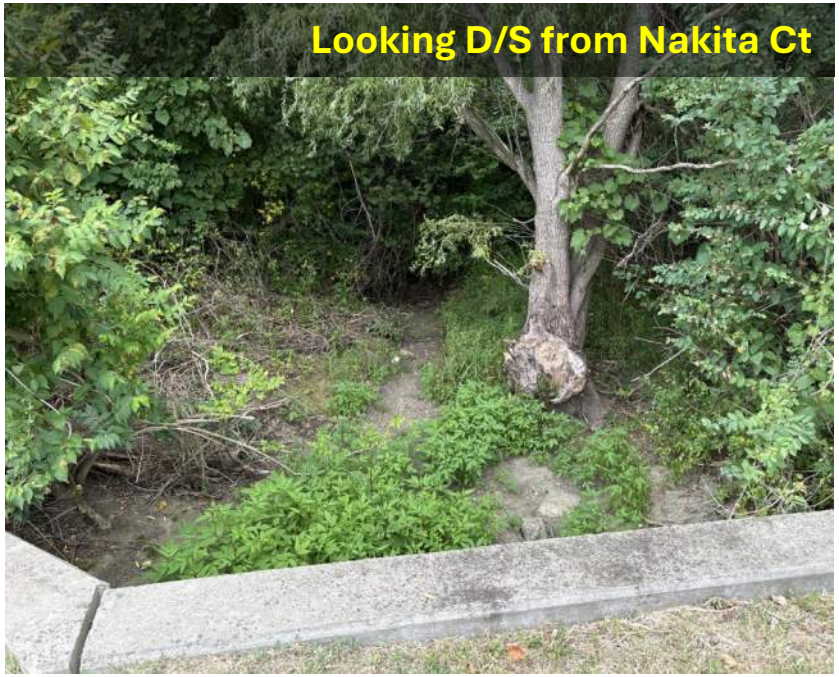
- Additional Stormwater Improvements to Consider
  - Additional stormwater ideas (not detailed in the contract)

- Other Alternatives
  - Revisit ideas from past efforts

Potential Stormwater Improvements to Consider

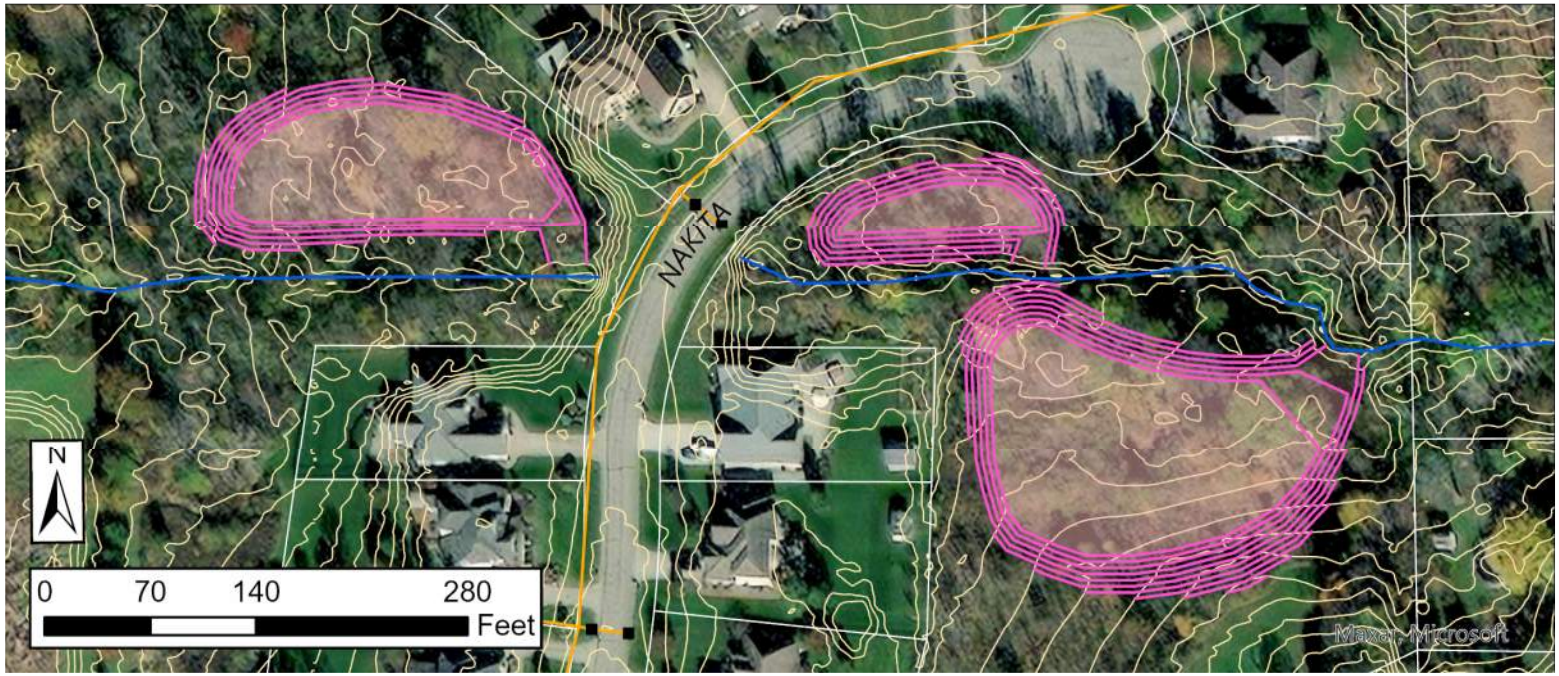


Potential Stormwater Improvements to Consider
Alternative A: Nakita Ct Bankfull Wetlands



- Nakita Ct culvert = 3’H x 8’W
- Areas are heavily wooded with dense vegetation
- Close proximity to residences

Potential Stormwater Improvements to Consider
Alternative A: Nakita Ct Bankfull Wetlands



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~50%

Probability for Flow Attenuation at Chaffee Culvert = **Low**

Probability for Water Quality Benefits = **High**

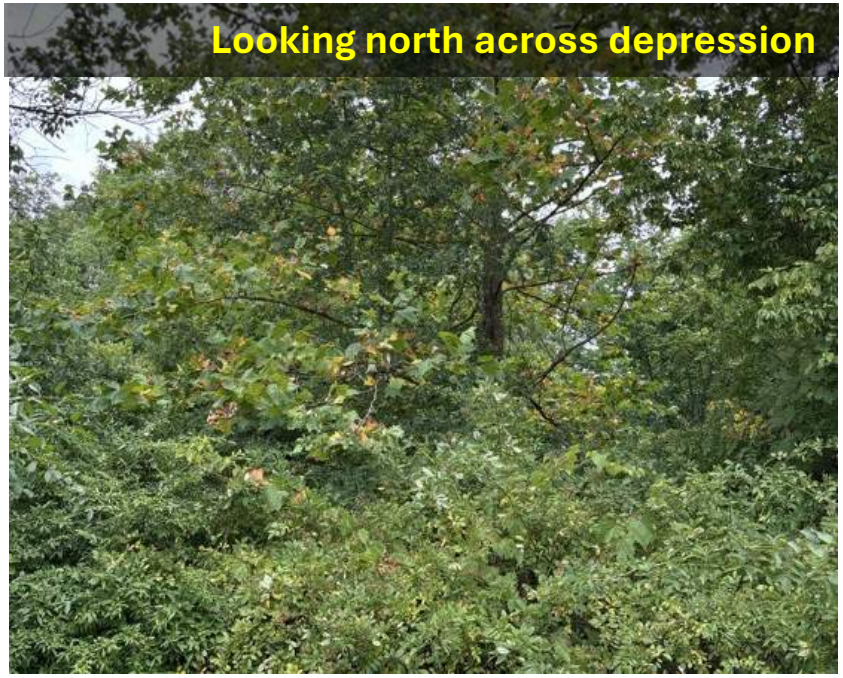
Ballpark Construction Cost* = ~$700,000

Approx. Storage compared to 25-yr Runoff Volume = ~7%

**unknown property acquisition/easement costs*

Potential Stormwater Improvements to Consider

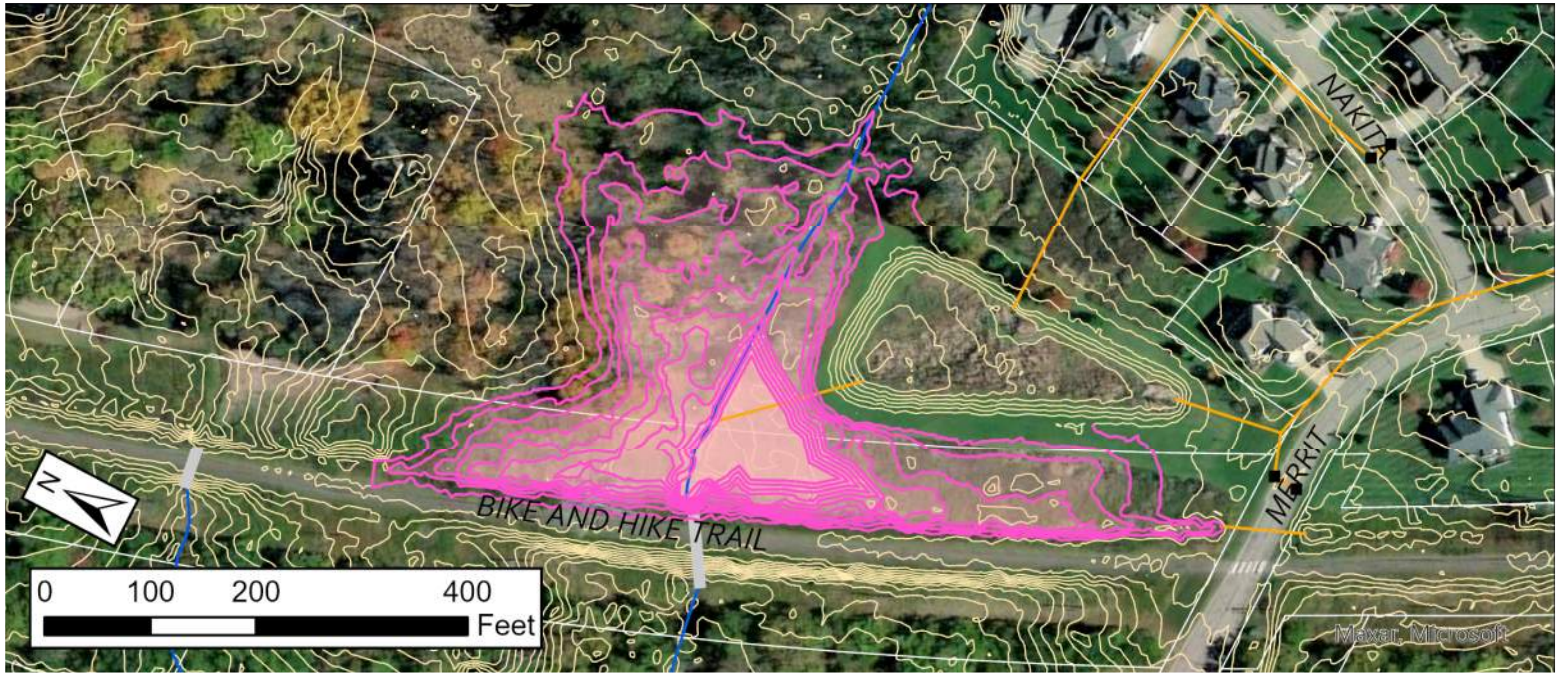
Alternative B: Detention within Red Hawk HOA Depression



- Likely a jurisdictional stream
- Area is heavily wooded with dense vegetation
- Unconventional downstream culvert through historic railroad embankment

Potential Stormwater Improvements to Consider

Alternative B: Detention within Red Hawk HOA Depression



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~70%

Probability for Flow Attenuation at Chaffee Culvert = **High**

Probability for Water Quality Benefits = **High**

Ballpark Construction Cost* = ~$600,000 / Potential Mitigation Fees = ~$130,000

Approx. Storage compared to 25-yr Runoff Volume = ~28%

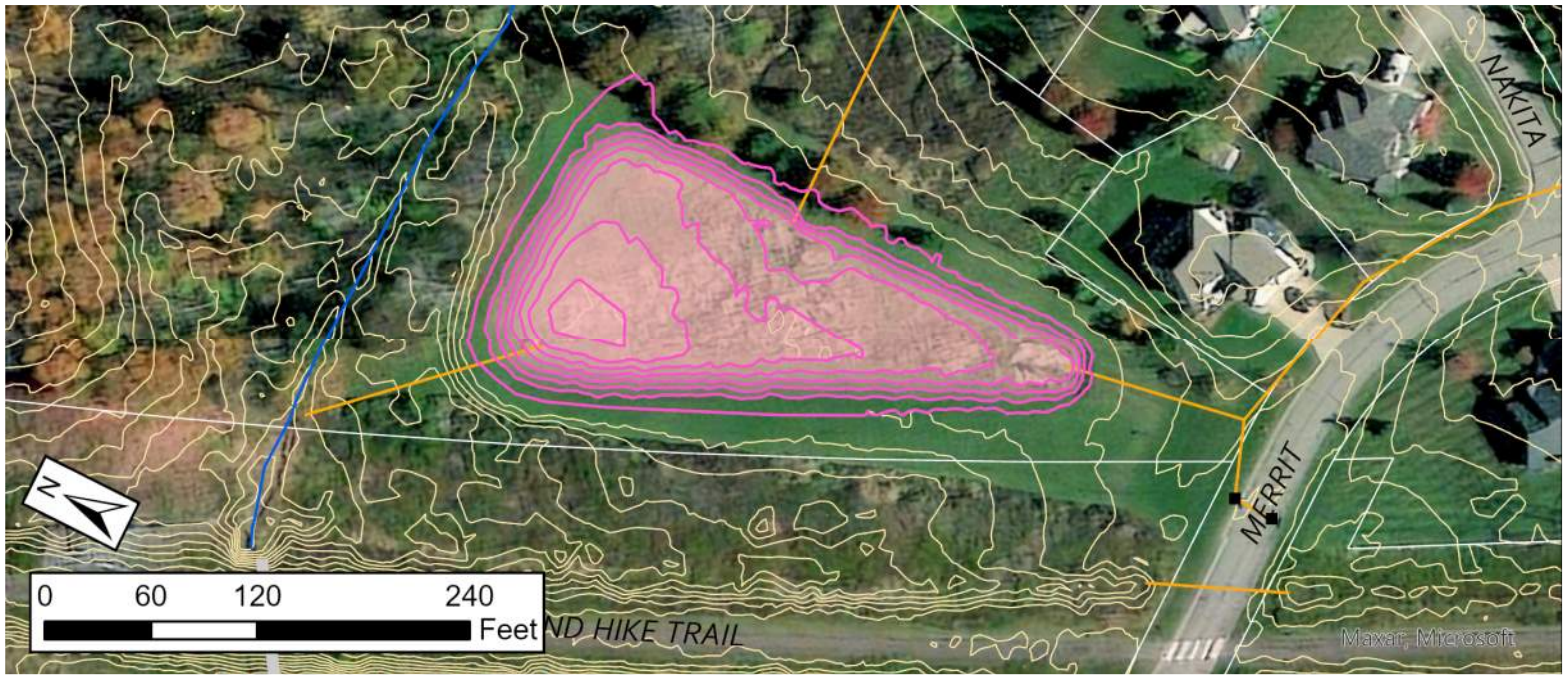
**unknown property acquisition/easement costs*

Potential Stormwater Improvements to Consider
Alternative C: Existing Detention within Red Hawk Reserve

- Wetland-type vegetation in basin bottom
- Standpipe is cracked towards ground surface
- Concrete outlet structure intact
- Original stormwater calculations indicate flood control and water quality treatment

Potential Stormwater Improvements to Consider

Alternative C: Existing Detention within Red Hawk Reserve



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~5%

Probability for Flow Attenuation at Chaffee Culvert = n/a (already providing)

Probability for Water Quality Benefits = n/a (already providing)

