DRAINAGE IMPACT ANALYSIS FOR MAGNOLIA ISD JUNIOR HIGH SCHOOL

MONTGOMERY COUNTY, TEXAS

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EXECUTIVE SUMMARY

The proposed Magnolia Independent School District Junior High School is located east of the City of Magnolia within unincorporated Montgomery County, Texas. The project will provide approximately 31.75 acres of new development for a Junior High School owned by Magnolia ISD. The purpose of this Drainage Impact Analysis is to determine the volume and configuration of detention storage required for the proposed development.

The objective of this study is to demonstrate that the proposed development, including the required drainage improvements identified in the study, will not cause any adverse impacts to existing flood hazard conditions in the watershed for the 4% Annual Exceedance Probability (AEP) (or 25-year Annual Recurrence Interval) and the 1% AEP (or 100-year Annual Recurrence Interval) storm event in accordance with Montgomery County Engineering Department criteria.

This report was updated in September 2023 to address comments from Montgomery County Engineering Department. The following items were updated or revised:

- The EPA-SWMM model was revised to include the following features from the S&G Engineering Consultants' construction drawings, dated July 24, 2023:
    - Proposed Grate Inlet A1c was added as SWMM node "GrateInlet_A1c", in order to show the proposed water surface elevations at this inlet.
    - Proposed swales connecting Grate Inlet A1a, Grate Inlet A1b, and Grate Inlet A1c were added as SWMM links "Swale1" and "Swale2", to reflect the plans more accurately.
- Sections 3.7 and 5.3 were added to the report to reflect a new unsteady HEC-RAS analysis of the Lake Creek tributary from the proposed detention basin's outfall to a point downstream of Garwood Drive. This HEC-RAS analysis shows that the increased runoff volume and revised timing of proposed discharge from the developed school site do not adversely impact downstream water surface elevations.

On-Site Detention Basin Analysis

A proposed pumped detention basin located along the northern boundary of the property will be provided to meet detention storage requirements and mitigate the drainage impacts of the proposed development. The proposed development will drain to an existing unnamed tributary of Lake Creek (for the purposes of this report, the tributary is referred to as "Lake Creek Tributary A1").

Hydrologic parameters for the project site were calculated using the Rational Method for peak discharge and the Small Watershed Hydrograph Method was used to produce the runoff hydrographs. Per the Montgomery County drainage criteria, the Rational Method can be used to calculate the peak discharge for study areas categorized as a small drainage area. An EPA-SWMM model was created to route the proposed developed conditions runoff hydrographs through the proposed detention basin.

The detention summary table below summarizes the proposed detention system.

	Project Name: Magnolia ISD Junior High		9/11/2023
	Detention Basin Service Area (developed ac)	31.8	acres
	Detention Basin Offsite Drainage Area	4.8	acres
	Storm Event	**4% (25-yr)**	**1% (100-yr)**
FLOWS	**Detention Basin Peak Post-development Inflow (cfs)**	188.2	265.3
FLOWS	**Maximum Allowable Outflow (pre-development - cfs)**	44.1	62.8
FLOWS	**Maximum Outflow Provided (post-development - cfs)**	36.0	38.6
DETN BASIN (1988 NAVD, 2001 adj.)	**Detention Basin Min. High Bank Elev**	214.0	
DETN BASIN (1988 NAVD, 2001 adj.)	**Water Surface Elevation Calculated**	212.3	212.8
DETN BASIN (1988 NAVD, 2001 adj.)	**Detention Storage Provided (ac-ft)**	27.8	29.7
DETN BASIN (1988 NAVD, 2001 adj.)	**Storage Rate Provided (ac-ft/ac)**	0.876	0.935
Outflow Structure	**Proposed Gravity Outfall Structure**	121 LF 24" RCP; u/s FL = 206.0, d/s FL = 205.0	
Outflow Structure	**Proposed Pump Discharge**	Duplex pump station w/ 1170 GPM (2.6 cfs) pumps; only one pump in operation	
Outflow Structure	**Emergency Overflow - Trapezoidal Weir**	10' BW, 10:1 slopes, Crest El. = 213.0'	
	Drainage Time - 1% only (hours)	34 hrs (to release 80% of peak 100yr vol)	

Watershed Analysis

An additional analysis was performed for the watershed draining to the Lake Creek tributary downstream of Garwood Road. Drainage areas were delineated for existing and proposed conditions, and hydrographs created using the Small Watershed Method. An unsteady state 1D HEC-RAS model was created to compare existing and proposed water surface elevations for the 25- and 100-year storm events.

The table below compares the peak flow rates for each drainage area, which were then input to HEC-RAS.

Comparison of Existing and Proposed Development Peak Flows

25-YEAR EXISTING VS. PROPOSED Q SUMMARY			
Drainage Area Name	Existing (allowable) Q (cfs)	Proposed Q (cfs)	Difference (Prop - Exist)
LC Trib DS Gar	10.5	10.5	0.0
LC Trib US Gar	46.0	46.0	0.0
LC Trib A	39.3	39.3	0.0
LC Trib A1	45.3	0.9	-44.3
LC Trib B	10.6	1.5	-9.2
LC Trib B1	32.1	28.0	-4.1
Jr High School	44.1	188.2	*

100-YEAR EXISTING VS. PROPOSED Q SUMMARY			
Drainage Area Name	Existing (allowable) Q (cfs)	Proposed Q (cfs)	Difference (Prop - Exist)
LC Trib DS Gar	14.9	14.9	0.0
LC Trib US Gar	67.4	67.4	0.0
LC Trib A	55.5	55.5	0.0
LC Trib A1	63.8	1.3	-62.5
LC Trib B	15.1	2.1	-13.0
LC Trib B1	47.0	41.0	-6.1
Jr High School	62.8	265.3	*

**Note: The "allowable Q" represents existing conditions runoff from portion of "LC Trib A1" within the Jr High School site. The "proposed Q" represents peak inflow rate to the Jr High School detention basin. See the Detention Summary Table for proposed discharge rate from the detention basin.*

The tables below compare the existing and proposed peak water surface elevations in the Lake Creek tributary system downstream of the project site, for 25- and 100-year storm events:

25-YEAR PEAK FLOW AND WSEL COMPARISON FOR LAKE CREEK TRIBUTARY WATERSHED

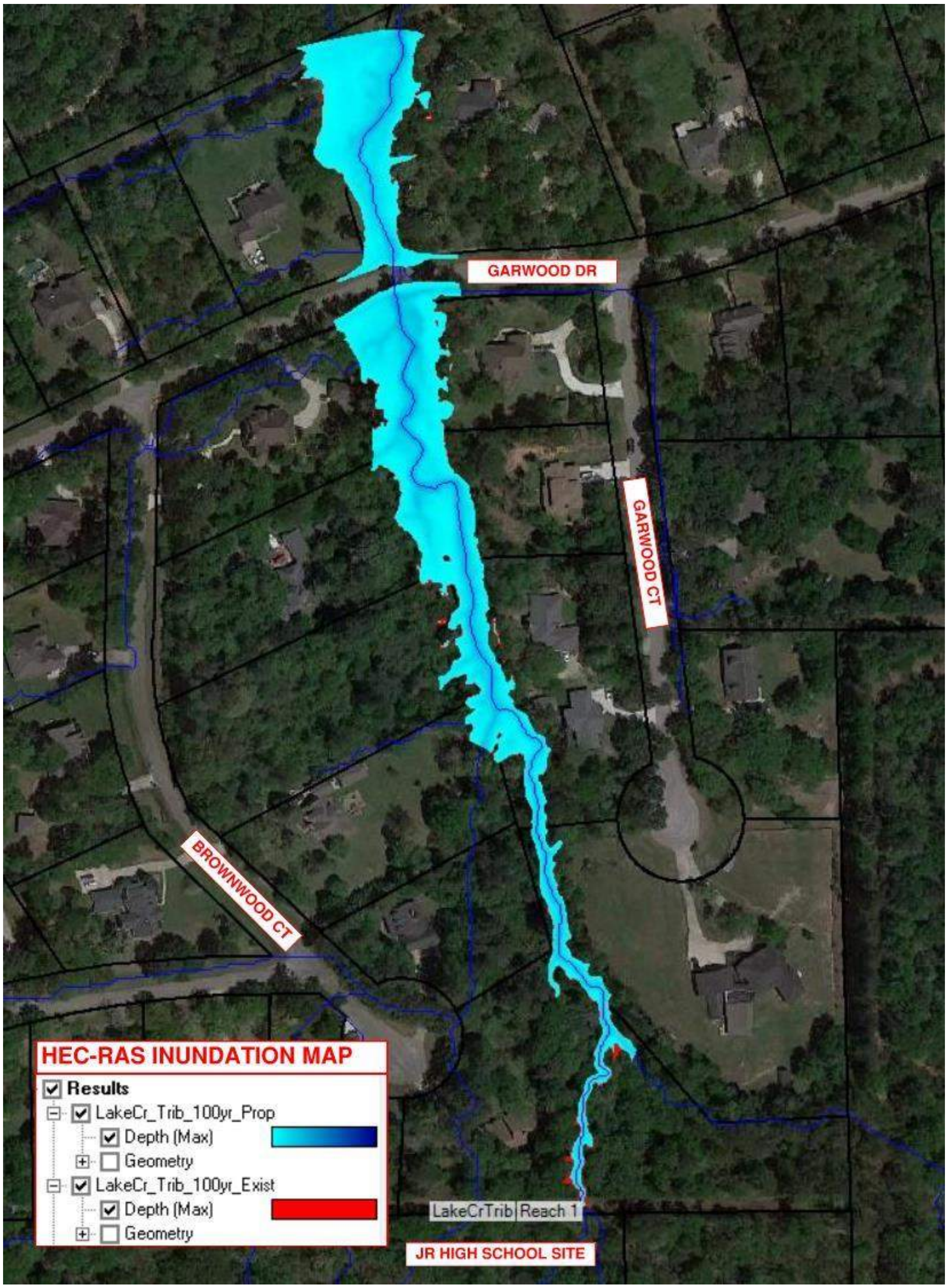
	Peak Flow (cfs)			Max WSEL (ft)		
River Station	Existing	Proposed	Diff. (Prop - Exist)	Existing	Proposed	Diff. (Prop - Exist)
1855	45.2	36.0	-9.2	206.98	206.80	-0.18
1800	45.0	35.9	-9.1	206.14	205.96	-0.18
1716	45.2	36.5	-8.7	204.36	204.20	-0.16
1609	44.9	34.9	-9.9	202.30	202.16	-0.14
1495	77.0	72.4	-4.5	201.31	201.24	-0.07
1351	77.0	72.4	-4.5	200.62	200.54	-0.08
1222	76.3	72.3	-4.0	199.62	199.59	-0.03
1046	76.4	72.3	-4.1	198.84	198.83	-0.01
946	110.4	109.4	-1.0	198.61	198.61	0.00
825	121.2	120.7	-0.5	198.19	198.19	0.00
654	131.3	131.3	-0.1	197.57	197.57	0.00
516	142.0	142.1	0.1	197.23	197.23	0.00
412	142.0	142.1	0.1	197.11	197.11	0.00
400	Garwood Dr Culvert			Garwood Dr Culvert		
345	142.0	142.1	0.1	194.73	194.73	0.00
275	142.0	142.1	0.1	194.29	194.29	0.00
151	150.0	147.9	-2.1	193.79	193.78	-0.01
5	150.0	147.9	-2.1	193.55	193.54	-0.01

100-YEAR PEAK FLOW AND WSEL COMPARISON FOR LAKE CREEK TRIBUTARY WATERSHED

	Peak Flow (cfs)			Max WSEL (ft)		
River Station	Existing	Proposed	Diff. (Prop - Exist)	Existing	Proposed	Diff. (Prop - Exist)
1855	63.7	38.6	-25.1	207.27	206.86	-0.41
1800	63.7	38.4	-25.3	206.48	206.04	-0.44
1716	63.6	39.6	-24.1	204.64	204.24	-0.40
1609	62.8	38.3	-24.5	202.70	202.40	-0.30
1495	108.7	93.3	-15.4	201.73	201.54	-0.19
1351	108.7	93.3	-15.4	200.95	200.78	-0.17
1222	107.6	93.0	-14.6	200.00	199.90	-0.10
1046	97.6	91.9	-5.7	199.34	199.26	-0.08
946	161.9	149.0	-12.9	199.11	199.04	-0.07
825	177.7	166.7	-11.1	198.64	198.58	-0.06
654	192.5	183.2	-9.3	197.95	197.90	-0.05
516	208.3	200.0	-8.3	197.53	197.49	-0.04
412	208.3	200.0	-8.3	197.36	197.33	-0.03
400	Garwood Dr Culvert			Garwood Dr Culvert		
345	208.3	200.0	-8.3	195.16	195.11	-0.05
275	208.1	200.0	-8.2	194.70	194.65	-0.05
151	220.2	209.2	-10.9	194.16	194.11	-0.05
5	220.1	209.2	-10.9	193.91	193.86	-0.05

The comparisons demonstrate that there are no increased WSEL's downstream of the project, and therefore no adverse hydraulic impacts as a result of the proposed project.

A plot of the extents of the 100-year flood inundation areas also shows no structural flooding in existing or proposed conditions.



CONCLUSION

Odyssey Engineering Group performed a drainage impact analysis of the proposed development of approximately 31.75-acre Junior High School for Magnolia ISD. The EPA-SWMM results demonstrate that runoff from the proposed development (with the proposed detention basin) will not exceed the existing allowable peak discharges into the receiving streams downstream of the project. The proposed detention storage results show benefits in terms of reduced peak flows into the receiving streams. The watershed HEC-RAS analysis demonstrates that the proposed Junior High School development will not adversely impact the existing water surface elevations of the watershed. Based on these results, the proposed project will not cause any adverse impacts to receiving streams for storm events up to and including the 100-year (Atlas 14) storm.

DRAINAGE IMPACT ANALYSIS FOR PROPOSED MAGNOLIA ISD JUNIOR HIGH SCHOOL MONTGOMERY COUNTY, TEXAS

SECTION 1 - INTRODUCTION

1.1 Project Name and Purpose

The proposed Montgomery County ISD Junior High School development is located east of the City of Magnolia within unincorporated Montgomery County, Texas. The proposed development is located on approximately 31.75 acres of undeveloped land.

The purpose of this Drainage Impact Analysis is to quantify the impacts of the proposed development and to identify the improvements necessary to mitigate these impacts through determining the volume and configuration of detention storage required for the proposed development.

1.2 Project Limits

The approximate 31.75-acre project is generally located north of Farm to Market Road 1488, and east of Country Forest Drive. The Country Forest West subdivision is located to the north and west of the project site, and an existing industrial site is located to the east of the project. A vicinity map with the project boundary is included as **Exhibit 1**.

1.3 Project Objectives

The objective of this study is to demonstrate that the proposed detention storage and outfall meets the requirements to mitigate the impacts of increased impervious cover on the proposed site from existing conditions. The calculations utilize the Montgomery County Engineering Department's NOAA Atlas 14 rainfall data. The proposed detention basin outfall is designed so that the proposed discharge into the receiving streams will not exceed the existing (allowable) discharge, for storm events up to and including the 100-year storm.

1.4 Assumptions and Constraints

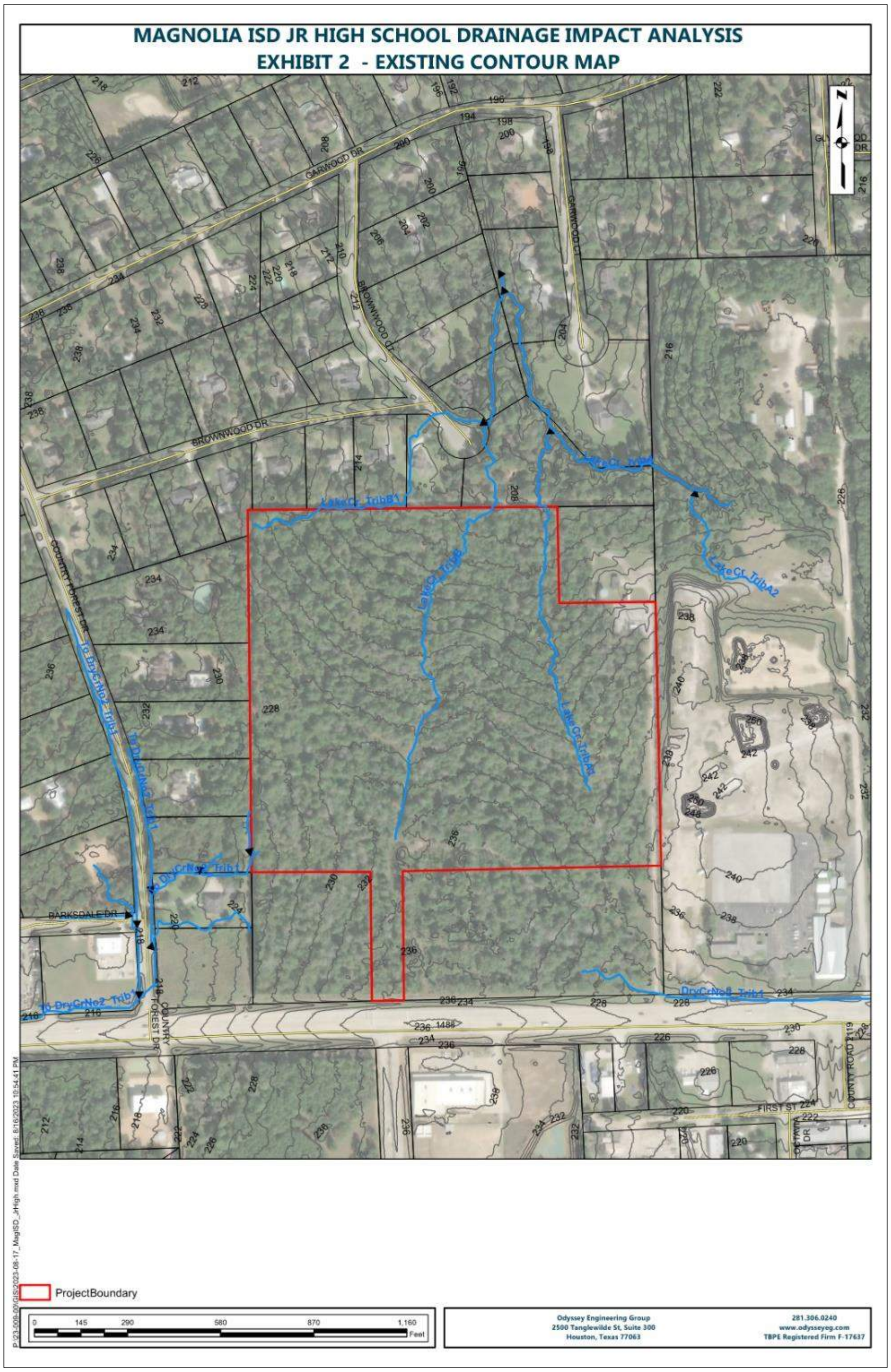
This report generally refers to storm events in terms of Annual Exceedance Probability (AEP), or the likelihood of a storm rainfall, flow rate or runoff volume being exceeded each year. An example of this is the 1PCT AEP storm event, which is estimated to have a 1% chance of being exceeded each year. There are instances where this report may refer to a storm event in terms of Annual Recurrence Interval (ARI), the return period, or the average number of years between years containing one or more events exceeding the specified AEP. While AEP is the preferred method of expressing probability of exceedance, for this report the AEP and ARI are assumed to be equivalent. The table below shows equivalent expressions of AEP and ARI used in this report:

