Phillip H. Sheridan Army Reserve Center (ARC) Stormwater Drainage Improvement Project

100% Stormwater Design Analysis

FY 2021 88th Readiness Division

Town of Fort Sheridan,
Lake County, Illinois
Submitted September 2021

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Engineer's Project Number: 28691.02.00

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TAB 1

1.0 General Description

1.1 Background

This document provides the design analysis calculations and documentation for the Sheridan USARC Stormwater Drainage Improvement Project (Project). The objective of the Project is to assess the existing stormwater drainage system at the Philip H. Sheridan United States Army Reserve Center (Sheridan USARC or Facility), conduct a regulatory review, obtain topography and utility surveys, evaluate potential stormwater improvements, and develop construction documents for recommended stormwater improvements. The intent of this document is to demonstrate that the proposed improvements will improve the stormwater drainage throughout Sheridan USARC and achieve compliance with the Lake County Watershed Development Ordinance (LCWDO) to the maximum extent practicable.

Sheridan USARC is an approximately 92.6-acre site located in the City of Highwood, Lake County, Illinois, and is situated north of Walker Ave, south of Simonds Way, east of Sheridan Rd (IL131), and west of Patten Rd. Location maps for Sheridan USARC are provided within **Tab 2** in Exhibits 1, 2, and 7. The Facility is located in the Lake Michigan watershed and generally drains from west toward the lake to the east. Drainage patterns are influenced by the topography at the Facility and the existing stormwater utilities. Topographic and utility survey of the Facility was performed by Anderson Engineering, and all elevations referenced herein are in North American Vertical Datum 1988. A topographic map of the Facility is provided within **Tab 2** in Exhibit 8 and Anderson's survey files are provided in **Appendix A**. The Facility currently consists of parking lots, buildings, and open grass areas with light vegetation. There are no Federal Emergency Management Agency

(FEMA) flood hazard areas located on the Facility, see Exhibits 3 and 4 within Tab 2. The National Wetland Inventory (NWI) database shows that there are no wetland areas located on the Facility, see Exhibit 5 within **Tab 2**.

Sheridan USARC experiences varying levels of flooding from relatively small storm events. Construction, demolition, and reconstruction of facilities throughout Sheridan USARC is relatively constant, with approximately 1 building constructed and/or demolished every 3-5 years. Each construction/demolition project was standalone and the stormwater drainage system for each newly constructed building was designed considering only the building site itself, not Sheridan USARC comprehensively. This has created a segregated stormwater management system at the Facility which is a primary cause of flooding throughout the Site.

A Regulatory Review (RR) for the Project was performed by Stanley Consultants, Inc. (SCI) and is provided in **Appendix B**. The Lake County Stormwater Management Commission (SMC) is the local regulatory authority and implements the Lake County Watershed Development Ordinance (WDO). The basis of design for the Project is founded on the stormwater requirements of the WDO. Consultation with regulatory authorities at the State and Federal level will also be required for the Project. A National Pollutant Discharge Elimination System (NPDES) General Permit which covers stormwater discharges from construction site activities is required by the Illinois Environmental Protection Agency (IEPA). Although not noted in the original Regulatory Review document, additional consultation with the IEPA will be required for the Project. Two landfills, each with 100-ft buffer zones, are located on Facility property that contain special waste soil and land use restrictions are in place for both landfills which prohibit intrusive activities of any kind within the landfill buffer zones or construction that will impact surface water flow near the landfills without permission from the Army, IEPA, and the Army Reserve or the Navy. The appropriate entities will be coordinated with to ensure adherence to the land use restrictions. A list of the required permits and consultations is provided below.

- USFWS Consultation
- IHPA Consultation
- IDNR-OREP - EcoCAT Consultation
- IEPA NPDES General Permit
- IEPA Landfill Land Use Restrictions Consultation

SCI has been tasked to develop stormwater drainage improvements for Sheridan USARC that will address localized areas of flooding while minimizing future costs and maintenance. A hydraulic and hydrologic model (H&H Model) of the Facility's existing conditions was developed using Environmental Protection Agency Storm Water Management Model (EPA SWMM) software, version 5.1. The H&H Model was used to quantify, and better understand, problem areas throughout the Facility and develop conceptual solutions. These improvements are organized into three alternatives (Minor, Moderate, Major), with each alternative generally building upon the previous. Brief descriptions of the criteria for each alterative are provided below.

- Minor Alternative: Low-cost alternative to fix most problematic issues and address any major compliance issues
- Moderate Alternative: Includes solutions from the minor alternative but provides additional conveyance, detention, and water quality features to control storm water discharge and improve water quality
- Major Alternative: Includes solutions from the moderate alternative but provides significant detention and water quality features to maximize the site's potential detention and water quality improvements

Following the 65% design submittal the 88th opted for the Major Alternative to be developed to a 95% level of design and ultimately a 100% design was prepared. Details regarding the Minor and Moderate Alternatives are provided in the attachments.

Pavement construction is also being recommended as part of the overall recommendations to improve drainage throughout the Facility.

The ongoing construction and demolition throughout the Facility have resulted in a disorganized utility network. The existing utility network is present throughout the majority of the Facility, which a significant portion is estimated to be not documented. Based on 88th provided data it appears that there are many instances where the proposed improvements may conflict with the existing utilities. This creates numerous locations where existing utilities may be encountered while installing and constructing the proposed storm sewers, drainage ditches, detention basins, and other improvements. The potential conflicts include all types of utilities (electrical, communication, etc.) and in-service and abandoned lines. If a utility conflict is detected during construction in the field, then a relocation of the existing utility or a redesign of the proposed improvement may be required.

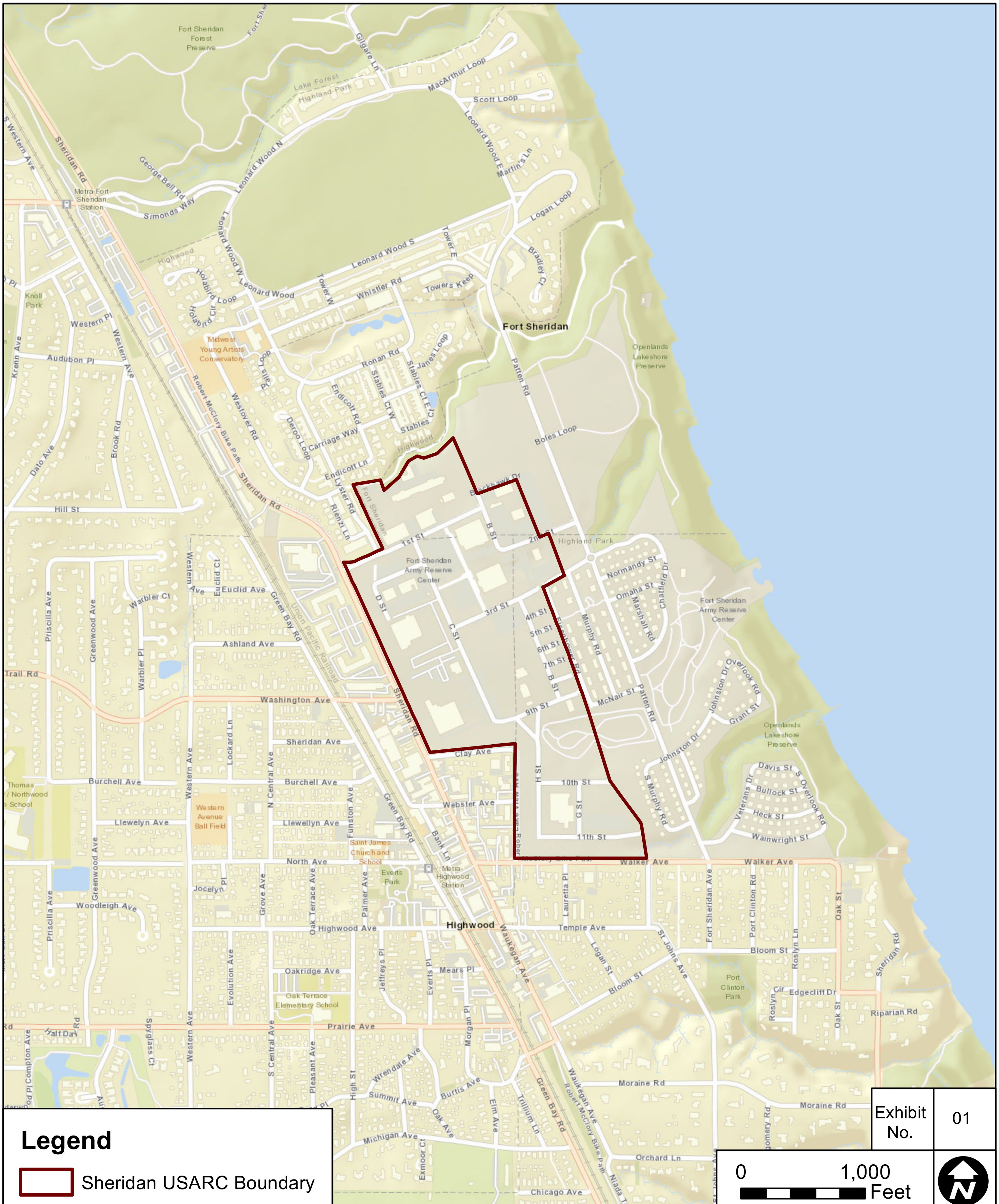
Sheridan USARC has two IEPA capped landfills located at the north and southeast areas of the Facility. Given this, there is a potential for encountering contaminated soils (POLs and solvents) during the proposed earthwork. Any material that is removed during construction activities (soil, asphalt, construction debris, etc.) must be accounted for by the 88th's Remediation Department in their Solid Waste Annual Reporting Web (SWARWEB) tracking system. This would include quantifying approximate weights and material types of any material taken from the Facility.

SCI recommends that the 88th RD conduct soil investigations in the areas that will be disturbed for the projects and develop a plan for handling and disposing of contaminated soils encountered during excavation activities. The purpose of this will be to identify all waste codes applicable to each hazardous waste stream based on requirements in 40 CFR 261 or applicable state or local law or regulation and to identify applicable treatment standards in 40 CFR 268 and state land disposal restrictions to make a determination as to whether or not the waste meets or exceeds the standards.