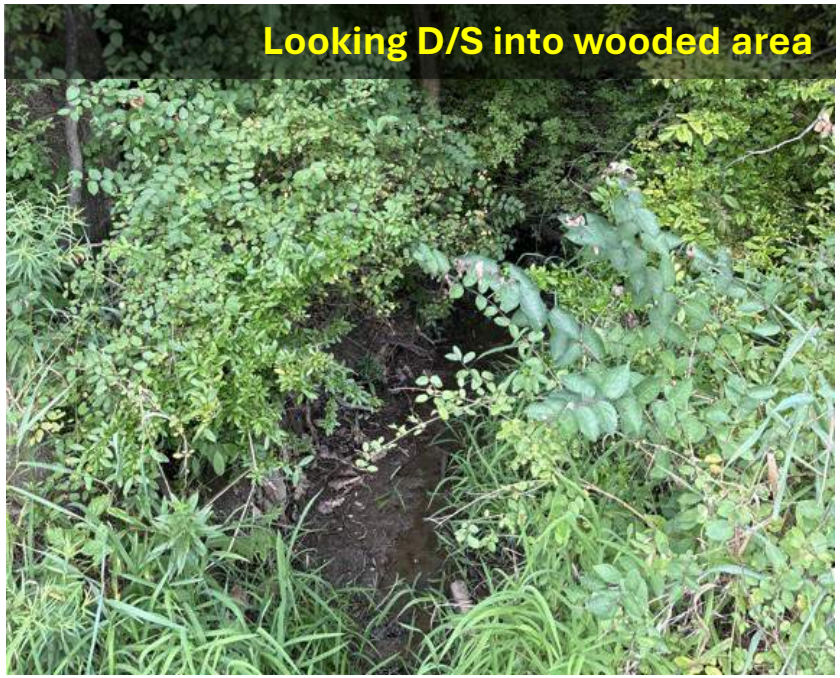
Ballpark Construction Cost = n/a

Approx. Storage compared to 25-yr Runoff Volume = ~9%

Existing conditions appears to provide adequate control for drainage area

Potential Stormwater Improvements to Consider

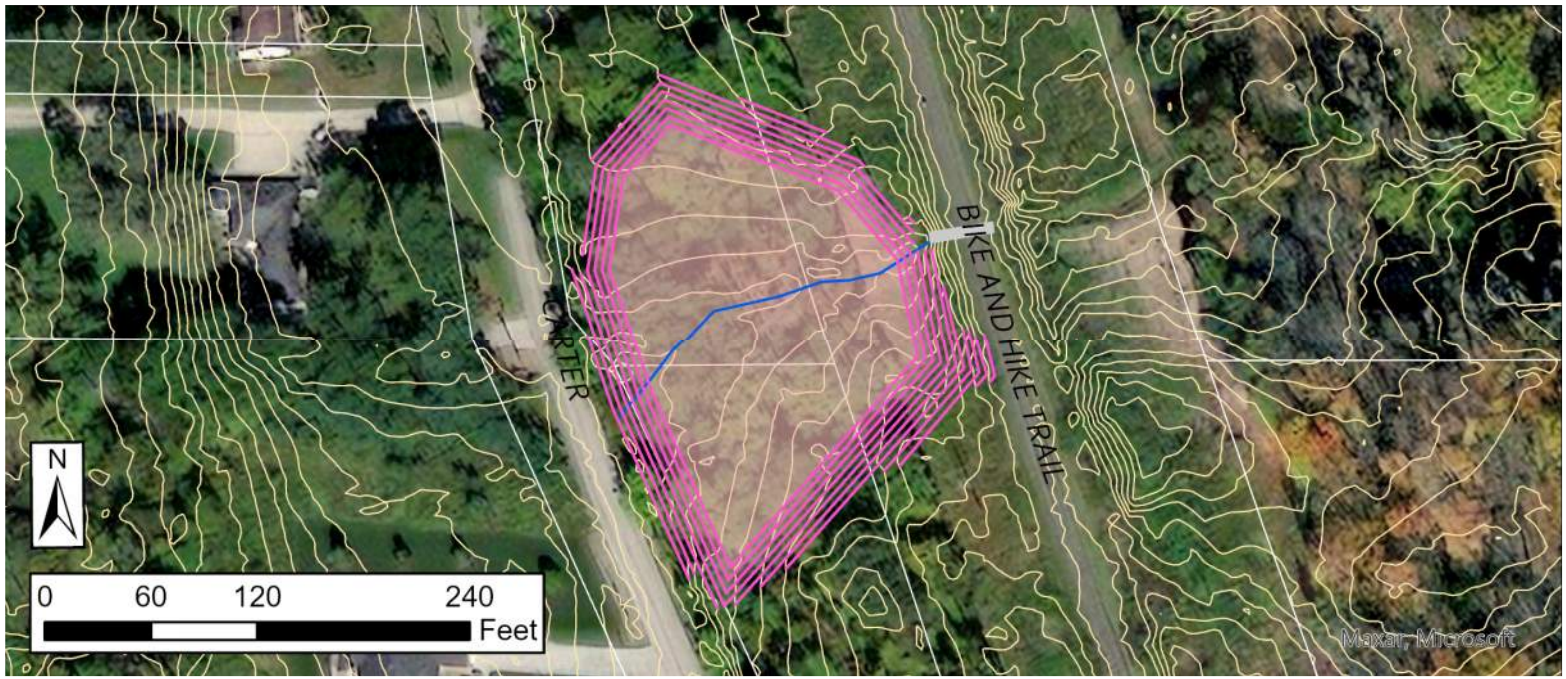
Alternative D: Storage within Small Depression between Bike Path & Carter Rd



- Buried petroleum and overhead electric utilities within the corridor
- Heavily forested
- Stream is potentially jurisdictional
- Would need to maintain freeboard (if present) on downstream roadway (Carter Rd)

Potential Stormwater Improvements to Consider

Alternative D: Storage within Small Depression between Bike Path & Carter Rd



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~10%

Probability for Flow Attenuation at Chaffee Culvert = **Low**

Probability for Water Quality Benefits = **Medium**

Ballpark Construction Cost* = ~$500,000

Approx. Storage compared to 25-yr Runoff Volume = ~7%

**unknown property acquisition/easement costs*

Potential Stormwater Improvements to Consider
Alternative E: Stream Restoration on Private Property at 7720 Carter Rd

- Relatively flat wetland area around power corridor, with steeper wooded reach upstream.
- Entirely on private property.
- The most upstream reach (near Carter Rd) is channelized next to driveway, exhibits signs of bank erosion, and lacks a wooded riparian corridor.

Potential Stormwater Improvements to Consider

Alternative E: Stream Restoration on Private Property at 7720 Carter Rd

Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~80%

Probability for Flow Attenuation at Chaffee Culvert = **Low**

Probability for Water Quality Benefits = **Medium**

Ballpark Construction Cost* = ~$250,000

Approx. Storage compared to 25-yr Runoff Volume = 0%

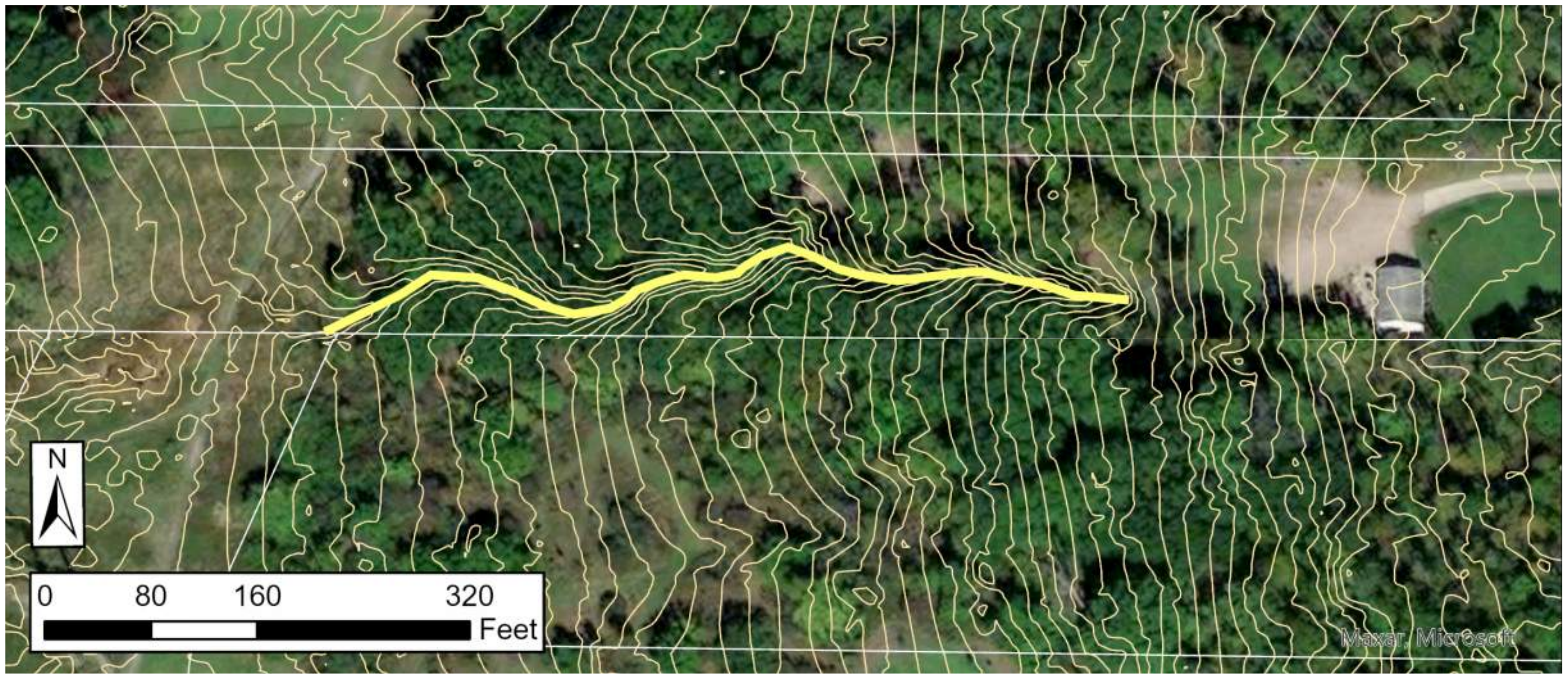
**unknown property acquisition/easement costs*

Potential Stormwater Improvements to Consider
Alternative F: Stream Restoration on Private Property at 7760 Carter Rd

- Relatively flat wetland area around power corridor, with steeper wooded reach upstream.
- Entirely on private property.

Potential Stormwater Improvements to Consider

Alternative F: Stream Restoration on Private Property at 7760 Carter Rd



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = 0%

Probability for Flow Attenuation at Chaffee Culvert =n/a (already providing)

Probability for Water Quality Benefits = n/a (already providing)

Ballpark Construction Cost = n/a

Approx. Storage compared to 25-yr Runoff Volume = 0%

Drains to different culvert that crosses Chaffee Road

Potential Stormwater Improvements to Consider

Alternative G: Storage near CEI Property at 1063 W Aurora Rd

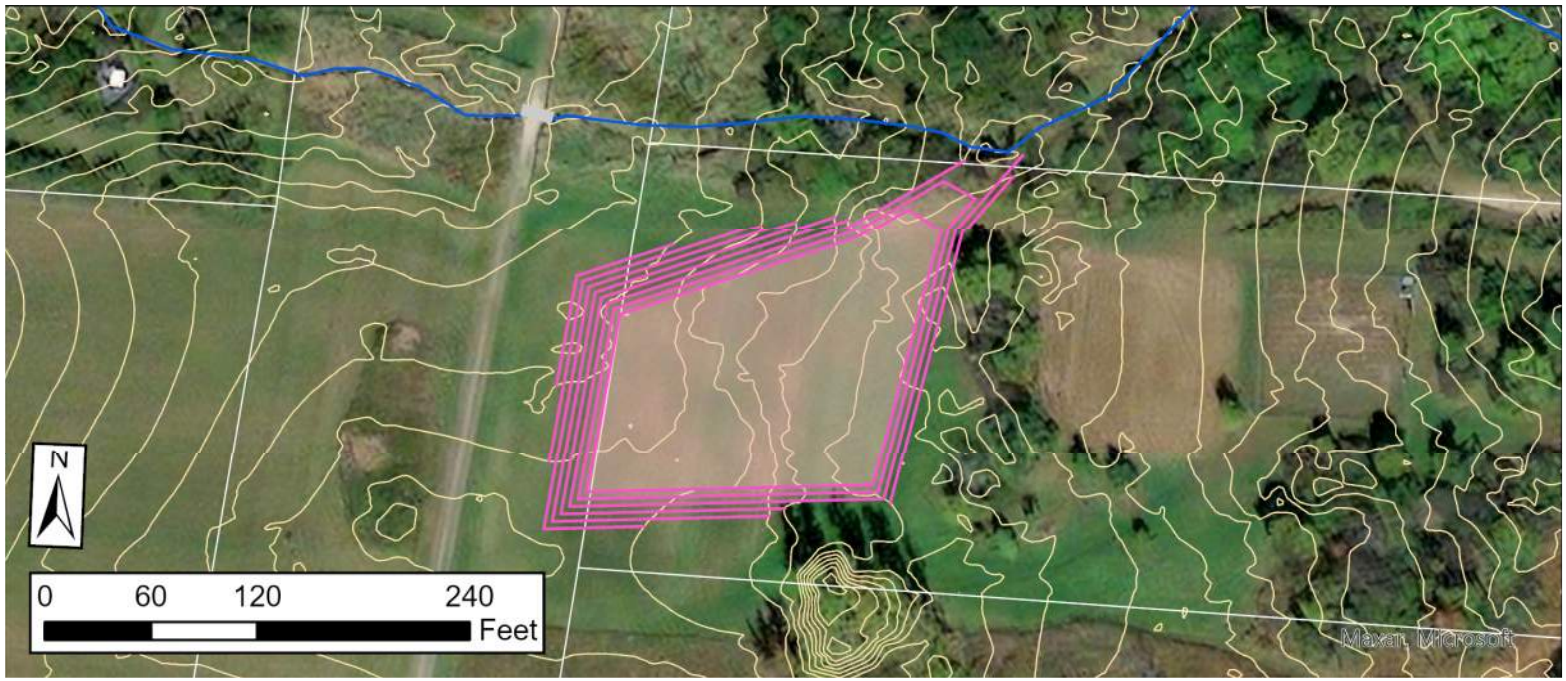
Looking north toward end of parcel

Looking U/S along stream channel

- Wetland-like areas prevalent within parcel
- Several drainage channels and culverts crossing maintenance road

Potential Stormwater Improvements to Consider

Alternative G: Storage near CEI Property at 1063 W Aurora Rd



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~85%

Probability for Flow Attenuation at Chaffee Culvert = **Medium**

Probability for Water Quality Benefits = **Medium**

Ballpark Construction Cost* = ~$300,000

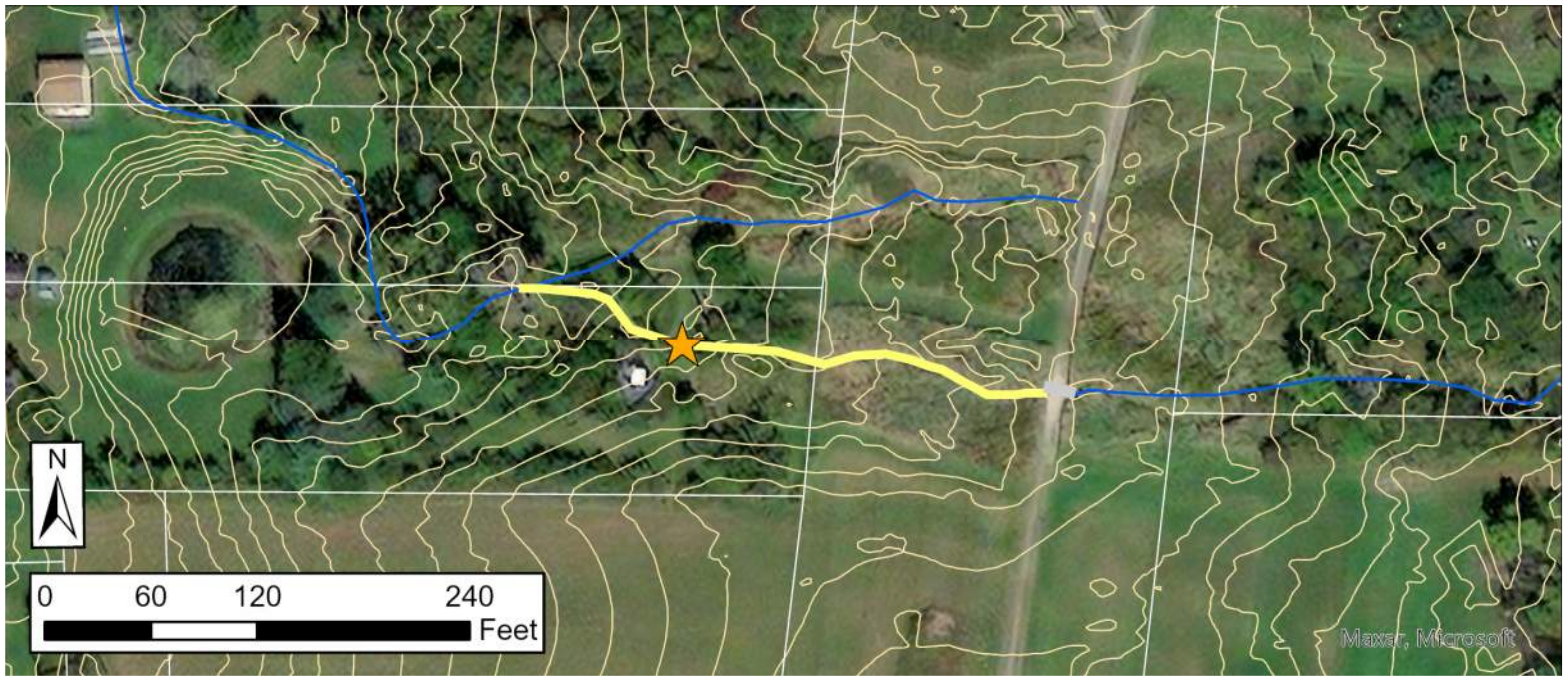
Approx. Storage compared to 25-yr Runoff Volume = ~4%

