Prein&Newhof
Engineers ▪ Surveyors ▪ Environmental ▪ Laboratory

November 10, 2023
2230360

Mr. James Baker
City of Kalamazoo
415 Stockbridge Ave.
Kalamazoo, MI 49001

RE: 322 Stockbridge Site Investigation

Dear Mr. Baker:

The following report summarizes our investigation of flood impacts to the 322 Stockbridge site and the feasibility of the City using this site for an affordable housing development.

Flood Event Scenarios and Impacts

The 322 Stockbridge site is in the floodplain of Portage Creek and is also affected by flooding from the Kalamazoo River. The maximum extent of flooding is illustrated in the FEMA map in Figure 1.

Using a 1D hydraulic model to determine the steady state flooding levels, the four originally proposed flood scenarios were reviewed. Because the flood profiles revealed that the Stockbridge Avenue crossing created a flow restriction and a corresponding hydraulic grade increase, we also reviewed the option of enlarging the Stockbridge flow opening. The resulting flood profiles are illustrated in Figure 2 and the flood elevations on the site are tabulated as follows:

Portage Creek	**Kalamazoo River**	**Water Elevation at 322 Stockbridge**
Low flows	Low flows	759.9
Low flows	100-year flows	762.2
100-year flows	Low flows	764.4
100-year flows	100-year flows	764.6
100-year flows, Stockbridge opening enlargement	100-year flows	763.9

Figure 3 illustrates the extent of flooding resulting from 100-year Kalamazoo River flows as the floodwater source. This flood level is lower than when flood flows from Portage Creek are added. Because most of the area storms move from west to east and affect Portage Creek before they affect the Kalamazoo River, Portage Creek flows are often receding before the Kalamazoo River flows create any effect on the 322 Stockbridge parcel.

As identified in the table above, increasing the size of the Portage Creek opening under Stockbridge Avenue can reduce the highest flood level by 0.6 feet. This reduction may not justify the cost of enlarging the Stockbridge Avenue crossing opening.

Flood Genesis and Propagation

A site investigation has been completed, along with a LiDAR survey of existing site elevations. Floodwater from Portage Creek enters the site at the northeast corner. That corner of the site has an existing stormwater collection area, a controlled outlet pipe, a non-functioning stormwater lift station structure, and a concrete spillway. As Portage Creek floodwaters rise, they overtop the existing concrete spillway and flow onto a large portion of the site.

When Portage Creek rises above the site stormwater outlet pipe, a duckbill backflow preventer on the pipe causes a backup of locally generated runoff water to pond on the site side of the overflow spillway.

No other direct connections to Portage Creek were discovered.

Based on these conditions, site flooding originates from the northeast site corner connection to Portage Creek when Portage Creek is flooding and from locally generated stormwater runoff that is trapped on the site when Portage Creek levels block the stormwater outlet pipe.

Existing Conditions Stormwater Management

Two soil borings were obtained on the east edge of the site between the existing buildings and the railroad. The borings indicate a groundwater elevation of approximately 756.5 at the northeast site corner. This is approximately 4 feet below ground at that location. As a comparison, the Portage Creek baseflow elevation is just under elevation 760. Groundwater is expected to seasonally fluctuate by at least 1 foot with summer being a lower groundwater season.

A review of the soils encountered indicates enough sandy material that stormwater infiltration can occur. However, there are varying amounts of sand, silt, and gravel which means that infiltration will not be consistent across the site. The soil boring logs are included as attachments. The boring near the northeast site area encountered a 1.5 foot thick layer with organics and the boring in the southeast site area encountered a 2 foot thick layer containing some brick debris (previous fill material).

With the local history of presence of foundry sand fill, we have tested the fill material layer in the southeast boring for metals as that may impact the cost of soils handling during site development. The soil testing results are included as an attachment. Arsenic, mercury, and selenium were found to exceed allowable limits. Delineation of the contamination boundary and further soil testing on the remainder of the site should be performed as part of the full site development.

Existing stormwater management includes a small detention pond on the east side of the property that appears to be sized for site runoff but not floodwater containment. The area also has a stormwater filtration system and a stormwater lift station (not currently functioning) to pump water into Portage Creek.

Current City of Kalamazoo Stormwater regulations indicate the site is located in the 1-year capture zone for wellhead protection. The current zoning of Community Commercial District (CC) is considered a high-risk use for wellhead protection. High-risk properties in the 1-year capture zone are not allowed to use infiltration for stormwater management. If the City changes the property use to residential (either RS-5 single family or RM-15 multifamily), the property will be considered as a low-risk use. Low risk properties require water quality treatment and allow the use of infiltration for stormwater management.

This site qualifies as a "large site" in the City's stormwater standards, so a 1-inch runoff volume over the entire site is required for treatment. The existing site has significant impervious coverage, and the City's standards allow for a 50% credit for existing impervious coverage for detention/retention calculations.

Flood Risk Reduction Strategies

1. **Full site development above the 100-year flood elevation**
   With full site development, a preliminary road/lot layout (see Figure 4), could provide approximately 57 (50'x100') lots. Lots of this size could accommodate multi-story single family townhomes.