A 100% design cost estimate was developed for the proposed improvements. The cost estimate utilizes MII which is the second generation of the micro-Computer Aided Cost Estimating System. MII provides an integrated cost estimating system that meets the USACE requirements for preparing cost estimates. A Cost Estimate Memo summarizing the MII Cost Estimate is provided with this 100% design submittal.

TAB 2

EXHIBITS



Legend

Sheridan USARC Boundary

Exhibit No.	01

0 1,000 Feet

N

Drawn by:	BPD	Checked by:	MDW

Stanley Consultants

Exhibit Title:	Site Location Exhibit	Project Title:	Sheridan USARC Stormwater Drainage Improvement Project
Filepath:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\SiteLocation.mxd	Project No: 28691.02.00	Date: 05/26/2020

Legend

Sheridan USARC Boundary

Exhibit No.	02

0 400 Feet

Stanley Consultants	Exhibit Title:	Aerial Exhibit	Drawn by: BPD	Checked by: MDW	
			Project Title:	Sheridan USARC Stormwater Drainage Improvement Project	
Filepath:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\Aerial.mxd		Project No: 28691.02.00	Date: 05/26/2020	

National Flood Hazard Layer FIRMette

FEMA

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/25/2019 at 8:49:18 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Exhibit No.	03		
Scale N/A			
Drawn by:	BPD	Checked by:	MDW
Project Title:	Sheridan USARC Stormwater Drainage Improvement Project		
Project No:	28691.02.00	Date:	05/26/2020

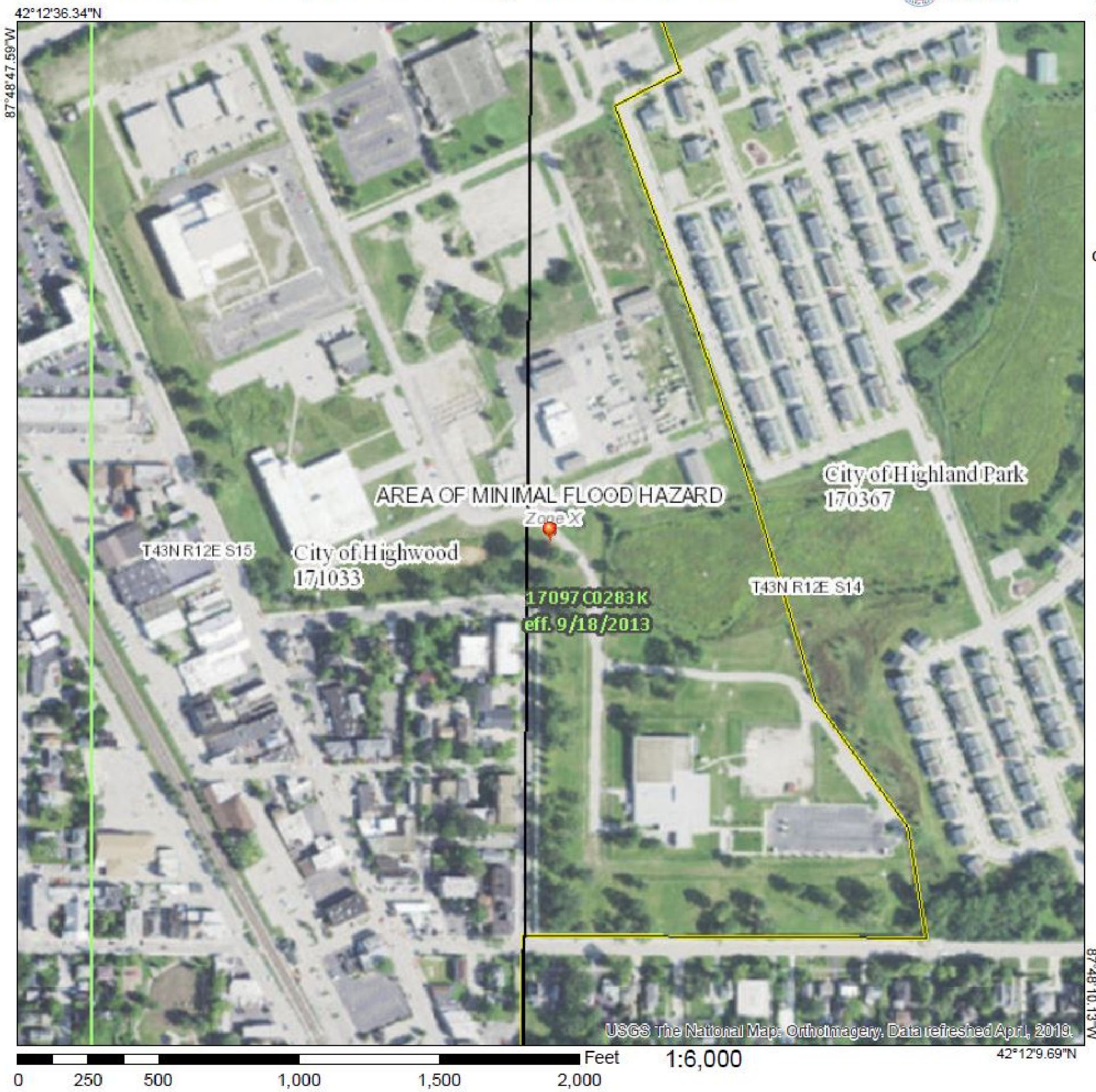
Stanley Consultants

Exhibit Title: FIRM Exhibit - North side of USARC

Filepath: Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\FIRMnorth.mxd

National Flood Hazard Layer FIRMette

FEMA



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS	NO SCREEN	Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES	20.2 / 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/25/2019 at 8:53:04 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Exhibit No.	04			
Scale N/A				
Drawn by:	BPD	Checked by:	MDW	
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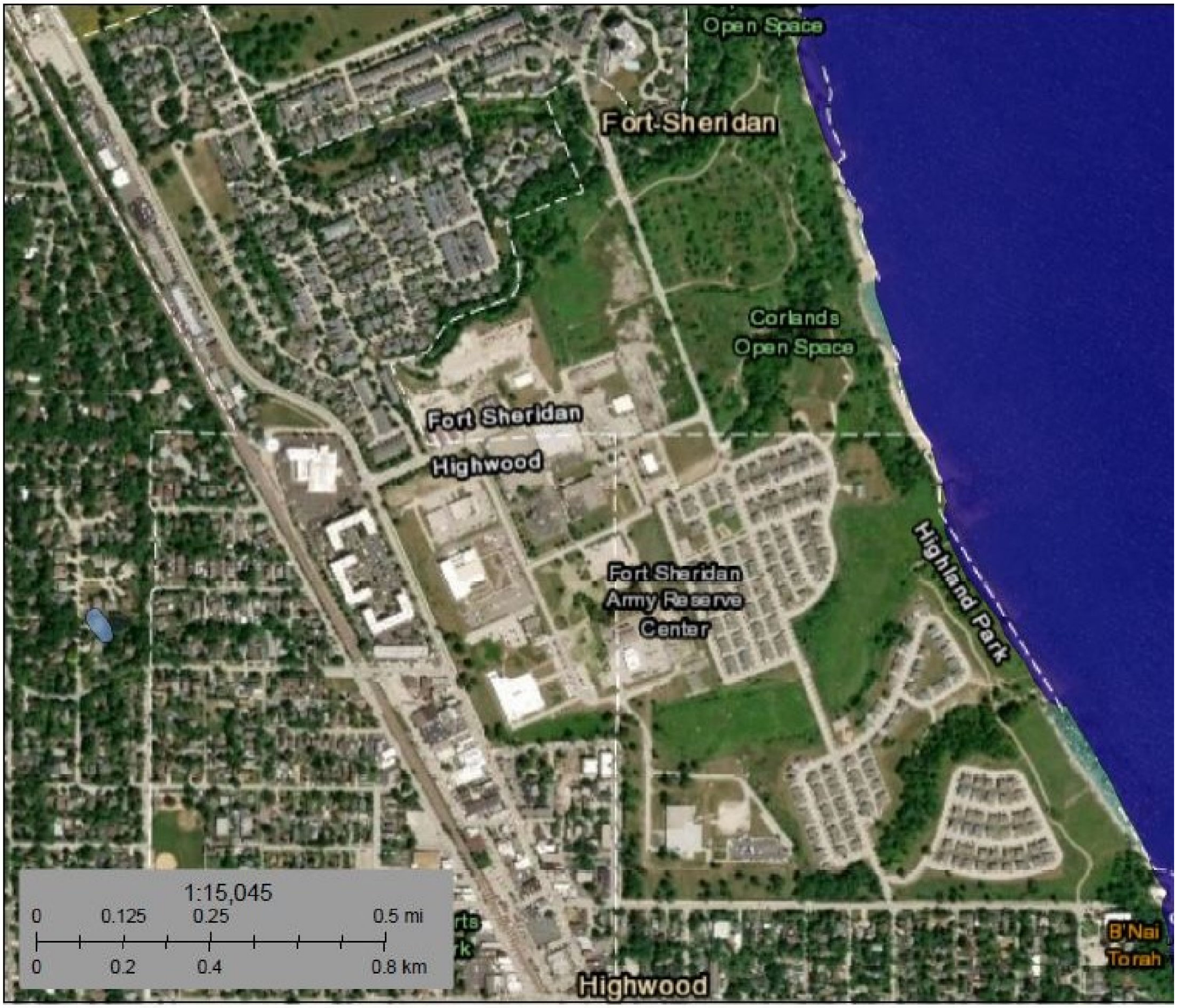
Filepath:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\FIRMsouth.mxd	Project No: 28691.02.00	Date:	05/26/2020