**unknown property acquisition/easement costs*

Potential Stormwater Improvements to Consider
Alternative H: Stream Restoration near Gas Main

- Section of stream with worst erosion
- Gas main exposed

Potential Stormwater Improvements to Consider
Alternative H: Stream Restoration near Gas Main



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~87%

Probability for Flow Attenuation at Chaffee Culvert = **Low**

Probability for Water Quality Benefits = **Medium**

Ballpark Construction Cost* = ~$200,000

Approx. Storage compared to 25-yr Runoff Volume = 0%

**unknown property acquisition/easement costs*

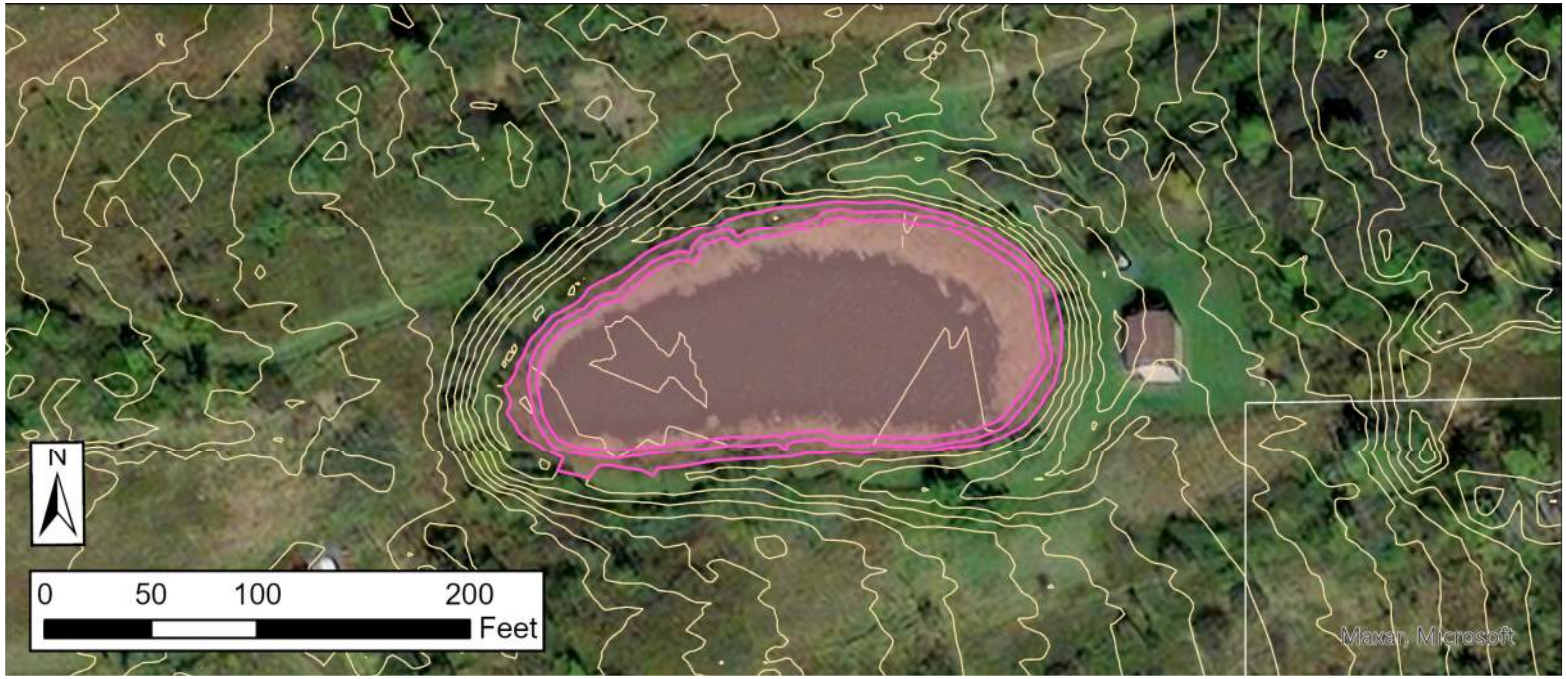
Potential Stormwater Improvements to Consider

Alternative I: Pond on Private Carter Rd Parcel / Past NEORSD Project

- Wetland-like area
- Completely private parcel with mowed paths and shed

Potential Stormwater Improvements to Consider

Alternative I: Pond on Private Carter Rd Parcel / Past NEORSD Project



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~0.3%

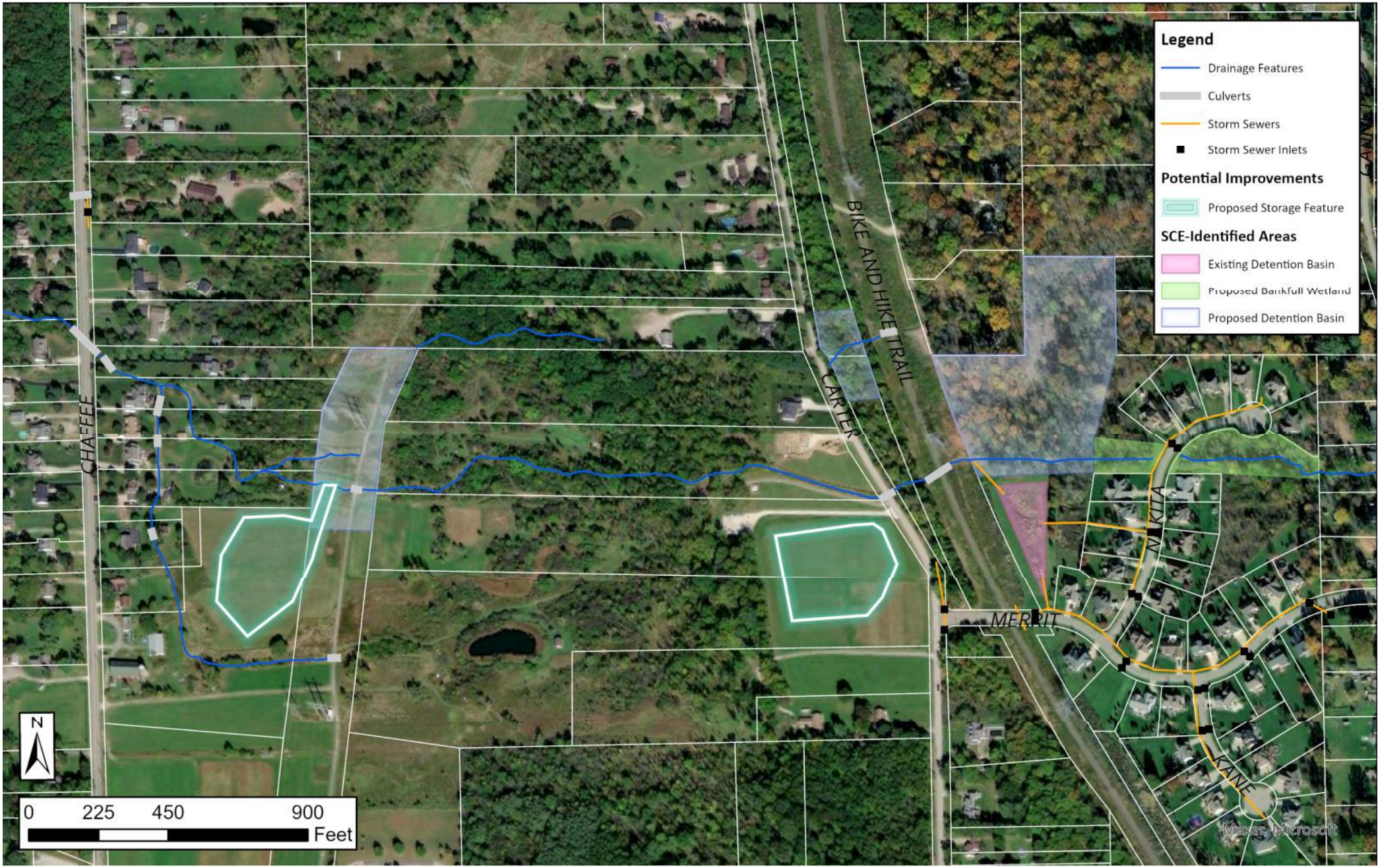
Probability for Flow Attenuation at Chaffee Culvert = n/a

Probability for Water Quality Benefits = n/a (provided via adjacent wetlands)

Ballpark Construction Cost = n/a

Approx. Storage compared to 25-yr Runoff Volume = ~3%

Additional Stormwater Improvements to Consider



Additional Stormwater Improvements to Consider

Alternative J: Bankfull Wetlands on Private Parcels next to Carter Rd

- Open field across two private parcels

Additional Stormwater Improvements to Consider

Alternative J: Bankfull Wetlands on Private Parcels next to Carter Rd

Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~80%

Probability for Flow Attenuation at Chaffee Culvert = **High**

Probability for Water Quality Benefits = **High**

Ballpark Construction Cost* = ~$1,500,000

Approx. Storage compared to 25-yr Runoff Volume = ~21%

**unknown property acquisition/easement costs*

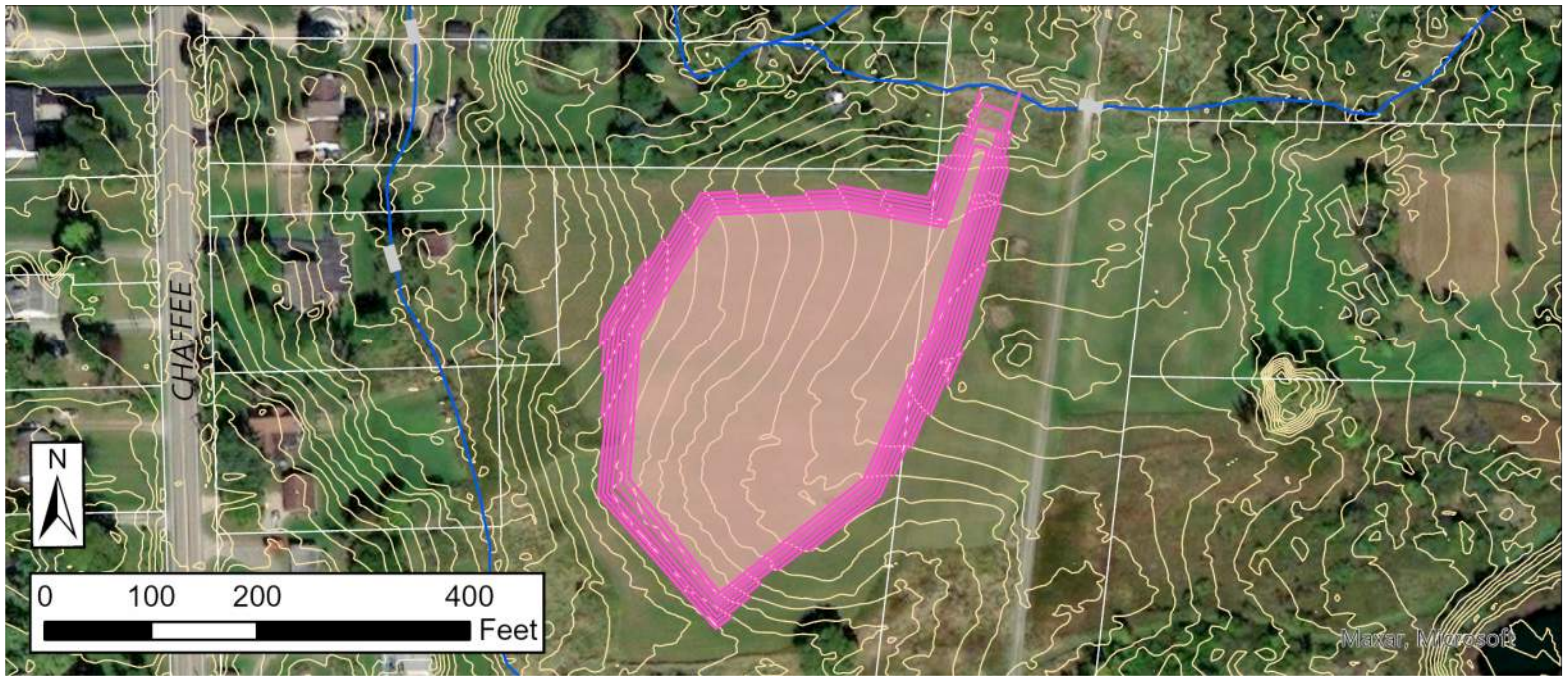
Additional Stormwater Improvements to Consider

Alternative K: Bankfull Wetlands on Private Parcels next to CEI Parcel

- Mostly open field areas on up to three private parcels

Additional Stormwater Improvements to Consider

Alternative K: Bankfull Wetlands on Private Parcels next to CEI Parcel



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~87%

Probability for Flow Attenuation at Chaffee Culvert = **High**

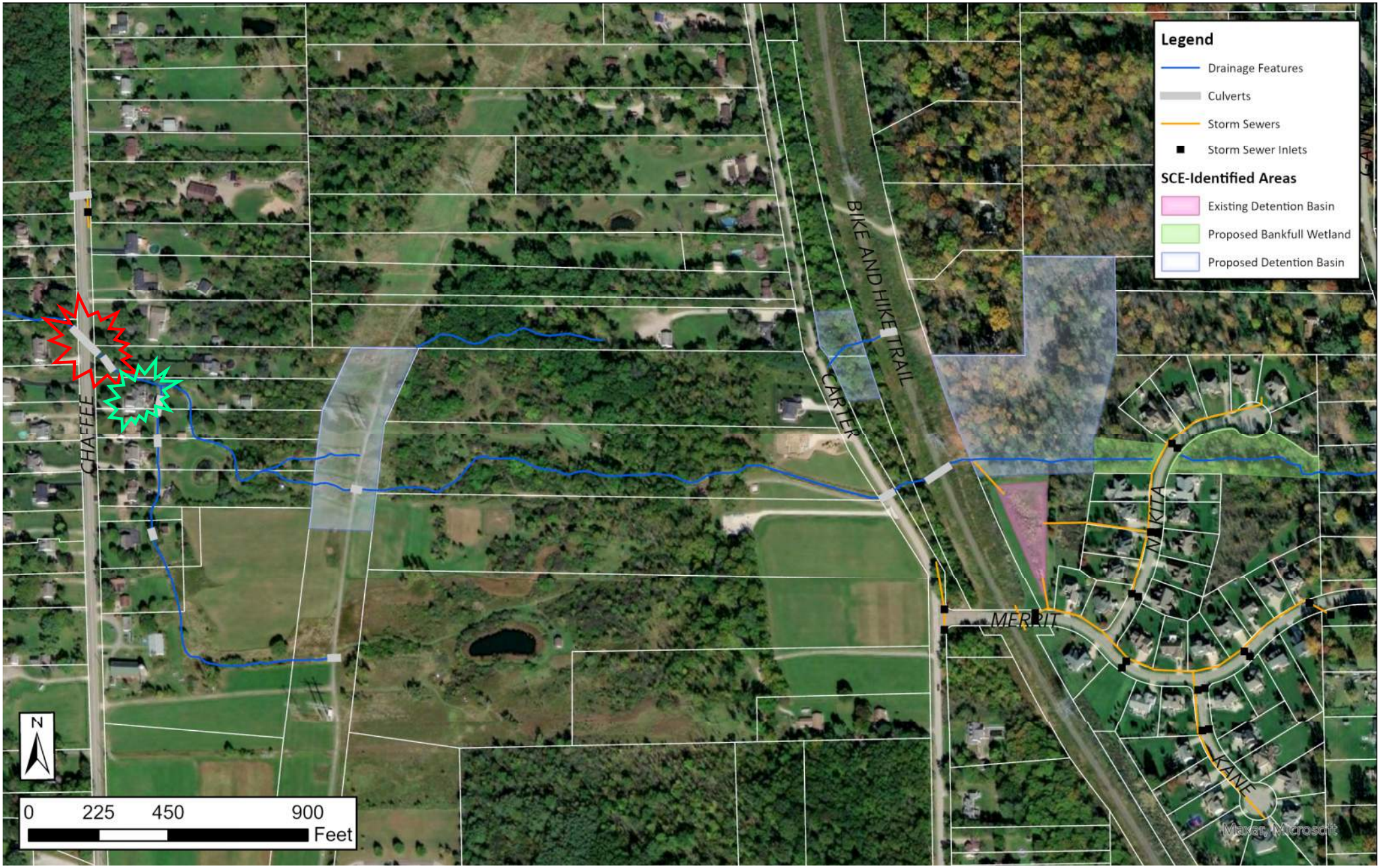
Probability for Water Quality Benefits = **High**