   At existing site elevations, there is approximately 36,000 cy of floodwater capacity below the highest flood elevation of 764.6. If the entire site were to be removed from the floodplain, this volume would need to be compensated for to accommodate Portage Creek flooding. We reviewed the following nearby compensatory cut areas:
   a. City-owned parcel east of the Stockbridge site and east of the railroad
   b. Three existing parcels on Stockbridge near the northeast site corner
   c. Embankment removal along the east side of the site parallel with the railroad right-of-way

   None of these areas, either alone or in combination, provide the necessary compensatory cut volume. Therefore, additional parcel areas are required which increases compensatory cut expenses. Rough current costs are estimated at $1,500,000 for the compensatory cut.

   With a full parcel development scenario, there are two site grading options:
   1. Import enough fill to raise all the lots 1-foot above the 100-year flood level ($800,000)
   2. Keep the existing site grades but construct a levy and stormwater lift station ($1,500,000 initial construction, $50,000 annual O&M)

   Total flood risk reduction costs for Option 1 are $2,300,000 and for Option 2 are $2,500,000 initial with $50,000 annual. These are order of magnitude cost estimates and should not be used for project budget establishment.

   With the ordinance allowed 50% existing impervious credit for stormwater detention, Full site development will drive the need for on-site detention.

2. Partial site development above the 100-year flood elevation

With partial site development, a preliminary road/lot layout (see Figure 5) provides 39 (50'x150') townhome lots and maintains flood control volumes on the east side of the site. No off-site compensatory cut is required.

To accomplish this, the partial development option includes excavation of the east side of the site down to an elevation of 760.0, which is the elevation of the Portage Creek base flow. An elevation of 765.5 is proposed for the new roadway with lots having dwelling first-floor elevations of 766.5 (1 foot above the 100-year flood).

The east side ponding area will be accessible to all Portage Creek flooding above the base flow elevation of 760.0 and will accommodate up to the 100-year event without allowing flooding of the new street or homes. All site stormwater will flow by gravity so no pumping infrastructure is required.

Approximately 14,000 cubic yards of fill is required for the street/lots along with a corresponding 14,000 cubic yards of on-site cut for flood control volume. This results in an approximate earthwork cost of $700,000.

Green infrastructure will be incorporated into the east pond area to provide the required first flush treatment (1" of runoff from the entire site). With the ordinance allowed 50% existing impervious credit for stormwater detention, no on-site detention is required. We have attached a draft Stormwater Calculations Worksheet.

The proposed pond areas could be designed as wetlands if that benefits the City for use as wetland mitigation credit needed elsewhere.

3. Other Development Considerations

a. Connection to E Emerson Street on the west appears possible with the City's current property ownership. Using this connection facilitates 6 lots included in the partial development option.
b. The proposed lot size of 50' x 100' was based utilizing single family, multi-story townhomes. Density could be increased by constructing multi-family homes or decreasing the lot sizes and road width.
c. Figure 6 illustrates the existing 27" concrete sanitary sewer pipe through the center of the property. This sewer appears to be sufficient in depth and available flow volume to allow for sanitary connection from the proposed development. No basements are proposed due to the water table. An easement will be required for sanitary sewer and lot configurations adapted to provide a utility corridor.
d. The City can consider purchasing 408 and 411 Stockbridge to create a neighborhood park. A wetland viewing area could be incorporated into the south end of the park, with a sidewalk from the south end of the park to the proposed road to allow for easy neighborhood access.

e. A vegetated sound barrier could be considered between the railroad and the residential development. Development design should evaluate the quality of the existing tree line along the railroad to determine tree value and density. Additional trees/vegetation may need to be added to create a sufficient sound barrier.

Recommendations

The 322 Stockbridge site experiences substantial flooding from both Kalamazoo River and Portage Creek, but residential site development does appear feasible. We recommend the partial site development as the most cost effective option to allow for both residential development and flood control volumes maintained on site. A more detailed environmental investigation should be performed as part of the site development.

Sincerely,

Prein&Newhof

Brian Vilmont

Enclosure(s):

Figure 1 - FEMA Floodplain Map
Figure 2 - Portage Creek Water Profiles
Figure 3 - Kalamazoo River 100 Year Flood Extents
Figure 4 - Full Site Development
Figure 5 - Partial Site Development
Figure 6 - Existing Sanitary Sewer

Table 1- Summary of Soil Analytical Results

Soil Boring Logs
Stormwater Calculations Worksheet

cc:

FEMA

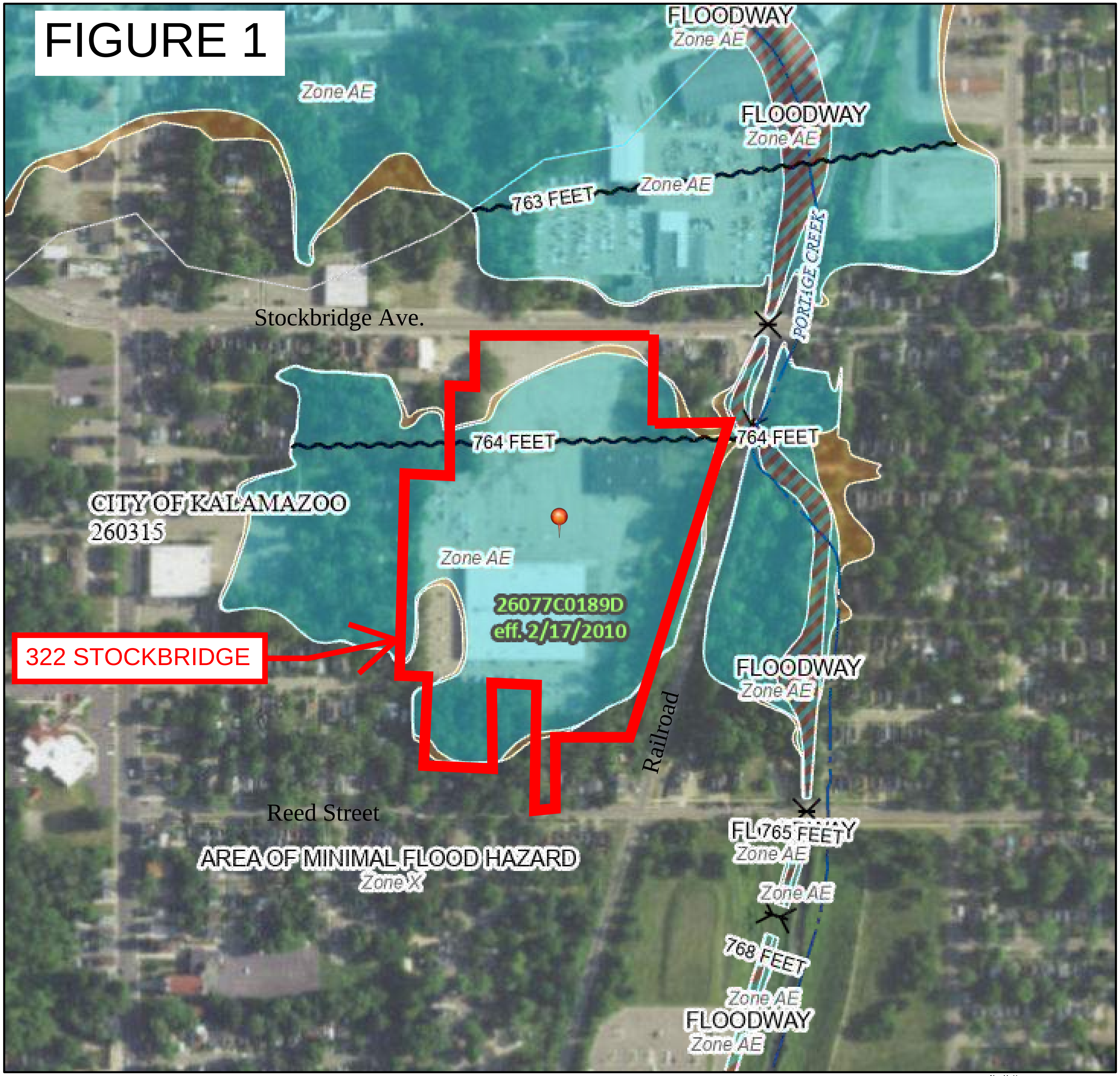


FIGURE 1
FLOODWAY
Zone AE
Zone AE
FLOODWAY
Zone AE
763 FEET
Zone AE
PORTAGE CREEK
Stockbridge Ave.
764 FEET
764 FEET
CITY OF KALAMAZOO
260315
Zone AE
26077C0189D
eff. 2/17/2010
322 STOCKBRIDGE
FLOODWAY
Zone AE
Railroad
Reed Street
765 FEET
Zone AE
AREA OF MINIMAL FLOOD HAZARD
Zone X
Zone AE
768 FEET
Zone AE
FLOODWAY
Zone AE