Annual Exceedance Probability (AEP)	**Annual Recurrence Interval (ARI)**
4PCT	25-year
1PCT	100-year

SECTION 2 – EXISTING CONDITIONS

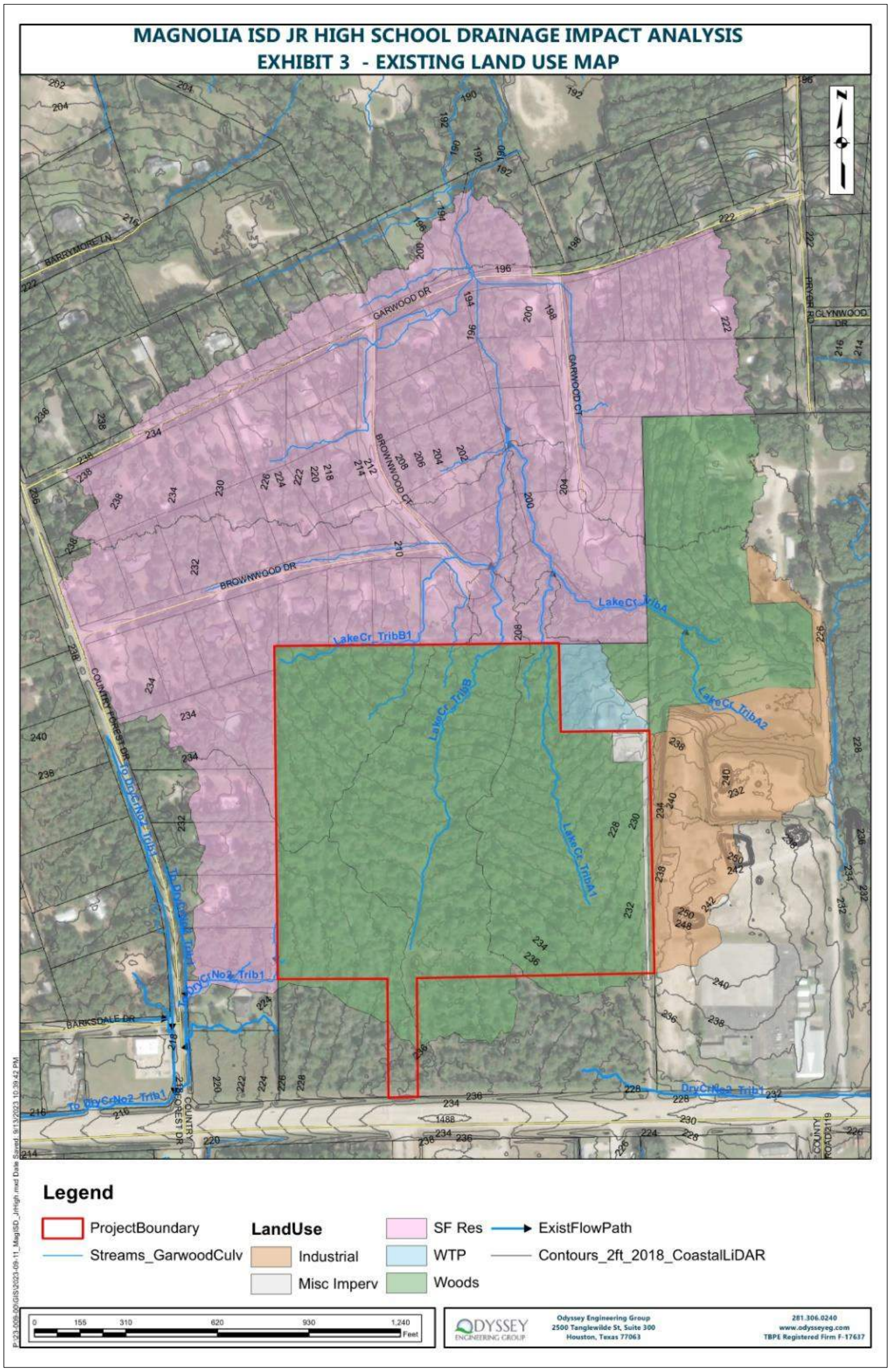
2.1 Topography

This report utilizes the 2018 Coastal Region Digital Elevation Model (DEM) data, obtained from the United States Geological Survey. Elevations in this report are referenced to the North American Vertical Datum (NAVD) of 1988, and all GIS shape files are in the NAD 83 Texas State Plane Central Zone horizontal coordinate system. A contour map is included as **Exhibit 2**.



2.2 Existing Land Use

In existing conditions, all of the site is undeveloped with existing tree and grass vegetation. However, there are contributing offsite drainage areas including existing single family residential, an existing water treatment plant to the northeast of the site, a portion of the existing industrial site east of the project, and an existing driveway serving the water treatment plant and an existing cell tower site. An existing land use map is included as **Exhibit 3**.

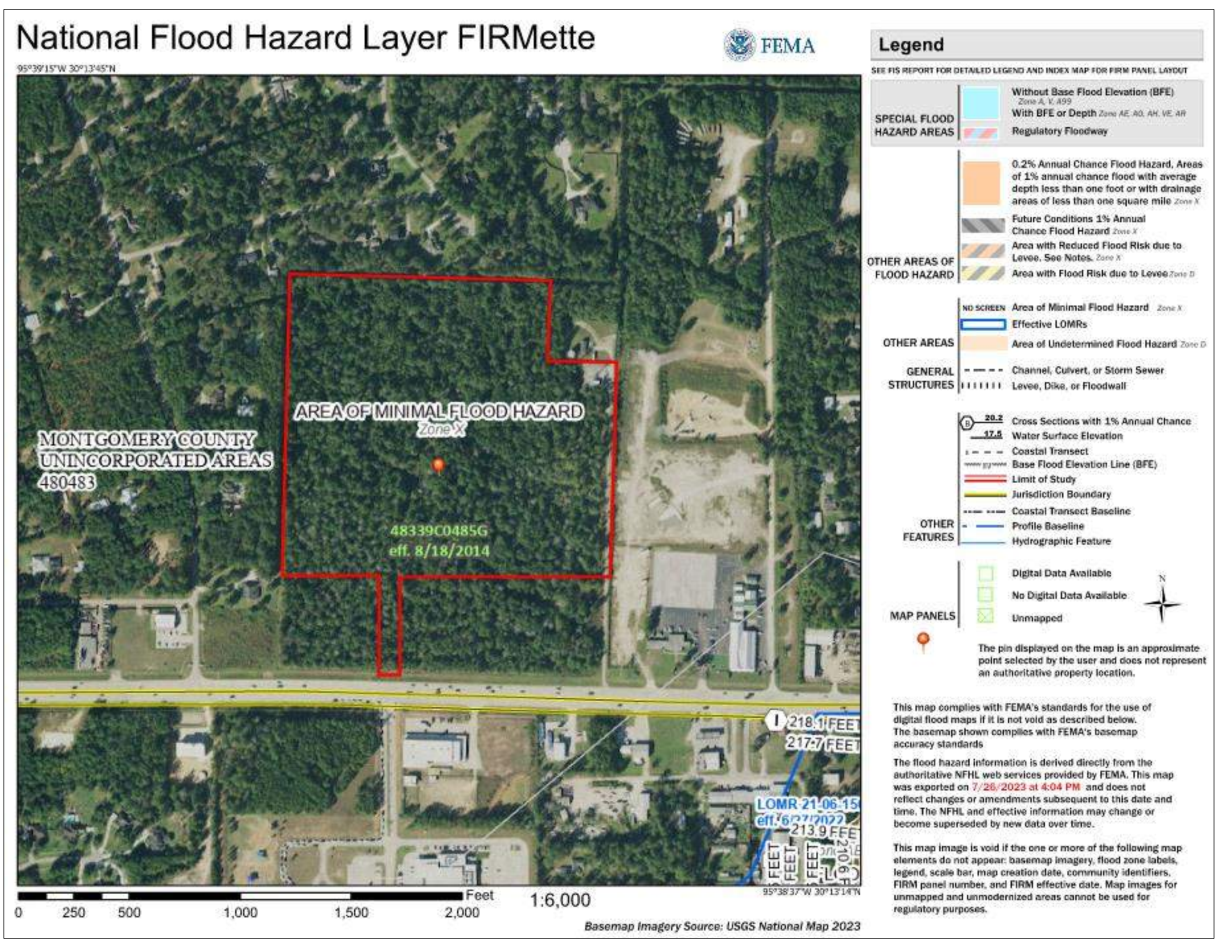


2.3 Watershed and Drainage Facilities

In existing conditions, most of the project site lies within the Lake Creek watershed and drains north to several unnamed tributaries of Lake Creek. For the purposes of this report, these tributaries are referred to as Lake Creek Tributary A1, Lake Creek Tributary B and Lake Creek Tributary B1. The southwest corner of the project site drains west to Dry Creek No. 2 Tributary No. 1. For proposed conditions, the site runoff drains through the proposed detention pond and outfalls to Lake Creek Tributary A1.

2.4 FEMA Effective Floodplain

The project area is located on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panel numbers 48339C0485G (effective 08/18/2014). Based on the effective maps, the project area is not located within the 0.1% annual change (100-year) or 0.2% annual chance (500-year) floodplain. The FEMA flood zones are depicted below and included as **Exhibit 4**.



SECTION 3 – HYDROLOGIC AND HYDRAULIC METHODOLOGY

3.1 Analysis Objective and Methodology

The objective of this analysis is to demonstrate that the proposed development will not cause any adverse impacts to existing flood hazard conditions in the watershed for storm events up to and including the Atlas 14 100-year storm event. This objective is proven with a detention routing modeling that demonstrates that the proposed detention basin has sufficient storage to offset the developed site runoff while releasing reduced discharges to the receiving streams.

The Small Watershed Hydrograph Method was used to calculate pre- and post-development inflow hydrographs into the existing and proposed detention basin. The Small Watershed Method uses a drainage area's peak flows (based on the Rational Method), and total runoff volume (using direct runoff depths and impervious cover) to generate runoff hydrographs. The pre- and post-development hydrographs were generated for input into the EPA-SWMM model.

The table below summarizes the Atlas 14 total rainfall depths for Montgomery County and is provided in the July 2019 Atlas 14 update to the Drainage Criteria Manual for Montgomery County. These rainfall depths were modeled in HEC-HMS version 4.3 software to determine specified direct runoff depths for various impervious covers. The rainfall depths and direct runoff depths were used to calculate the Small Watershed Method runoff hydrographs for the 25-year (4% annual exceedance probability) and 100-year (1% annual exceedance probability) storm events.

Duration	Rainfall Frequency					
	2-year	5-year	10-year	25-year	50-year	100-year
5-minute	0.57	0.70	0.82	0.98	1.10	1.23
10-minute	0.90	1.12	1.31	1.56	1.76	1.96
15-minute	1.14	1.41	1.64	1.95	2.19	2.43
30-minute	1.62	2.00	2.31	2.74	3.06	3.39
60-minute	2.14	2.67	3.11	3.71	4.16	4.64
2-hour	2.69	3.44	4.11	5.09	5.88	6.76
3-hour	3.02	3.94	4.79	6.06	7.14	8.36
6-hour	3.60	4.79	5.94	7.72	9.28	11.10
12-hour	4.19	5.62	7.04	9.26	11.30	13.60
24-hour	4.80	6.48	8.17	10.80	13.30	16.10

Source: NOAA Atlas 14, Vol 11, Version 2, Conroe Location, Sep. 2018

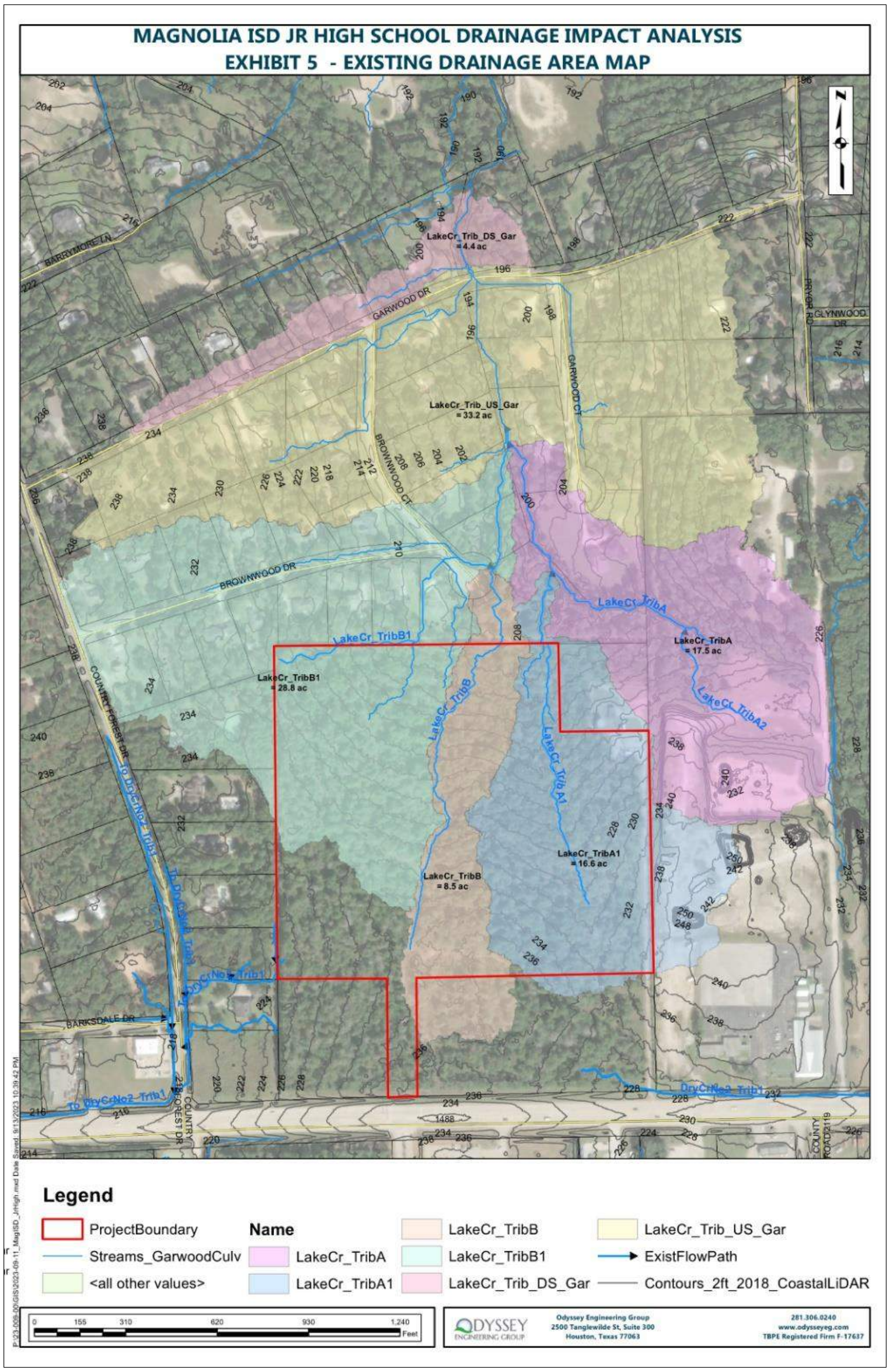
EPA-SWMM software was used to analyze the proposed detention basin for the development conditions of the project area. A system of nodes and links representing the detention basin, outfall pipe, pump station, tailwater conditions, and overflow weir was set up for project conditions. Hydrographs for the applicable post-development drainage sub-areas were input to the appropriate nodes and were routed through the proposed detention systems. The proposed overflow weir is above the proposed 100-year detention WSEL and does not impact the detention basin routing.