U.S. Fish and Wildlife Service

National Wetlands Inventory

NWI Map 1



June 25, 2019

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

Exhibit No.	05
Scale N/A	

Stanley Consultants	Exhibit Title:	NWI Exhibit	Drawn by: BPD	Checked by: MDW
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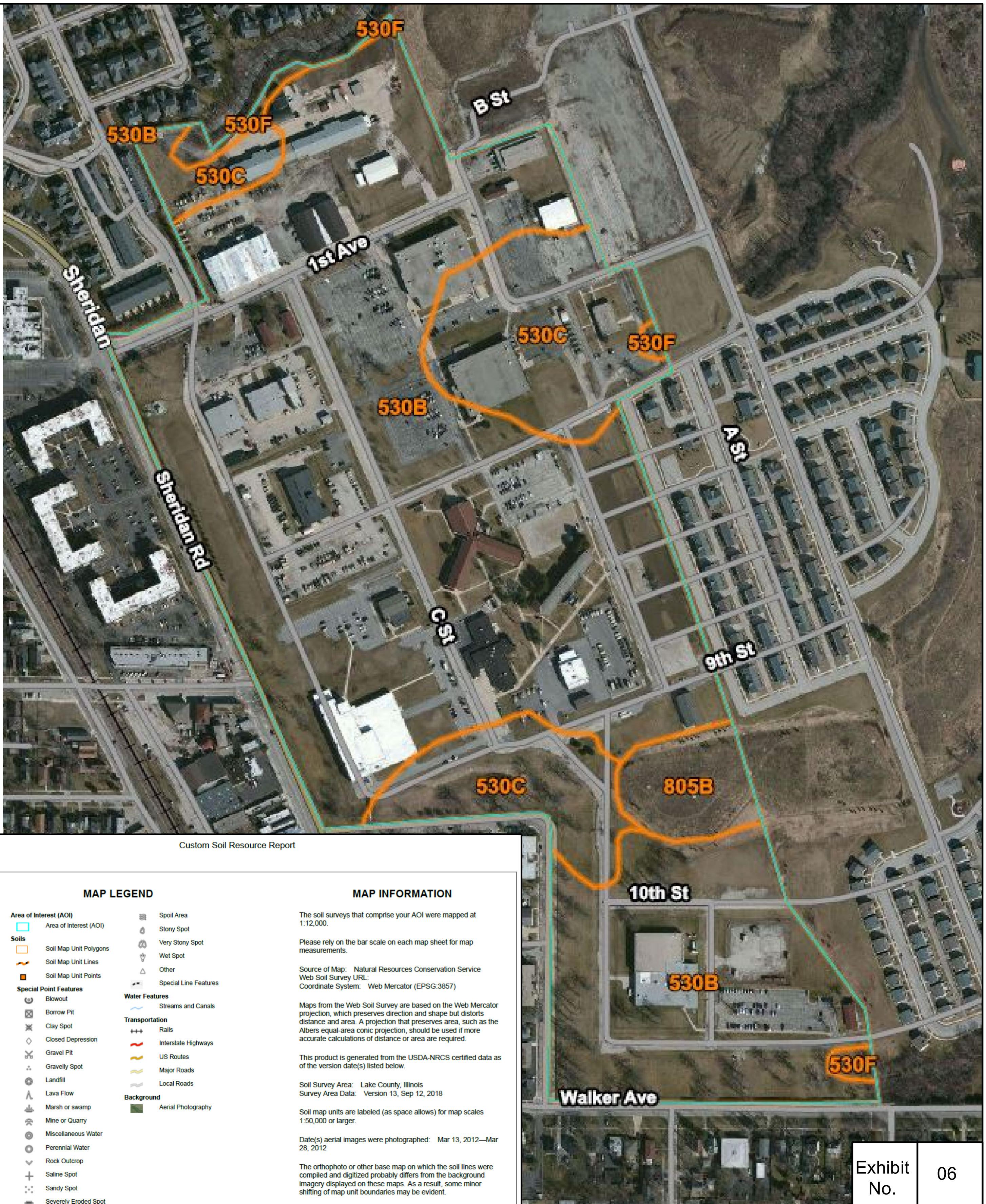

Custom Soil Resource Report

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 1:12,000.

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 and area are required.

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

Soil Survey Area: Lake County, Illinois
Survey Area Data: Version 13, Sep 12, 2018

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

Date(s) aerial images were photographed: Mar 13, 2012—Mar 28, 2012

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.

Exhibit No.	06
Scale N/A	N

Stanley Consultants	Exhibit Title:	Web Soil Survey Exhibit	Drawn by: BPD	Checked by: MDW	
			Project Title:	Sheridan USARC Stormwater Drainage Improvement Project	
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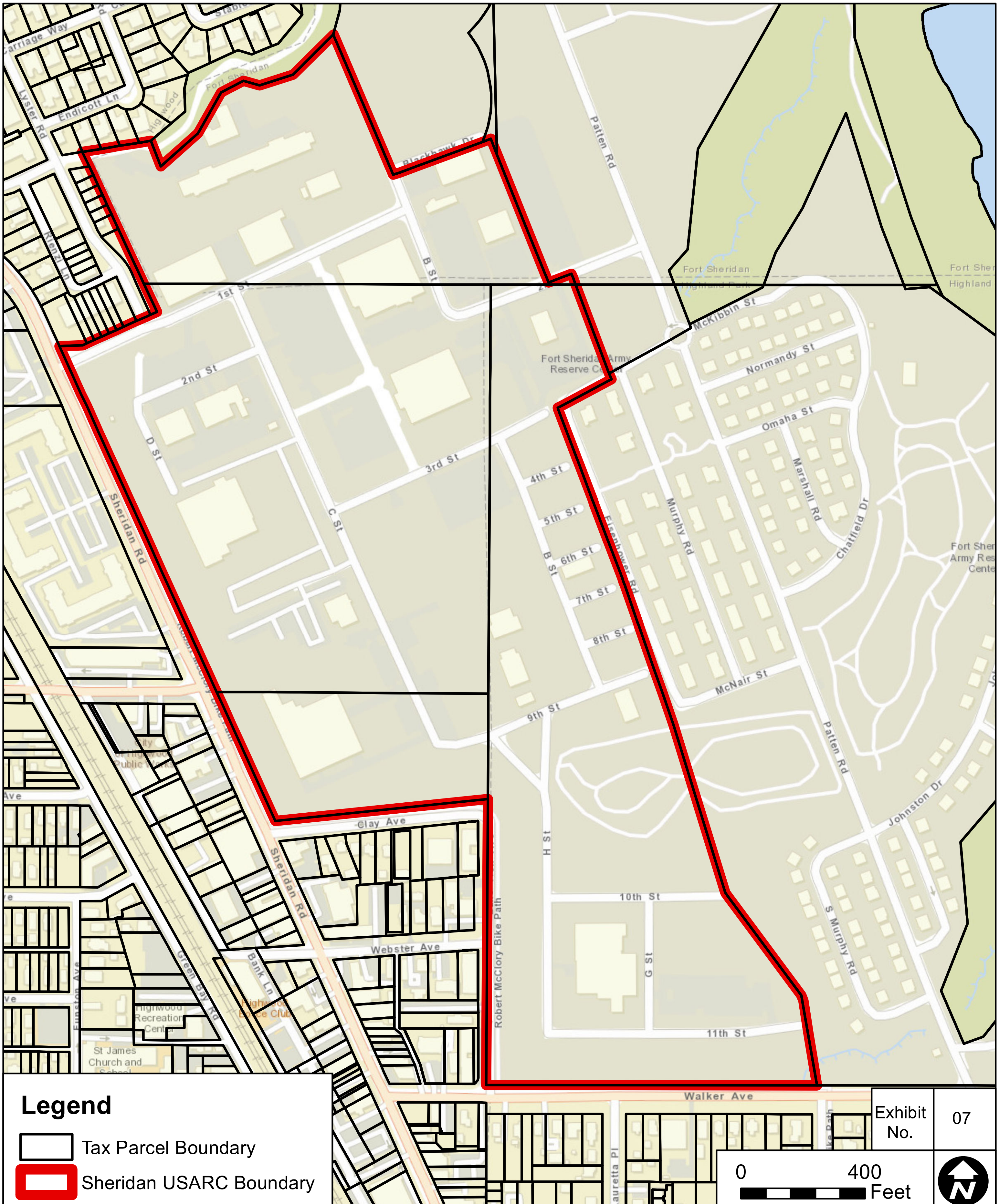
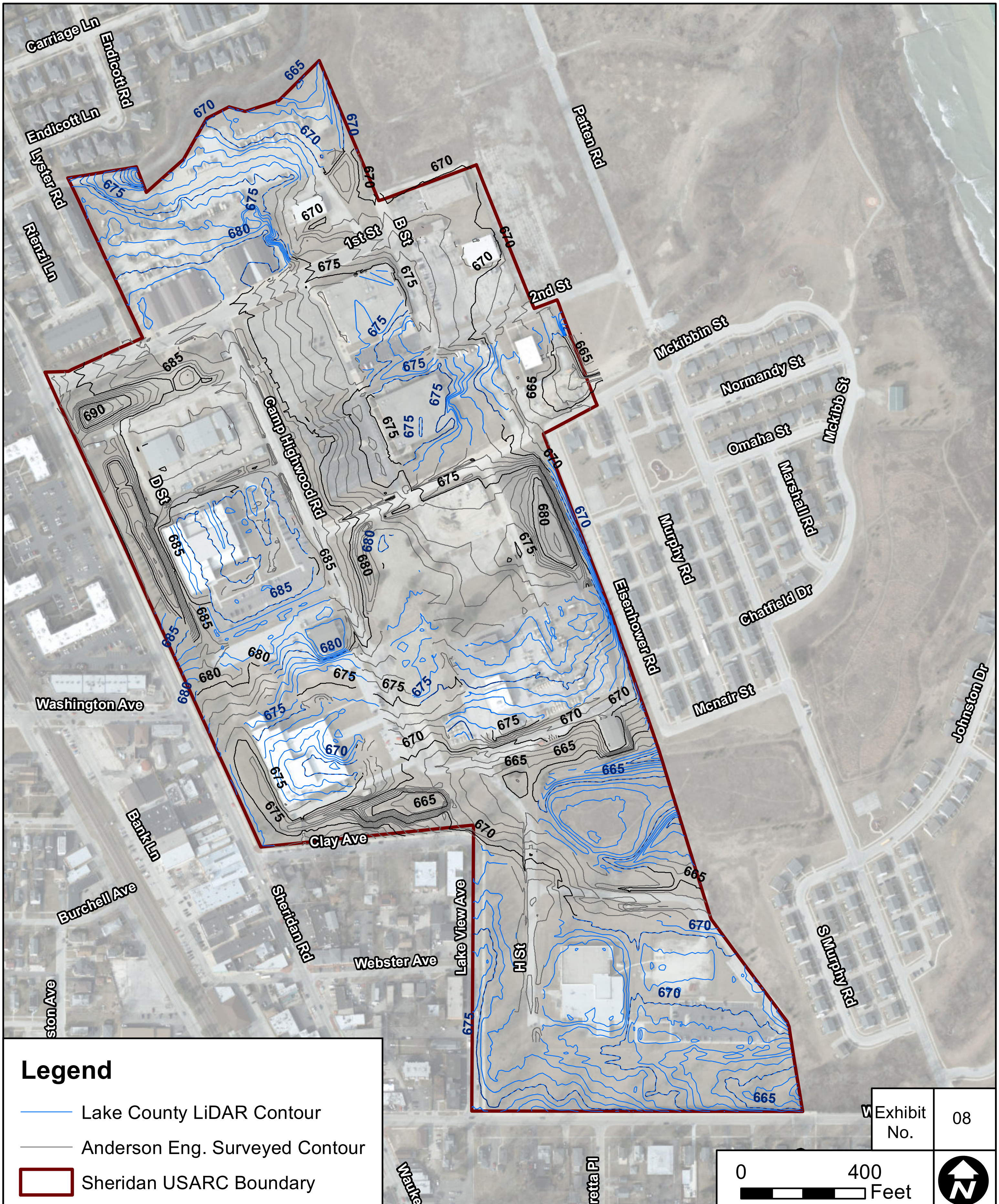