FIGURE 2

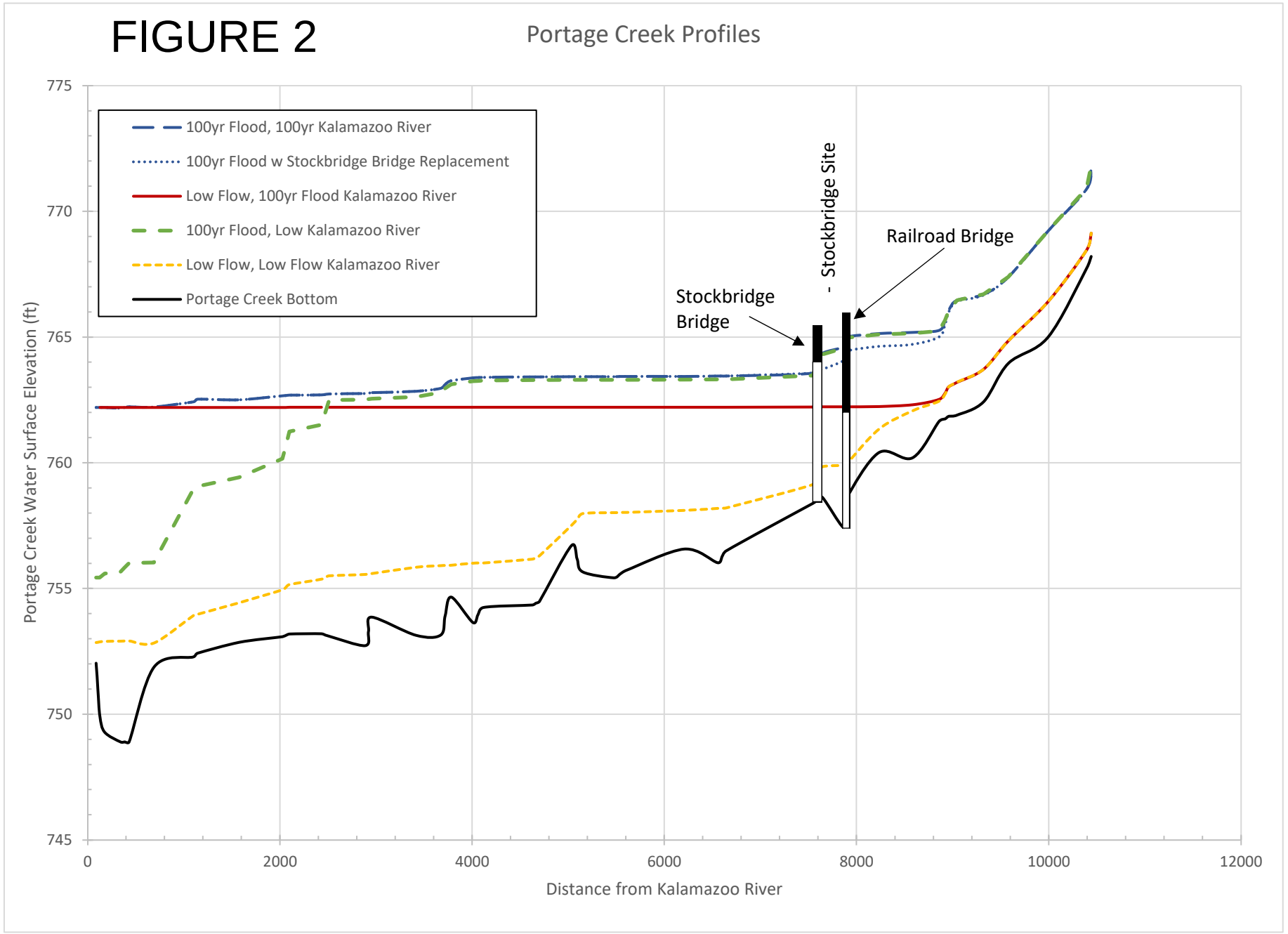
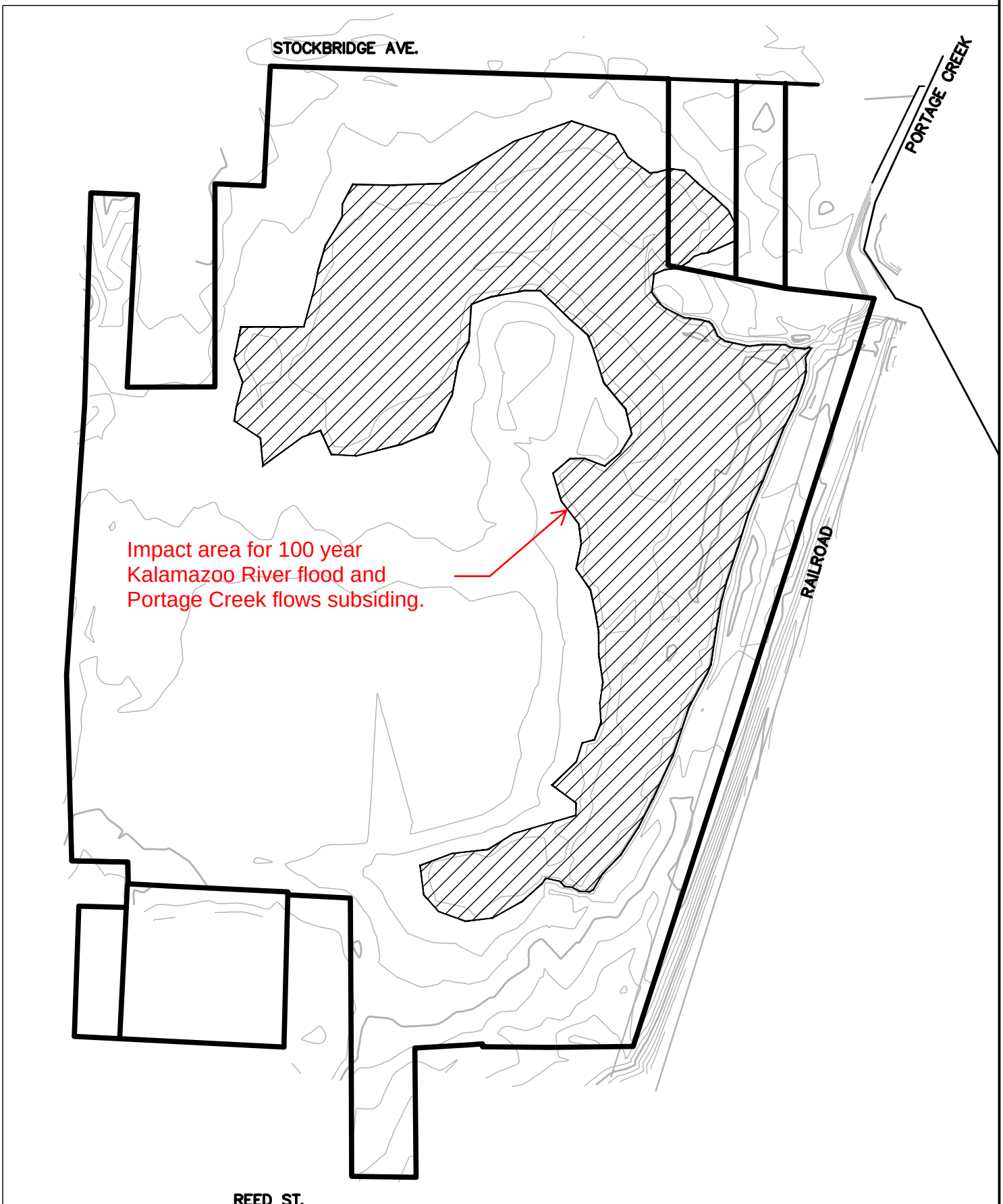