Ballpark Construction Cost* = ~$1,400,000

Approx. Storage compared to 25-yr Runoff Volume = ~20%

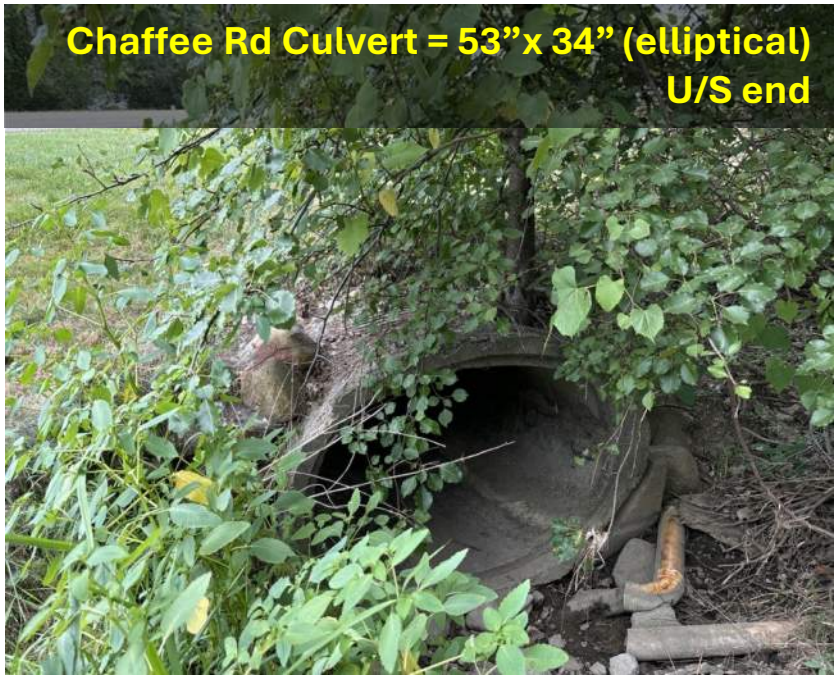
**unknown property acquisition/easement costs*

Other Alternatives



Other Alternatives

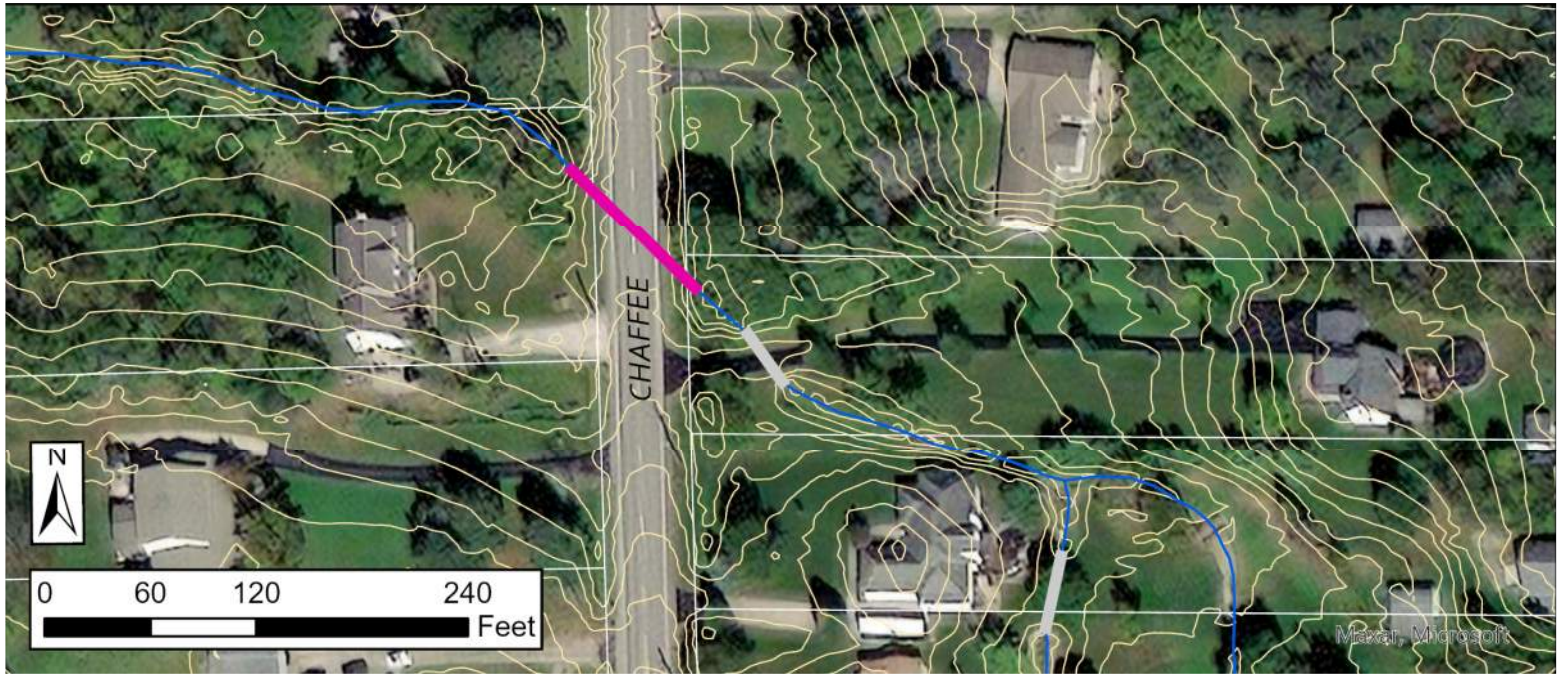
Alternative L: Upsizing the Chaffee Road Culvert



- Existing culvert under Chaffee Road

Other Alternatives

Alternative L: Upsizing the Chaffee Road Culvert



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = 100%

Probability for Flow Attenuation at Chaffee Culvert = **Low** *(but may achieve desired level of service for roadway and potentially benefit WSE at adjacent house)*

Probability for Water Quality Benefits = **Low**

Ballpark Construction Cost = ~$400,000

Approx. Storage compared to 25-yr Runoff Volume = 0%

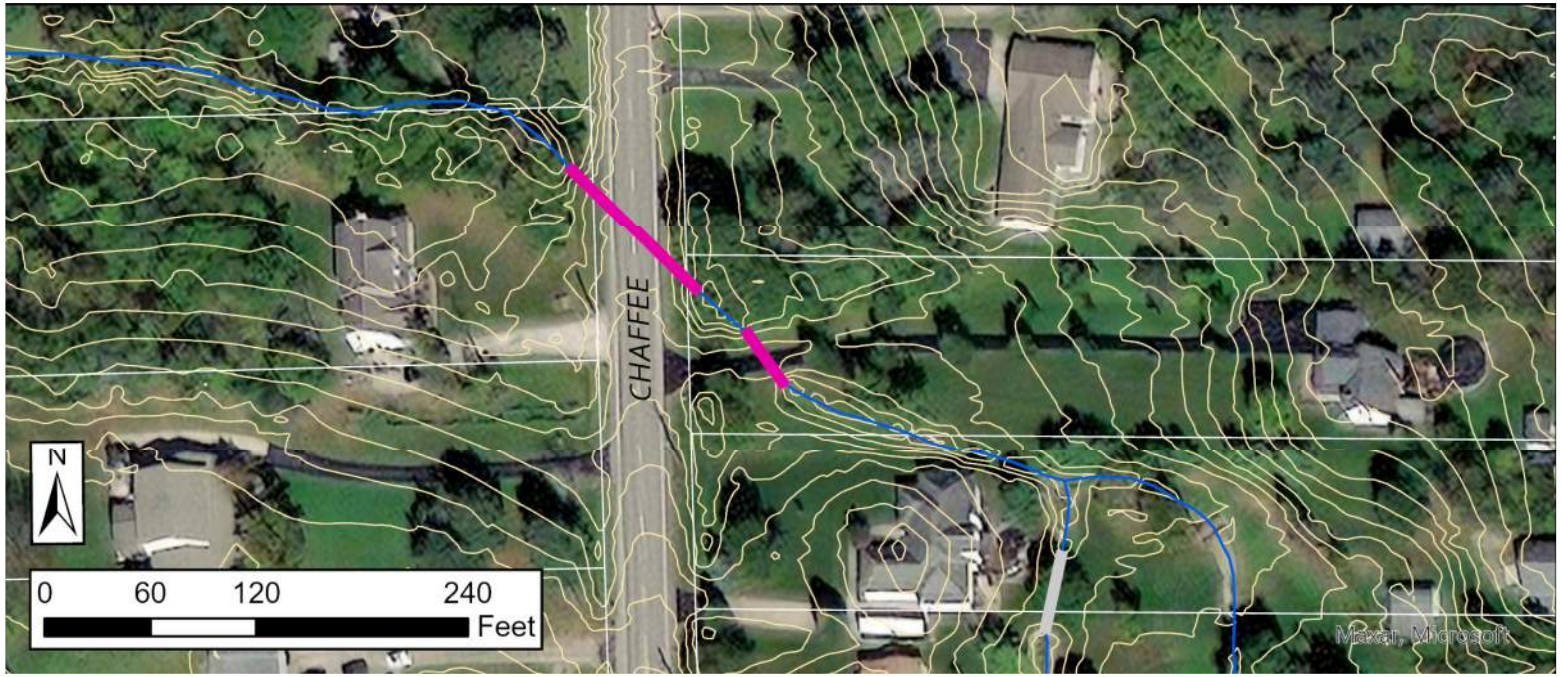
Other Alternatives

Alternative M: Upsizing the Chaffee Road & Driveway Culverts

- Existing culvert under Chaffee Road
- Existing culvert under 7565 Chaffee Road

Other Alternatives

Alternative M: Upsizing the Chaffee Road & Driveway Culverts



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = 100%

Probability for Flow Attenuation at Chaffee Culvert = **Low** *(but may achieve desired level of service for roadway and potentially benefit WSE at adjacent house)*

Probability for Water Quality Benefits = **Low**

Ballpark Construction Cost = ~$475,000

Approx. Storage compared to 25-yr Runoff Volume = 0%

Other Alternatives

Alternative N: Property Acquisition of 7555 Chaffee Road

- Anecdotal and historical mapping evidence of stream movement for house construction
- Steep rock armoring along bank adjacent to structure

Other Alternatives

Alternative N: Property Acquisition of 7555 Chaffee Road

Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~99%

Probability for Flow Attenuation at Chaffee Culvert = **Low**

Probability for Water Quality Benefits = **Low**

Ballpark Construction Cost* = ~$675,000

Approx. Storage compared to 25-yr Runoff Volume = 0%

**includes placeholder estimate for potential property acquisition and demolition*

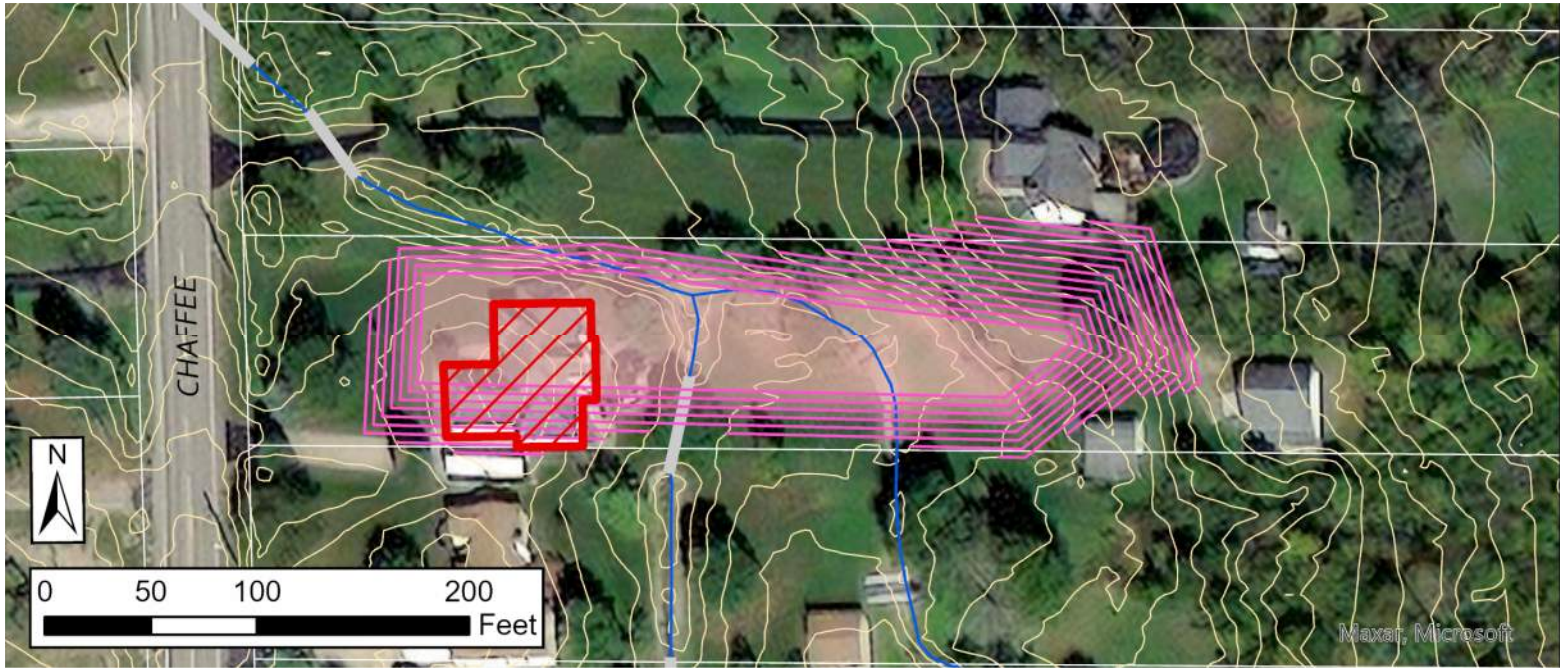
Other Alternatives

Alternative O: Property Acquisition of 7555 Chaffee Road with Storage

- Anecdotal and historical mapping evidence of stream movement for house construction
- Steep rock armoring along bank adjacent to structure

Other Alternatives

Alternative O: Property Acquisition of 7555 Chaffee Road with Storage



Drainage Area Capture as % of Chaffee Rd Culvert Drainage = ~99%

Probability for Flow Attenuation at Chaffee Culvert = **Medium**

Probability for Water Quality Benefits = **High**

Ballpark Construction Cost* = ~$1,050,000

Approx. Storage compared to 25-yr Runoff Volume = ~4%

**includes placeholder estimate for potential property acquisition and demolition*

Easement Considerations

Potential Solution	Parcel Type	Existing Easement Observations
A - Nakita Ct Bankfull Wetlands	HOA	Overlaps with riparian easement.
B - Red Hawk HOA Depression	HOA	Overlaps with riparian and detention easements.
D – Storage in depression btwn Bike Path/Carter Rd	Utility & HOA	Overlaps with utility easement. Gas marker found during field investigation.
E - 7720 Carter Rd Stream Restoration	Private (residence)	No documented easements found.
G - Storage adjacent to CEI Property (east)	Private (open) & Utility	No documented easements found. Grading likely to extend into utility-owned parcel.
H - Stream Restoration near Gas Main	Private (ag) & Utility	No documented easements found. Gas main likely to have easement. Restoration likely to extend into utility-owned parcel.
J - Carter Rd Bankfull Wetlands	Private (open)	No documented easements found.
K - Bankfull Wetland adj to CEI Property (west)	Private (ag) & Utility	No documented easements found. Grading likely to extend into utility-owned parcel.
L - Culvert Upsizing – Chaffee Rd	ROW	No documented easements found. Sanitary and water mains located in ROW per SCE survey file.
M - Culvert Upsizing – Chaffee Rd & Driveway	ROW & Private (residence)	No documented easements found. Sanitary and water mains located in ROW per SCE survey file.
N - 7555 Chaffee Property Acquisition	Private (residence)	Adjacent to utility easement.
O - 7555 Chaffee Property Ac. & Storage	Private (residence)	Overlaps with utility easement.