Legend

Tax Parcel Boundary

Sheridan USARC Boundary

Stanley Consultants	Exhibit Title:	Tax Parcel Exhibit	Drawn by: BPD	Checked by: MDW	
			Project Title:	Sheridan USARC Stormwater Drainage Improvement Project	
Filepath:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\Parcel.mxd		Project No: 28691.02.00	Date: 05/28/2020	



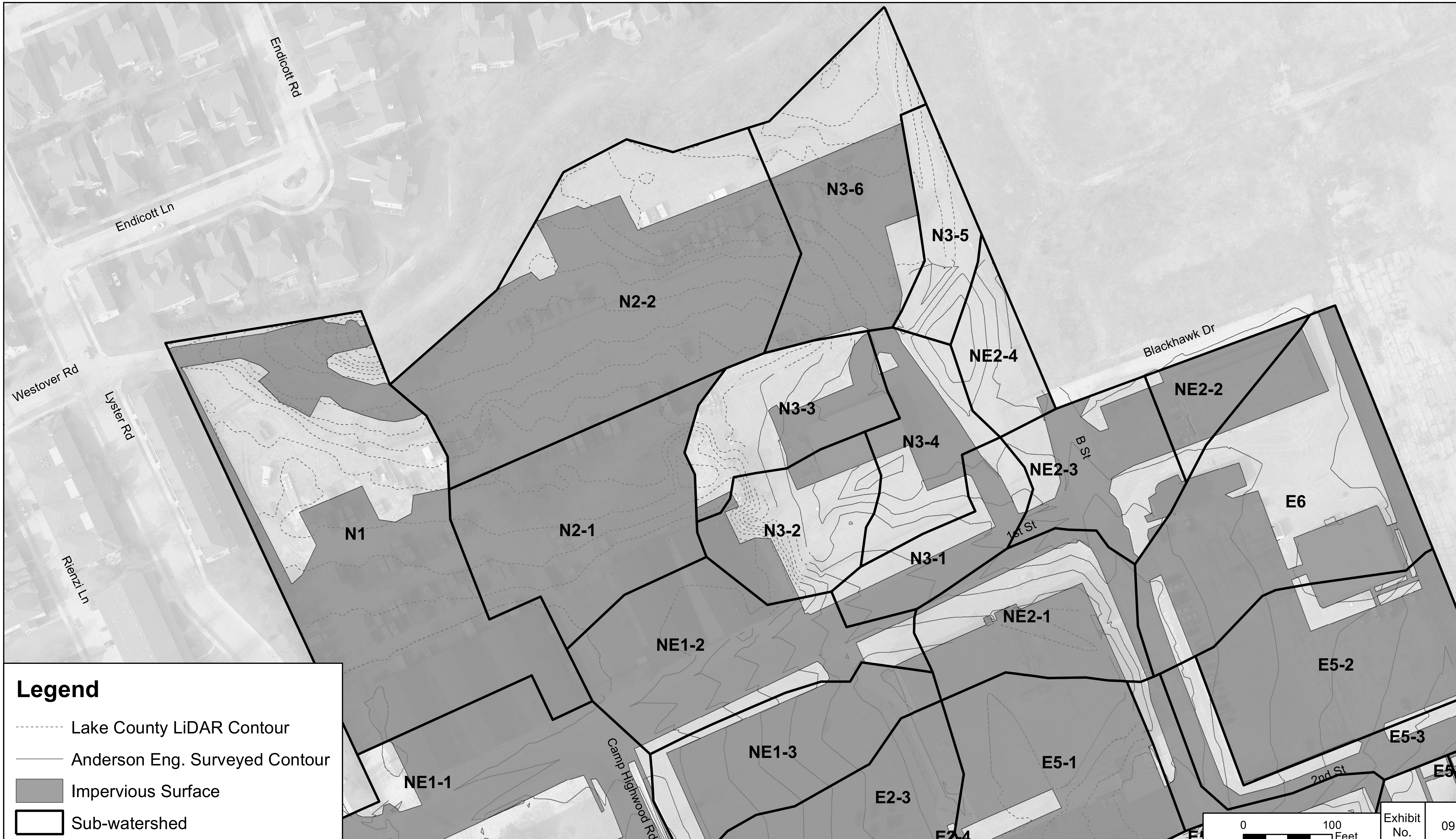
Legend

- Lake County LiDAR Contour
- Anderson Eng. Surveyed Contour
- Sheridan USARC Boundary

Stanley Consultants	Exhibit Title:	Topographic Exhibit	Drawn by: BPD	Checked by: MDW	Exhibit No. 08
			Project Title:	Sheridan USARC Stormwater Drainage Improvement Project	

Filepath: Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\Topo.mxd

Project No: 28691.02.00 | Date: 05/31/2020



Stanley Consultants	Exhibit Title:	Impervious Area Exhibit 1	Drawn by:	BPD	Checked by:	MDW
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	Source:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\EC1.mxd	Project No.:	28691.02.00	Date:	05/31/2020

Exhibit No. 09

Exhibit No.	10

Stanley Consultants

Exhibit Title:	Impervious Area Exhibit 2	Drawn by:	BPD	Checked by:	MDW
		Project Title:	Sheridan USARC Stormwater Drainage Improvement Project		
Source:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\EC2.mxd	Project No.:	28691.02.00	Date:	05/31/2020

Exhibit No.	11

Stanley Consultants

Exhibit Title:	Impervious Area Exhibit 3	Drawn by: BPD	Checked by: MDW
		Project Title:	Sheridan USARC Stormwater Drainage Improvement Project
Source:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\EC3.mxd	Project No.: 28691.02.00	Date: 05/31/2020

Exhibit No.	12

Stanley Consultants

Exhibit Title:	Impervious Area Exhibit 4	Drawn by: BPD	Checked by: MDW
		Project Title:	Sheridan USARC Stormwater Drainage Improvement Project
Source:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\EC4.mxd	Project No.: 28691.02.00	Date: 05/31/2020