Portage Creek Profiles
100yr Flood, 100yr Kalamazoo River
100yr Flood w Stockbridge Bridge Replacement
Low Flow, 100yr Flood Kalamazoo River
100yr Flood, Low Kalamazoo River
Low Flow, Low Flow Kalamazoo River
Portage Creek Bottom
Stockbridge Site
Railroad Bridge
Stockbridge Bridge
Portage Creek Water Surface Elevation (ft)
775
770
765
760
755
750
745
0
2000
4000
6000
8000
10000
12000
Distance from Kalamazoo River

FIGURE 3



CITY OF KALAMAZOO
KALAMAZOO COUNTY, MICHIGAN
322 STOCKBRIDGE PARCEL
100YR FLOOD KALAMAZOO RIVER

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100 YEAR FLOOD
LIMITS – KZOO
RIVER INLFUENCE

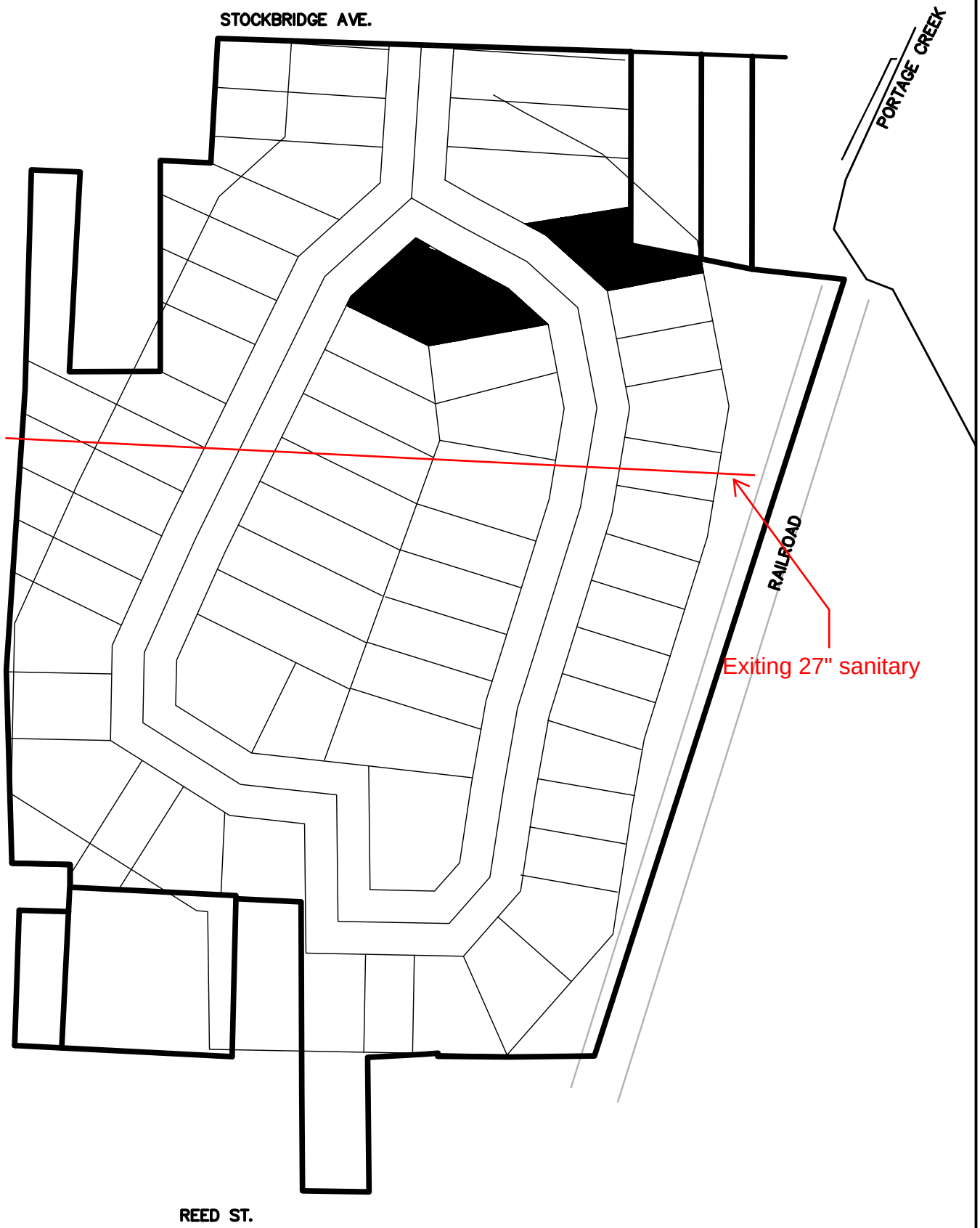