Conceptual-level Decision Matrix

Potential Solution	Prelim. Constr. Cost*	Fed. & State Permits	Parcel Type	Flow Atten.	Water Quality	Maint. Needs	25-yr Goal at Chaffee	Project Risks**
A - Nakita Ct Bankfull Wetlands	$700,000	404 NWP 401 poss. eligible	HOA	LOW	HIGH	LOW	LOW	MEDIUM
B - Red Hawk HOA Depression	$600,000	Pot. Ind. 404/401 & Mitigation	HOA	HIGH	HIGH	HIGH	HIGH	HIGH
D – Storage in depression btwn Bike Path/Carter Rd	$500,000	404 NWP 401 poss. eligible	Utility & HOA	LOW	MEDIUM	MEDIUM	LOW	HIGH
E - 7720 Carter Rd Stream Restoration	$250,000	404 NWP 401 poss. eligible	Private (residence)	LOW	MEDIUM	LOW	LOW	LOW-MEDIUM
G - Storage adjacent to CEI Property (east)	$300,000	404 NWP 401 poss. eligible	Private (open) & Utility	MEDIUM	MEDIUM	LOW	LOW	MEDIUM
H - Stream Restoration near Gas Main	$200,000	404 NWP 401 poss. eligible	Private (ag) & Utility	LOW	MEDIUM	LOW	LOW	LOW-MEDIUM
J - Carter Rd Bankfull Wetlands	$1,500,000	404 NWP 401 poss. eligible	Private (open)	HIGH	HIGH	LOW	HIGH	MEDIUM-HIGH
K - Bankfull Wetland adj to CEI Property (west)	$1,400,000	404 NWP 401 poss. eligible	Private (ag) & Utility	HIGH	HIGH	LOW	HIGH	MEDIUM
L - Culvert Upsizing – Chaffee Rd	$400,000	Depends	ROW	LOW	LOW	LOW	HIGH	LOW
M - Culvert Upsizing – Chaffee Rd & Driveway	$475,000	Depends	ROW & Private (residence)	LOW	LOW	LOW	HIGH	LOW
N - 7555 Chaffee Property Acquisition	$675,000	None	Private (residence)	LOW	LOW	LOW	N/A	MEDIUM
O - 7555 Chaffee Property Ac. & Storage	$1,050,000	404 NWP 401 poss. eligible	Private (residence)	MEDIUM	HIGH	LOW	MEDIUM	HIGH

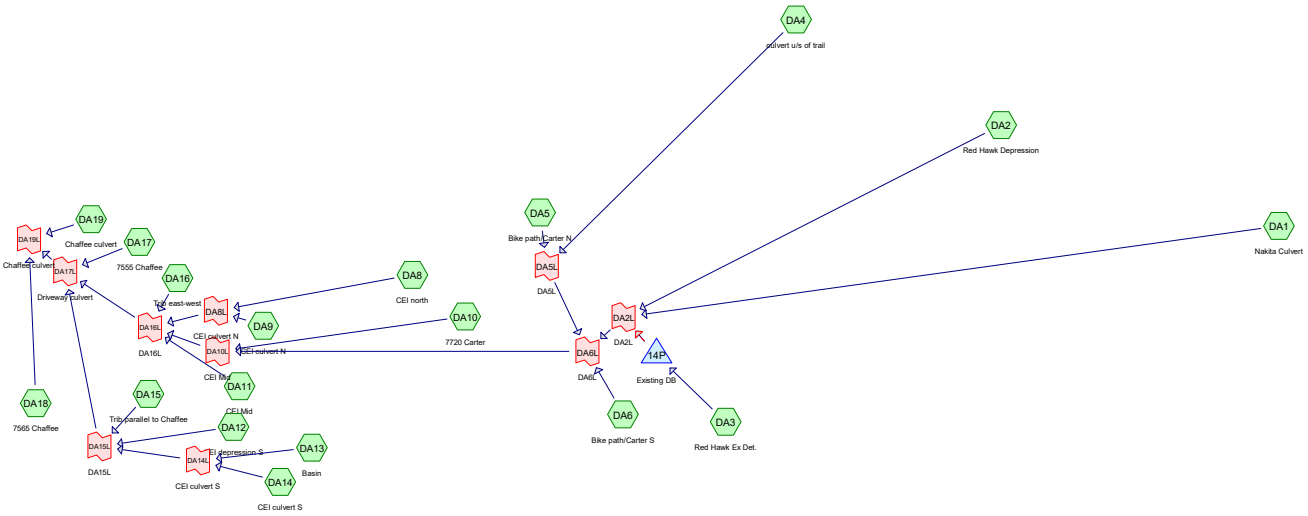
**Cursory, conceptual-level solutions with no survey or geotechnical data. Prelim. constr. costs do not account for the potential for shallow bedrock within proposed grading zones. Costs do not include land acquisition costs unless included as the main concept solution. Potential mitigation fees not included.*
***Prelim. project risks relative to the gradient of potential solutions and informed by considerations for safety, ease of land acquisition, permitting risks, and other factors, and should be revised as more detailed stakeholder feedback is acquired.*

Next Steps

- SCE to provide direction on the concepts to further evaluate in the conceptual analysis/report
- SCE to provide direction about initial stakeholder outreach

APPENDIX C

Hydrologic Modeling of the Watershed



Subcat Reach Pond Link

Routing Diagram for Watershed_Model_Existing
Prepared by Sustainable Streams, LLC, Printed 1/21/2025

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=0.13"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=3.46 cfs 1.678 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=0.15"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=0.53 cfs 0.132 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=0.19"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=0.22 cfs 0.034 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=0.19"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=0.59 cfs 0.131 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=2.04"
Tc=3.0 min CN=100 Runoff=2.55 cfs 0.139 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=0.26"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=1.60 cfs 0.239 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=0.59"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=8.47 cfs 0.597 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=0.55"
Flow Length=929' Tc=13.5 min CN=79 Runoff=4.04 cfs 0.269 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=0.63"
Flow Length=551' Tc=14.9 min CN=81 Runoff=0.53 cfs 0.036 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=0.94"
Flow Length=751' Tc=12.1 min CN=87 Runoff=1.47 cfs 0.087 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=591' Tc=21.5 min CN=84 Runoff=2.21 cfs 0.178 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=0.04"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=0.21 cfs 0.166 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=0.63"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=13.26 cfs 0.841 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=0.04"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=0.13 cfs 0.104 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=0.13"
Flow Length=305' Tc=18.7 min CN=64 Runoff=0.09 cfs 0.025 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=0.63"
Flow Length=542' Tc=8.0 min CN=81 Runoff=3.26 cfs 0.170 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=0.19"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=0.45 cfs 0.067 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=0.51"
Flow Length=435' Tc=19.6 min CN=78 Runoff=0.34 cfs 0.029 af

Pond 14P: Existing DB Peak Elev=880.07' Storage=27,986 cf Inflow=13.26 cfs 0.841 af
Primary=0.20 cfs 0.816 af Secondary=0.00 cfs 0.000 af Outflow=0.20 cfs 0.816 af

Link DA10L: CEl Mid Inflow=4.31 cfs 3.091 af
Primary=4.31 cfs 3.091 af

Link DA14L: CEl culvert S Inflow=2.58 cfs 0.378 af
Primary=2.58 cfs 0.378 af

Link DA15L: DA15L Inflow=9.78 cfs 1.107 af
Primary=9.78 cfs 1.107 af

Link DA16L: DA16L Inflow=7.63 cfs 3.489 af
Primary=7.63 cfs 3.489 af

Link DA17L: Driveway culvert Inflow=17.41 cfs 4.632 af
Primary=17.41 cfs 4.632 af

Link DA19L: Chaffee culvert Inflow=20.72 cfs 4.897 af
Primary=20.72 cfs 4.897 af

Link DA2L: DA2L Inflow=3.77 cfs 2.660 af
Primary=3.77 cfs 2.660 af

Link DA5L: DA5L Inflow=0.16 cfs 0.129 af
Primary=0.16 cfs 0.129 af

Link DA6L: DA6L Inflow=4.09 cfs 2.959 af
Primary=4.09 cfs 2.959 af

Link DA8L: CEl culvert N Inflow=0.79 cfs 0.096 af
Primary=0.79 cfs 0.096 af

Summary for Subcatchment DA1: Nakita Culvert

Runoff = 3.46 cfs @ 13.39 hrs, Volume= 1.678 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	6,852,298	64	
	6,852,298		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	48	0.0208	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.44"
3.3	687	0.0466	3.48		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	791	0.0063	0.97	0.37	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.25' Z= 6.0 '/' Top.W=3.00' n= 0.030
13.5	619	0.0016	0.76	0.95	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=0.50' Z= 3.0 '/' Top.W=4.00' n= 0.035
0.1	47	0.0213	10.25	18.12	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
27.8	887	0.0011	0.53	0.93	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045
1.5	692	0.0159	7.50	13.25	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Concrete pipe, bends & connections
4.5	511	0.0137	1.88	3.29	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045
0.1	58	0.0172	9.21	16.28	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
7.6	752	0.0106	1.65	2.89	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045
80.8	5,092	Total			

Summary for Subcatchment DA10: 7720 Carter

Runoff = 0.53 cfs @ 12.31 hrs, Volume= 0.132 af, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	470,622	65	
	470,622		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.5	34	0.0294	0.04		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
3.9	844	0.0509	3.63		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.6	802	0.0249	2.91	8.73	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=0.75' Z= 4.0 '/' Top.W=7.00' n= 0.045
24.0	1,680	Total			

Summary for Subcatchment DA11: CEl Mid

Runoff = 0.22 cfs @ 12.18 hrs, Volume= 0.034 af, Depth= 0.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	94,379	67	
	94,379		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	40	0.0250	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 2.44"
3.7	810	0.0506	3.62		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.6	485	0.0227	2.22	0.83	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.25' Z= 6.0 '/' Top.W=3.00' n= 0.025
18.1	1,335	Total			

Summary for Subcatchment DA12: CEI depression S

Runoff = 0.59 cfs @ 12.42 hrs, Volume= 0.131 af, Depth= 0.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	369,283	67	
	369,283		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4	53	0.0189	0.03		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
1.8	439	0.0615	3.99		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.2	1,107	0.0239	4.37	19.66	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.00' Z= 3.0 & 4.0 '/' Top.W=8.00' n= 0.035
32.4	1,599	Total			

Summary for Subcatchment DA13: Basin

Runoff = 2.55 cfs @ 11.93 hrs, Volume= 0.139 af, Depth= 2.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	35,719	100	
	35,719		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment DA14: CEI culvert S

Runoff = 1.60 cfs @ 12.28 hrs, Volume= 0.239 af, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	487,917	70	
	487,917		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.5	72	0.0139	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.44"
2.4	321	0.0187	2.20		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.3	720	0.0458	5.31	21.25	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00' n= 0.040
7.1	932	0.0220	2.18	0.82	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.25' Z= 6.0 '/' Top.W=3.00' n= 0.025
26.3	2,045	Total			

Summary for Subcatchment DA15: Trib parallel to Chaffee

Runoff = 8.47 cfs @ 12.09 hrs, Volume= 0.597 af, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	531,688	80	
	531,688		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	38	0.0263	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.44"
2.3	405	0.0321	2.88		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.5	747	0.0131	2.74	10.97	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=1.00' Z= 2.0 '/' Top.W=6.00' n= 0.045
0.0	14	0.0214	5.48	17.21	**Pipe Channel, CMP_Round 24"** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.025 Corrugated metal
1.1	289	0.0135	4.20	34.68	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.50' Z= 3.0 '/' Top.W=10.00' n= 0.035
0.0	15	0.0333	18.02	88.46	**Pipe Channel, RCP_Round 30"** 30.0" Round Area= 4.9 sf Perim= 7.9' r= 0.63' n= 0.011 Concrete pipe, straight & clean
0.6	91	0.0044	2.40	19.80	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.50' Z= 3.0 '/' Top.W=10.00' n= 0.035
0.1	41	0.0024	6.05	58.25	**Pipe Channel, CMP_Round 42"** 42.0" Round Area= 9.6 sf Perim= 11.0' r= 0.88' n= 0.011 Concrete pipe, straight & clean
0.2	43	0.0070	3.03	24.97	**Trap/Vee/Rect Channel Flow,** Bot.W=1.00' D=1.50' Z= 3.0 '/' Top.W=10.00' n= 0.035
15.6	1,683	Total			

Summary for Subcatchment DA16: Trib east-west

Runoff = 4.04 cfs @ 12.07 hrs, Volume= 0.269 af, Depth= 0.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	257,061	79	
	257,061		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	52	0.0192	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.44"
0.6	119	0.0420	3.30		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.1	758	0.0218	4.09	24.53	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00' D=1.00' Z= 3.0 '/' Top.W=9.00' n= 0.040
13.5	929	Total			

Summary for Subcatchment DA17: 7555 Chaffee

Runoff = 0.53 cfs @ 12.08 hrs, Volume= 0.036 af, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	29,915	81	
	29,915		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	28	0.0357	0.04		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
2.4	468	0.0406	3.24		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.2	55	0.0336	5.08	30.45	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00' D=1.00' Z= 3.0 '/' Top.W=9.00' n= 0.040
14.9	551	Total			

Summary for Subcatchment DA18: 7565 Chaffee

Runoff = 1.47 cfs @ 12.04 hrs, Volume= 0.087 af, Depth= 0.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	48,348	87	
	48,348		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	22	0.0455	0.04		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
2.9	729	0.0233	4.16	16.63	**Trap/Vee/Rect Channel Flow,** Bot.W=0.50' D=1.00' Z= 3.0 & 4.0 '/' Top.W=7.50' n= 0.035
12.1	751	Total			

Summary for Subcatchment DA19: Chaffee culvert

Runoff = 2.21 cfs @ 12.16 hrs, Volume= 0.178 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	120,797	84	
	120,797		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.8	40	0.0250	0.04		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
2.1	405	0.0395	3.20		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	146	0.0308	4.08	29.56	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 4.5 & 10.0 '/' Top.W=14.50' n= 0.040
21.5	591	Total			

Summary for Subcatchment DA2: Red Hawk Depression

Runoff = 0.21 cfs @ 15.54 hrs, Volume= 0.166 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	1,941,759	58	
	1,941,759		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.2	30	0.0083	0.02		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
8.3	896	0.0126	1.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	30	0.0333	12.82	22.65	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
5.8	572	0.0105	1.65	2.88	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045
0.0	35	0.0286	11.88	20.99	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.011 Concrete pipe, straight & clean
7.0	980	0.0214	2.35	4.11	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045
7.7	964	0.0171	2.10	3.67	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045
52.0	3,507	Total			

Summary for Subcatchment DA3: Red Hawk Ex Det.