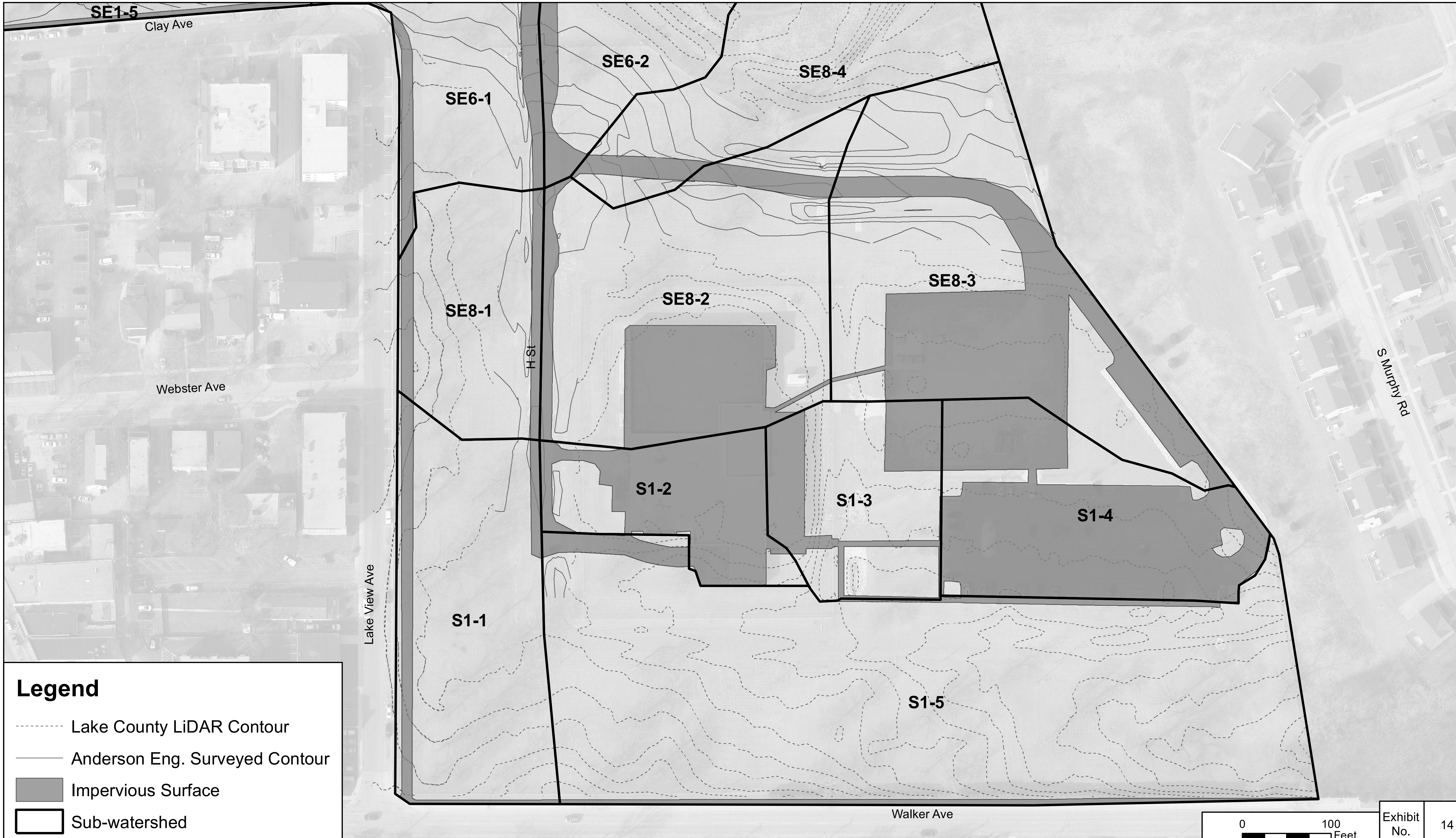
Legend

- Lake County LiDAR Contour
- Anderson Eng. Surveyed Contour
- Impervious Surface
- Sub-watershed

Exhibit No.	13

Stanley Consultants

Exhibit Title:	Impervious Area Exhibit 5	Drawn by: BPD	Checked by: MDW
		Project Title:	Sheridan USARC Stormwater Drainage Improvement Project
Source:	Document Path: C:\Users\9616\Documents\Projects\Stormwater Projects\Federal Business Unit - 28691.02 - Fort Sheridan\06-GIS\03-MXD\DA\EC5.mxd	Project No.: 28691.02.00	Date: 05/31/2020



Legend

- Lake County LiDAR Contour
- Anderson Eng. Surveyed Contour
- Impervious Surface
- Sub-watershed

Exhibit No.	14		
Drawn by:	BPD	Checked by:	MDW
Exhibit Title:	Impervious Area Exhibit 6	Project Title:	Sheridan USARC Stormwater Drainage Improvement Project
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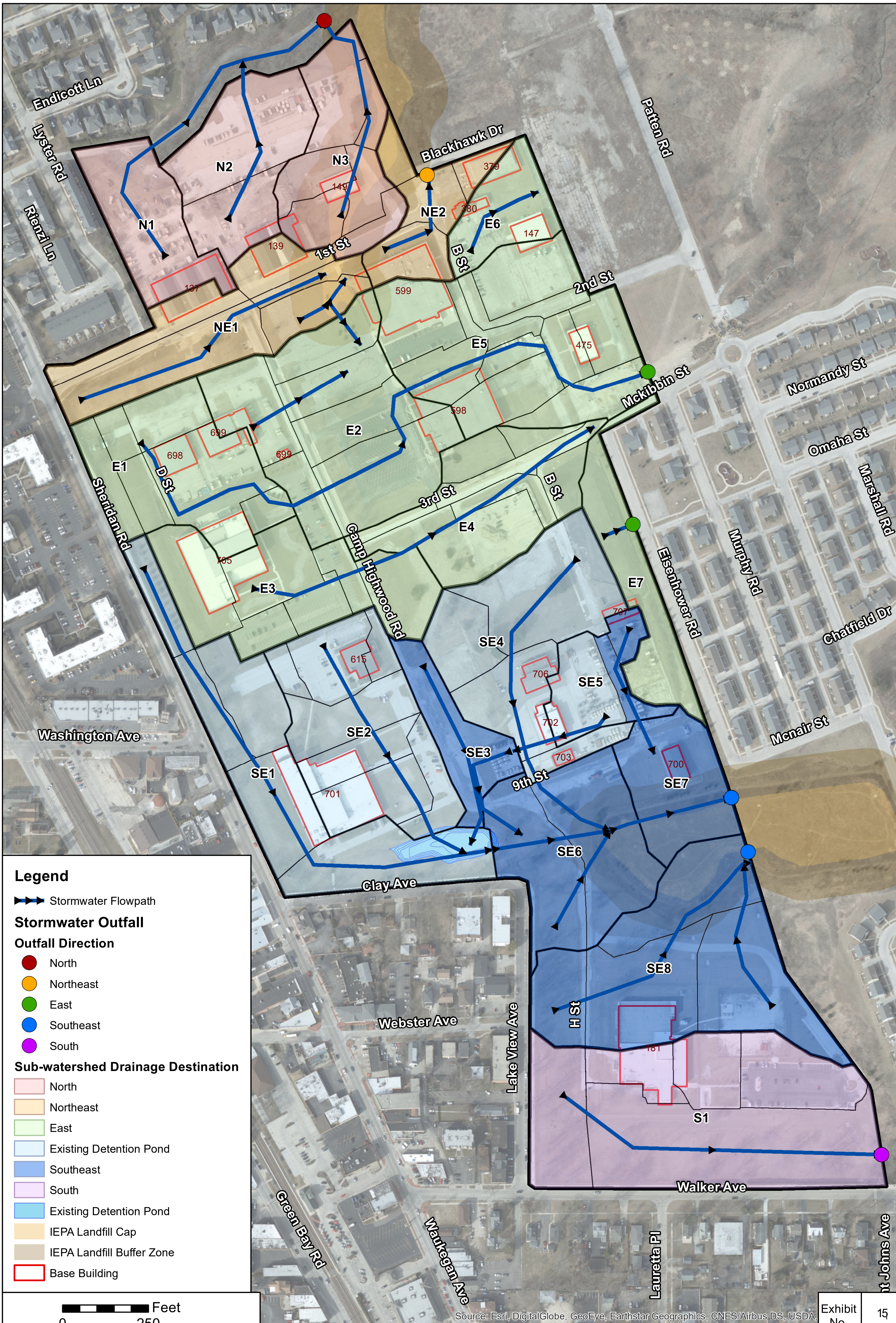
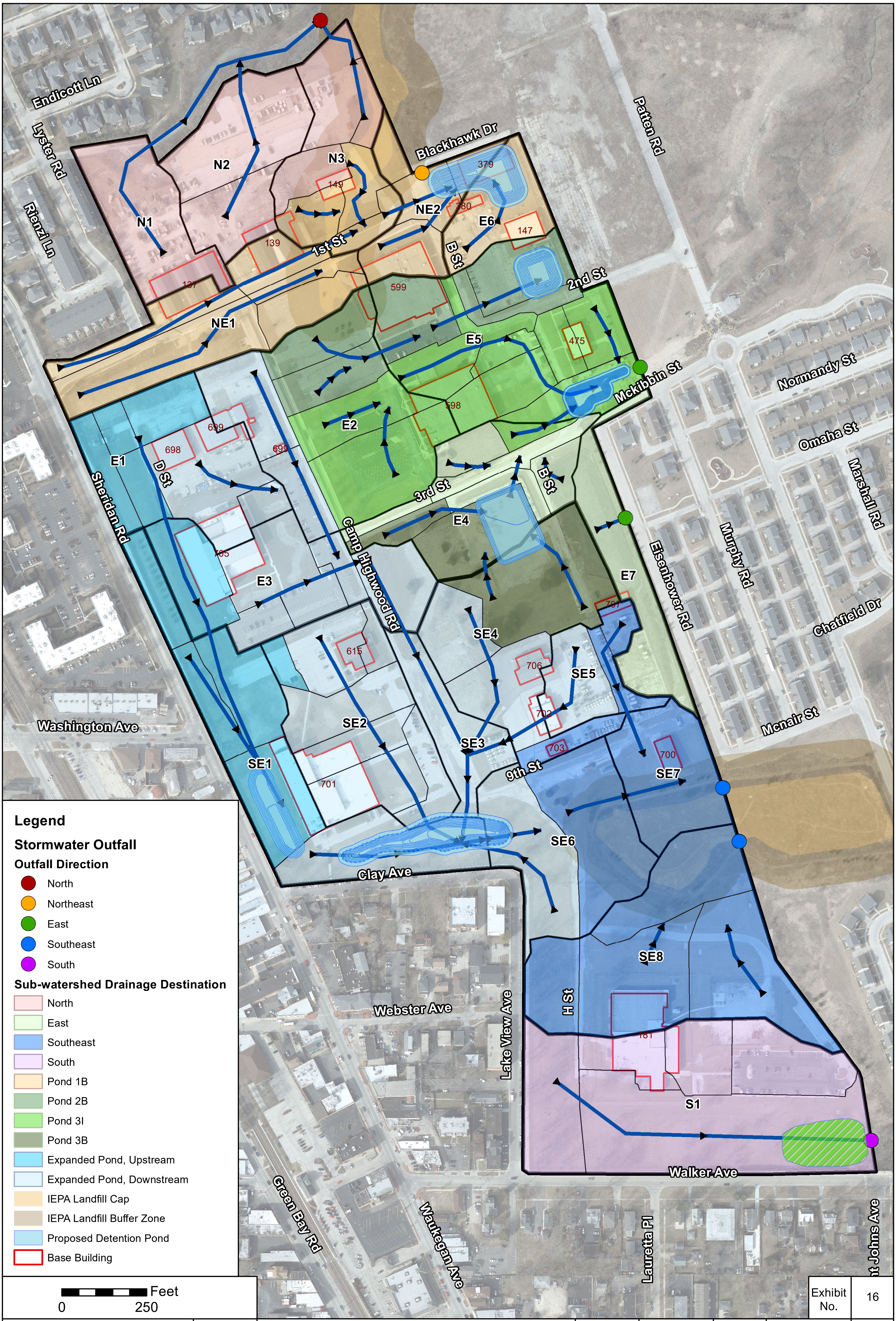
Stanley Consultants