Date : 8/25/2023

Project No.
2230360

FIGURE 3

JPRUS – 2230360_SBase.dwg – FIG 1 – Aug, 29 2023 – 03:16pm

FIGURE 4



CITY OF KALAMAZOO
KALAMAZOO COUNTY, MICHIGAN
322 STOCKBRIDGE PARCEL
RESIDENTIAL DEVELOPMENT A

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57 LOTS, 50'X100'

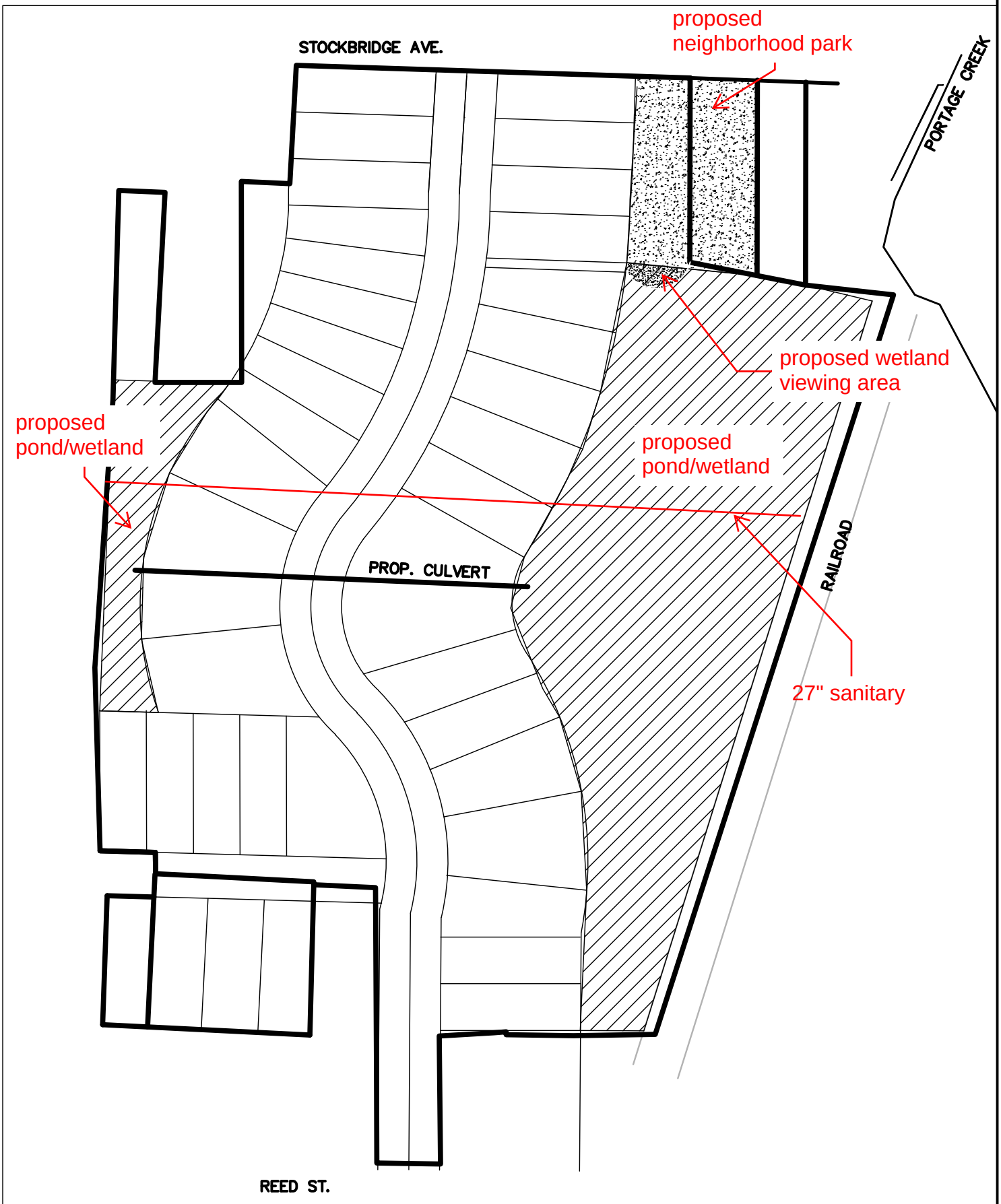
Date : 8/25/2023

Project No.
2230360

FIGURE 4

JPRUS – 2230360_SBase.dwg – FIG 2 – Aug, 29 2023 – 03:16pm

FIGURE 5



CITY OF KALAMAZOO
KALAMAZOO COUNTY, MICHIGAN
322 STOCKBRIDGE PARCEL
RESIDENTIAL DEVELOPMENT B

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40 LOTS, 50'X150'
2 PONDS,
POSSIBLE PARK