Runoff = 13.26 cfs @ 12.06 hrs, Volume= 0.841 af, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	698,036	81	
	698,036		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.5	37	0.0270	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.44"
1.3	340	0.0706	4.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.3	320	0.0063	1.61		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	14	0.0175	6.50	5.11	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
1.1	303	0.0064	4.56	5.60	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.012
0.9	340	0.0062	6.14	19.30	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.012
13.1	1,354	Total			

Summary for Subcatchment DA4: culvert u/s of trail

Runoff = 0.13 cfs @ 15.42 hrs, Volume= 0.104 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	1,217,036	58	
	1,217,036		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.9	34	0.0074	0.02		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
1.7	292	0.0325	2.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
16.8	1,114	0.0144	1.10	0.41	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.25' Z= 6.0 '/' Top.W=3.00' n= 0.040
3.3	431	0.0188	2.20	3.85	**Trap/Vee/Rect Channel Flow,** Bot.W=2.00' D=0.50' Z= 3.0 '/' Top.W=5.00' n= 0.045 Winding stream, pools & shoals
48.7	1,871	Total			

Summary for Subcatchment DA5: Bike path/Carter N

Runoff = 0.09 cfs @ 12.24 hrs, Volume= 0.025 af, Depth= 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	103,481	64	
	103,481		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.1	37	0.0270	0.04		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
1.6	268	0.0317	2.87		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
18.7	305	Total			

Summary for Subcatchment DA6: Bike path/Carter S

Runoff = 3.26 cfs @ 12.00 hrs, Volume= 0.170 af, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	140,887	81	
	140,887		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	23	0.0217	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 2.44"
3.1	519	0.0308	2.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	542	Total			

Summary for Subcatchment DA8: CEI north

Runoff = 0.45 cfs @ 12.17 hrs, Volume= 0.067 af, Depth= 0.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	188,467	67	
	188,467		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	17	0.0294	0.03		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
4.3	909	0.0473	3.50		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.8	638	0.0360	2.77	4.16	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.50' Z= 6.0 '/' Top.W=6.00' n= 0.040
17.0	1,564	Total			

Summary for Subcatchment DA9: CEl culvert N

Runoff = 0.34 cfs @ 12.15 hrs, Volume= 0.029 af, Depth= 0.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.04"

	Area (sf)	CN	Description
*	29,684	78	
	29,684		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	34	0.0221	0.03		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 2.44"
2.2	401	0.0349	3.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
19.6	435	Total			

Summary for Pond 14P: Existing DB

Inflow Area = 16.025 ac, 0.00% Impervious, Inflow Depth = 0.63" for 1-yr event
Inflow = 13.26 cfs @ 12.06 hrs, Volume= 0.841 af
Outflow = 0.20 cfs @ 24.10 hrs, Volume= 0.816 af, Atten= 98%, Lag= 722.3 min
Primary = 0.20 cfs @ 24.10 hrs, Volume= 0.816 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 880.07' @ 24.10 hrs Surf.Area= 20,269 sf Storage= 27,986 cf

Plug-Flow detention time= 1,474.0 min calculated for 0.815 af (97% of inflow)
Center-of-Mass det. time= 1,458.0 min (2,326.3 - 868.3)

Volume	Invert	Avail.Storage	Storage Description
#1	877.30'	150,411 cf	**Custom Stage Data (per modeling) (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
877.30	0	0	0
878.00	3,136	1,098	1,098
879.00	13,896	8,516	9,614
880.00	20,038	16,967	26,581
881.00	23,348	21,693	48,274
882.00	26,572	24,960	73,234
883.00	29,969	28,271	101,504
884.00	33,585	31,777	133,281
884.50	34,935	17,130	150,411

Device	Routing	Invert	Outlet Devices
#1	Primary	875.59'	**12.0" Round Culvert** L= 128.3' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 875.59' / 875.29' S= 0.0023 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 3	877.30'	**0.5" Vert. Orifice/Grate X 3.00 columns** X 3 rows with 5.0" cc spacing C= 0.600
#3	Device 1	875.80'	**4.0" Vert. Underdrain** C= 0.600
#4	Device 1	877.30'	**1.6" Vert. 1.6" Orifice** C= 0.600
#5	Device 1	880.09'	**8.0" Vert. 8" Orifice** C= 0.600
#6	Device 1	883.17'	**27.0" x 27.0" Horiz. Top Grate X 0.60** C= 0.600 Limited to weir flow at low heads
#7	Secondary	884.11'	**Spillway, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.39 Width (feet) 43.00 45.34

Primary OutFlow Max=0.20 cfs @ 24.10 hrs HW=880.07' (Free Discharge)
└─**1=Culvert** (Passes 0.20 cfs of 5.21 cfs potential flow)
  ├─**3=Underdrain** (Passes 0.09 cfs of 0.85 cfs potential flow)
  │ └─**2=Orifice/Grate** (Orifice Controls 0.09 cfs @ 7.33 fps)
  ├─**4=1.6" Orifice** (Orifice Controls 0.11 cfs @ 7.92 fps)
  ├─**5=8" Orifice** (Controls 0.00 cfs)
  └─**6=Top Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=877.30' (Free Discharge)
└─**7=Spillway** (Controls 0.00 cfs)

Summary for Link DA10L: CEI Mid

Inflow Area = 262.262 ac, 0.00% Impervious, Inflow Depth > 0.14" for 1-yr event
Inflow = 4.31 cfs @ 13.40 hrs, Volume= 3.091 af
Primary = 4.31 cfs @ 13.40 hrs, Volume= 3.091 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA14L: CEl culvert S

Inflow Area = 12.021 ac, 6.82% Impervious, Inflow Depth = 0.38" for 1-yr event
Inflow = 2.58 cfs @ 11.93 hrs, Volume= 0.378 af
Primary = 2.58 cfs @ 11.93 hrs, Volume= 0.378 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA15L: DA15L

Inflow Area = 32.704 ac, 2.51% Impervious, Inflow Depth = 0.41" for 1-yr event
Inflow = 9.78 cfs @ 12.11 hrs, Volume= 1.107 af
Primary = 9.78 cfs @ 12.11 hrs, Volume= 1.107 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA16L: DA16L

Inflow Area = 275.338 ac, 0.00% Impervious, Inflow Depth > 0.15" for 1-yr event
Inflow = 7.63 cfs @ 12.05 hrs, Volume= 3.489 af
Primary = 7.63 cfs @ 12.05 hrs, Volume= 3.489 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA17L: Driveway culvert

Inflow Area = 308.729 ac, 0.27% Impervious, Inflow Depth > 0.18" for 1-yr event
Inflow = 17.41 cfs @ 12.08 hrs, Volume= 4.632 af
Primary = 17.41 cfs @ 12.08 hrs, Volume= 4.632 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA19L: Chaffee culvert

Inflow Area = 312.612 ac, 0.26% Impervious, Inflow Depth > 0.19" for 1-yr event
Inflow = 20.72 cfs @ 12.08 hrs, Volume= 4.897 af
Primary = 20.72 cfs @ 12.08 hrs, Volume= 4.897 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA2L: DA2L

Inflow Area = 217.908 ac, 0.00% Impervious, Inflow Depth > 0.15" for 1-yr event
Inflow = 3.77 cfs @ 13.41 hrs, Volume= 2.660 af
Primary = 3.77 cfs @ 13.41 hrs, Volume= 2.660 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA5L: DA5L

Inflow Area = 30.315 ac, 0.00% Impervious, Inflow Depth = 0.05" for 1-yr event
Inflow = 0.16 cfs @ 15.20 hrs, Volume= 0.129 af
Primary = 0.16 cfs @ 15.20 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA6L: DA6L

Inflow Area = 251.458 ac, 0.00% Impervious, Inflow Depth > 0.14" for 1-yr event
Inflow = 4.09 cfs @ 13.40 hrs, Volume= 2.959 af
Primary = 4.09 cfs @ 13.40 hrs, Volume= 2.959 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link DA8L: CEI culvert N

Inflow Area = 5.008 ac, 0.00% Impervious, Inflow Depth = 0.23" for 1-yr event
Inflow = 0.79 cfs @ 12.16 hrs, Volume= 0.096 af
Primary = 0.79 cfs @ 12.16 hrs, Volume= 0.096 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond 14P: Existing DB

Inflow Area = 16.025 ac, 0.00% Impervious, Inflow Depth = 0.63" for 1-yr event
Inflow = 13.26 cfs @ 12.06 hrs, Volume= 0.841 af
Outflow = 0.20 cfs @ 24.10 hrs, Volume= 0.816 af, Atten= 98%, Lag= 722.3 min
Primary = 0.20 cfs @ 24.10 hrs, Volume= 0.816 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 880.07' @ 24.10 hrs Surf.Area= 20,269 sf Storage= 27,986 cf

Plug-Flow detention time= 1,474.0 min calculated for 0.815 af (97% of inflow)
Center-of-Mass det. time= 1,458.0 min (2,326.3 - 868.3)

Volume	Invert	Avail.Storage	Storage Description
#1	877.30'	150,411 cf	**Custom Stage Data (per modeling) (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
877.30	0	0	0
878.00	3,136	1,098	1,098
879.00	13,896	8,516	9,614
880.00	20,038	16,967	26,581
881.00	23,348	21,693	48,274
882.00	26,572	24,960	73,234
883.00	29,969	28,271	101,504
884.00	33,585	31,777	133,281
884.50	34,935	17,130	150,411

Device	Routing	Invert	Outlet Devices
#1	Primary	875.59'	**12.0" Round Culvert** L= 128.3' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 875.59' / 875.29' S= 0.0023 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 3	877.30'	**0.5" Vert. Orifice/Grate X 3.00 columns** X 3 rows with 5.0" cc spacing C= 0.600
#3	Device 1	875.80'	**4.0" Vert. Underdrain** C= 0.600
#4	Device 1	877.30'	**1.6" Vert. 1.6" Orifice** C= 0.600
#5	Device 1	880.09'	**8.0" Vert. 8" Orifice** C= 0.600
#6	Device 1	883.17'	**27.0" x 27.0" Horiz. Top Grate X 0.60** C= 0.600 Limited to weir flow at low heads
#7	Secondary	884.11'	**Spillway, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.39 Width (feet) 43.00 45.34

Primary OutFlow Max=0.20 cfs @ 24.10 hrs HW=880.07' (Free Discharge)
└─**1=Culvert** (Passes 0.20 cfs of 5.21 cfs potential flow)
  ├─**3=Underdrain** (Passes 0.09 cfs of 0.85 cfs potential flow)
  │ └─**2=Orifice/Grate** (Orifice Controls 0.09 cfs @ 7.33 fps)
  ├─**4=1.6" Orifice** (Orifice Controls 0.11 cfs @ 7.92 fps)
  ├─**5=8" Orifice** (Controls 0.00 cfs)
  └─**6=Top Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=877.30' (Free Discharge)
└─**7=Spillway** (Controls 0.00 cfs)

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=0.25"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=9.38 cfs 3.266 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=0.28"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=1.63 cfs 0.248 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=0.33"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=0.56 cfs 0.060 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=0.33"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=1.45 cfs 0.234 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=2.44"
Tc=3.0 min CN=100 Runoff=3.05 cfs 0.167 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=0.43"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=3.34 cfs 0.398 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=0.85"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=12.65 cfs 0.862 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=0.80"
Flow Length=929' Tc=13.5 min CN=79 Runoff=6.14 cfs 0.392 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=0.90"
Flow Length=551' Tc=14.9 min CN=81 Runoff=0.78 cfs 0.051 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=1.26"
Flow Length=751' Tc=12.1 min CN=87 Runoff=1.98 cfs 0.117 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=1.07"
Flow Length=591' Tc=21.5 min CN=84 Runoff=3.11 cfs 0.247 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=0.12"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=0.87 cfs 0.444 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=0.90"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=19.41 cfs 1.202 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=0.12"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=0.56 cfs 0.278 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=0.25"
Flow Length=305' Tc=18.7 min CN=64 Runoff=0.35 cfs 0.049 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=0.90"
Flow Length=542' Tc=8.0 min CN=81 Runoff=4.73 cfs 0.243 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=0.33"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=1.15 cfs 0.120 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=0.75"
Flow Length=435' Tc=19.6 min CN=78 Runoff=0.54 cfs 0.043 af

Pond 14P: Existing DB Peak Elev=880.42' Storage=35,192 cf Inflow=19.41 cfs 1.202 af
Primary=0.54 cfs 1.131 af Secondary=0.00 cfs 0.000 af Outflow=0.54 cfs 1.131 af

Link DA10L: CEl Mid Inflow=11.83 cfs 5.659 af
Primary=11.83 cfs 5.659 af

Link DA14L: CEl culvert S Inflow=3.65 cfs 0.565 af
Primary=3.65 cfs 0.565 af

Link DA15L: DA15L Inflow=15.63 cfs 1.662 af
Primary=15.63 cfs 1.662 af

Link DA16L: DA16L Inflow=12.70 cfs 6.273 af
Primary=12.70 cfs 6.273 af

Link DA17L: Driveway culvert Inflow=28.40 cfs 7.987 af
Primary=28.40 cfs 7.987 af

Link DA19L: Chaffee culvert Inflow=33.03 cfs 8.350 af
Primary=33.03 cfs 8.350 af

Link DA2L: DA2L Inflow=10.46 cfs 4.841 af
Primary=10.46 cfs 4.841 af

Link DA5L: DA5L Inflow=0.65 cfs 0.327 af
Primary=0.65 cfs 0.327 af

Link DA6L: DA6L Inflow=11.38 cfs 5.411 af
Primary=11.38 cfs 5.411 af

Link DA8L: CEl culvert N Inflow=1.69 cfs 0.162 af
Primary=1.69 cfs 0.162 af

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=0.48"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=22.85 cfs 6.318 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=0.52"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=4.14 cfs 0.468 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=0.60"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=1.24 cfs 0.108 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=0.60"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=3.25 cfs 0.424 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=3.03"
Tc=3.0 min CN=100 Runoff=3.78 cfs 0.207 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=0.73"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=6.61 cfs 0.682 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=1.27"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=19.38 cfs 1.294 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=1.21"
Flow Length=929' Tc=13.5 min CN=79 Runoff=9.55 cfs 0.595 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=1.34"
Flow Length=551' Tc=14.9 min CN=81 Runoff=1.18 cfs 0.076 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=1.77"
Flow Length=751' Tc=12.1 min CN=87 Runoff=2.76 cfs 0.163 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=1.54"
Flow Length=591' Tc=21.5 min CN=84 Runoff=4.53 cfs 0.356 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=0.28"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=3.67 cfs 1.053 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=1.34"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=29.23 cfs 1.785 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=0.28"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=2.38 cfs 0.660 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=0.48"
Flow Length=305' Tc=18.7 min CN=64 Runoff=0.96 cfs 0.095 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=1.34"
Flow Length=542' Tc=8.0 min CN=81 Runoff=7.08 cfs 0.360 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=0.60"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=2.59 cfs 0.216 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=1.15"
Flow Length=435' Tc=19.6 min CN=78 Runoff=0.85 cfs 0.065 af

Pond 14P: Existing DB Peak Elev=880.86' Storage=45,049 cf Inflow=29.23 cfs 1.785 af
Primary=1.34 cfs 1.702 af Secondary=0.00 cfs 0.000 af Outflow=1.34 cfs 1.702 af

Link DA10L: CEl Mid Inflow=30.59 cfs 10.657 af
Primary=30.59 cfs 10.657 af

Link DA14L: CEl culvert S Inflow=7.01 cfs 0.889 af
Primary=7.01 cfs 0.889 af

Link DA15L: DA15L Inflow=26.10 cfs 2.608 af
Primary=26.10 cfs 2.608 af

Link DA16L: DA16L Inflow=32.08 cfs 11.642 af
Primary=32.08 cfs 11.642 af

Link DA17L: Driveway culvert Inflow=49.58 cfs 14.326 af
Primary=49.58 cfs 14.326 af

Link DA19L: Chaffee culvert Inflow=56.24 cfs 14.846 af
Primary=56.24 cfs 14.846 af

Link DA2L: DA2L Inflow=27.13 cfs 9.073 af
Primary=27.13 cfs 9.073 af

Link DA5L: DA5L Inflow=2.64 cfs 0.756 af
Primary=2.64 cfs 0.756 af

Link DA6L: DA6L Inflow=29.66 cfs 10.189 af
Primary=29.66 cfs 10.189 af

Link DA8L: CEl culvert N Inflow=3.44 cfs 0.282 af
Primary=3.44 cfs 0.282 af

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=0.72"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=37.73 cfs 9.376 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=0.76"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=6.80 cfs 0.687 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=0.86"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=1.93 cfs 0.156 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=0.86"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=5.12 cfs 0.609 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=3.52"
Tc=3.0 min CN=100 Runoff=4.39 cfs 0.241 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=1.02"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=9.81 cfs 0.953 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=1.65"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=25.33 cfs 1.681 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=1.58"
Flow Length=929' Tc=13.5 min CN=79 Runoff=12.57 cfs 0.778 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=1.72"
Flow Length=551' Tc=14.9 min CN=81 Runoff=1.53 cfs 0.099 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=2.20"
Flow Length=751' Tc=12.1 min CN=87 Runoff=3.42 cfs 0.204 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=1.95"
Flow Length=591' Tc=21.5 min CN=84 Runoff=5.76 cfs 0.451 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=0.46"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=7.51 cfs 1.712 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=1.72"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=37.85 cfs 2.303 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=0.46"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=4.91 cfs 1.073 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=0.72"
Flow Length=305' Tc=18.7 min CN=64 Runoff=1.61 cfs 0.142 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=1.72"
Flow Length=542' Tc=8.0 min CN=81 Runoff=9.13 cfs 0.465 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=0.86"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=4.02 cfs 0.311 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=1.51"
Flow Length=435' Tc=19.6 min CN=78 Runoff=1.14 cfs 0.086 af

Pond 14P: Existing DB Peak Elev=881.38' Storage=57,332 cf Inflow=37.85 cfs 2.303 af
Primary=1.89 cfs 2.211 af Secondary=0.00 cfs 0.000 af Outflow=1.89 cfs 2.211 af

Link DA10L: CEl Mid Inflow=51.15 cfs 15.664 af
Primary=51.15 cfs 15.664 af

Link DA14L: CEl culvert S Inflow=10.28 cfs 1.193 af
Primary=10.28 cfs 1.193 af

Link DA15L: DA15L Inflow=35.96 cfs 3.482 af
Primary=35.96 cfs 3.482 af

Link DA16L: DA16L Inflow=53.24 cfs 16.994 af
Primary=53.24 cfs 16.994 af

Link DA17L: Driveway culvert Inflow=71.14 cfs 20.575 af
Primary=71.14 cfs 20.575 af