Feet
0 250

Exhibit No.	15		
Stanley Consultants	Exhibit Title:	**Drainage Area Map Existing Conditions**	Drawn by: BPD · Checked by: JJM
			Project Title: Storm Water Runoff, Drainage Survey and Design for Fort Sheridan ARC, 88th Readiness Division
	Filepath:	pw://SCI-PWINTEG-2.stanleygroup.com:Datasource-1/Documents/D{af212629-0e92-49c9-9980-7746bf5afea1}	Project No.: 28691.02.00



Stanley Consultants	Exhibit Title:	**Drainage Area Map Proposed Conditions**	Drawn by: BPD	Checked by: JJM
			Project Title:	Storm Water Runoff, Drainage Survey and Design for Fort Sheridan ARC, 88th Readiness Division
	Filepath:	pw://SCI-PWINTEG-2.stanleygroup.com:Datasource-1/Documents/D{af212629-0e92-49c9-9980-7746bf5afea1}	Project No.:	28691.02.00

Exhibit No. 16

TAB 3

HYDROLOGIC ANALYSIS

3.0 Background

A detailed description of the process that went into the stormwater design analysis is documented in the Sheridan USARC Stormwater Drainage Improvements 100% Design Technical Report (Draft Report), provided in **Appendix C**. Descriptions regarding the hydrologic and hydraulic analyses, development of the existing conditions model, the conceptual improvements, and how the improvements were partitioned into minor, moderate, and major alternatives are described within the Draft Report. The three alternatives that were developed form the basis of the Major Alternative 100% Design Drawings. Following the 35% design submittal, Facility personnel indicated their desire for the Moderate and Major Alternatives to be completed to 65% design and for the Major Alternative to proceed to 100% design completion. The Design Analysis Calculations that are the basis of the proposed improvements described in the Technical Report are provided in **Appendix D**.

3.1 EPA SWMM Model

The Environmental Protection Agency's Stormwater Management Model (EPA SWMM) is the hydraulic and hydrologic (H&H) software that was used for the Project. EPA SWMM inputs and results for Existing Conditions and each of the 2 alternatives is provided in **Appendix E**. Section 3.10.2 of the EPA SWMM Reference Manual, Volume I (provided in **Appendix F** along with the other EPA SWMM Reference Manual Volumes), states that the Curve Number method's peak discharge computational methods are incompatible with EPA SWMM's approach. Therefore, the Green Ampt Method was infiltration method used within the Model.

3.10.2 SCS Curve Number Method

The SCS (Soil Conservation Service, now known as the Natural Resources Conservation Service) Curve Number method is a widely used procedure for computing runoff from single-event design storms. As implemented in NRCS's TR-55 manual (NRCS, 1986) it consists of three separate runoff–related computations: one computes total runoff volume for any given rainfall event while the other two estimate a peak discharge and a runoff hydrograph for a synthetic 24-hour design storm with a given return period. These latter two computations utilize a kinematic wave approach to overland flow as well as a standard 24-hour design storm time distribution and are therefore incompatible with SWMM's approach to generating runoff hydrographs. SWMM can however, approximate the Curve Number method's estimate of total runoff volume from a subcatchment by doing the following:

The use of the Green Ampt Method influenced how hydrologic parameters were quantified. Inputs such as the percentage of impervious area and the roughness (manning's n value) of a subcatchment were entered into the Model instead of a Curve Number. Similarly, inputs such as the average width, slope, and again roughness (manning's n value) were entered into the Model instead of a time of concentration (t_c).

3.2 Green Ampt Method

The Green Ampt Method is based on the assumption that water infiltrates into relatively dry soil as a sharp wetting front, and that the infiltration capacity decreases as the storm progresses and the soil becomes wetter. The soil parameters that are applied for the Green Ampt infiltration method include:

K_s – Saturated Hydraulic Conductivity (in/hr)

Ψ_s – Suction Head at the wetting front (in or mm)

Θ_{dmax} – Maximum Moisture Deficit available (volume of dry voids per volume of soil)

Note: Θ_{dmax} is also known as Effective Porosity (ϕ_e)

Table 4-7 in Section 4.4.4 of the EPA SWMM Reference Manual, Volume I, provides value inputs for the three soil parameters. The values for the Silt loam soil class were selected for the Model as this is the reported soil type for the Project site.

Due to the ongoing construction-related-earthwork performed on-site, a 50% factor of safety was applied to the saturated hydraulic conductivity value listed in the table. This was done to better represent the compacted nature of the soils.

When repeated storm events occur, it is typically the subsequent storms that result in flooding. This is due to the soils becoming fully saturated from the first storm thus reducing their absorptive capacity for the subsequent storms which results in more precipitation manifesting as runoff instead filtering into the ground. To account for this the minimum Effective Porosity value was selected for the Model.

The Green Ampt Parameters used within the Model are listed below:

K_s	=	0.13 in/hr
Ψ_s	=	6.57 in
Θ_{dmax}	=	0.21

Table 4-7 Green-Ampt parameters for different soil classes (Rawls et al., 1983)

(Numbers in parentheses are ± one standard deviation from the parameter value shown.)

Soil Class	Porosity, ϕ	Effective Porosity, ϕ_e*	Wetting Front Suction Head, ψ_s (in)	Saturated Hydraulic Conductivity, K_s (in/hr)
Sand	0.437 (0.374–0.500)	0.417 (0.354–0.480)	1.95 (0.38–9.98)	4.74
Loamy sand	0.437 (0.363–0.506)	0.401 (0.329–0.473)	2.41 (0.53–11.00)	1.18
Sandy loam	0.453 (0.351–0.555)	0.412 (0.283–0.541)	4.33 (1.05–17.90)	0.43
Loam	0.463 (0.375–0.551)	0.434 (0.334–0.534)	3.50 (0.52–23.38)	0.13
Silt loam	0.501 (0.420–0.582)	0.486 (0.394–0.578)	6.57 (1.15–37.56)	0.26
Sandy clay loam	0.398 (0.332–0.464)	0.330 (0.235–0.425)	8.60 (1.74–42.52)	0.06
Clay loam	0.464 (0.409–0.519)	0.309 (0.279–0.501)	8.22 (1.89–35.87)	0.04
Silty clay loam	0.471 (0.418–0.524)	0.432 (0.347–0.517)	10.75 (2.23–51.77)	0.04
Sandy clay	0.430 (0.370–0.490)	0.321 (0.207–0.435)	9.41 (1.61–55.20)	0.02
Silty clay	0.479 (0.425–0.533)	0.423 (0.334–0.512)	11.50 (2.41–54.88)	0.02
Clay	0.475 (0.427–0.523)	0.385 (0.269–0.501)	12.45 (2.52–61.61)	0.01

*Effective porosity is the difference between the porosity ϕ and the residual moisture content ϕ_r that remains after a saturated soil is allowed to drain thoroughly.

3.3 Rainfall Data

Precipitation Frequency Data was obtained from the updated Bulletin 70 for the northeast section of Illinois, which is provided in **Appendix G**.

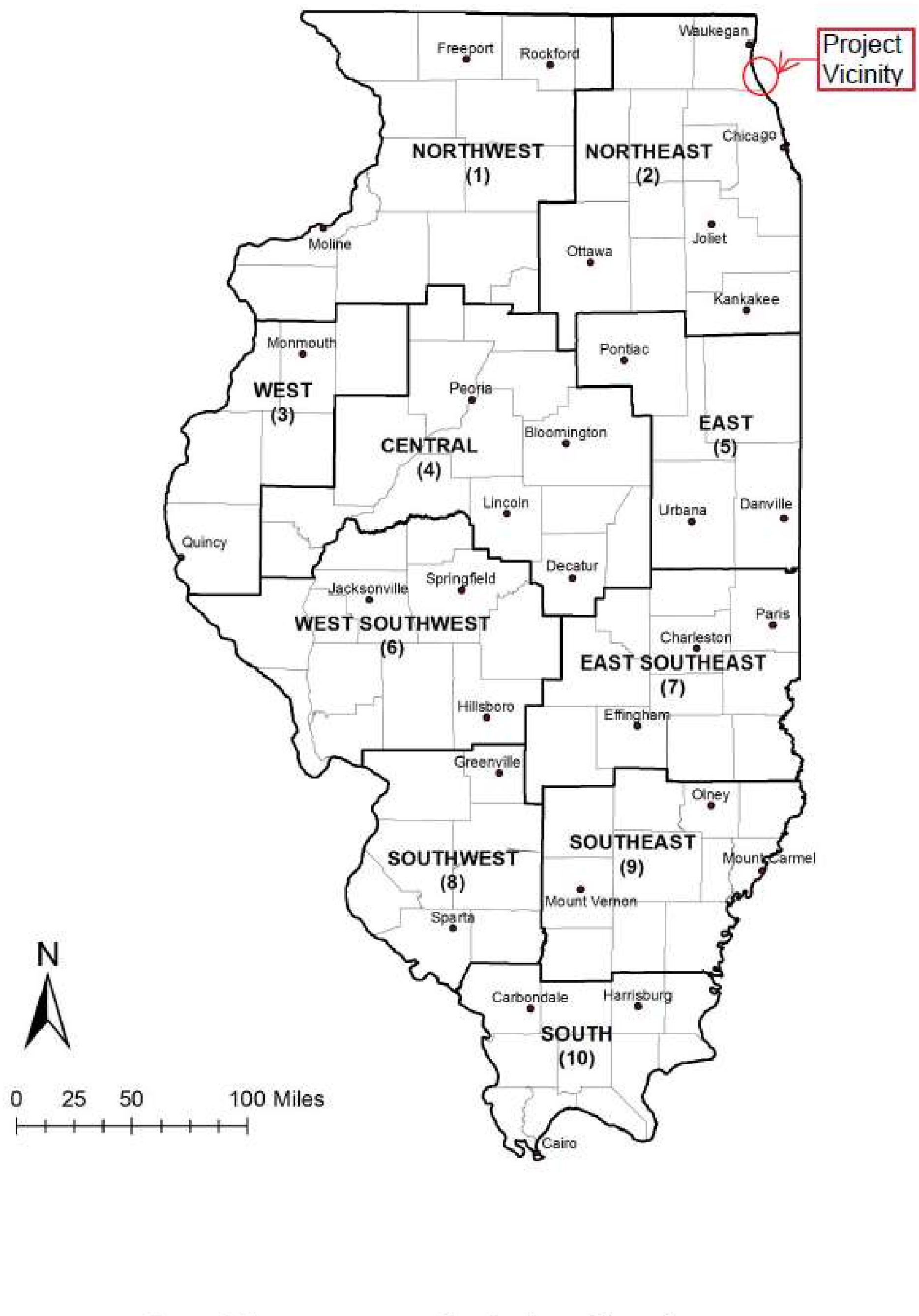


Figure 1 Climatic sections used in developing Illinois frequency estimates

Precipitation Frequency Data was obtained for the following storm durations: 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, 24-hour, and 48-hour

Frequency Estimates

To determine the precipitation frequency, the previously described regional frequency analysis was applied to the AMS data. The results were then converted to the PDS domain based on the relationship defined in Eq. 1 and adjusted for the trend (Eq. 3). These results, however, still had occasional minor inconsistencies caused by several factors, such as variable data length for different durations, which resulted in irregular frequency curves. To produce the final curves, these irregularities had to be smoothed out, which was done based on the authors' professional judgment and knowledge of specific regions and gages.