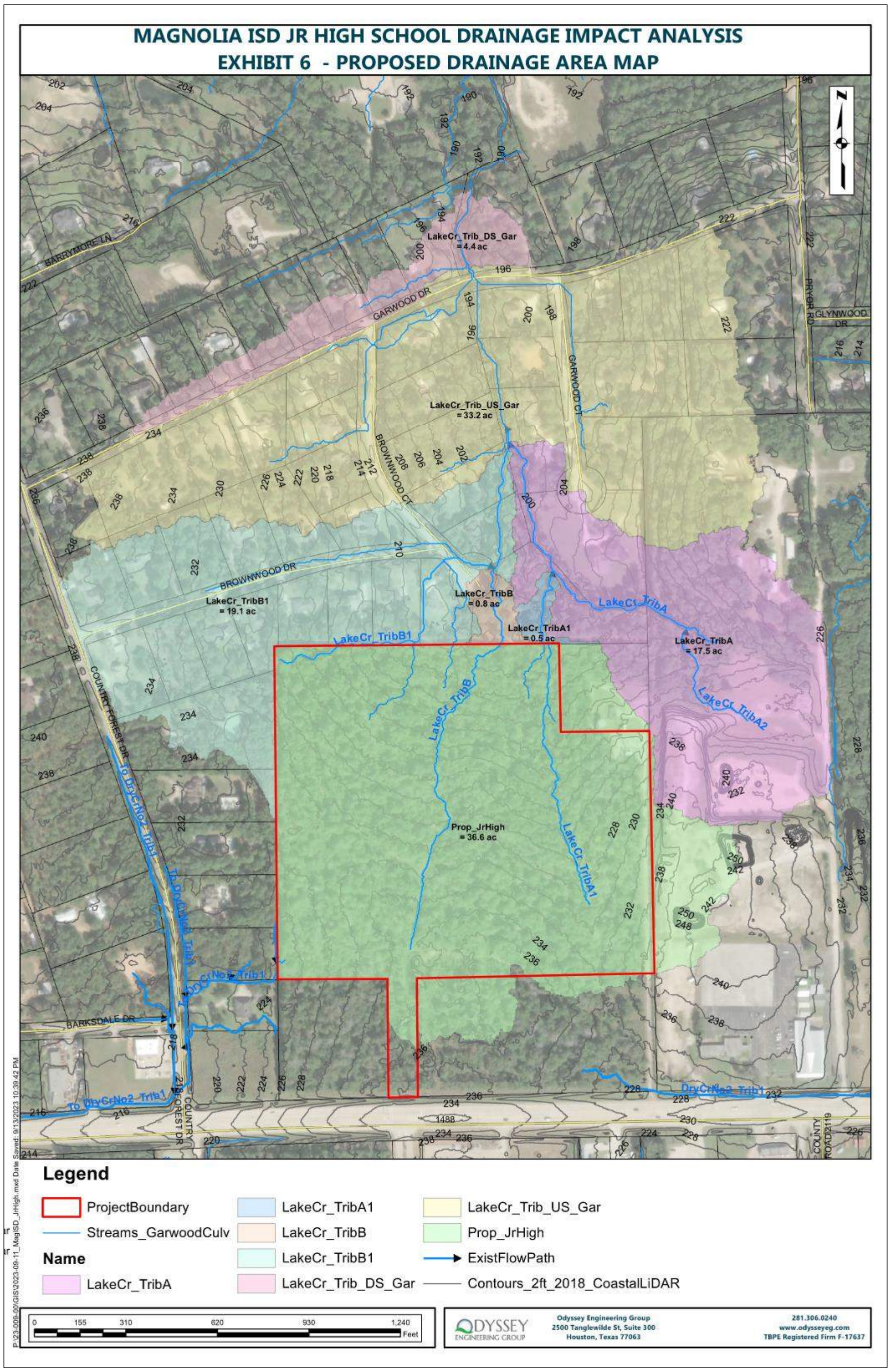
3.2 Drainage Sub-Area Delineation

The existing drainage areas were determined based on the existing contours and available information on existing drainage infrastructure. In existing conditions, the eastern portion of the site drains to Lake Creek Tributary A1. The central portion of the site drains to Lake Creek Tributary B. The northwest area of the site to Lake Creek Tributary B1, with the southwestern section of the site draining to Dry Creek No. 2 Tributary 1.

In proposed conditions, the school site and contributing offsite areas will be drained via underground storm sewer and surface swales to the proposed on-site detention basin. The detention basin will outfall to Lake Creek Tributary A1. Offsite drainage areas remain unchanged outside of the project boundary.

Exhibits 5 and 6 are the Existing and Proposed Conditions Drainage Area Maps with delineation of the watersheds.



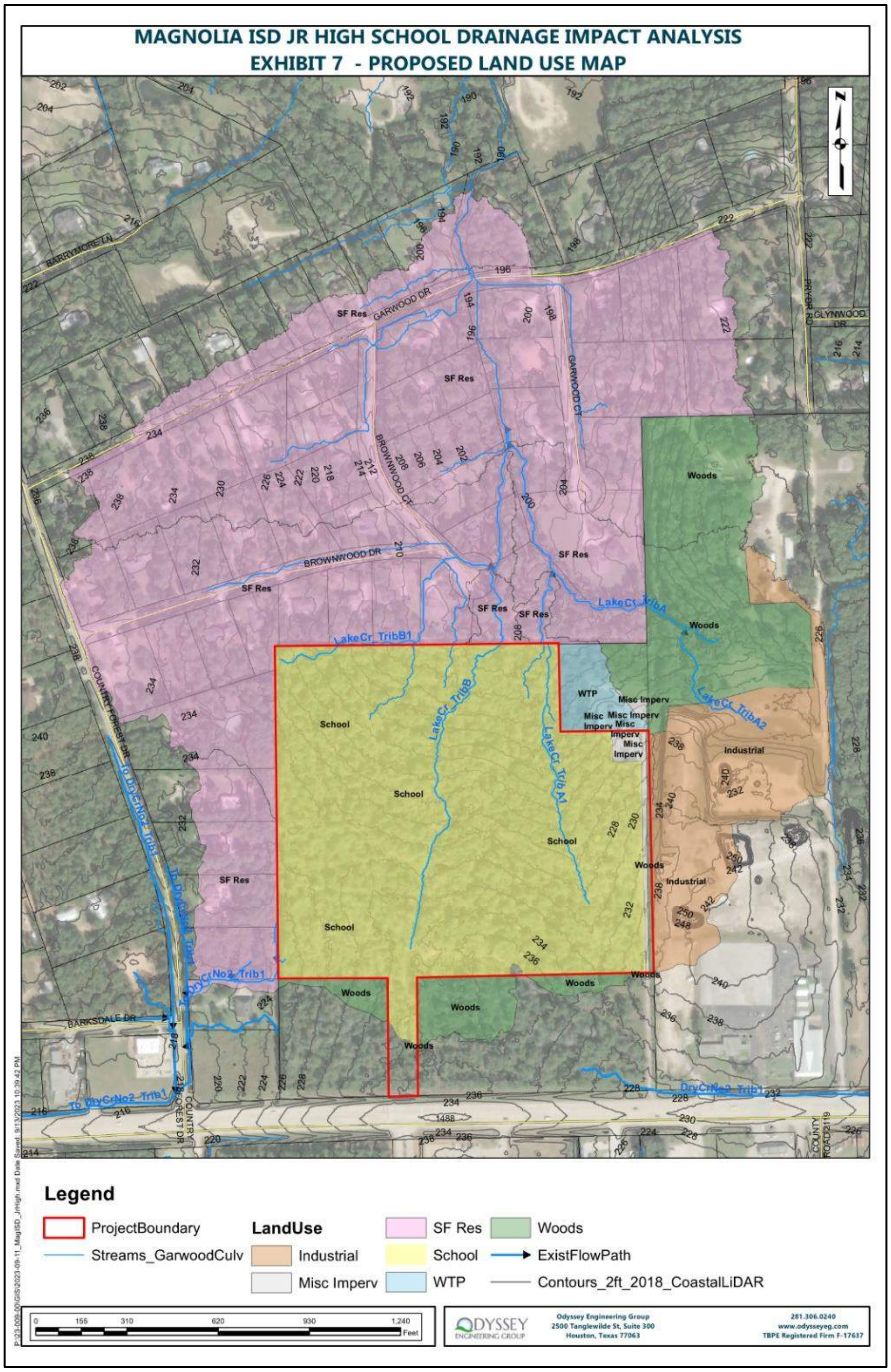


3.3 Land Use and Impervious Cover

Impervious cover values were based on pre-development conditions of the project area determined from current aerial photography. Impervious cover values for post-development conditions account for proposed land uses based on the current land plan. The following table shows the Impervious Cover values used in the analysis. For detention basin, the area inside the high banks is calculated to be 100% impervious.

Land Use	Imp. Cover (%)
Woods	0%
Single Family Residential (> 0.5 ac lots)	25%
WTP Site	11%
Misc. Imperv. (driveway and cell tower site)	100%
School and Detention Basin	67%

A proposed land use map is included as **Exhibit 7**.



3.4 Soil Type

Soil information for the project site drainage areas was obtained from the United States Department of Agriculture Natural Resources Conservation Service (NRCS) website. The curve number was calculated from the provided information in the soils report and applied to calculating the losses using the NRCS (SCS) infiltration loss method. Over 80% of the project site consists of Conroe Loamy Fine Sand (CoC). The remainder consist of Conroe Gravelly Loamy Fine Sand (CnC), Splendora Fine Sandy Loam (SpIB), and Conroe Soils (Ss). The Conroe Loamy Fine Sand (CoC) Conroe Loamy Fine Sand and Conroe Gravelly Loamy Fine Sand (CnC) are classified in the Hydrologic Soil Group B. The Splendora Fine Sandy Loam and Conroe Soils (Ss) are classified in the Hydrologic Soil Group D. The soil analysis report for the project site is in **Appendix A** of this report.

3.5 Rational Method

The Rational Method was used to calculate the peak discharge of the subject tract for existing and proposed conditions. The Rational Method incorporates drainage area, land use (runoff coefficients), time of concentration, and rainfall intensity to determine the peak discharge at a designated design point.

The peak discharge for each condition was determined for both drainage areas, LC Trib A1 and LC Trib B. The Tc is defined as the time required for all portions of the watershed to contribute runoff at the computation point. The Tc was calculated by identifying the longest flow path within the watershed and estimating the time required for runoff to travel the entire length of this path. Flow velocities for overland sheet flow and some concentrated flow conditions were estimated per Montgomery County criteria. The Tc was calculated based on a velocity-based travel time for the longest flow paths of the drainage area. The Tc equations for sheet flow, shallow concentrated flow, and storm sewer derived from the Montgomery County Drainage Criteria Manual were used to calculate total Tc.

The rainfall intensity was based on the time of concentration for each drainage area. The rainfall intensity was referenced from the Montgomery County IDF Curves, Figure 2.1. Intensities were obtained for the 25-yr and 100-yr storm.

Calculations were completed in Excel Worksheet. The methods for calculating the variables of the Rational Method were referenced from the Montgomery County drainage criteria. Mapping and calculations for the drainage areas and the longest flow paths were completed in ArcGIS 10.8. Calculations for time of concentration, Tc, for existing and proposed conditions are provided below.

Existing Tc

Drainage Area	Area (ac)	Sheet Flow				Shallow Concentrated Flow					Open Channel Flow				Tc, Total (hr)	Tc, Total (min)
		Manning's n	Flow Length (ft)	Slope (ft/ft)	Tc (hrs)	Flow Length (ft)	Slope (%)	Paved/ Unpaved	Flow Velocity	Tc (hrs)	Flow Length (ft)	Slope (%)	Flow Velocity	Tc (hrs)		
LC Trib DS Gar	4.4	0.40	76	0.05260	0.21	1264	0.03244	u	2.91	0.12	318	0.00943	1.37	0.06	0.39	23.6
LC Trib US Gar	33.2	0.40	167	0.01197	0.71	1838	0.02449	u	2.52	0.20	0	0.00000	-----------	0.00	0.91	54.6
LC Trib A	17.5	0.40	150	0.05321	0.36	835	0.02875	u	2.74	0.08	1128	0.01153	1.59	0.20	0.64	38.4
LC Trib A1	16.6	0.011	158	0.00951	0.04	1393	0.02225	u	2.41	0.16	298	0.01677	1.92	0.04	0.25	14.7
LC Trib B	8.5	0.40	151	0.01328	0.63	1938	0.01857	u	2.20	0.24	0	0.00000	-----------	0.00	0.87	52.2
LC Trib B1	28.8	0.40	150	0.01334	0.62	1546	0.02394	u	2.50	0.17	478	0.00628	1.24	0.11	0.90	54.1

Proposed Tc

Drainage Area	Area (ac)	Sheet Flow				Shallow Concentrated Flow					Shallow Concentrated Flow				Tc, Total (hr)	Tc, Total (min)
		Manning's n	Flow Length (ft)	Slope (%)	Tc (hrs)	Flow Length (ft)	Slope (%)	Paved/ Unpaved	Flow Velocity	Tc (hrs)	Flow Length (ft)	Slope (%)	Flow Velocity	Tc (hrs)		
LC Trib DS Gar	4.4	0.400	76	0.05260	0.21	1263.73999	0.03244	u	2.91	0.12	318	0.00943	1.37	0.06	0.39	23.6
LC Trib US Gar	33.2	0.400	150	0.01197	0.71	1837.55005	0.02449	u	2.52	0.20	0	0.00000	-----------	0.00	0.91	54.6
LC Trib A	17.5	0.400	150	0.05321	0.36	834.843994	0.02875	u	2.74	0.08	1128	0.01153	1.59	0.20	0.64	38.4
LC Trib A1	0.5	0.400	198	0.02024	0.66	0	0.00000	u	0.00	0.00	298	0.01677	2.03	0.04	0.70	41.9
LC Trib B	0.8	0.40	116	0.00859	0.60	321	0.02800	u	2.70	0.03	0	0.00000	-----------	0.00	0.64	38.2
LC Trib B1	36.6	0.40	150	0.01334	0.62	1550	0.02387	u	2.49	0.17	478	0.00628	1.24	0.11	0.90	54.1

Time of concentration for sheet flow was calculated with the following equation:

$$T_t = \frac{0.007(nxL)^{0.8}}{\sqrt{P_2}\,x\,S^{0.4}}$$

Manning's roughness coefficient

Overland flow distance, L

2-year, 24-hour rainfall depth, P_2 = 2.8 in

Land slope, S

Time of concentration for shallow concentrated flow was calculated with the following equations:

$$T = \frac{D_F}{60V} \quad \text{and} \quad V = 20.3282\sqrt{S}\,(paved)$$

Flow distance, D_F

Flow velocity, V

Overland slope, S

Existing and proposed flows for the 25-year and 100-year storm events are provided below.

Existing 25- and 100-Year Peak Flows

Peak Flows - 25-Yr Storm Event - EXISTING														
				Runoff Coefficient, c							Existing		
Drainage Area Name	Drainage Area (acres)	Tc (min)	I (in/hr)	Woods (ac) c = 0.18 0% IC	SF Res (ac) (>0.5 ac) c = 0.35 25% IC	WTP Site (ac) c = 0.27 11% IC	Industrial (ac) c = 0.75 90% IC	Misc Imperv (ac) c = 0.85 100% IC	School (ac) c = 0.6 67% IC	Freq. Factor Cf	Weighted c	Imperv. Cover (%)	Q (cfs)
LC Trib DS Gar	4.4	23.6	6.2	0.00	4.42	0.00	0.00	0.00	0.00	1.10	0.35	25%	10.5
LC Trib US Gar	33.2	54.6	3.8	3.67	29.55	0.00	0.00	0.00	0.00		0.33	22%	46.0
LC Trib A	17.5	38.4	4.8	6.51	4.82	0.00	6.13	0.08	0.00		0.43	39%	39.3
LC Trib A1	16.6	14.7	7.9	11.28	0.53	1.41	2.93	0.49	0.00		0.31	21%	45.3
LC Trib B	8.5	52.2	4.0	11.87	0.80	0.00	0.00	0.00	0.00		0.28	2%	10.6
LC Trib B1	28.8	54.1	3.8	5.49	19.11	0.00	0.00	0.00	0.00		0.27	17%	32.1
LC Trib A1 (allowable)	16.1	11.7	8.7	11.27	0.00	1.41	2.93	0.49	0.00		0.29	20%	44.1

Peak Flows - 100-Yr Storm Event - EXISTING													
				Runoff Coefficient, c							Existing		
Drainage Area Name	Drainage Area (acres)	Tc (min)	I (in/hr)	Woods (ac) c = 0.18 0% IC	SF Res (ac) (>0.5 ac) c = 0.35 25% IC	WTP Site (ac) c = 0.27 11% IC	Industrial (ac) c = 0.75 90% IC	Misc Imperv (ac) c = 0.85 100% IC	School (ac) c = 0.6 67% IC	Freq. Factor Cf	Weighted c	Imperv. Cover (%)	Q (cfs)
LC Trib DS Gar	4.4	23.6	7.7	0.00	4.42	0.00	0.00	0.00	0.00	1.25	0.35	25%	14.9
LC Trib US Gar	33.2	54.6	4.9	3.67	29.55	0.00	0.00	0.00	0.00		0.33	22%	67.4
LC Trib A	17.5	38.4	5.9	6.51	4.82	0.00	6.13	0.08	0.00		0.43	39%	55.5
LC Trib A1	16.6	14.7	9.8	11.28	0.53	1.41	2.93	0.49	0.00		0.31	21%	63.8
LC Trib B	8.5	52.2	5.0	11.87	0.80	0.00	0.00	0.00	0.00		0.28	2%	15.1
LC Trib B1	28.8	54.1	4.9	5.49	19.11	0.00	0.00	0.00	0.00		0.27	17%	47.0
LC Trib A1 (allowable)	16.1	11.7	10.9	11.27	0.00	1.41	2.93	0.49	0.00		0.29	20%	62.8