Link DA19L: Chaffee culvert Inflow=79.51 cfs 21.230 af
Primary=79.51 cfs 21.230 af

Link DA2L: DA2L Inflow=45.34 cfs 13.298 af
Primary=45.34 cfs 13.298 af

Link DA5L: DA5L Inflow=5.33 cfs 1.215 af
Primary=5.33 cfs 1.215 af

Link DA6L: DA6L Inflow=49.73 cfs 14.978 af
Primary=49.73 cfs 14.978 af

Link DA8L: CEl culvert N Inflow=5.16 cfs 0.396 af
Primary=5.16 cfs 0.396 af

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=1.11"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=64.28 cfs 14.554 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=1.17"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=11.36 cfs 1.054 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=1.30"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=3.09 cfs 0.234 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=1.30"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=8.26 cfs 0.915 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=4.24"
Tc=3.0 min CN=100 Runoff=5.29 cfs 0.290 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=1.49"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=15.00 cfs 1.393 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=2.24"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=34.46 cfs 2.280 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=2.16"
Flow Length=929' Tc=13.5 min CN=79 Runoff=17.23 cfs 1.062 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=2.32"
Flow Length=551' Tc=14.9 min CN=81 Runoff=2.06 cfs 0.133 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=2.86"
Flow Length=751' Tc=12.1 min CN=87 Runoff=4.40 cfs 0.264 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=2.58"
Flow Length=591' Tc=21.5 min CN=84 Runoff=7.61 cfs 0.597 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=0.78"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=15.18 cfs 2.886 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=2.32"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=50.99 cfs 3.104 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=0.78"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=9.97 cfs 1.809 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=1.11"
Flow Length=305' Tc=18.7 min CN=64 Runoff=2.73 cfs 0.220 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=2.32"
Flow Length=542' Tc=8.0 min CN=81 Runoff=12.25 cfs 0.627 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=1.30"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=6.40 cfs 0.467 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=2.08"
Flow Length=435' Tc=19.6 min CN=78 Runoff=1.58 cfs 0.118 af

Pond 14P: Existing DB Peak Elev=882.21' Storage=78,759 cf Inflow=50.99 cfs 3.104 af
Primary=2.52 cfs 2.993 af Secondary=0.00 cfs 0.000 af Outflow=2.52 cfs 2.993 af

Link DA10L: CEl Mid Inflow=88.94 cfs 24.141 af
Primary=88.94 cfs 24.141 af

Link DA14L: CEl culvert S Inflow=15.57 cfs 1.683 af
Primary=15.57 cfs 1.683 af

Link DA15L: DA15L Inflow=51.68 cfs 4.878 af
Primary=51.68 cfs 4.878 af

Link DA16L: DA16L Inflow=91.94 cfs 26.022 af
Primary=91.94 cfs 26.022 af

Link DA17L: Driveway culvert Inflow=108.96 cfs 31.032 af
Primary=108.96 cfs 31.032 af

Link DA19L: Chaffee culvert Inflow=119.86 cfs 31.894 af
Primary=119.86 cfs 31.894 af

Link DA2L: DA2L Inflow=77.78 cfs 20.432 af
Primary=77.78 cfs 20.432 af

Link DA5L: DA5L Inflow=10.66 cfs 2.028 af
Primary=10.66 cfs 2.028 af

Link DA6L: DA6L Inflow=86.56 cfs 23.087 af
Primary=86.56 cfs 23.087 af

Link DA8L: CEl culvert N Inflow=7.97 cfs 0.585 af
Primary=7.97 cfs 0.585 af

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=1.48"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=90.02 cfs 19.454 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=1.55"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=15.67 cfs 1.400 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=1.70"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=4.16 cfs 0.307 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=1.70"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=11.18 cfs 1.201 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=4.85"
Tc=3.0 min CN=100 Runoff=6.05 cfs 0.331 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=1.93"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=19.75 cfs 1.798 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=2.76"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=42.41 cfs 2.810 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=2.67"
Flow Length=929' Tc=13.5 min CN=79 Runoff=21.30 cfs 1.315 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=2.85"
Flow Length=551' Tc=14.9 min CN=81 Runoff=2.52 cfs 0.163 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=3.43"
Flow Length=751' Tc=12.1 min CN=87 Runoff=5.24 cfs 0.317 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=3.13"
Flow Length=591' Tc=21.5 min CN=84 Runoff=9.19 cfs 0.724 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=1.09"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=23.21 cfs 4.039 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=2.85"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=62.39 cfs 3.810 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=1.09"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=15.26 cfs 2.531 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=1.48"
Flow Length=305' Tc=18.7 min CN=64 Runoff=3.79 cfs 0.294 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=2.85"
Flow Length=542' Tc=8.0 min CN=81 Runoff=14.95 cfs 0.769 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=1.70"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=8.60 cfs 0.613 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=2.58"
Flow Length=435' Tc=19.6 min CN=78 Runoff=1.97 cfs 0.147 af

Pond 14P: Existing DB Peak Elev=882.91' Storage=98,782 cf Inflow=62.39 cfs 3.810 af
Primary=2.94 cfs 3.678 af Secondary=0.00 cfs 0.000 af Outflow=2.94 cfs 3.678 af

Link DA10L: CEl Mid Inflow=126.09 cfs 32.165 af
Primary=126.09 cfs 32.165 af

Link DA14L: CEl culvert S Inflow=20.40 cfs 2.129 af
Primary=20.40 cfs 2.129 af

Link DA15L: DA15L Inflow=65.77 cfs 6.139 af
Primary=65.77 cfs 6.139 af

Link DA16L: DA16L Inflow=129.89 cfs 34.546 af
Primary=129.89 cfs 34.546 af

Link DA17L: Driveway culvert Inflow=145.46 cfs 40.849 af
Primary=145.46 cfs 40.849 af

Link DA19L: Chaffee culvert Inflow=158.49 cfs 41.890 af
Primary=158.49 cfs 41.890 af

Link DA2L: DA2L Inflow=110.02 cfs 27.171 af
Primary=110.02 cfs 27.171 af

Link DA5L: DA5L Inflow=16.28 cfs 2.825 af
Primary=16.28 cfs 2.825 af

Link DA6L: DA6L Inflow=122.95 cfs 30.765 af
Primary=122.95 cfs 30.765 af

Link DA8L: CEl culvert N Inflow=10.56 cfs 0.759 af
Primary=10.56 cfs 0.759 af

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment DA1: Nakita Culvert Runoff Area=6,852,298 sf 0.00% Impervious Runoff Depth=1.91"
Flow Length=5,092' Tc=80.8 min CN=64 Runoff=119.84 cfs 25.091 af

Subcatchment DA10: 7720 Carter Runoff Area=470,622 sf 0.00% Impervious Runoff Depth=1.99"
Flow Length=1,680' Tc=24.0 min CN=65 Runoff=20.58 cfs 1.796 af

Subcatchment DA11: CEl Mid Runoff Area=94,379 sf 0.00% Impervious Runoff Depth=2.16"
Flow Length=1,335' Tc=18.1 min CN=67 Runoff=5.37 cfs 0.390 af

Subcatchment DA12: CEl depression S Runoff Area=369,283 sf 0.00% Impervious Runoff Depth=2.16"
Flow Length=1,599' Tc=32.4 min CN=67 Runoff=14.51 cfs 1.525 af

Subcatchment DA13: Basin Runoff Area=35,719 sf 100.00% Impervious Runoff Depth=5.50"
Tc=3.0 min CN=100 Runoff=6.86 cfs 0.376 af

Subcatchment DA14: CEl culvert S Runoff Area=487,917 sf 0.00% Impervious Runoff Depth=2.41"
Flow Length=2,045' Tc=26.3 min CN=70 Runoff=25.07 cfs 2.254 af

Subcatchment DA15: Trib parallel to Runoff Area=531,688 sf 0.00% Impervious Runoff Depth=3.33"
Flow Length=1,683' Tc=15.6 min CN=80 Runoff=51.03 cfs 3.391 af

Subcatchment DA16: Trib east-west Runoff Area=257,061 sf 0.00% Impervious Runoff Depth=3.24"
Flow Length=929' Tc=13.5 min CN=79 Runoff=25.72 cfs 1.592 af

Subcatchment DA17: 7555 Chaffee Runoff Area=29,915 sf 0.00% Impervious Runoff Depth=3.43"
Flow Length=551' Tc=14.9 min CN=81 Runoff=3.02 cfs 0.196 af

Subcatchment DA18: 7565 Chaffee Runoff Area=48,348 sf 0.00% Impervious Runoff Depth=4.04"
Flow Length=751' Tc=12.1 min CN=87 Runoff=6.13 cfs 0.374 af

Subcatchment DA19: Chaffee culvert Runoff Area=120,797 sf 0.00% Impervious Runoff Depth=3.73"
Flow Length=591' Tc=21.5 min CN=84 Runoff=10.90 cfs 0.862 af

Subcatchment DA2: Red Hawk Runoff Area=1,941,759 sf 0.00% Impervious Runoff Depth=1.45"
Flow Length=3,507' Tc=52.0 min CN=58 Runoff=33.11 cfs 5.400 af

Subcatchment DA3: Red Hawk Ex Det. Runoff Area=698,036 sf 0.00% Impervious Runoff Depth=3.43"
Flow Length=1,354' Tc=13.1 min CN=81 Runoff=74.70 cfs 4.582 af

Subcatchment DA4: culvert u/s of trail Runoff Area=1,217,036 sf 0.00% Impervious Runoff Depth=1.45"
Flow Length=1,871' Tc=48.7 min CN=58 Runoff=21.74 cfs 3.385 af

Subcatchment DA5: Bike path/Carter N Runoff Area=103,481 sf 0.00% Impervious Runoff Depth=1.91"
Flow Length=305' Tc=18.7 min CN=64 Runoff=5.03 cfs 0.379 af

Subcatchment DA6: Bike path/Carter S Runoff Area=140,887 sf 0.00% Impervious Runoff Depth=3.43"
Flow Length=542' Tc=8.0 min CN=81 Runoff=17.86 cfs 0.925 af

Subcatchment DA8: CEl north Runoff Area=188,467 sf 0.00% Impervious Runoff Depth=2.16"
Flow Length=1,564' Tc=17.0 min CN=67 Runoff=11.09 cfs 0.779 af

Subcatchment DA9: CEl culvert N Runoff Area=29,684 sf 0.00% Impervious Runoff Depth=3.14"
Flow Length=435' Tc=19.6 min CN=78 Runoff=2.40 cfs 0.178 af

Pond 14P: Existing DB Peak Elev=883.43' Storage=114,758 cf Inflow=74.70 cfs 4.582 af
Primary=5.59 cfs 4.436 af Secondary=0.00 cfs 0.000 af Outflow=5.59 cfs 4.436 af

Link DA10L: CEl Mid Inflow=171.99 cfs 41.412 af
Primary=171.99 cfs 41.412 af

Link DA14L: CEl culvert S Inflow=25.82 cfs 2.629 af
Primary=25.82 cfs 2.629 af

Link DA15L: DA15L Inflow=81.34 cfs 7.545 af
Primary=81.34 cfs 7.545 af

Link DA16L: DA16L Inflow=176.74 cfs 44.350 af
Primary=176.74 cfs 44.350 af

Link DA17L: Driveway culvert Inflow=194.73 cfs 52.092 af
Primary=194.73 cfs 52.092 af

Link DA19L: Chaffee culvert Inflow=204.03 cfs 53.328 af
Primary=204.03 cfs 53.328 af

Link DA2L: DA2L Inflow=149.90 cfs 34.928 af
Primary=149.90 cfs 34.928 af

Link DA5L: DA5L Inflow=23.11 cfs 3.763 af
Primary=23.11 cfs 3.763 af

Link DA6L: DA6L Inflow=167.77 cfs 39.616 af
Primary=167.77 cfs 39.616 af

Link DA8L: CEl culvert N Inflow=13.47 cfs 0.957 af
Primary=13.47 cfs 0.957 af

APPENDIX D

Hydraulic Modeling Results

EXISTING CONDITIONS RESULTS									
2-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	11.83	868.82	869.6	869.6	869.79	0.032396	3.54	3.34	8.54
4218.27	11.83	863.33	864.55	864.32	864.67	0.010944	2.72	4.35	7.02
3954.65	11.83	859.34	859.8	859.8	859.99	0.033353	3.45	3.43	9.27
3691.34	11.83	846.58	847.3	847.41	847.68	0.069871	4.96	2.39	6.50
3136.38	11.83	818.27	819.12	819.15	819.4	0.038727	4.29	2.76	5.84
2709.58	11.83	806.48	807.78	807.03	807.83	0.002277	1.67	7.08	5.86
2675	Culvert								
2642.96	12.7	805.25	805.96	806.22	806.83	0.210802	7.50	1.58	4.48
2369.02	12.7	798.4	799.11	799.11	799.36	0.032639	4.01	3.16	6.43
2103.17	12.7	793.34	793.43	793.34	793.45	0.015237	0.56	10.06	50.38
1838.67	12.7	787.69	788.75	788.75	789.03	0.018163	4.20	3.03	5.68
1807.93	28.4	786.46	787.74	787.87	788.3	0.025446	6.00	4.74	6.65
1742.34	28.4	785.71	786.73	786.73	787.06	0.01646	4.62	6.15	9.49
1665.95	28.4	784.15	786.69	785.08	786.72	0.000382	1.30	21.84	12.25
1640	Culvert								
1617.33	28.4	784	786.13		786.15	0.001114	1.16	24.52	26.38
1603.64	33.03	784.46	786.1	785.31	786.13	0.00148	1.33	24.93	27.77
1589.09	33.03	783.78	786.11	784.64	786.12	0.000335	0.80	41.38	31.86
1550	Culvert								
1481.98	33.03	781.32	783.37		783.4	0.001134	1.50	22.04	15.73
1470.43	33.03	782.35	783.23		783.36	0.009333	2.98	11.1	14.02
1353	33.03	779.56	781.7	781.43	781.98	0.015206	4.25	7.77	7.27

EXISTING CONDITIONS RESULTS									
25-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	88.94	868.82	870.56	870.56	871.01	0.025285	5.34	16.67	70.40
4218.27	88.94	863.33	865.91	865.57	866.22	0.013987	4.49	21.01	35.92
3954.65	88.94	859.34	860.82	860.82	861.4	0.024587	6.15	14.47	12.50
3691.34	88.94	846.58	848.03	848.52	849.6	0.103512	10.04	8.86	11.11
3136.38	88.94	818.27	820.34	820.44	821.09	0.030208	6.95	12.80	10.53
2709.58	88.94	806.48	809.58	808.53	809.81	0.00724	4.09	29.15	53.49
2675	Culvert								
2642.96	91.94	805.25	807.59	807.59	807.86	0.012007	4.79	27.99	45.49
2369.02	91.94	798.4	800.01	800.54	801.16	0.05702	8.61	10.68	10.21
2103.17	91.94	793.34	793.72	793.72	793.87	0.040645	2.46	30.18	102.79
1838.67	91.94	787.69	789.96	790	790.21	0.006848	4.69	32.55	84.87
1807.93	108.96	786.46	788.76	789	789.77	0.021514	8.05	13.54	10.61
1742.34	108.96	785.71	789.25	787.67	789.34	0.000786	2.52	57.85	63.03
1665.95	108.96	784.15	789.29	786.2	789.3	0.000057	0.87	217.29	142.60
1640	Culvert								
1617.33	108.96	784	788.41		788.43	0.000169	0.94	144.05	88.57
1603.64	119.86	784.46	788.41	786.03	788.42	0.000163	0.95	179.71	125.03
1589.09	119.86	783.78	788.41	785.37	788.42	0.000092	0.74	209.40	124.99
1550	Culvert								
1481.98	119.86	781.32	784.54		784.66	0.001936	2.73	47.80	39.98
1470.43	119.86	782.35	784.44		784.61	0.006626	3.35	37.20	36.19
1353	119.86	779.56	782.94	782.64	783.45	0.015207	5.87	25.34	50.75