The results for all sections are shown in the following tables. Table 4 displays the key for the codes used in Table 5 where the results are presented numerically. The results are shown graphically in Figures 8–12.

Table 4 Storm and Sectional Codes for Table 5

Storm Code		Sectional Code	
1	240 hours	1	Northwest
2	120 hours	2	Northeast
3	72 hours	3	West
4	48 hours	4	Central
5	24 hours	5	East
6	18 hours	6	West Southwest
7	12 hours	7	Southeast
8	6 hours	8	Southwest
9	3 hours	9	Southeast
10	2 hours	10	South
11	1 hour		

The 24-hour duration was obtained to analyze the 2-year, 10-year, 50-year, and 100-year storm events. The remaining durations were obtained to perform a critical duration analysis for the 100-year storm.

	Storm code	Section code	Rainfall (inches) for given recurrence interval 2-year	5-year	10-year	25-year	50-year	100-year	500-year
48hrs	4	1	3.61	4.59	5.43	6.72	7.73	8.83	11.53
	4	2	3.66	4.71	5.62	6.99	8.13	9.28	12.10
	4	3	3.76	4.76	5.62	6.81	7.72	8.60	10.58
	4	4	3.59	4.61	5.47	6.65	7.55	8.40	10.21
	4	5	3.54	4.49	5.32	6.48	7.38	8.27	10.26
	4	6	3.66	4.61	5.38	6.48	7.33	8.11	9.93
	4	7	3.92	4.85	5.61	6.67	7.46	8.21	9.76
	4	8	4.28	5.29	6.10	7.25	8.15	9.08	11.40
	4	9	4.64	5.54	6.27	7.24	7.94	8.58	10.06
	4	10	4.06	5.02	5.86	7.04	8.01	9.02	11.56
24hrs	5	1	3.34	4.22	5.03	6.20	7.20	8.25	10.84
	5	2	3.34	4.30	5.15	6.45	7.50	8.57	11.24
	5	3	3.48	4.45	5.24	6.38	7.25	8.06	9.91
	5	4	3.32	4.30	5.10	6.20	7.05	7.85	9.53
	5	5	3.12	3.97	4.71	5.78	6.62	7.43	9.32
	5	6	3.23	4.07	4.76	5.79	6.56	7.31	9.04
	5	7	3.49	4.33	5.00	5.98	6.71	7.40	8.84
	5	8	3.69	4.56	5.27	6.30	7.14	7.96	10.06
	5	9	4.07	4.89	5.55	6.42	7.06	7.68	8.99
	5	10	3.63	4.52	5.28	6.38	7.29	8.23	10.57
18hrs	6	1	3.14	3.97	4.73	5.83	6.77	7.75	10.19
	6	2	3.14	4.04	4.84	6.06	7.05	8.06	10.57
	6	3	3.27	4.18	4.93	6.00	6.82	7.58	9.32
	6	4	3.12	4.04	4.79	5.83	6.63	7.38	8.96
	6	5	2.93	3.73	4.43	5.43	6.22	6.98	8.76
	6	6	3.04	3.83	4.47	5.44	6.17	6.87	8.50
	6	7	3.28	4.07	4.70	5.62	6.31	6.96	8.31
	6	8	3.47	4.29	4.95	5.92	6.71	7.48	9.45
	6	9	3.83	4.60	5.22	6.03	6.64	7.22	8.45
	6	10	3.41	4.25	4.96	6.00	6.85	7.73	9.93

	Storm code	Section code	Rainfall (inches) for given recurrence interval 2-year	5-year	10-year	25-year	50-year	100-year	500-year
12hrs	7	1	2.91	3.67	4.38	5.40	6.26	7.18	9.43
	7	2	2.91	3.74	4.48	5.61	6.53	7.46	9.78
	7	3	3.03	3.87	4.56	5.55	6.31	7.01	8.62
	7	4	2.89	3.74	4.44	5.39	6.13	6.83	8.29
	7	5	2.71	3.45	4.10	5.03	5.76	6.46	8.11
	7	6	2.81	3.54	4.14	5.04	5.71	6.36	7.86
	7	7	3.04	3.77	4.35	5.20	5.84	6.44	7.69
	7	8	3.21	3.97	4.58	5.48	6.21	6.93	8.75
	7	9	3.54	4.25	4.83	5.59	6.14	6.69	7.82
	7	10	3.16	3.93	4.59	5.55	6.34	7.16	9.19
6hrs	8	1	2.51	3.17	3.77	4.65	5.40	6.19	8.13
	8	2	2.51	3.23	3.86	4.84	5.63	6.43	8.43
	8	3	2.61	3.34	3.93	4.79	5.44	6.05	7.43
	8	4	2.49	3.23	3.83	4.65	5.29	5.89	7.15
	8	5	2.34	2.98	3.53	4.34	4.97	5.57	6.99
	8	6	2.42	3.05	3.57	4.34	4.92	5.48	6.78
	8	7	2.62	3.25	3.75	4.49	5.03	5.55	6.63
	8	8	2.77	3.42	3.95	4.73	5.36	5.97	7.54
	8	9	3.05	3.67	4.16	4.82	5.30	5.76	6.74
	8	10	2.72	3.39	3.96	4.79	5.47	6.17	7.92
3hrs	9	1	2.14	2.70	3.22	3.97	4.61	5.28	6.94
	9	2	2.14	2.75	3.30	4.13	4.80	5.49	7.20
	9	3	2.23	2.85	3.35	4.08	4.64	5.16	6.34
	9	4	2.12	2.75	3.26	3.97	4.51	5.02	6.10
	9	5	2.00	2.54	3.01	3.70	4.24	4.76	5.97
	9	6	2.07	2.60	3.05	3.71	4.20	4.68	5.79
	9	7	2.23	2.77	3.20	3.83	4.29	4.74	5.66
	9	8	2.36	2.92	3.37	4.03	4.57	5.09	6.44
	9	9	2.60	3.13	3.55	4.11	4.52	4.92	5.75
	9	10	2.32	2.89	3.38	4.09	4.66	5.26	6.76

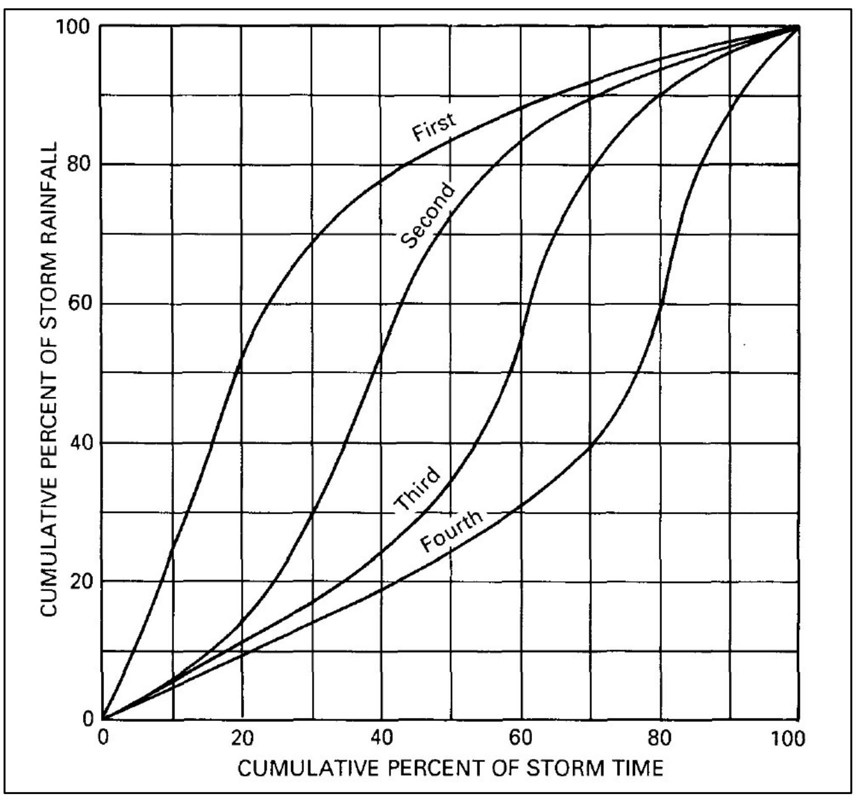
		Rainfall (inches) for given recurrence interval						
Storm code	Section code	2-year	5-year	10-year	25-year	50-year	100-year	500-year
2hrs 10	1	1.94	2.45	2.92	3.60	4.17	4.78	6.29
10	2	1.94	2.49	2.99	3.74	4.35	4.97	6.52
10	3	2.02	2.58	3.04	3.70	4.21	4.67	5.75
10	4	1.93	2.49	2.96	3.60	4.09	4.55	5.53
10	5	1.81	2.30	2.73	3.35	3.84	4.31	5.41
10	6	1.87	2.36	2.76	3.36	3.80	4.24	5.24
10	7	2.02	2.51	2.90	3.47	3.89	4.29	5.13
10	8	2.14	2.64	3.06	3.65	4.14	4.62	5.83
10	9	2.36	2.84	3.22	3.72	4.09	4.46	5.21
10	10	2.10	2.62	3.06	3.70	4.23	4.77	6.13
1hrs 11	1	1.57	1.98	2.36	2.92	3.38	3.88	5.09
11	2	1.57	2.02	2.42	3.03	3.53	4.03	5.28
11	3	1.64	2.09	2.46	3.00	3.41	3.79	4.66
11	4	1.56	2.02	2.40	2.91	3.31	3.69	4.48
11	5	1.47	1.87	2.21	2.72	3.11	3.49	4.38
11	6	1.52	1.91	2.24	2.72	3.08	3.44	4.25
11	7	1.64	2.04	2.35	2.81	3.15	3.48	4.15
11	8	1.73	2.14	2.48	2.96	3.36	3.74	4.73
11	9	1.91	2.30	2.61	3.02	3.32	3.61	4.23
11	10	1.71	2.12	2.48	3.00	3.43	3.87	4.97

Time Distribution data was obtained from the original Bulletin 70 document as the updated values were not published until December 2019.