Date : 8/25/2023

Project No.
2230360

FIGURE 5

JPRUS – 2230360_SBase.dwg – FIG 3 – Aug, 29 2023 – 03:18pm

FIGURE 6

322 Stockbridge — Existing Sanitary Sewer

TABLE 1 - Summary of Soil Analytical Results

	Soil Sample	Part 201 Generic Residential Criteria, µg/Kg						
				Groundwater Protection		Ambient Air		Contact	Csat
Sample Location	**SB-2**	Chemical Abstract Service Number	Statewide Default Background Levels	Drinking Water Protection	Groundwater Surface Water Interface Protection (GSIP)	Infinite Source Volatile Soil Inhalation Criteria (VSIC)	Particulate Soil Inhalation Criteria	Direct Contact Criteria	Soil Saturation Concentration Screening Levels
Sample Depth, ft. [1]	1 - 2.5'								
Collection Date	08-24-2023								
MI 10 METALS, µg/Kg									
Arsenic	**17,200**	7440382	5,800	5,800 (B)	5,800 (B)	NLV	720,000	7,600	NA
Barium	**94,600**	7440393	75,000	1,300,000	440,000 (G)	NLV	330,000,000	37,000,000	NA
Cadmium	**448**	7440439	1,200	6,000	3,000 (G,X)	NLV	1,700,000	550,000	NA
Chromium	**10,400**	16065831	18,000 (total)	30,000	18,000 (total) (B)	NLV	260,000	2,500,000	NA
Copper	**16,400**	7440508	32,000	5,800,000	75,000 (G)	NLV	130,000,000	20,000,000	NA
Lead	**55,100**	7439921	21,000	700,000	2,500,000 (G,X)	NLV	NA	400,000	NA
Mercury	**163**	Varies	130	1,700	130 (B)	52,000	20,000,000	160,000	NA
Selenium	**1,660**	7782492	410	4,000	410(B)	NLV	130,000,000	2,600,000	NA
Silver	**60.3**	7440224	1,000	4,500	1,000 (B)	NLV	6,700,000	2,500,000	NA
Zinc	**73,900**	7440666	47,000	2,400,000	170,000 (G)	NLV	ID	170,000,000	NA

Exceeds GRCC. Highlighting to identify the Part 201 Criterion exceeded.

1. Depth is referenced to the ground surface.

B. Background, as defined in R 299.5701(b), may be substituted if higher than the calculated cleanup criterion. Background levels substituted for drinking water and GSIP criteria for arsenic; and GSIP criteria of chromium, mercury, selenium, and silver.

C. Value presented is a screening level based on the chemical-specific generic soil saturation concentration (Csat).

G. GSIP criterion calculated using hardness of 150 mg/L for surface water.

H. Valence-specific chromium data (Cr III and Cr VI) shall be compared to the corresponding valance-specific cleanup criteria. When only the total chromium is available, the total chromium concentration is compared to the Hexavalent Chromium cleanup criteria.

X. The GSI criterion shown in the generic cleanup criteria tables is not protective for surface water that is used as a drinking water source.

"ID" Insufficient Data to develop criterion.

"MDL" means the method detection limit for the analysis.

"NA" means Not Analyzed, or a criterion or value is not available or, in the case of backgr

"NLV" hazardous substance is Not Likely to Volatilize under most conditions.

Reference:

1. The Part 201 groundwater and soil cleanup criteria and screening levels, criteria footnotes and the toxicological and chemical-physical properties of the hazardous substances, obtained from Michigan Department of Environment, Great Lakes, and Energy -Remediation Division, as follows:
Generic cleanup criteria (Table 1 - groundwater; Table 2 - soil), December 21, 2020.

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Log of Soil Boring # SB-1

Sheet: 1 of 1	Date: 8/24/23	Drilling Cont.: Rosendall
Project #: 2230360	Project Title: Stockbridge Rd	Driller: Jeff
Project Location: Kalamazoo, MI		Inspector: Scott Cathey
Boring Location: GIS- S. of N. Building		Drilling Method: 4.25" HSA - ATV
		Sample Method: SPT
		Plugging Procedure: Soil