EXISTING CONDITIONS RESULTS									
100-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	171.99	868.82	871.15	871.15	871.65	0.018875	5.71	31.92	136.39
4218.27	171.99	863.33	866.25	866.39	866.68	0.020456	5.57	39.56	75.87
3954.65	171.99	859.34	861.72	861.72	862.06	0.016338	4.92	43.36	72.58
3691.34	171.99	846.58	848.27	849.16	851.61	0.17966	14.66	11.73	12.60
3136.38	171.99	818.27	821.12	821.37	821.85	0.024466	7.12	33.06	95.48
2709.58	171.99	806.48	809.54	809.94	810.5	0.028891	8.17	27.49	50.48
2675	Culvert								
2642.96	176.74	805.25	807.92	807.92	808.16	0.023337	4.60	49.17	81.41
2369.02	176.74	798.4	800.68	800.88	801.37	0.027392	7.43	33.43	49.88
2103.17	176.74	793.34	793.89	793.89	794.09	0.050498	3.40	48.79	123.85
1838.67	176.74	787.69	790.63	790.18	790.69	0.001462	2.86	123.09	213.02
1807.93	194.73	786.46	789.99	789.99	790.55	0.006648	6.23	38.04	49.57
1742.34	194.73	785.71	789.13	788.45	789.44	0.002946	4.73	50.89	52.31
1665.95	194.73	784.15	789.22	786.92	789.3	0.000501	2.55	105.08	130.85
1640	Culvert								
1617.33	194.73	784	788.7		788.72	0.000365	1.46	171.09	102.97
1603.64	204.03	784.46	788.7	786.44	788.72	0.000308	1.38	216.79	137.03
1589.09	204.03	783.78	788.7	785.83	788.71	0.000182	1.10	247.67	142.01
1550	Culvert								
1481.98	204.03	781.32	784.91		785.12	0.003041	3.78	66.65	57.31
1470.43	204.03	782.35	784.78		785.06	0.009066	4.26	50.86	43.89
1353	204.03	779.56	783.4	783.4	783.82	0.011983	5.98	49.99	68.47

SCENARIO A RESULTS									
2-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	11.83	868.82	869.6	869.6	869.79	0.032396	3.54	3.34	8.54
4218.27	11.83	863.33	864.55	864.32	864.67	0.010944	2.72	4.35	7.02
3954.65	11.83	859.34	859.8	859.8	859.99	0.033353	3.45	3.43	9.27
3691.34	11.83	846.58	847.3	847.41	847.68	0.069871	4.96	2.39	6.5
3136.38	11.83	818.27	819.12	819.15	819.4	0.038727	4.29	2.76	5.84
2709.58	11.83	806.48	807.78	807.03	807.83	0.002277	1.67	7.08	5.86
2675	Culvert								
2642.96	12.7	805.25	805.96	806.22	806.83	0.210802	7.5	1.58	4.48
2369.02	12.7	798.4	799.11	799.11	799.36	0.032639	4.01	3.16	6.43
2103.17	12.7	793.34	793.43	793.34	793.45	0.01525	0.56	10.06	50.38
1838.67	12.7	787.69	788.75	788.75	789.03	0.018152	4.2	3.03	5.68
1807.93	28.4	786.46	787.74	787.87	788.3	0.025446	6	4.74	6.65
1742.34	28.4	785.71	786.73	786.73	787.06	0.01646	4.62	6.15	9.49
1665.95	28.4	784.15	786.72	785.08	786.75	0.000364	1.28	22.22	12.31
1640	Culvert								
1617.33	28.4	784	785.68		785.74	0.003958	1.95	14.55	18.48
1603.64	33.03	784.46	785.31	785.31	785.6	0.029236	4.29	7.71	13.63
1589.09	33.03	783.78	785.43	784.55	785.46	0.001328	1.37	24.08	23.07
1550	Culvert								
1481.98	33.03	781.32	783.37		783.4	0.001134	1.5	22.04	15.73
1470.43	33.03	782.35	783.23		783.36	0.009333	2.98	11.1	14.02
1353	33.03	779.56	781.7	781.43	781.98	0.015206	4.25	7.77	7.27

SCENARIO A RESULTS									
25-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	88.94	868.82	870.56	870.56	871.01	0.025285	5.34	16.67	70.4
4218.27	88.94	863.33	865.91	865.57	866.22	0.013987	4.49	21.01	35.92
3954.65	88.94	859.34	860.82	860.82	861.4	0.024587	6.15	14.47	12.5
3691.34	88.94	846.58	848.03	848.52	849.6	0.103512	10.04	8.86	11.11
3136.38	88.94	818.27	820.34	820.44	821.09	0.030208	6.95	12.8	10.53
2709.58	88.94	806.48	809.58	808.53	809.81	0.00724	4.09	29.15	53.49
2675	Culvert								
2642.96	91.94	805.25	807.59	807.59	807.86	0.012007	4.79	27.99	45.49
2369.02	91.94	798.4	800.01	800.54	801.16	0.05702	8.61	10.68	10.21
2103.17	91.94	793.34	793.72	793.72	793.87	0.040645	2.46	30.18	102.79
1838.67	91.94	787.69	789.96	790	790.21	0.006848	4.69	32.55	84.87
1807.93	108.96	786.46	788.76	789	789.77	0.021514	8.05	13.54	10.61
1742.34	108.96	785.71	789.25	787.67	789.34	0.000786	2.52	57.85	63.03
1665.95	108.96	784.15	789.29	786.2	789.3	0.000057	0.87	217.29	142.6
1640	Culvert								
1617.33	108.96	784	787.17		787.22	0.001363	1.88	60.44	54.23
1603.64	119.86	784.46	787.15	786.03	787.2	0.001352	2.02	69.59	61.9
1589.09	119.86	783.78	787.15	785.3	787.18	0.000604	1.43	89.67	66.62
1550	Culvert								
1481.98	119.86	781.32	784.54		784.66	0.001936	2.73	47.8	39.98
1470.43	119.86	782.35	784.44		784.61	0.006626	3.35	37.2	36.19
1353	119.86	779.56	782.94	782.64	783.45	0.015207	5.87	25.34	50.75

SCENARIO A RESULTS									
100-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	171.99	868.82	871.15	871.15	871.65	0.018875	5.71	31.92	136.39
4218.27	171.99	863.33	866.25	866.39	866.68	0.020456	5.57	39.56	75.87
3954.65	171.99	859.34	861.72	861.72	862.06	0.016338	4.92	43.36	72.58
3691.34	171.99	846.58	848.27	849.16	851.61	0.17966	14.66	11.73	12.6
3136.38	171.99	818.27	821.12	821.37	821.85	0.024466	7.12	33.06	95.48
2709.58	171.99	806.48	809.54	809.94	810.5	0.028891	8.17	27.49	50.48
2675	Culvert								
2642.96	176.74	805.25	807.92	807.92	808.16	0.023337	4.6	49.17	81.41
2369.02	176.74	798.4	800.68	800.88	801.37	0.027392	7.43	33.43	49.88
2103.17	176.74	793.34	793.89	793.89	794.09	0.050498	3.4	48.79	123.85
1838.67	176.74	787.69	790.63	790.18	790.69	0.001462	2.86	123.09	213.02
1807.93	194.73	786.46	789.99	789.99	790.55	0.006648	6.23	38.04	49.57
1742.34	194.73	785.71	789.13	788.45	789.44	0.002946	4.73	50.88	52.3
1665.95	194.73	784.15	789.22	786.92	789.3	0.000501	2.55	105.08	130.85
1640	Culvert								
1617.33	194.73	784	788.54		788.57	0.000452	1.57	155.62	95.24
1603.64	204.03	784.46	788.54	786.44	788.57	0.000387	1.51	195.88	129.67
1589.09	204.03	783.78	788.54	785.77	788.56	0.00022	1.18	227.24	136.31
1550	Culvert								
1481.98	204.03	781.32	784.91		785.12	0.003041	3.78	66.65	57.31
1470.43	204.03	782.35	784.78		785.06	0.009066	4.26	50.86	43.89
1353	204.03	779.56	783.4	783.4	783.82	0.011983	5.98	49.99	68.47

SCENARIO B RESULTS									
2-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	11.83	868.82	869.6	869.6	869.79	0.032396	3.54	3.34	8.54
4218.27	11.83	863.33	864.55	864.32	864.67	0.010944	2.72	4.35	7.02
3954.65	11.83	859.34	859.8	859.8	859.99	0.033353	3.45	3.43	9.27
3691.34	11.83	846.58	847.3	847.41	847.68	0.069871	4.96	2.39	6.5
3136.38	11.83	818.27	819.12	819.15	819.4	0.038727	4.29	2.76	5.84
2709.58	11.83	806.48	807.78	807.03	807.83	0.002277	1.67	7.08	5.86
2675	Culvert								
2642.96	12.7	805.25	805.96	806.22	806.83	0.210802	7.5	1.58	4.48
2369.02	12.7	798.4	799.11	799.11	799.36	0.032639	4.01	3.16	6.43
2103.17	12.7	793.34	793.43	793.34	793.45	0.015237	0.56	10.06	50.38
1838.67	12.7	787.69	788.75	788.75	789.03	0.018163	4.2	3.03	5.68
1807.93	28.4	786.46	787.74	787.87	788.3	0.025446	6	4.74	6.65
1742.34	28.4	785.71	786.73	786.73	787.06	0.01646	4.62	6.15	9.49
1665.95	28.4	784.15	786.05	785.08	786.11	0.001231	1.96	14.46	10.75
1640	Culvert								
1617.33	28.4	784	785.68		785.74	0.003958	1.95	14.55	18.48
1603.64	33.03	784.46	785.31	785.31	785.6	0.029236	4.29	7.71	13.63
1589.09	33.03	783.78	785.43	784.55	785.46	0.001328	1.37	24.08	23.07
1550	Culvert								
1481.98	33.03	781.32	783.37		783.4	0.001134	1.5	22.04	15.73
1470.43	33.03	782.35	783.23		783.36	0.009333	2.98	11.1	14.02
1353	33.03	779.56	781.7	781.43	781.98	0.015206	4.25	7.77	7.27

SCENARIO B RESULTS									
25-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	88.94	868.82	870.56	870.56	871.01	0.025285	5.34	16.67	70.4
4218.27	88.94	863.33	865.91	865.57	866.22	0.013987	4.49	21.01	35.92
3954.65	88.94	859.34	860.82	860.82	861.4	0.024587	6.15	14.47	12.5
3691.34	88.94	846.58	848.03	848.52	849.6	0.103512	10.04	8.86	11.11
3136.38	88.94	818.27	820.34	820.44	821.09	0.030208	6.95	12.8	10.53
2709.58	88.94	806.48	809.58	808.53	809.81	0.00724	4.09	29.15	53.49
2675	Culvert								
2642.96	91.94	805.25	807.59	807.59	807.86	0.012007	4.79	27.99	45.49
2369.02	91.94	798.4	800.01	800.54	801.16	0.05702	8.61	10.68	10.21
2103.17	91.94	793.34	793.72	793.72	793.87	0.040645	2.46	30.18	102.79
1838.67	91.94	787.69	789.96	790	790.21	0.006848	4.69	32.55	84.87
1807.93	108.96	786.46	788.76	789	789.77	0.021514	8.05	13.54	10.61
1742.34	108.96	785.71	788.39	787.67	788.65	0.003358	4.12	28.01	22.26
1665.95	108.96	784.15	788.45	786.2	788.51	0.000428	2.06	67.04	98.64
1640	Culvert								
1617.33	108.96	784	787.17		787.22	0.001363	1.88	60.44	54.23
1603.64	119.86	784.46	787.15	786.03	787.2	0.001352	2.02	69.59	61.9
1589.09	119.86	783.78	787.15	785.3	787.18	0.000604	1.43	89.67	66.62
1550	Culvert								
1481.98	119.86	781.32	784.54		784.66	0.001936	2.73	47.8	39.98
1470.43	119.86	782.35	784.44		784.61	0.006626	3.35	37.2	36.19
1353	119.86	779.56	782.94	782.64	783.45	0.015207	5.87	25.34	50.75

SCENARIO B RESULTS									
100-YEAR									
River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)
4470.3	171.99	868.82	871.15	871.15	871.65	0.018875	5.71	31.92	136.39
4218.27	171.99	863.33	866.25	866.39	866.68	0.020456	5.57	39.56	75.87
3954.65	171.99	859.34	861.72	861.72	862.06	0.016338	4.92	43.36	72.58
3691.34	171.99	846.58	848.27	849.16	851.61	0.17966	14.66	11.73	12.6
3136.38	171.99	818.27	821.12	821.37	821.85	0.024466	7.12	33.06	95.48
2709.58	171.99	806.48	809.54	809.94	810.5	0.028891	8.17	27.49	50.48
2675	Culvert								
2642.96	176.74	805.25	807.92	807.92	808.16	0.023337	4.6	49.17	81.41
2369.02	176.74	798.4	800.68	800.88	801.37	0.027392	7.43	33.43	49.88
2103.17	176.74	793.34	793.89	793.89	794.09	0.050498	3.4	48.79	123.85
1838.67	176.74	787.69	790.63	790.18	790.69	0.001462	2.86	123.09	213.02
1807.93	194.73	786.46	789.99	789.99	790.55	0.006648	6.23	38.04	49.57
1742.34	194.73	785.71	789.13	788.45	789.44	0.002946	4.73	50.88	52.3
1665.95	194.73	784.15	789.22	786.92	789.3	0.000501	2.55	105.08	130.85
1640	Culvert								
1617.33	194.73	784	788.54		788.57	0.000452	1.57	155.62	95.24
1603.64	204.03	784.46	788.54	786.44	788.57	0.000387	1.51	195.88	129.67
1589.09	204.03	783.78	788.54	785.77	788.56	0.00022	1.18	227.24	136.31
1550	Culvert								
1481.98	204.03	781.32	784.91		785.12	0.003041	3.78	66.65	57.31
1470.43	204.03	782.35	784.78		785.06	0.009066	4.26	50.86	43.89
1353	204.03	779.56	783.4	783.4	783.82	0.011983	5.98	49.99	68.47

APPENDIX E

Itemized Preliminary Engineer's Opinion of Probable Construction Cost

Chaffee Road Culvert Upsizing - Scenario A

Engineer's Preliminary Opinion of Probable Construction Cost

March 2025

Prepared by Sustainable Streams for

Summit County Engineer's Office

Item	Total Unit Cost	Units	Quantity	Sub-Total
Mobilization	$ 20,000	LS	1	$ 20,000
Remove Existing Pavement (Chaffee Rd)	$ 30	SY	230	$ 6,900
Restore Pavement (Chaffee Rd)	$ 300	SY	230	$ 69,000
2'H x 6'W Box Culvert	$ 1,700	LF	100	$ 170,000
Headwall for Box Culvert	$ 10,000	EA	2	$ 20,000
ODOT Type C Aggregate for Scour Hole Armoring	$ 100	TON	80	$ 8,000
Construction Staking/Layout/Control Establishment	$ 1,000	LS	1	$ 1,000
Maintenance of Traffic	$ 4,000	LS	1	$ 4,000
Site Protection/Restoration	$ 5,000	LS	1	$ 5,000
Sub-Total				**$ 303,900**
Contingency		30%		$91,200
Total				**$ 395,100**

These preliminary engineer's OPCCs should be further refined using recent and relevant bid tab data from comparable culvert replacement and transportation infrastructure projects (Sustainable Streams maintains a large inventory of bid tabs related to stream, wetland, and stormwater construction projects but does not have readily accessible transportation project bid tabs).

Chaffee Road Culvert Upsizing - Scenario B

Engineer's Preliminary Opinion of Probable Construction Cost

March 2025

Prepared by Sustainable Streams for

Summit County Engineer's Office

Item	Total Unit Cost	Units	Quantity	Sub-Total
Mobilization	$ 24,000	LS	1	$ 24,000
Remove Existing Pavement (Chaffee Rd)	$ 30	SY	230	$ 6,900
Restore Pavement (Chaffee Rd)	$ 300	SY	230	$ 69,000
Remove Existing Driveway Pavement	$ 20	SY	60	$ 1,200
Restore Driveway Pavement	$ 20	SY	60	$ 1,200
2'H x 6'W Box Culvert	$ 1,700	LF	100	$ 170,000
43” x 68” Elliptical Pipe	$ 1,000	LF	35	$ 35,000
Headwall for Box Culvert	$ 10,000	EA	2	$ 20,000
Headwall for Elliptical Pipe	$ 7,000	EA	2	$ 14,000
ODOT Type C Aggregate for Scour Hole Armoring	$ 100	TON	80	$ 8,000
Construction Staking/Layout/Control Establishment	$ 1,800	LS	1	$ 1,800
Maintenance of Traffic	$ 4,500	LS	1	$ 4,500
Site Protection/Restoration	$ 7,500	LS	1	$ 7,500
Sub-Total				**$ 363,100**
Contingency		30%		$109,000
Total				**$ 472,100**

These preliminary engineer’s OPCCs should be further refined using recent and relevant bid tab data from comparable culvert replacement and transportation infrastructure projects (Sustainable Streams maintains a large inventory of bid tabs related to stream, wetland, and stormwater construction projects but does not have readily accessible transportation project bid tabs).