Proposed 25- and 100-Year Peak Flows

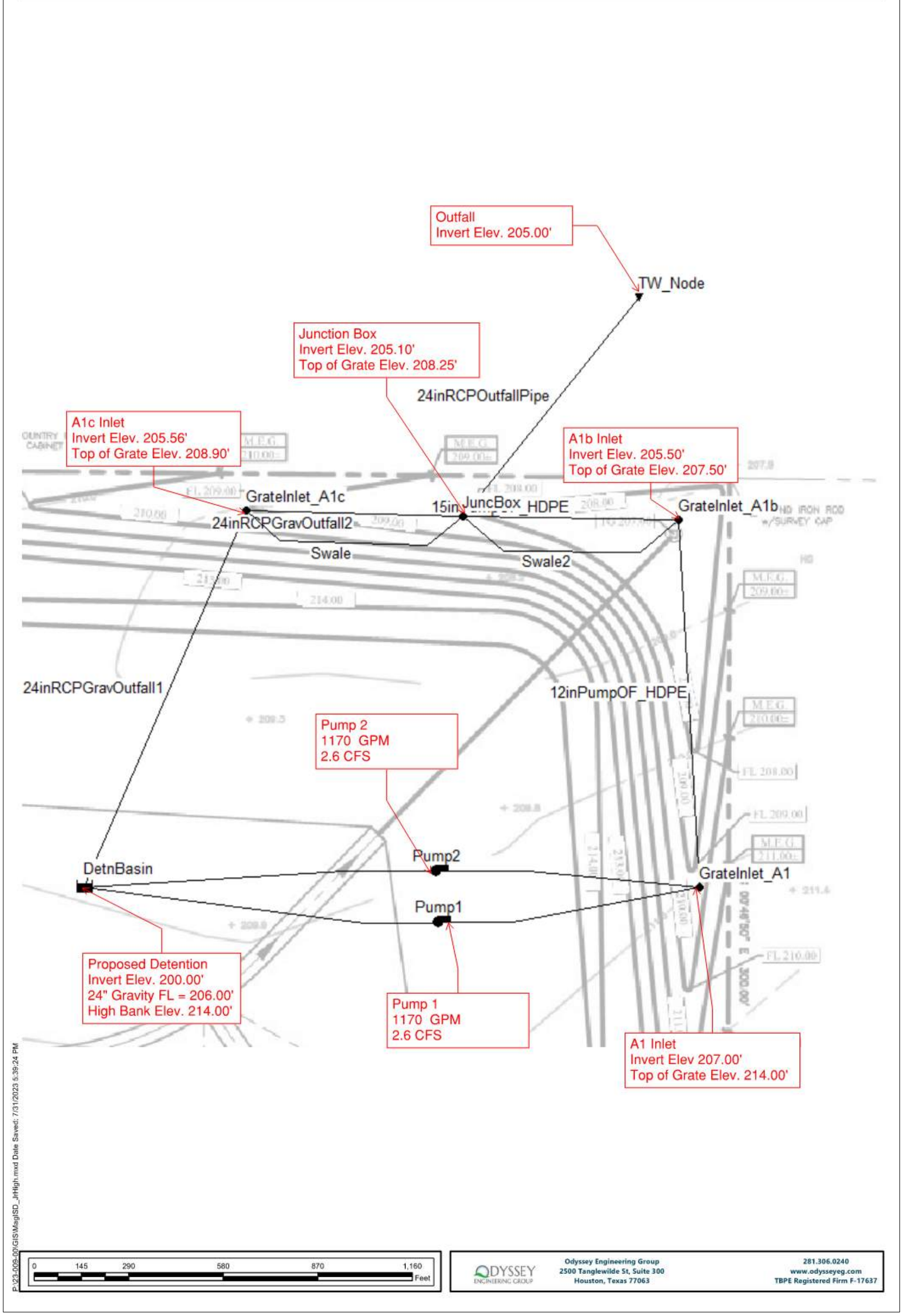
Peak Flows - 25-Yr Storm Event - PROPOSED													
				Runoff Coefficient, c							Proposed		
Drainage Area Name	Drainage Area (acres)	Tc (min)	I (in/hr)	Woods (ac) c = 0.18 0% IC	SF Res (ac) (>0.5 ac) c = 0.35 25% IC	WTP Site (ac) c = 0.27 11% IC	Industrial (ac) c = 0.75 90% IC	Misc Imperv (ac) c = 0.85 100% IC	School (ac) c = 0.6 67% IC	Freq. Factor Cf	Weighted c	Imperv. Cover (%)	Q (cfs)
LC Trib DS Gar	4.4	23.6	6.2	0.00	4.42	0.00	0.00	0.00	0.00	1.10	0.35	25%	10.5
LC Trib US Gar	33.2	54.6	3.8	3.67	29.55	0.00	0.00	0.00	0.00		0.33	22%	46.0
LC Trib A	17.5	38.4	4.8	6.51	4.82	0.00	6.13	0.08	0.00		0.43	39%	39.3
LC Trib A1	0.5	41.9	4.6	0.00	0.53	0.00	0.00	0.00	0.00		0.35	25%	0.9
LC Trib B	0.8	38.2	4.8	0.00	0.80	0.00	0.00	0.00	0.00		0.35	25%	1.5
LC Trib B1	19.1	54.1	3.8	0.00	19.11	0.00	0.00	0.00	0.00		0.35	25%	28.0
Jr High School	36.6	14.7	7.9	0.00	0.00	1.41	2.93	0.49	31.80		0.59	67%	188.2

Peak Flows - 100-Yr Storm Event - PROPOSED													
				Runoff Coefficient, c & Impervious Cover %							Proposed		
Drainage Area Name	Drainage Area (acres)	Tc (min)	I (in/hr)	Woods (ac) c = 0.18 0% IC	SF Res (ac) (>0.5 ac) c = 0.35 25% IC	WTP Site (ac) c = 0.27 11% IC	Industrial (ac) c = 0.75 90% IC	Misc Imperv (ac) c = 0.85 100% IC	School (ac) c = 0.6 67% IC	Freq. Factor Cf	Weighted c	Imperv. Cover (%)	Q (cfs)
LC Trib DS Gar	4.4	23.6	7.7	0.00	4.42	0.00	0.00	0.00	0.00	1.25	0.35	25%	14.9
LC Trib US Gar	33.2	54.6	4.9	3.67	29.55	0.00	0.00	0.00	0.00		0.33	22%	67.4
LC Trib A	17.5	38.4	5.9	6.51	4.82	0.00	6.13	0.08	0.00		0.43	39%	55.5
LC Trib A1	0.5	41.9	5.6	0.00	0.53	0.00	0.00	0.00	0.00		0.35	25%	1.3
LC Trib B	0.8	38.2	5.9	0.00	0.80	0.00	0.00	0.00	0.00		0.35	25%	2.1
LC Trib B1	19.1	54.1	4.9	0.00	19.11	0.00	0.00	0.00	0.00		0.35	25%	41.0
Jr High School	36.6	14.7	9.8	0.00	0.00	1.41	2.93	0.49	31.80		0.59	67%	265.3

3.6 EPA-SWMM Modeling

EPA-SWMM software was used to analyze the proposed detention systems for the development conditions of the project area. A system of nodes and links representing detention basins, outfall pipe, junction boxes, pump station, and tailwater conditions was set up for project conditions. Hydrographs for the applicable post-development drainage sub-areas were input to the appropriate nodes and were routed through the proposed detention systems. The detention outfall produces a system that does not increase peak discharges at the detention, while also maintaining acceptable peak water surface elevations within the development during the 1PCT and 4PCT Atlas-14 storm events. The EPA-SWMM schematic layout for the proposed detention and outfall is provided as **Exhibit 8**.

MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 8 - EPA-SWMM MODEL LAYOUT



SECTION 4 – PROPOSED DRAINAGE PLAN

4.1 Detention Basin Configuration

The proposed detention basin is proposed to be designed in general conformance with Montgomery County Drainage Criteria Manual. The proposed detention basin is designed to drain to existing Lake Creek Tributary A1 through a proposed 24-inch RCP outfall. The detention basins will be grass-lined, with side slopes 4:1 (H:V) or flatter, or as recommended by geotechnical consultant.

The outfall from the detention basin is a 24-inch RCP to convey the 100-yr storm. The detention basins mitigate peak flows for the 4PCT and 1PCT AEP Atlas 14 24-hour storm events. The detention basin is designed as a dry detention basin with a high bank elevation of 214′. The outfall culvert from the detention basin consists of 121 LF of proposed 24″ RCP. The detention basin will be a combination of gravity flow at 206′ and pumped for the remaining water under 206′. The proposed pump discharge will be a duplex pump system with 1170 GMP (2.6 cfs) pumps. However, the pumps will only operate one at time, and the pump station will be designed to shut off when the gravity outfall is engaged. The detention pond layout and profiles obtained from the construction plans titled "Magnolia Junior High School No. 3" prepared by S&G Engineering Consultants, LLC are included as **Exhibit 8 and Exhibit 9**.

It should be noted that the detention basin configuration is subject to change based on future land plan revisions. The design assumptions described here are preliminary, and design configurations are subject to change pending final design by the project's civil design engineer. The required detention storage will remain unchanged if the general assumptions in this report (such as maximum water surface elevation, and proportion of land uses) remain unchanged.

4.2 Critical Water Surface Elevations

The Design WSEL for the detention basins are set to allow a minimum of one foot of freeboard below the proposed minimum high bank elevation of the basin. The Maximum Allowable WSEL is based on the proposed site fill elevation. The table below summarizes the High Bank, Design

WSEL, Calculated 1PCT WSEL, Freeboard and Maximum Allowable WSEL.

High Bank Elev.	Design WSEL (1PCT Stm)	Calculated WSEL (1PCT Stm)	Calculated Freeboard	Max Allowable WSEL (high bank)	Prop FF Elev. Of School
214.0	212.8	212.8	1.2	214.0	230.0

4.3 Emergency Overflow Structures

The emergency overflow weir was sized as a 10-foot-long spillway, with spillway crest at elevation 213.0′. The emergency overflow weir was modeled in EPA-SWMM by routing the proposed 100-year developed inflow hydrograph through the pond, assuming that the gravity outfall is blocked, and the pumps are inoperable (i.e., the only discharge is over the overflow weir). The EPA-SWMM model confirmed that the proposed emergency overflow structure is sufficient to pass the 100-year overflows without overtopping the detention basin high bank elevation.

4.4 Stormwater Quality Requirements

Stormwater Quality design is beyond the scope of this analysis. Design and construction of future improvements must comply with Montgomery County Stormwater Quality regulations.

4.5 Geotechnical Requirements

Specific geotechnical requirements for the proposed detention improvements are beyond the scope of this analysis. The proposed improvements should be coordinated with geotechnical consultants to confirm that the proposed facilities will comply with Montgomery County criteria, and that appropriate analysis and engineering design is performed.

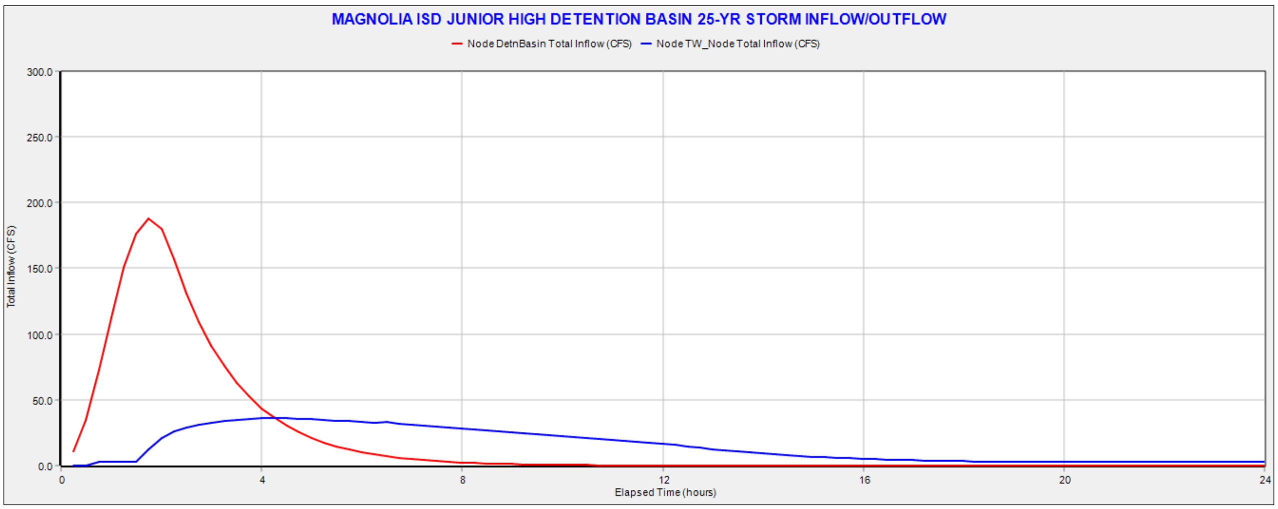
4.6 Environmental Requirements

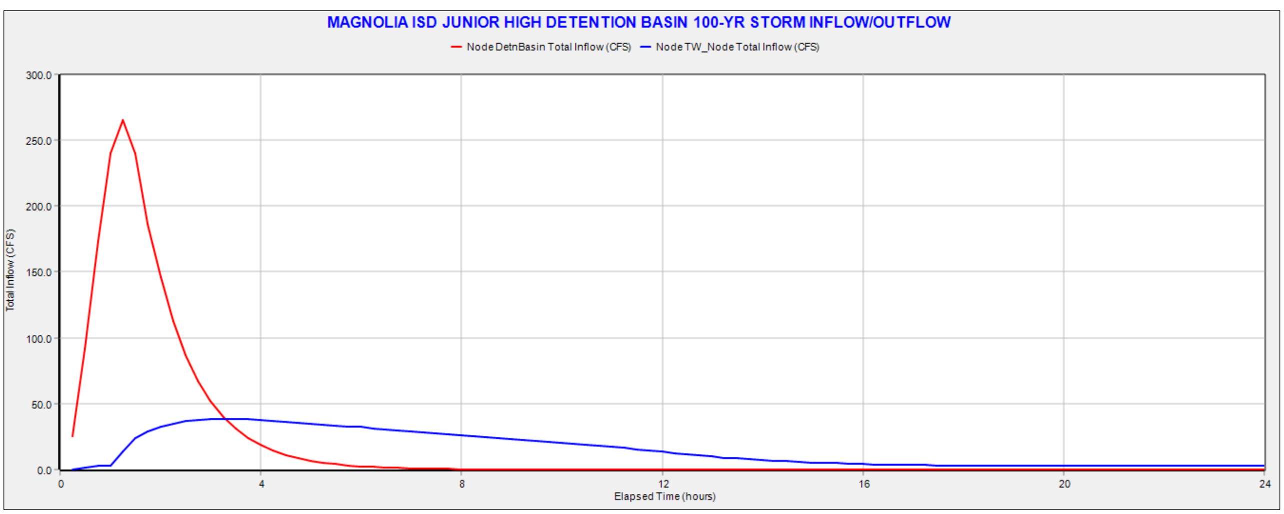
Specific environmental requirements are beyond the scope of this analysis. The proposed detention improvements should be coordinated with environmental consultants to ensure compliance with appropriate environmental rules, regulations and permits.

SECTION 5 – HYDROLOGIC AND HYDRAULIC ANALYSIS RESULTS

5.1 EPA-SWMM Model Results

The post-development results include runoff from the proposed development routed through the proposed detention pond (in EPA-SWMM). The full EPA-SWMM results are included as **Appendix B.** The schematic layout for the EPA-SWMM model is shown in **Exhibit 7**, and plots of the development Inflow-Outflow hydrographs are shown below.





5.2 Detention Summary Table

The detention summary table for the proposed detention pond is presented in the table on the following page. The results demonstrate that the proposed project does not exceed allowable discharge rates, and that peak water surface elevations in the detention basin provide at least 1 foot of freeboard in the 100-year storm event.

	Project Name: Magnolia ISD Junior High		9/11/2023
	Detention Basin Service Area (developed ac)	31.8	acres
	Detention Basin Offsite Drainage Area	4.8	acres
	Storm Event	**4% (25-yr)**	**1% (100-yr)**
FLOWS	**Detention Basin Peak Post-development Inflow (cfs)**	188.2	265.3
	Maximum Allowable Outflow (pre-development - cfs)	44.1	62.8
	Maximum Outflow Provided (post-development - cfs)	36.0	38.6
DETN BASIN (1988 NAVD, 2001 adj.)	**Detention Basin Min. High Bank Elev**	214.0	
	Water Surface Elevation Calculated	212.3	212.8
	Detention Storage Provided (ac-ft)	27.8	29.7
	Storage Rate Provided (ac-ft/ac)	0.876	0.935
Outflow Structure	**Proposed Gravity Outfall Structure**	121 LF 24" RCP; u/s FL = 206.0, d/s FL = 205.0	
	Proposed Pump Discharge	Duplex pump station w/ 1170 GPM (2.6 cfs) pumps; only one pump in operation	
	Emergency Overflow - Trapezoidal Weir	10' BW, 10:1 slopes, Crest El. = 213.0'	
	Drainage Time - 1% only (hours)	34 hrs (to release 80% of peak 100yr vol)	

5.3 HEC-RAS Watershed Analysis

An additional analysis was performed for the watershed draining to the Lake Creek tributary downstream of Garwood Road. Drainage areas were delineated for existing and proposed conditions, and hydrographs created using the Small Watershed Method. An unsteady state 1D HEC-RAS model (version 6.3.1) was created to compare existing and proposed water surface elevations for the 25- and 100-year storm events.

The table below compares the peak flow rates for each drainage area, which were then input to HEC-RAS.