Water Level Information

	ENC	0 hour		
Depth of Water:	4	4		
Depth of Hole:	10'	4		

Site Conditions: dirt
Elevation: ~~-~~ +/- 760.5'
Datum: -

Drilling
Start: 1130
Finish: 1150

Remarks

Sample Type & Number	Depth of Sample Tip	Inches Driven	Inches Recovered	HN (ppm) of PP Value (1st)	"N" Value	Blows/6"	Depth (ft)	Sample Description	Generalized Log
							0		Fill
						7 10	1	Brn F-C w/	Medium dense brown F-C sand with trace silt, little gravel (SW-Fill)
SS1	2.5	18	10	-	23	13	2	ts - L.g.	
						6	3	4.0 ▼	
SS2	5	18	12	-	11	5 6	4	Brn F-M w/ ts.	Medium dense brown F-M sand with trace silt, trace to little gravel (SP)
							5	ts,	
						2 2	6	6.5	
SS3	7.5	18	12	-	4	2	7		Very loose dark brown clayey sand with little silt, trace organics (roots/wood)
						9	8	8.0	
SS4	10	18	10	-	25	13 12	9		Medium dense brown F-C sand with trace silt, little gravel (SW)
							10	10.0	
							1		EOB @ 10'
							2		
							3		
							4		
							5		
							6		
							7		
							8		
							9		
							0		

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Log of Soil Boring # SB2

Sheet: 1 of 1	Date: 8/24/23	Drilling Cont.: Rosendall
Project #: 2230360	Project Title: Stack bridge Rd	Driller: Jeff
Project Location: Kalamazoo, MI		Inspector Scott Cathey
Boring Location: GIS - SE corner of site		Drilling Method: 4.25" HSA - ATV
		Sample Method: SPT
		Plugging Procedure: Soil

Water Level Information

	ENC	0 hour		
Depth of Water:	~	~		
Depth of Hole:	15'	~		

Site Conditions: grass
Elevation: +/- 765'
Datum: ~

Drilling
Start: 1200
Finish: 1235

Remarks

Sample Type & Number	Depth of Sample Tip	Inches Driven	Inches Recovered	HN (ppm) of PP Value (1st)	"N" Value	Blows/6"	Depth (ft)	Sample Description	Generalized Log
							0	0.2	Topsoil
								0.5	Asphalt
						6	1	1.0	Fill - medium dense brown F-C sand with trace silt, little gravel (SW-Fill
						7			
SS1	2.5	18	12	—	17	10	2	3.0	
							3		Fill - Dark brown F-m sand with trace-little silt, trace gravel, brick (SP-Fill
						4			
SS2	5	18	12	—	8	3	4	Brn F-C to, +Lg	
						5	5		Loose to medium dense brown F-C Sand with trace silt, trace to little gravel (SW)
						6	6	SAA 7.0 ▼	
						6			
SS3	7.5	18	14	—	16	10	7		
						6	8		
SS4	10	18	2	—	13	6	9	SAA	
						7			
							10		
							11		
							12		
							13		
						7			
SS5	15	18	12	—	20	8	14	SAA 15.0	
						12			EOB @ 15'
							15		
							16		
							17		
							18		
							19		
							20		

Stormwater Calculations Worksheet

PRE-DEVELOPMENT CONDITIONS

Surface Cover	Runoff Coefficient, C	Area of Surface Cover (ft^2)
Lawns	0.1	
Forest	0.15	321,082
Gardens	0.25	
Meadow	0.3	67,500
Gravel	0.6	
Brick/Pavers	0.8	
Asphalt/Concrete	0.9	175,660
Roofs	0.9	47,951
Total Site Size (ft^2)		612,192
Total Site Size (acres)		14.05
Runoff Coefficient (weighted average)		0.44
Flow Rate (ft^3/s): 1 year - 30 minute event		10.21
Runoff Volume (ft^3): 2 year - 24 hour event		57,765
Runoff Volume (ft^3): 10 year - 24 hour event		81,834
Treatment Volume = Site Area x 0.083 ft	Standard 1	
i = 1.65 inches/hour for Treatment (1 year - 0.5 hour)	Standard 1	
i = 0.108 inches/hour for Storage (2 year - 24 hour)	Standard 2, 3, 7	
i = 0.153 inches/hour for Storage (10 year - 24 hour)	Standard 3, 7 NFP	

POST-DEVELOPMENT CONDITIONS

Surface Cover	Runoff Coefficient, C	Area of Surface Cover (ft^2)
Lawns	0.1	263,192
Forest	0.15	
Gardens	0.25	
Meadow	0.3	186,125
Gravel	0.6	
Brick/Pavers	0.8	
Asphalt/Concrete	0.9	76,775
Roofs	0.9	86,100
Total Site Size (ft^2)		612,192
Total Site Size (acres)		14.05
Runoff Coefficient (weighted average)		0.37
Flow Rate (ft^3/s): 1 year - 30 minute event		8.66
Runoff Volume (ft^3): 2 year - 24 hour event		49,000
Runoff Volume (ft^3): 10 year - 24 hour event		69,417
Required Treatment Volume (ft^3)		51,016
Required Treatment Flow Rate (ft^3/s)		8.66
Required Storage Volume (ft^3): 2 year - 24 hour		-8,765
Required Storage Volume (ft^3): 10 year - 24 hour		-12,417

***Rational Method Used for All Calculations, where Q = CiA (unless stated otherwise)**

***Instructions: Input the areas (ft^2) of the site for each type of surface cover**

***For determining required detention/retention volumes, Pre-Development Conditions shall be 100% forested with a 50% allowance for existing impervious coverage (example: if a site is 100% impervious, existing conditions shall be 50% forested and 50% impervious).**