Comparison of Existing and Proposed Development Peak Flows

25-YEAR EXISTING VS. PROPOSED Q SUMMARY			
Drainage Area Name	Existing (allowable) Q (cfs)	Proposed Q (cfs)	Difference (Prop - Exist)
LC Trib DS Gar	10.5	10.5	0.0
LC Trib US Gar	46.0	46.0	0.0
LC Trib A	39.3	39.3	0.0
LC Trib A1	45.3	0.9	-44.3
LC Trib B	10.6	1.5	-9.2
LC Trib B1	32.1	28.0	-4.1
Jr High School	44.1	188.2	*

100-YEAR EXISTING VS. PROPOSED Q SUMMARY			
Drainage Area Name	Existing (allowable) Q (cfs)	Proposed Q (cfs)	Difference (Prop - Exist)
LC Trib DS Gar	14.9	14.9	0.0
LC Trib US Gar	67.4	67.4	0.0
LC Trib A	55.5	55.5	0.0
LC Trib A1	63.8	1.3	-62.5
LC Trib B	15.1	2.1	-13.0
LC Trib B1	47.0	41.0	-6.1
Jr High School	62.8	265.3	*

**Note: The "allowable Q" represents existing conditions runoff from portion of "LC Trib A1" within the Jr High School site. The "proposed Q" represents peak inflow rate to the Jr High School detention basin. See the Detention Summary Table for proposed discharge rate from the detention basin.*

The tables below compare the existing and proposed peak water surface elevations in the Lake Creek tributary system downstream of the project site, for 25- and 100-year storm events:

25-YEAR PEAK FLOW AND WSEL COMPARISON FOR LAKE CREEK TRIBUTARY WATERSHED

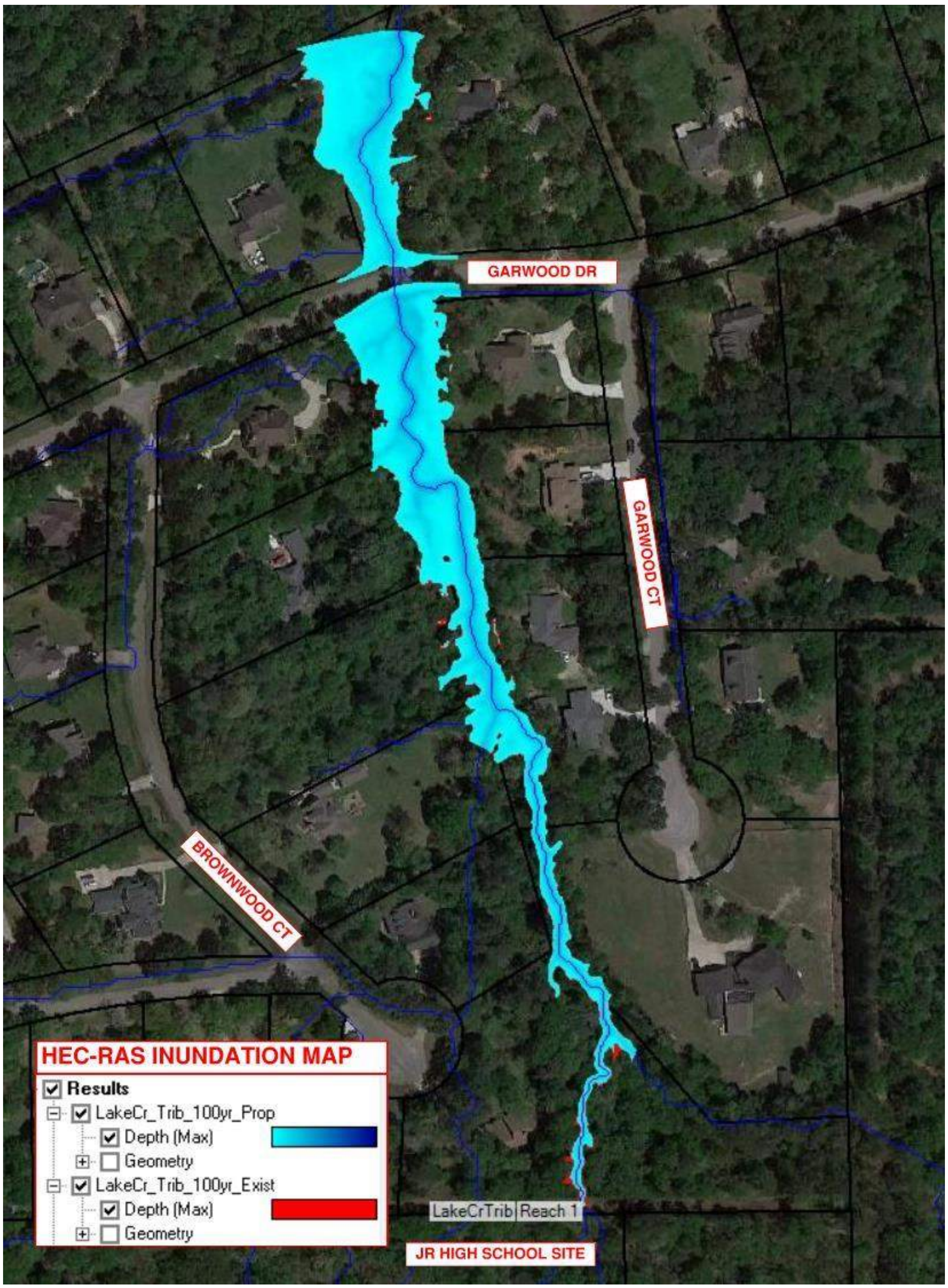
	Peak Flow (cfs)			Max WSEL (ft)		
River Station	Existing	Proposed	Diff. (Prop - Exist)	Existing	Proposed	Diff. (Prop - Exist)
1855	45.2	36.0	-9.2	206.98	206.80	-0.18
1800	45.0	35.9	-9.1	206.14	205.96	-0.18
1716	45.2	36.5	-8.7	204.36	204.20	-0.16
1609	44.9	34.9	-9.9	202.30	202.16	-0.14
1495	77.0	72.4	-4.5	201.31	201.24	-0.07
1351	77.0	72.4	-4.5	200.62	200.54	-0.08
1222	76.3	72.3	-4.0	199.62	199.59	-0.03
1046	76.4	72.3	-4.1	198.84	198.83	-0.01
946	110.4	109.4	-1.0	198.61	198.61	0.00
825	121.2	120.7	-0.5	198.19	198.19	0.00
654	131.3	131.3	-0.1	197.57	197.57	0.00
516	142.0	142.1	0.1	197.23	197.23	0.00
412	142.0	142.1	0.1	197.11	197.11	0.00
400	Garwood Dr Culvert			Garwood Dr Culvert		
345	142.0	142.1	0.1	194.73	194.73	0.00
275	142.0	142.1	0.1	194.29	194.29	0.00
151	150.0	147.9	-2.1	193.79	193.78	-0.01
5	150.0	147.9	-2.1	193.55	193.54	-0.01

100-YEAR PEAK FLOW AND WSEL COMPARISON FOR LAKE CREEK TRIBUTARY WATERSHED

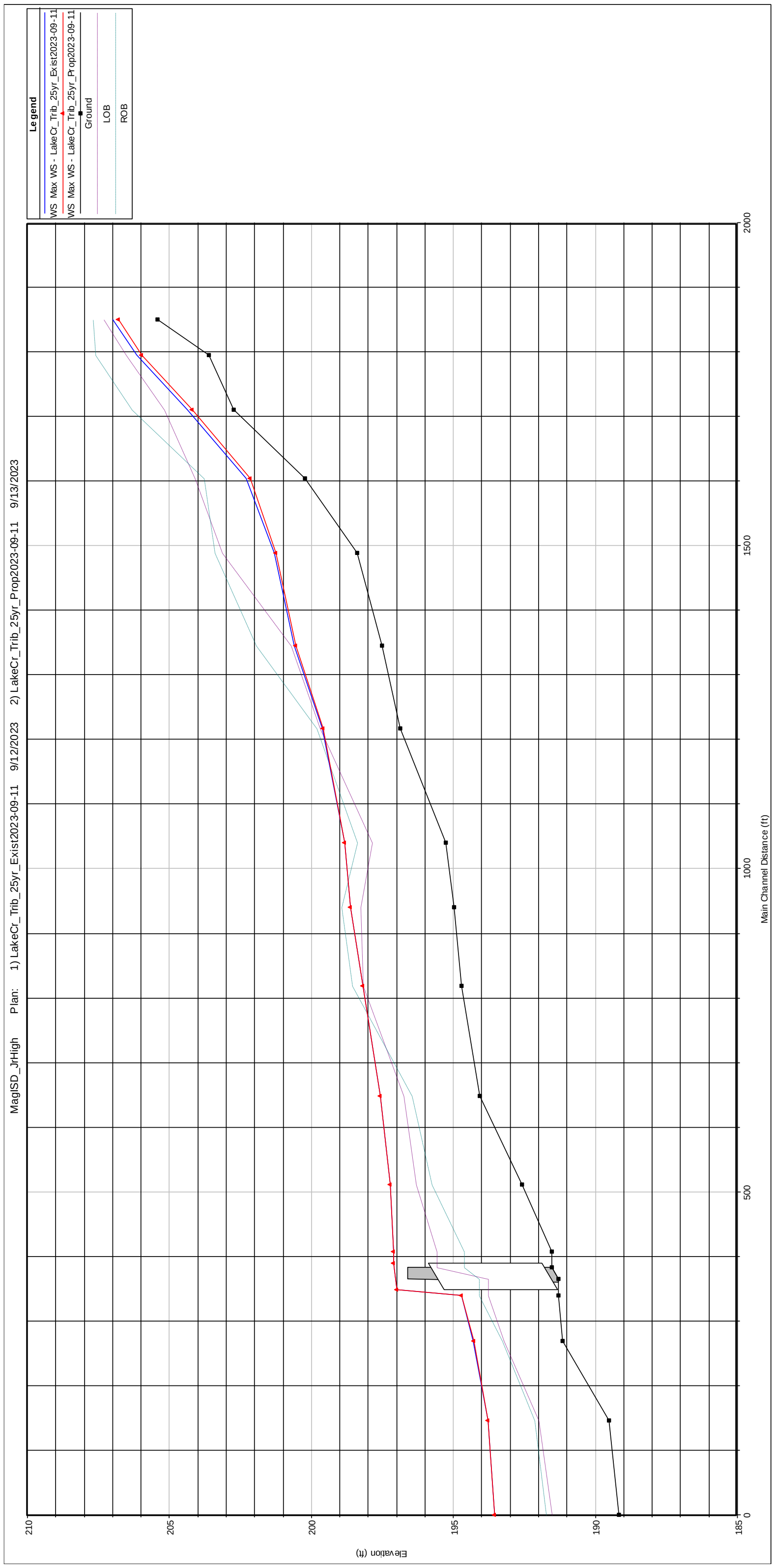
	Peak Flow (cfs)			Max WSEL (ft)		
River Station	Existing	Proposed	Diff. (Prop - Exist)	Existing	Proposed	Diff. (Prop - Exist)
1855	63.7	38.6	-25.1	207.27	206.86	-0.41
1800	63.7	38.4	-25.3	206.48	206.04	-0.44
1716	63.6	39.6	-24.1	204.64	204.24	-0.40
1609	62.8	38.3	-24.5	202.70	202.40	-0.30
1495	108.7	93.3	-15.4	201.73	201.54	-0.19
1351	108.7	93.3	-15.4	200.95	200.78	-0.17
1222	107.6	93.0	-14.6	200.00	199.90	-0.10
1046	97.6	91.9	-5.7	199.34	199.26	-0.08
946	161.9	149.0	-12.9	199.11	199.04	-0.07
825	177.7	166.7	-11.1	198.64	198.58	-0.06
654	192.5	183.2	-9.3	197.95	197.90	-0.05
516	208.3	200.0	-8.3	197.53	197.49	-0.04
412	208.3	200.0	-8.3	197.36	197.33	-0.03
400	Garwood Dr Culvert			Garwood Dr Culvert		
345	208.3	200.0	-8.3	195.16	195.11	-0.05
275	208.1	200.0	-8.2	194.70	194.65	-0.05
151	220.2	209.2	-10.9	194.16	194.11	-0.05
5	220.1	209.2	-10.9	193.91	193.86	-0.05

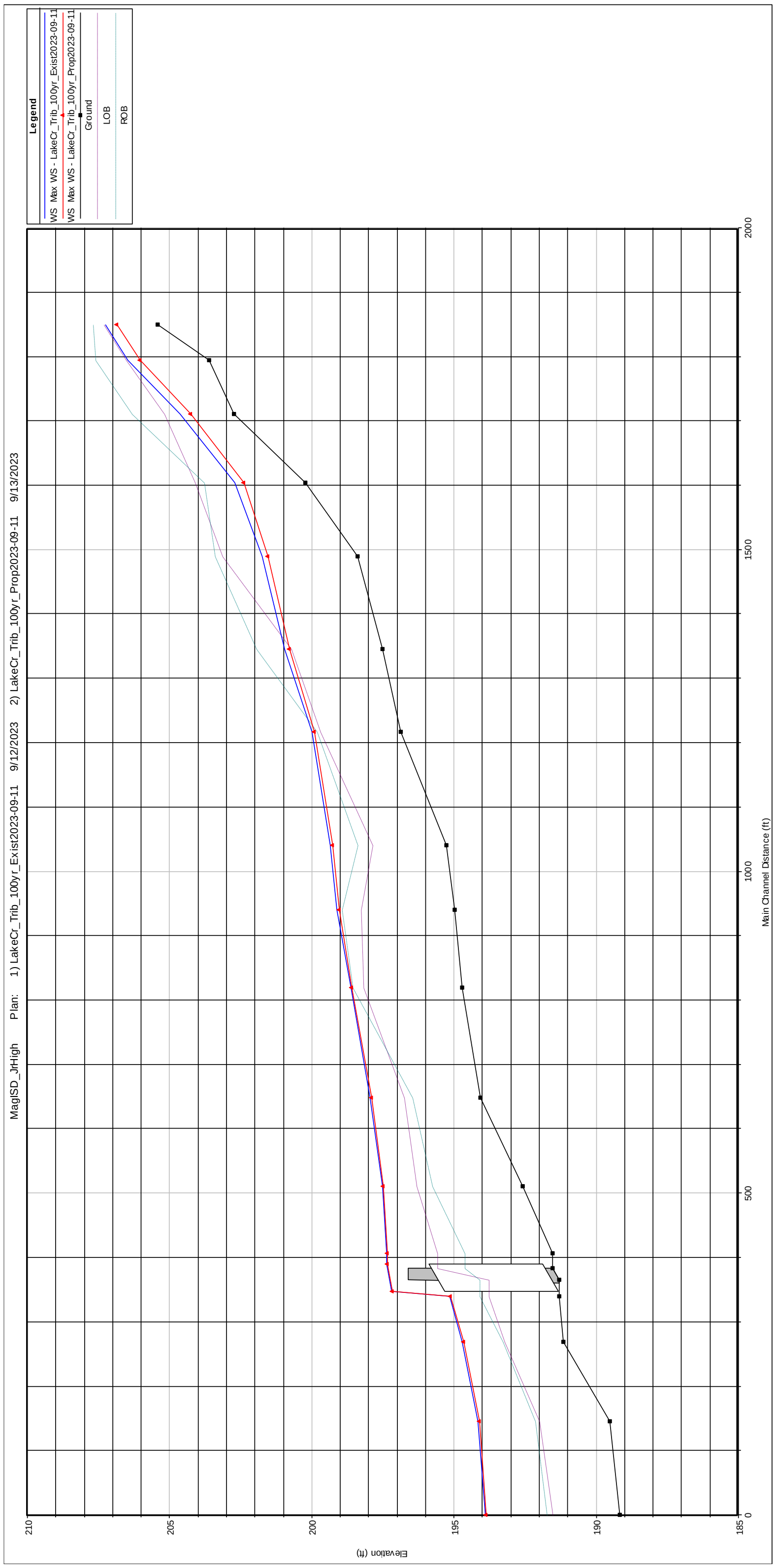
The comparisons demonstrate that there are no increased WSEL's downstream of the project, and therefore no adverse hydraulic impacts as a result of the proposed project.

A plot of the extents of the 100-year flood inundation areas also shows no structural flooding in existing or proposed conditions.



The HEC-RAS profiles below demonstrate that the proposed 25- and 100-year WSELs does not exceed the existing WSEL in the studied area, from the north boundary of the Junior High School site to a point approximately 400’ downstream of Garwood Drive.




MagISD_JrHigh Plan: 1) LakeCr_Trib_100yr_Exist2023-09-11 9/12/2023 2) LakeCr_Trib_100yr_Prop2023-09-11 9/13/2023
Legend
WS Max WS - LakeCr_Trib_100yr_Exist2023-09-11
WS Max WS - LakeCr_Trib_100yr_Prop2023-09-11
Ground
LOB
ROB
Elevation (ft)
210
205
200
195
190
185
Main Channel Distance (ft)
0
500
1000
1500
2000

SECTION 6 – CONCLUSION

Odyssey Engineering Group performed a drainage impact analysis of the proposed development of approximately 31.75-acre Junior High School for Magnolia ISD. The EPA-SWMM results demonstrate that runoff from the proposed development (with the proposed detention basin) will not exceed the existing allowable peak discharges into the receiving streams downstream of the project. The proposed detention storage results show benefits in terms of reduced peak flows into the receiving streams. The watershed HEC-RAS analysis demonstrates that the proposed Junior High School development will not adversely impact the existing water surface elevations of the watershed. Based on these results, the proposed project will not cause any adverse impacts to receiving streams for storm events up to and including the 100-year (Atlas 14) storm.

The results of this analysis are based on the design assumptions recorded in this report, and deviation from the design assumptions can result in significant changes to the results. Odyssey Engineering Group should be consulted in the event of design changes to determine the potential impact on these results. It will be the responsibility of the Civil Engineer designing future site improvements to confirm that the project conforms to this master drainage plan, and that proposed structures are elevated appropriately above the proposed 1% AEP (100-year ARI) WSEL in the detention basin.

MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 1 - VICINITY MAP

ProjectBoundary

0 145 290 580 870 1,160 Feet

Odyssey Engineering Group
2500 Tanglewilde St, Suite 300
Houston, Texas 77063

281.306.0240
www.odysseyeg.com
TBPE Registered Firm F-17637

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MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 2 - EXISTING CONTOUR MAP

ProjectBoundary

0 145 290 580 870 1,160 Feet

Odyssey Engineering Group
2500 Tanglewilde St, Suite 300
Houston, Texas 77063

281.306.0240
www.odysseyeg.com
TBPE Registered Firm F-17637

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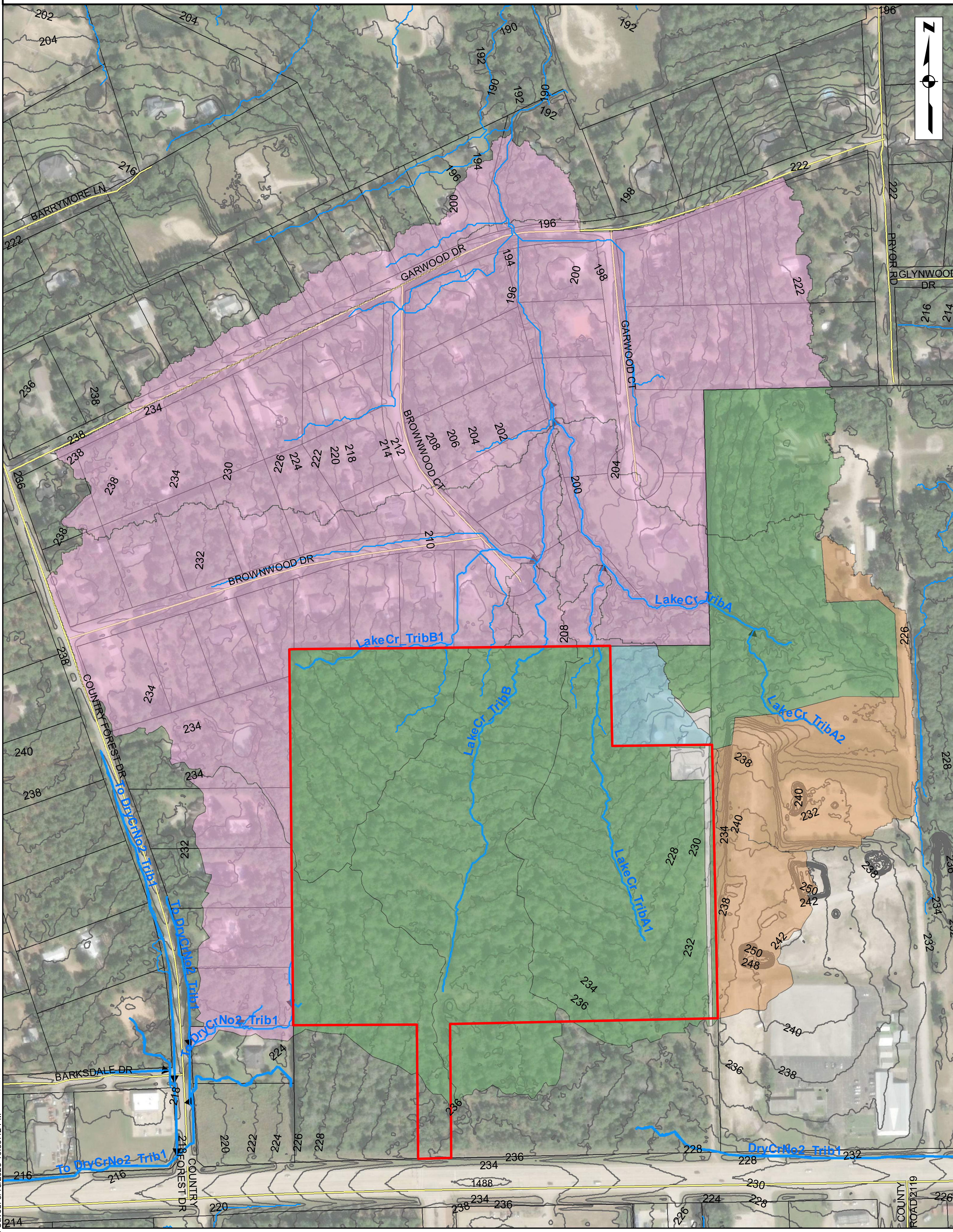
MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 3 - EXISTING LAND USE MAP



Legend

- ProjectBoundary
- Streams_GarwoodCulv
- **LandUse**
  - Industrial
  - Misc Imperv
  - SF Res
  - WTP
  - Woods
- ExistFlowPath
- Contours_2ft_2018_CoastalLiDAR

0 155 310 620 930 1,240 Feet

ODYSSEY ENGINEERING GROUP

Odyssey Engineering Group
2500 Tanglewilde St, Suite 300
Houston, Texas 77063

281.306.0240
www.odysseyeg.com
TBPE Registered Firm F-17637

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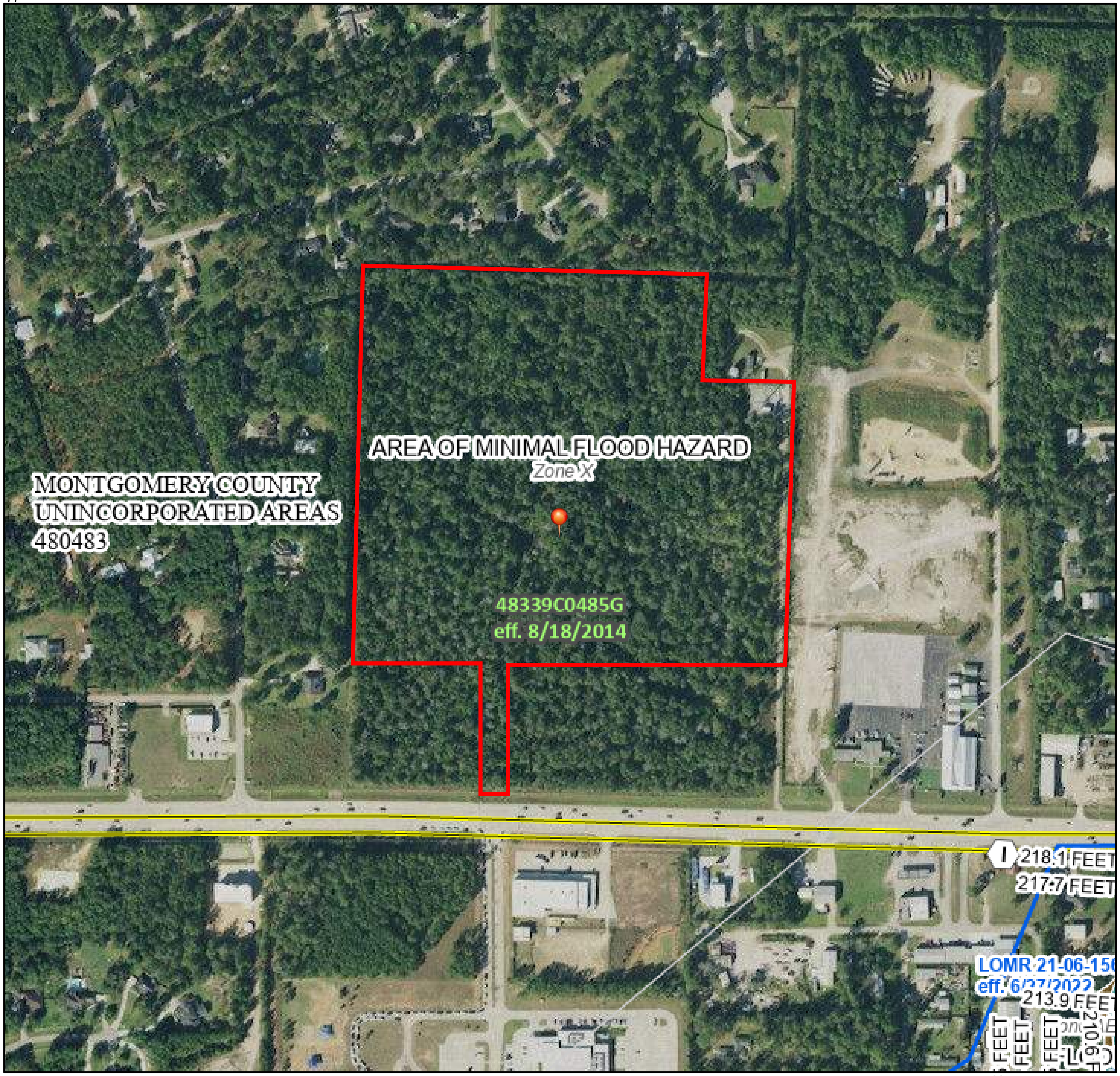

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L WK %)(RU 'HSWK =RQH $($2 $+ 9($5
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$QQXDO &KDQFH)ORRG +D]DUG $UHDV RI DQQXDO FKDQFH IORRG ZLWK DYHUDJH GHSWK OHVV WKDQ RQH IRRW RU ZLWK GUDLQDJH DUHDV RI OHVV WKDQ RQH VTXDUH PLOH =RQH ;
)XWXUH &RQGLWLRQV $QQXDO &KDQFH)ORRG +D]DUG =RQH ;
$UHD ZLWK 5HGXFHG)ORRG 5LVN GXH WR /HYHH 6HH 1RWHV =RQH ;
$UHD ZLWK)ORRG 5LVN GXH WR /HYHH =RQH '

$UHD RI 0LQLPDO)ORRG +D]DUG =RQH ;
(IIHFWLYH /20%V
$UHD RI 8QGHWHUPLQHG)ORRG +D]DUG =RQH '

&KDQQHO &XOYHUW RU 6WRUP 6HZHU
/HYHH 'LNH RU)ORRGZDOO

&URVV 6HFWLRQV ZLWK $QQXDO &KDQFH
:DWHU 6XUIDFH (OHYDWLRQ
&RDVWDO 7UDQVHFW
%DVH)ORRG (OHYDWLRQ /LQH %)(
/LPLW RI 6WXG\
-XULVGLFWLRQ %RXQGDU\
&RDVWDO 7UDQVHFW %DVHOLQH
3URILOH %DVHOLQH
+\GURJUDSKLF)HDWXUH

'LJLWDO 'DWD $YDLODEOH
1R 'LJLWDO 'DWD $YDLODEOH
8QPDSSHG

7KH SLQ GLVSOD\HG RQ WKH PDS LV DQ DSSUR[LPDWH SRLQW VHOHFWHG E\ WKH XVHU DQG GRHV QRW UHSUHVHQW DQ DXWKRULWDWLYH SURSHUW\ ORFDWLRQ

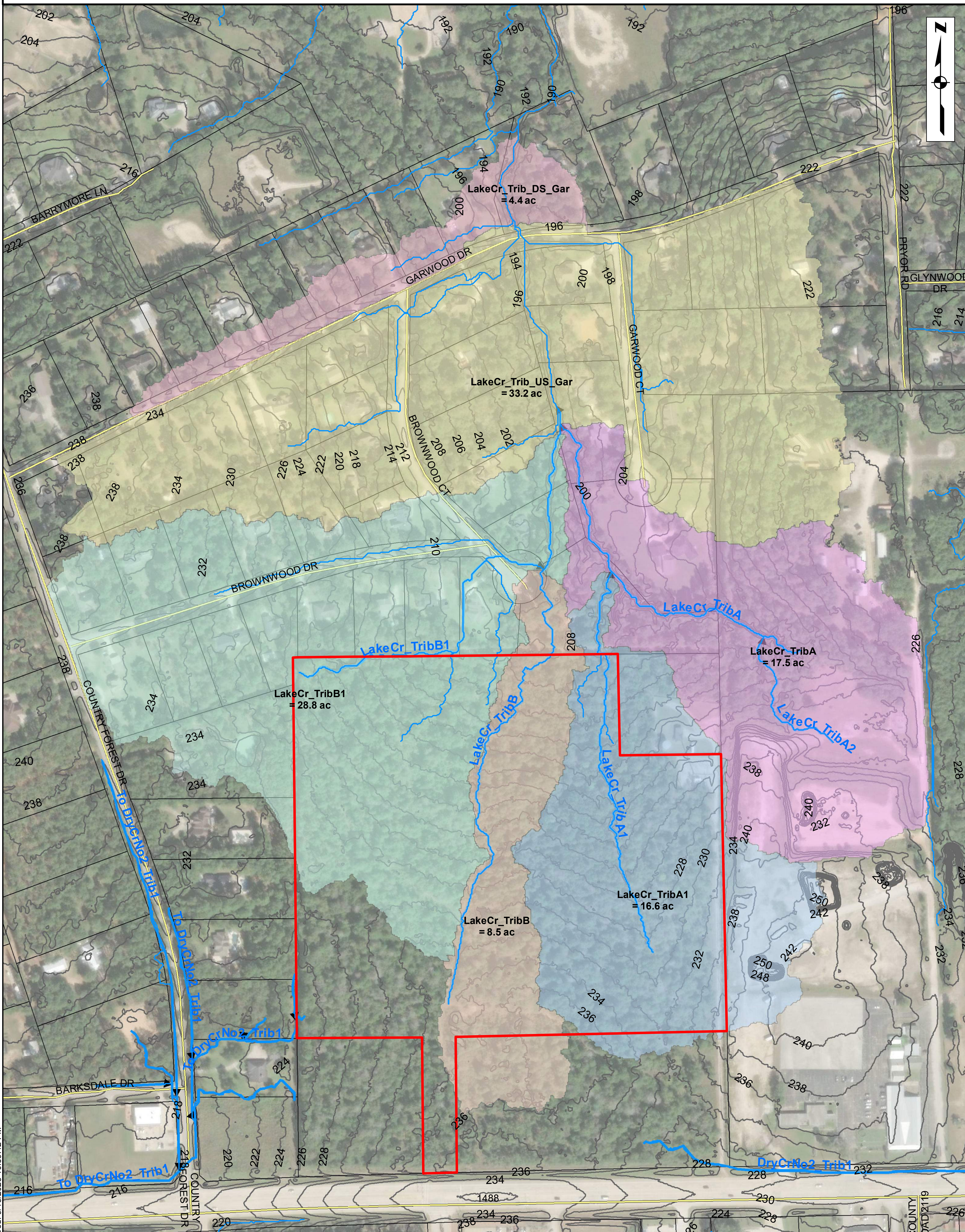
7KLV PDS FRPSOLHV ZLWK)(0\$V VWDQGDUGV IRU WKH XVH RI GLJLWDO IORRG PDSV LI LW LV QRW YRLG DV GHVFULEHG EHORZ 7KH EDVHPDS VKRZQ FRPSOLHV ZLWK)(0\$V EDVHPDS DFFXUDF\ VWDQGDUGV

7KH IORRG KD]DUG LQIRUPDWLRQ LV GHULYHG GLUHFWO\ IURP WKH DXWKRULWDWLYH 1)+/ ZHE VHUYLFHV SURYLGHG E\ )(0\$ 7KLV PDS ZDV H[SRUWHG RQ DW 30 DQG GRHV QRW UHIOHFW FKDQJHV RU DPHQGPHQWV VXEVHTXHQW WR WKLV GDWH DQG WLPH 7KH 1)+/ DQG HIIHFWLYH LQIRUPDWLRQ PD\ FKDQJH RU EHFRPH VXSHUVHGHG E\ QHZ GDWD RYHU WLPH

7KLV PDS LPDJH LV YRLG LI WKH RQH RU PRUH RI WKH IROORZLQJ PDS HOHPHQWV GR QRW DSSHDU EDVHPDS LPDJHU\ IORRG]RQH ODEHOV OHJHQG VFDOH EDU PDS FUHDWLRQ GDWH FRPPXQLW\ LGHQWLILHUV),50 SDQHO QXPEHU DQG)3,50 HIIHFWLYH GDWH 0DS LPDJHV IRU XQPDSSHG DQG XQPRGHUQL]HG DUHDV FDQQRW EH XVHG IRU UHJXODWRU\ SXUSRVHV

%DVHPDS ,PDJHU\ 6RXUFH 86*6 1DWLRQDO 0DS

MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 5 - EXISTING DRAINAGE AREA MAP



Legend

- ProjectBoundary
- Streams_GarwoodCulv
- <all other values>

Name

- LakeCr_TribA
- LakeCr_TribA1
- LakeCr_TribB
- LakeCr_TribB1
- LakeCr_Trib_DS_Gar
- LakeCr_Trib_US_Gar
- ExistFlowPath
- Contours_2ft_2018_CoastalLiDAR

0 155 310 620 930 1,240 Feet

ODYSSEY ENGINEERING GROUP

Odyssey Engineering Group
2500 Tanglewilde St, Suite 300
Houston, Texas 77063

281.306.0240
www.odysseyeg.com
TBPE Registered Firm F-17637

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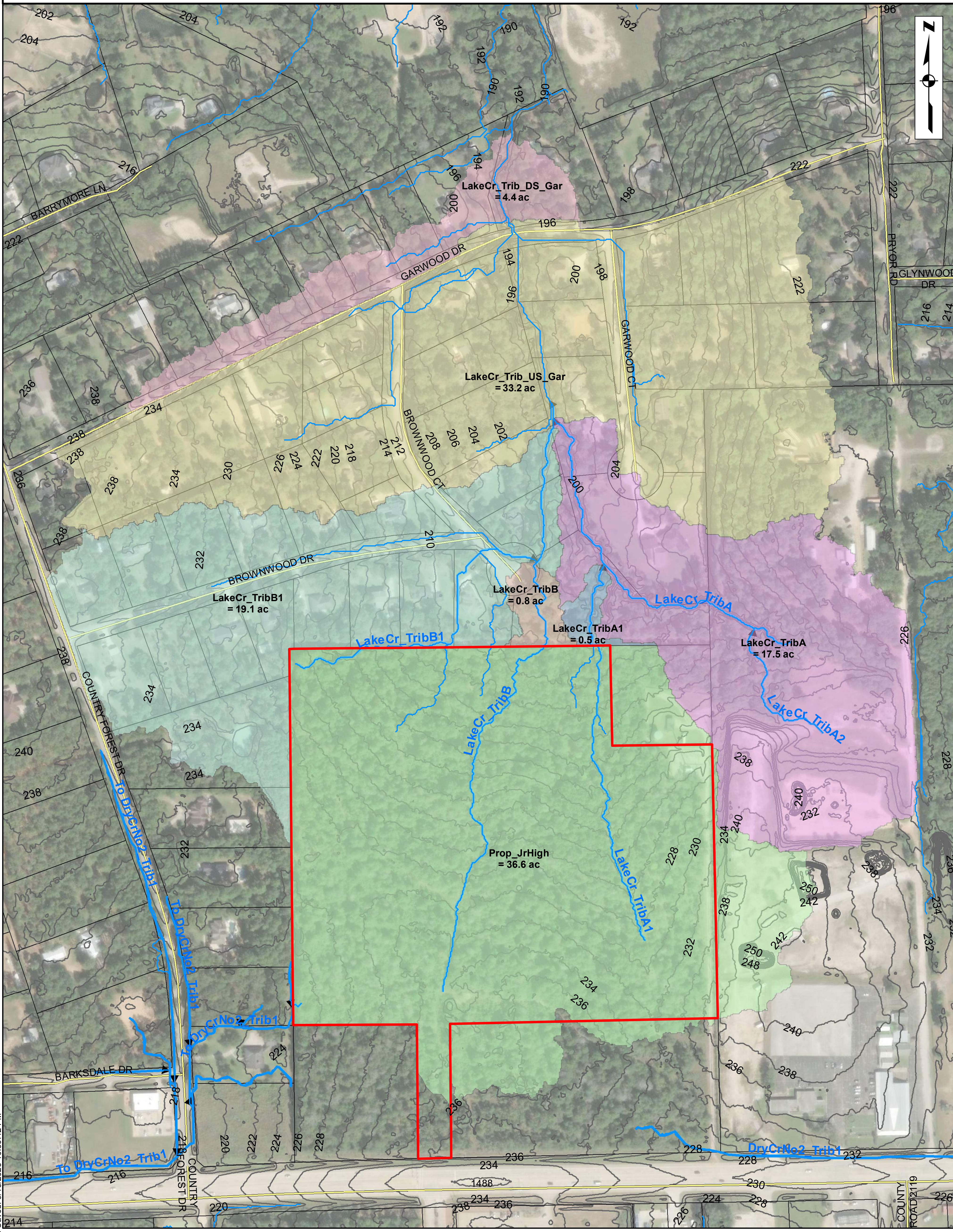
MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 6 - PROPOSED DRAINAGE AREA MAP



Legend

- ProjectBoundary
- Streams_GarwoodCulv
- LakeCr_TribA1
- LakeCr_TribB
- LakeCr_TribB1
- LakeCr_Trib_DS_Gar
- LakeCr_Trib_US_Gar
- Prop_JrHigh
- ExistFlowPath
- Contours_2ft_2018_CoastalLiDAR

Name

- LakeCr_TribA

0 155 310 620 930 1,240 Feet

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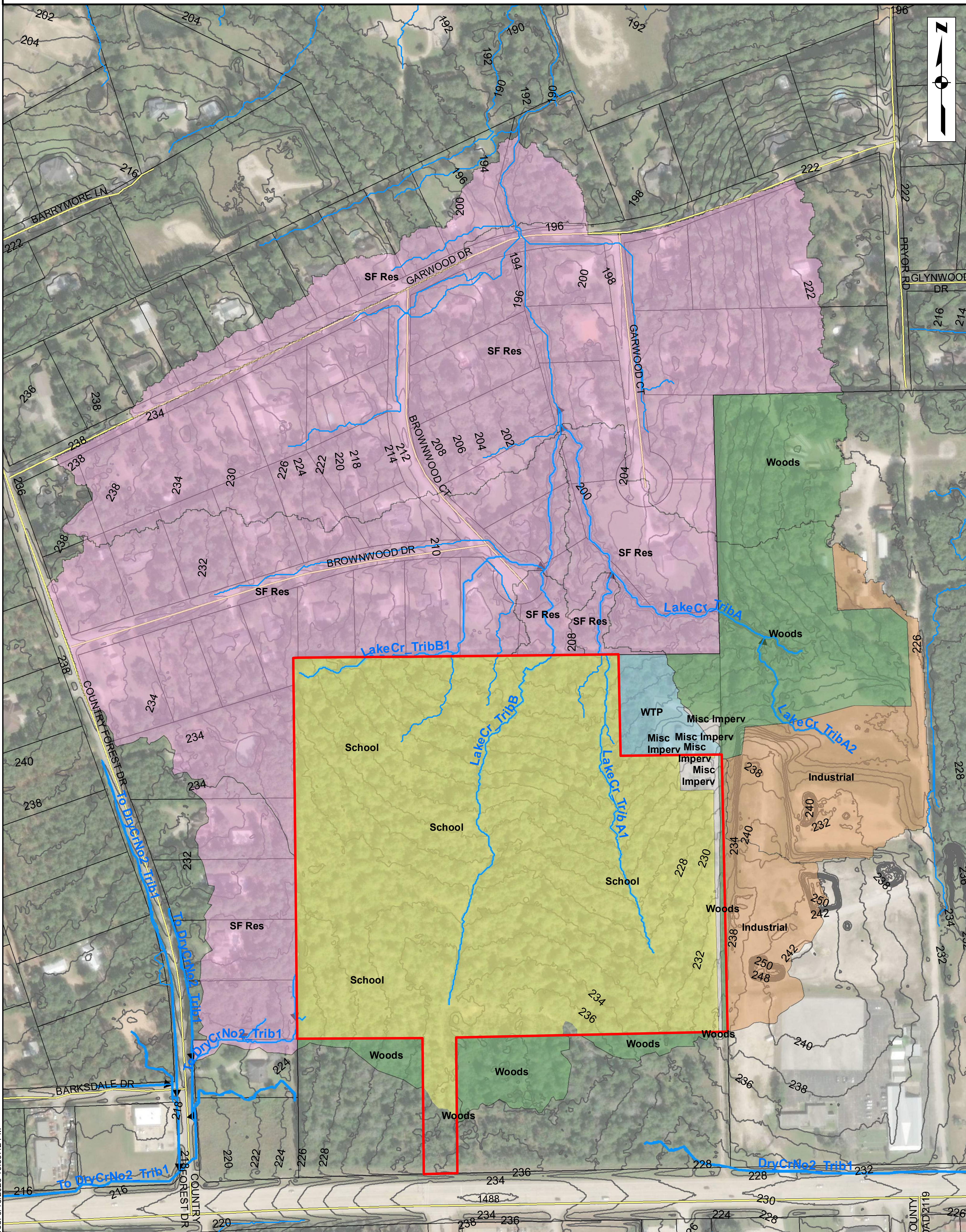
MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 7 - PROPOSED LAND USE MAP



Legend

- ProjectBoundary
- Streams_GarwoodCulv

LandUse

- Industrial
- Misc Imperv
- SF Res
- School
- WTP
- Woods
- ExistFlowPath
- Contours_2ft_2018_CoastalLiDAR

0 155 310 620 930 1,240 Feet

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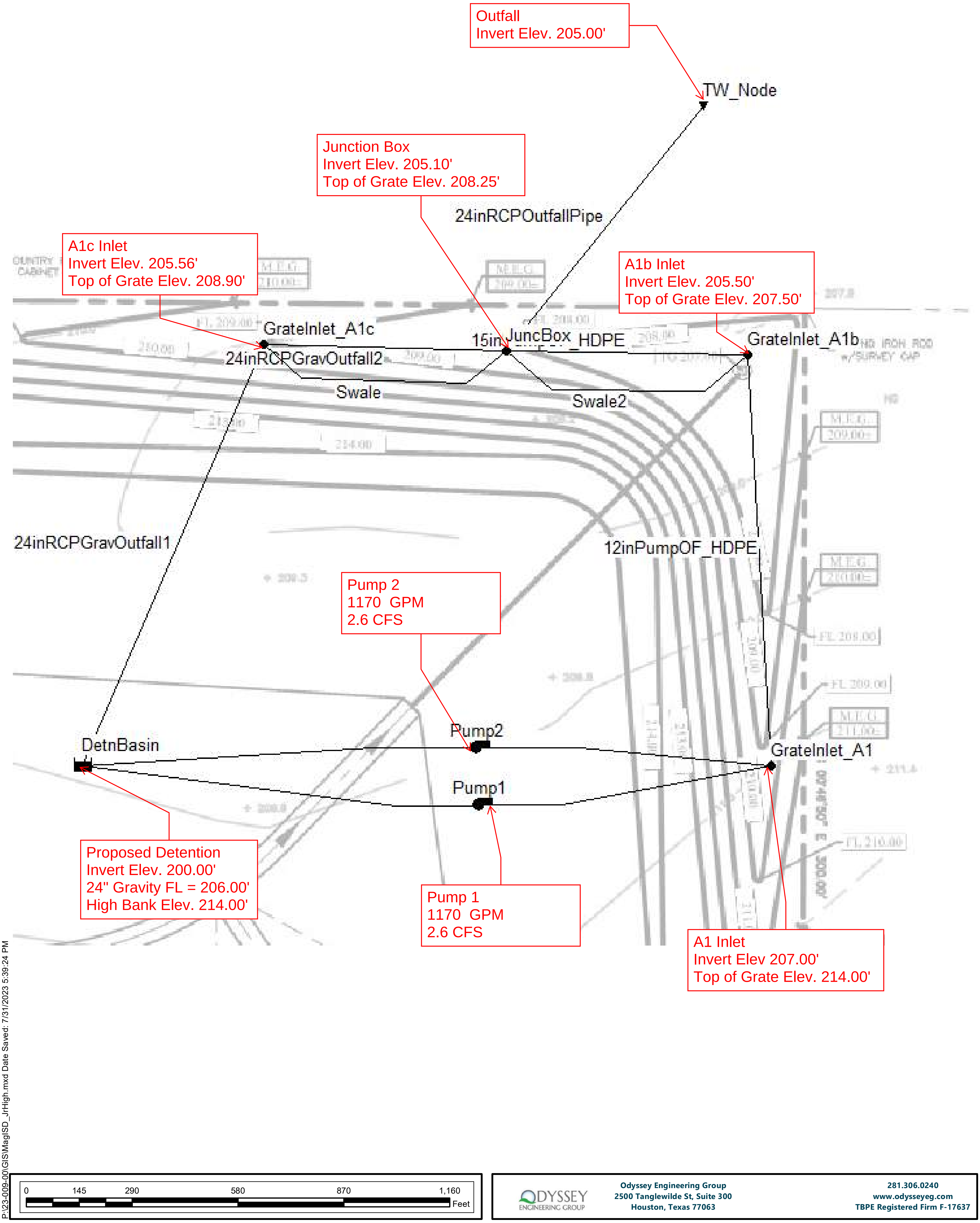
MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 8 - EPA-SWMM MODEL LAYOUT



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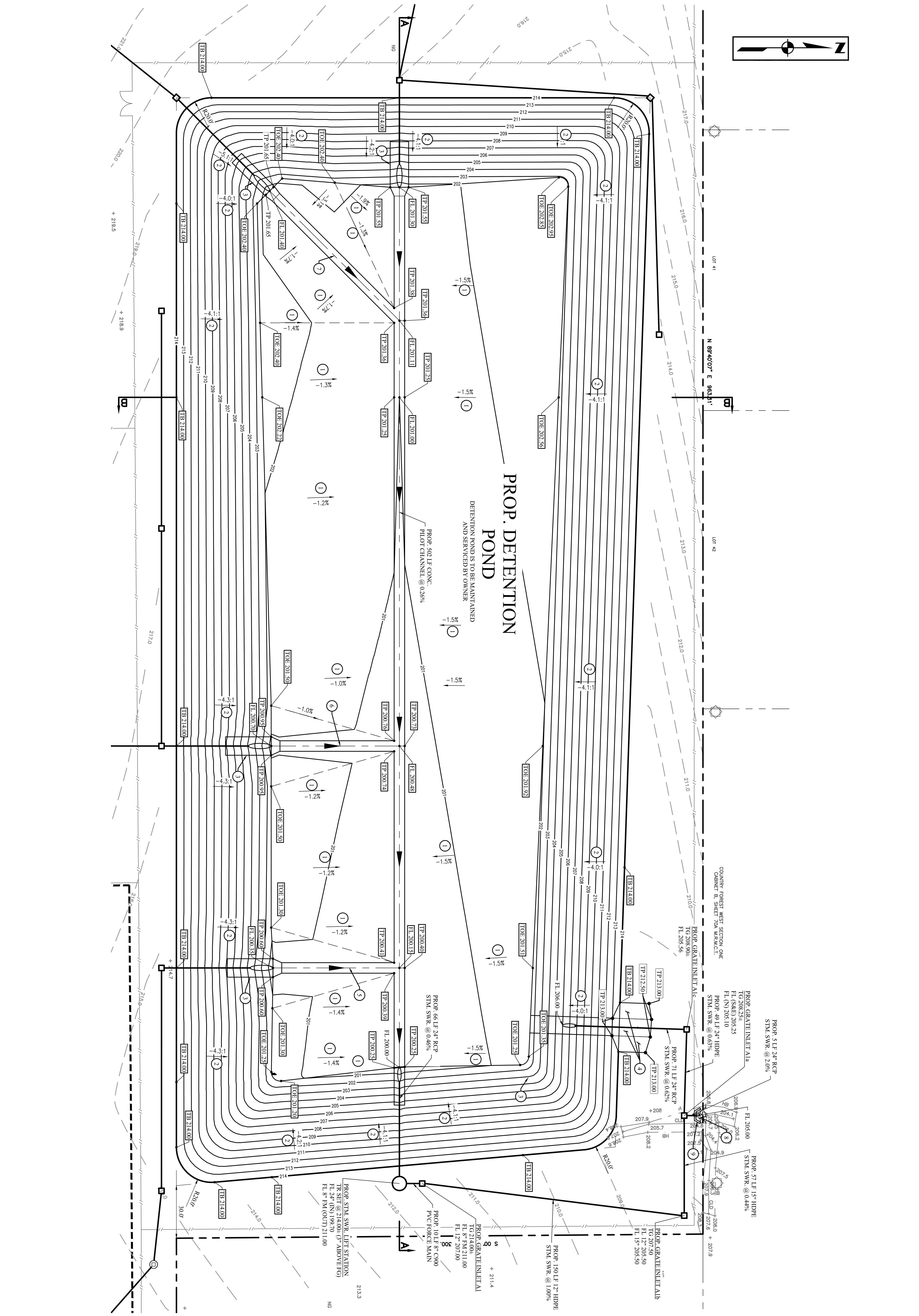
MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 9 - DETENTION POND LAYOUT



0 145 290 580 870 1,160 Feet

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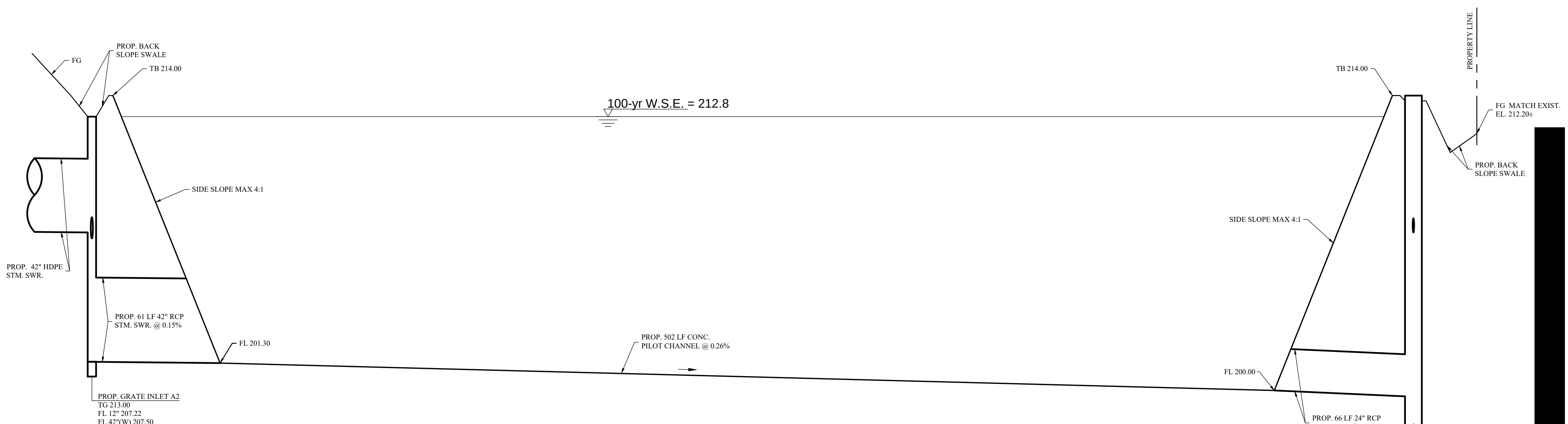
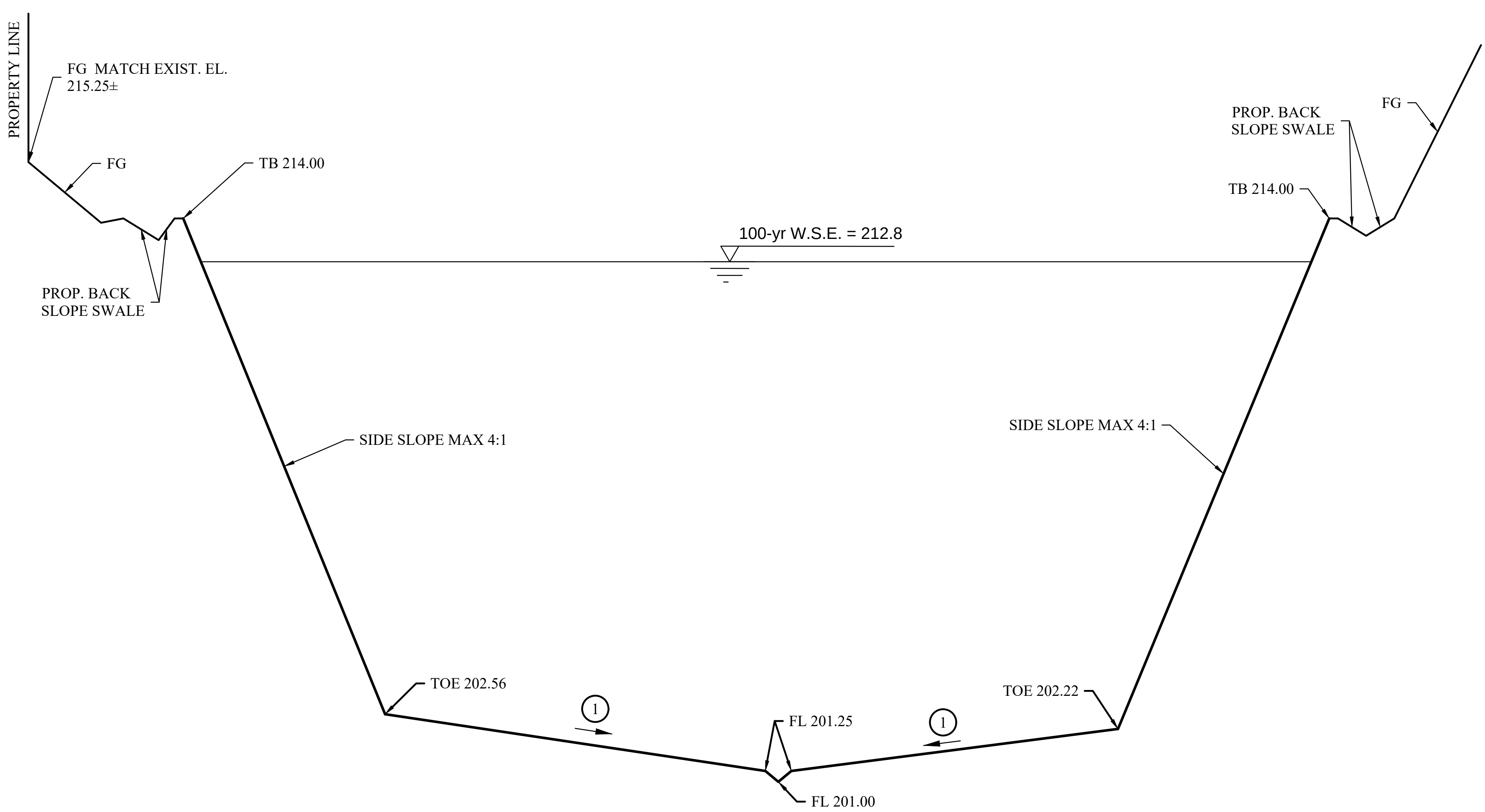
MAGNOLIA ISD JR HIGH SCHOOL DRAINAGE IMPACT ANALYSIS
EXHIBIT 10 - DETENTION POND PROFILES



SECTION "A-A"
(SCALE: H 1"=30', V 1"=3')



SECTION "B-B"
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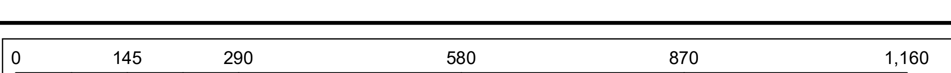

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Montgomery County, Texas

Magnolia ISD Jr High Site

May 23, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:4,100 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Montgomery County, Texas
Survey Area Data: Version 20, Aug 24, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 25, 2020—Feb 22, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CnC	Conroe gravelly loamy fine sand, 0 to 5 percent slopes	3.3	6.6%
CoC	Conroe loamy fine sand, 0 to 5 percent slopes	40.0	80.9%
SplB	Splendora fine sandy loam, 0 to 2 percent slopes	1.9	3.9%
Ss	Conroe soils	4.2	8.6%
WkC	Fetzer loamy fine sand, 1 to 5 percent slopes	0.0	0.1%
Totals for Area of Interest		**49.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Montgomery County, Texas

CnC—Conroe gravelly loamy fine sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2tlkb
Elevation: 140 to 430 feet
Mean annual precipitation: 47 to 53 inches
Mean annual air temperature: 66 to 68 degrees F
Frost-free period: 241 to 261 days
Farmland classification: Not prime farmland

Map Unit Composition

Conroe and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Conroe

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy and gravelly fluviomarine deposits over clayey fluviomarine deposits

Typical profile

A - 0 to 4 inches: gravelly loamy fine sand
E - 4 to 25 inches: gravelly loamy fine sand
Bt - 25 to 31 inches: sandy clay loam
Btv - 31 to 78 inches: clay
BCtv - 78 to 80 inches: sandy clay

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 48 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Ecological site: F133BY003TX - Loamy Over Clayey Upland
Hydric soil rating: No

Minor Components

Betis

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: F133BY008TX - Northern Deep Sandy Upland
Hydric soil rating: No

Pinetucky

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F133BY007TX - Southern Sandy Loam Upland
Hydric soil rating: No

CoC—Conroe loamy fine sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: m9xy
Elevation: 50 to 500 feet
Mean annual precipitation: 41 to 48 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 238 to 283 days
Farmland classification: Not prime farmland

Map Unit Composition

Conroe and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Conroe

Setting

Landform: Interfluves
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 25 inches: loamy fine sand
H2 - 25 to 31 inches: sandy clay loam
H3 - 31 to 78 inches: clay
H4 - 78 to 80 inches: sandy clay

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Ecological site: F133BY003TX - Loamy Over Clayey Upland
Hydric soil rating: No

SplB—Splendora fine sandy loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: f763
Elevation: 80 to 400 feet
Mean annual precipitation: 48 to 58 inches
Mean annual air temperature: 67 to 68 degrees F
Frost-free period: 240 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Splendora and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Splendora

Setting

Landform: Flatwoods
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Early pleistocene age loamy fluviomarine deposits derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 6 inches: fine sandy loam
E - 6 to 15 inches: fine sandy loam
Bt/E - 15 to 28 inches: loam
Bt - 28 to 70 inches: loam
Btg - 70 to 80 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 10 to 32 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 0.2 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: D
Ecological site: F152BY005TX - Seasonally Wet Loamy Upland
Hydric soil rating: No

Minor Components

Waller

Percent of map unit: 7 percent
Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F152BY007TX - Poorly Drained Loamy Upland
Hydric soil rating: Yes

Segno

Percent of map unit: 3 percent
Landform: Interfluves
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: F152BY006TX - Well Drained Loamy Upland
Hydric soil rating: No

Ss—Conroe soils

Map Unit Setting

National map unit symbol: m9yw
Elevation: 50 to 500 feet
Mean annual precipitation: 40 to 48 inches
Mean annual air temperature: 66 to 70 degrees F
Frost-free period: 260 to 285 days
Farmland classification: Not prime farmland

Map Unit Composition

Conroe and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Conroe

Setting

Landform: Interfluves
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Clayey marine deposits

Typical profile

H1 - 0 to 5 inches: sandy clay loam
H2 - 5 to 52 inches: sandy clay
H3 - 52 to 70 inches: sandy clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: F133BY003TX - Loamy Over Clayey Upland
Hydric soil rating: No

WkC—Fetzer loamy fine sand, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 30n1m
Elevation: 190 to 370 feet
Mean annual precipitation: 45 to 48 inches
Mean annual air temperature: 68 to 68 degrees F
Frost-free period: 240 to 272 days
Farmland classification: Not prime farmland

Map Unit Composition

Fetzer and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fetzer

Setting

Landform: Interfluves
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy and clayey marine deposits derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 6 inches: loamy fine sand
E - 6 to 28 inches: loamy fine sand
Btg - 28 to 80 inches: clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 10 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F133BY002TX - Seasonally Wet Upland
Hydric soil rating: No

Minor Components

Depcor

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: F133BY007TX - Southern Sandy Loam Upland
Hydric soil rating: No

Landman

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: F133BY013TX - Terrace
Hydric soil rating: No

Boy

Percent of map unit: 5 percent

Landform: Interfluves
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: F152BY006TX - Well Drained Loamy Upland
Hydric soil rating: No

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```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.014)
--------------------------------------------------------------

WARNING 03: negative offset ignored for Link 15inPumpOF_HDPE
WARNING 04: minimum elevation drop used for Conduit 15inPumpOF_HDPE
WARNING 05: minimum slope used for Conduit 15inPumpOF_HDPE
WARNING 02: maximum depth increased for Node JuncBox
WARNING 02: maximum depth increased for Node GrateInlet_A1b
WARNING 02: maximum depth increased for Node GrateInlet_A1c

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 05/05/1862 00:00:00
Ending Date .............. 05/08/1862 00:00:00
Antecedent Dry Days ...... 0.0
```

```
Report Time Step ......... 00:15:00
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume         Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........        38.565         12.567
External Outflow .........        38.347         12.496
Flooding Loss ............         0.000          0.000
Evaporation Loss .........         0.000          0.000
Exfiltration Loss ........         0.000          0.000
Initial Stored Volume ....         0.000          0.000
Final Stored Volume ......         0.220          0.072
Continuity Error (%) .....        -0.003


***************************
Time-Step Critical Elements
***************************
Link 24inRCPOutfallPipe (91.54%)


********************************
Highest Flow Instability Indexes
********************************
```

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	0.50 sec
Average Time Step	:	0.54 sec
Maximum Time Step	:	1.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.01
Percent Not Converging	:	0.04

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min	Reported Max Depth Feet
JuncBox	JUNCTION	0.61	2.43	207.53	0	04:16	2.43
GrateInlet_A1b	JUNCTION	1.02	2.18	207.68	0	04:17	2.18
GrateInlet_A1	JUNCTION	0.64	1.62	208.62	0	04:17	1.62
GrateInlet_A1c	JUNCTION	0.44	3.77	209.33	0	04:16	3.77
TW_Node	OUTFALL	0.53	2.00	207.00	0	02:52	2.00
DetnBasin	STORAGE	4.84	12.28	212.28	0	04:16	12.28

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
JuncBox	JUNCTION	0.00	36.00	0 04:16	0	12.5	-0.003
GrateInlet_A1b	JUNCTION	0.00	2.91	0 00:41	0	4.52	0.001
GrateInlet_A1	JUNCTION	0.00	2.60	0 00:40	0	4.52	-0.001
GrateInlet_A1c	JUNCTION	0.00	33.40	0 04:16	0	7.98	0.000
TW_Node	OUTFALL	0.00	36.00	0 04:16	0	12.5	0.000
DetnBasin	STORAGE	188.20	188.20	0 01:46	12.6	12.6	-0.000

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
GrateInlet_A1	JUNCTION	4.74	0.617	4.883

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
DetnBasin	329.831	22	0	0	1212.419	82	0 04:16	36.00

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
TW_Node	94.73	6.35	36.00	12.495
System	94.73	6.35	36.00	12.495

****
Link Flow Summary
****

	Maximum |Flow|	Time of Max Occurrence	Maximum |Veloc|	Max/ Full	Max/ Full

25-YR EPA-SWMM RESULTS

Link	Type	CFS	days	hr:min	ft/sec	Flow	Depth
24inRCPGravOutfall1	CONDUIT	33.40	0	04:16	10.63	1.88	1.00
24inRCPOutfallPipe	CONDUIT	36.00	0	04:16	11.46	1.13	1.00
15inPumpOF_HDPE	CONDUIT	2.99	0	06:22	3.01	4.63	1.00
12inPumpOF_HDPE	CONDUIT	2.91	0	00:41	5.51	0.82	1.00
24inRCPGravOutfall2	CONDUIT	29.16	0	02:52	9.40	1.62	1.00
Swale	CONDUIT	4.92	0	04:16	2.05	0.15	0.37
Swale2	CONDUIT	0.00	13753	00:00	0.00	0.00	0.12
Pump1	PUMP	2.60	0	00:40		1.00	
Pump2	PUMP	0.00	13753	00:00		0.00	

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		---------- Fraction of Time in Flow Class ----------								
24inRCPGravOutfall1	1.00	0.73	0.00	0.00	0.24	0.03	0.00	0.00	0.72	0.00
24inRCPOutfallPipe	1.00	0.01	0.00	0.00	0.08	0.92	0.00	0.00	0.09	0.00
15inPumpOF_HDPE	1.00	0.01	0.00	0.00	0.14	0.00	0.00	0.86	0.00	0.00
12inPumpOF_HDPE	1.00	0.01	0.05	0.00	0.95	0.00	0.00	0.00	0.86	0.00
24inRCPGravOutfall2	1.00	0.06	0.67	0.00	0.09	0.01	0.00	0.17	0.75	0.00
Swale	1.00	0.96	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Swale2	1.00	0.97	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
24inRCPGravOutfall1	9.15	9.76	9.15	8.77	9.15
24inRCPOutfallPipe	3.64	3.95	3.64	3.76	3.64
15inPumpOF_HDPE	6.36	7.67	6.36	64.53	6.36
12inPumpOF_HDPE	4.74	4.74	64.49	0.01	0.01
24inRCPGravOutfall2	3.49	9.15	3.49	8.70	3.49

****
Pumping Summary
****

Pump	Percent Utilized	Number of Start-Ups	Min Flow CFS	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal	Power Usage Kw-hr	% Time Off Pump Curve Low	% Time Off Pump Curve High
Pump1	89.61	1	0.00	2.60	2.60	4.517	44.97	0.0	0.0
Pump2	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0

Analysis begun on: Tue Sep 12 01:49:42 2023
Analysis ended on: Tue Sep 12 01:49:45 2023
Total elapsed time: 00:00:03

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.014)
--------------------------------------------------------------

WARNING 03: negative offset ignored for Link 15inPumpOF_HDPE
WARNING 04: minimum elevation drop used for Conduit 15inPumpOF_HDPE
WARNING 05: minimum slope used for Conduit 15inPumpOF_HDPE
WARNING 02: maximum depth increased for Node JuncBox
WARNING 02: maximum depth increased for Node GrateInlet_A1b
WARNING 02: maximum depth increased for Node GrateInlet_A1c

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 05/05/1862 00:00:00
Ending Date .............. 05/08/1862 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
```

```
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume         Volume
Flow Routing Continuity         acre-feet      10^6 gal
**************************      ---------      ---------
Dry Weather Inflow .......          0.000          0.000
Wet Weather Inflow .......          0.000          0.000
Groundwater Inflow .......          0.000          0.000
RDII Inflow ..............          0.000          0.000
External Inflow ..........         38.580         12.572
External Outflow .........         38.362         12.501
Flooding Loss ............          0.000          0.000
Evaporation Loss .........          0.000          0.000
Exfiltration Loss ........          0.000          0.000
Initial Stored Volume ....          0.000          0.000
Final Stored Volume ......          0.220          0.072
Continuity Error (%) .....         -0.003


***************************
Time-Step Critical Elements
***************************
Link 24inRCPOutfallPipe (90.75%)


*********************************
Highest Flow Instability Indexes
*********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
```

```
Minimum Time Step            :     0.46 sec
Average Time Step            :     0.55 sec
Maximum Time Step            :     1.00 sec
Percent in Steady State      :     0.00
Average Iterations per Step  :     2.01
Percent Not Converging       :     0.03
```

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days hr:min	Reported Max Depth Feet
JuncBox	JUNCTION	0.60	2.51	207.61	0 03:17	2.51
GrateInlet_A1b	JUNCTION	1.01	2.26	207.76	0 03:17	2.26
GrateInlet_A1	JUNCTION	0.64	1.70	208.70	0 03:17	1.70
GrateInlet_A1c	JUNCTION	0.43	3.86	209.42	0 03:17	3.86
TW_Node	OUTFALL	0.52	2.00	207.00	0 01:57	2.00
DetnBasin	STORAGE	4.81	12.84	212.84	0 03:17	12.84

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
JuncBox	JUNCTION	0.00	38.56	0 03:17	0	12.5	-0.003
GrateInlet_A1b	JUNCTION	0.00	2.91	0 00:29	0	4.47	0.001

GrateInlet_A1	JUNCTION	0.00	2.60	0	00:28	0	4.47	-0.001
GrateInlet_A1c	JUNCTION	0.00	35.96	0	03:17	0	8.03	0.000
TW_Node	OUTFALL	0.00	38.56	0	03:17	0	12.5	0.000
DetnBasin	STORAGE	265.30	265.30	0	01:15	12.6	12.6	-0.000

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
GrateInlet_A1	JUNCTION	4.92	0.696	4.804

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
DetnBasin	326.827	22	0	0	1295.110	88	0 03:17	38.56

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
TW_Node	94.23	6.28	38.56	12.500
System	94.23	6.28	38.56	12.500

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
24inRCPGravOutfall1	CONDUIT	35.96	0 03:17	11.45	2.02	1.00
24inRCPOutfallPipe	CONDUIT	38.56	0 03:17	12.28	1.21	1.00
15inPumpOF_HDPE	CONDUIT	2.99	0 05:50	3.01	4.63	1.00
12inPumpOF_HDPE	CONDUIT	2.91	0 00:29	5.51	0.82	1.00
24inRCPGravOutfall2	CONDUIT	29.17	0 01:57	9.40	1.62	1.00
Swale	CONDUIT	7.41	0 03:17	2.31	0.22	0.45
Swale2	CONDUIT	0.00	13753 00:00	0.00	0.00	0.17
Pump1	PUMP	2.60	0 00:28		1.00	
Pump2	PUMP	0.00	13753 00:00		0.00	

****
Flow Classification Summary

****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
		---------- Fraction of Time in Flow Class ----------								
24inRCPGravOutfall1	1.00	0.74	0.00	0.00	0.23	0.03	0.00	0.00	0.73	0.00
24inRCPOutfallPipe	1.00	0.00	0.00	0.00	0.09	0.91	0.00	0.00	0.10	0.00
15inPumpOF_HDPE	1.00	0.00	0.00	0.00	0.13	0.00	0.00	0.86	0.00	0.00
12inPumpOF_HDPE	1.00	0.00	0.05	0.00	0.94	0.00	0.00	0.00	0.87	0.00
24inRCPGravOutfall2	1.00	0.06	0.68	0.00	0.10	0.01	0.00	0.16	0.76	0.00
Swale	1.00	0.96	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Swale2	1.00	0.97	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
	--------- Hours Full --------				
24inRCPGravOutfall1	8.93	9.51	8.93	8.57	8.93
24inRCPOutfallPipe	4.02	4.27	4.02	4.12	4.02
15inPumpOF_HDPE	6.31	7.53	6.31	63.92	6.31
12inPumpOF_HDPE	4.92	4.92	63.88	0.01	0.01
24inRCPGravOutfall2	3.90	8.93	3.90	8.50	3.90

****
Pumping Summary
****

100-YR EPA-SWMM RESULTS

Pump	Percent Utilized	Number of Start-Ups	Min Flow CFS	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal	Power Usage Kw-hr	% Time Off Pump Curve Low	% Time Off Pump Curve High
Pump1	88.76	1	0.00	2.60	2.60	4.474	44.96	0.0	0.0
Pump2	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0

Analysis begun on: Wed Sep 13 11:53:34 2023
Analysis ended on: Wed Sep 13 11:53:37 2023
Total elapsed time: 00:00:03