Table 37. Average Time Distributions of Heavy Rainfall at a Point

Cumulative percent of storm time	Cumulative percent of storm rainfall for given storm type* First-quartile	Second-quartile	Third-quartile	Fourth-quartile
5	12	4	3	2
10	26	9	6	5
15	40	14	10	8
20	51	19	13	10
25	59	25	16	13
30	65	32	20	16
35	71	40	23	18
40	75	52	27	21
45	78	61	33	24
50	82	68	39	28
55	84	73	46	32
60	87	78	56	35
65	89	82	68	40
70	91	86	79	44
75	93	89	85	50
80	95	92	89	58
85	96	94	92	68
90	97	96	95	83
95	99	98	98	93

**Storms were categorized as first-, second-, third-, or fourth-quartile storms depending on whether the maximum rainfall occurred in the first, second, third, or fourth quarter of the storm.*



Based on Huff's research:

1. Storm durations of 6 hours or less correspond to a first-quartile distribution.
2. Storm durations from 6.1-12 hours correspond to a second-quartile distribution.
3. Storm durations from 12.1-24 hours correspond to a third-quartile distribution.
4. Storm durations greater than 24 hours correspond to a fourth-quartile distribution.

This analysis utilizes the third-quartile distribution for the 24-hour duration of the 2-year, 10-year, 50-year, and 100-year design storms. All four quartile distributions are applied to the appropriate duration when used for the critical duration analysis

Return Period (yr)	Duration (hr)	Huff Quartile	Precipitation Frequency Value (in)
2	2*	I	1.94
	24	III	3.34
10	24	III	5.15
50	24	III	7.50
100	1	I	4.03
	2	I	4.97
	3	I	5.49
	6	I	6.43
	12	II	7.46
	18	II	8.06
	24	III	8.57
	48	IV	9.28

*A 2-yr, 2-hr real-world storm event occurred in October 2019. This design storm is included for Model verification purposes.

3.4 Survey Data

Lake County Light Detection and Ranging (LiDAR) topographic data was used for the preliminary design of the Project. This was supplemented by surveyed topographic data that was performed by Anderson Engineering throughout approximately half of Sheridan USARC and focused on areas of the proposed improvements. Utility survey was also performed by Anderson Engineering. Both the utility and topographic survey source data are provided in **Appendix A**.

3.5 Sub-watershed Data

Sub-watershed data that was input into the Model is provided below. The associated hydrologic parameters include each sub-watershed's area, percentage of impervious area, average width, and average slope.

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
N1	2.52	1.68	67	N1	2.52	1.68	67	225	2.4
N2	3.49	3.07	88	N2-1	1.17	1.17	100	270	2.0
				N2-2	2.32	1.90	82	400	2.6
N3	3.61	1.52	42	N3-1	0.42	0.24	57	70	1.5
				N3-2	0.59	0.20	34	150	5.0
				N3-3	0.63	0.21	33	125	2.4
				N3-4	0.54	0.23	43	100	1.4
				N3-5	0.33	0.00	0	560	1.1
				N3-6	1.10	0.64	58	145	2.7
NE1	4.72	2.89	61	NE1-1N	0.84	0.73	87	30	1.2
				NE1-1S	2.01	0.63	31	130	1.2
				NE1-2N	0.72	0.70	98	30	1.7
				NE1-2S	0.35	0.22	62	30	1.7
				NE1-3	0.80	0.67	84	110	2.3
NE2	2.00	1.18	59	NE2-1	0.80	0.52	65	330	4.5
				NE2-2	0.28	0.25	89	75	0.5
				NE2-3	0.62	0.41	66	175	1.5
				NE2-4	0.30	0.00	0	230	1.6
E1	4.56	2.41	53	E1-1	0.66	0.08	12	375	3.3
				E1-2	0.32	0.05	16	180	4.0
				E1-3	0.78	0.42	54	450	0.4
				E1-4	0.46	0.05	11	220	4.4
				E1-5	2.02	1.74	86	600	1.2
				E1-6	0.32	0.07	22	100	1.0
E2	6.94	5.02	72	E2-1	1.26	0.88	70	315	0.5
				E2-2	0.66	0.45	68	275	2.7
				E2-3	0.94	0.87	93	110	3.0
				E2-4	0.88	0.71	81	100	3.0
				E2-5	1.14	0.77	68	110	3.4
				E2-6	2.06	1.34	65	200	3.4
E3	4.82	2.21	46	E3-1	1.27	0.49	38	720	5.5
				E3-2	0.44	0.34	77	360	0.7
				E3-3	1.19	0.31	26	265	1.2
				E3-4	0.48	0.4	83	350	0.7
				E3-5	0.39	0.28	72	220	1.5
				E3-6	1.05	0.39	37	530	5.8
E4	4.24	2.29	54	E4-1	0.41	0.16	39	40	2.1
				E4-2	1.38	1.34	98	200	1.1
				E4-3	0.43	0.26	60	50	1.25
				E4-4	0.22	0.13	59	40	2.8
				E4-5	0.50	0.02	4	205	1.3

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
				E4-6	0.25	0.02	8	50	2.1
				E4-7	0.47	0.08	17	110	3.3
				E4-8	0.58	0.28	48	40	1.6
E5	7.36	5.09	69	E5-1	1.14	1.08	95	240	1.7
				E5-2	1.17	1.08	92	200	1.6
				E5-3	0.45	0.30	67	45	1.8
				E5-4	0.72	0.24	33	410	1.4
				E5-5	0.78	0.33	42	520	0.9
				E5-6	0.31	0.28	90	70	2.9
				E5-7	0.98	0.69	70	140	4.2
				E5-8	0.36	0.22	61	35	1.4
				E5-9	0.47	0.20	43	200	1.0
				E5-10	0.98	0.67	68	100	2.9
E6	1.60	1	63	E6	1.60	1.00	63	125	1.3
E7	2.22	0.46	21	E7	2.22	0.46	21	600	10.4
SE1	6.08	1	13	SE1-1	0.62	0.10	16	360	1.0
				SE1-2	0.64	0.00	0	75	2.6
				SE1-3	1.22	0.20	16	150	2.4
				SE1-4	1.42	0.39	27	600	1.4
				SE1-5	2.18	0.31	14	1,200	1.7
SE2	5.40	2.94	53	SE2-1	0.24	0.17	71	70	2.7
				SE2-2	1.04	0.87	84	120	2.3
				SE2-3	0.30	0.10	33	60	2.2
				SE2-4	1.21	0.27	22	200	3.0
				SE2-5	0.80	0.46	58	100	0.6
				SE2-6	1.13	0.65	58	130	2.5
				SE2-7	0.68	0.42	62	75	1.5
SE3	1.63	1.34	82	SE3	1.63	1.34	82	100	2.7
SE4	5.52	3.35	61	SE4-1	2.62	0.98	38	320	0.9
				SE4-2	1.00	0.70	70	190	1.1
				SE4-3	1.45	1.26	87	125	1.7
				SE4-4	0.45	0.41	91	40	1.1
SE5	1.79	1.79	100	SE5-1	0.31	0.31	100	110	1.5
				SE5-2	0.35	0.35	100	40	1.4
				SE5-3	1.13	1.13	100	180	1.8
SE6	4.66	0.89	19	SE6-1	2.14	0.42	20	450	2.2
				SE6-2	2.52	0.47	19	950	2.9
SE7	2.41	0.49	20	SE7	2.41	0.49	20	500	4.8
SE8	7.43	1.91	26	SE8-1	0.98	0.13	13	290	2.6
				SE8-2	2.26	0.79	35	325	1.4
				SE8-3	2.43	0.99	41	250	2.5
				SE8-4	1.76	0.00	0	550	2.6
S1	9.64	2.59	27	S1-1	1.64	0.18	11	550	1.1
				S1-2	0.77	0.60	78	240	0.5
				S1-3	0.93	0.31	33	200	2.0
				S1-4	1.44	1.25	87	370	1.6
				S1-5	4.86	0.25	5	230	1.2
Total	**92.64**	**45.12**	**48**						

3.6 Hydraulic Data

Generally, the hydraulic parameters input into the Model consist of a series of nodes and links. Nodes can represent manhole structures, stormwater outfalls, or detention ponds. Links can represent conduits that represent a storm sewer pipe or a drainage ditch, or weirs. The information for the nodes and links that were input into the Model was obtained from the survey data performed by Anderson Engineering. An AutoCAD dwg file containing this survey data is included in **Appendix A**. A summary of the input data is provided below. An EPA SWMM Summary Report containing the hydraulic data input into the Model, amongst other input and output data, is included in **Appendix E**. Brief descriptions of the pertinent inputs for the nodes and junctions are provided below and are obtained from the EPA SWMM User's Manual Version 5.1 – **Appendix F**. Typical values used for hydraulic parameters that required engineering judgement including Manning's Roughness Coefficients, Energy Loss Coefficients, and Stage-Storage Curves for the detention ponds, are also provided.

3.6.1 Nodes

<u>Junctions</u>

Invert El.: Invert elevation of the junction.

Max Depth: Maximum depth of junction (i.e., from ground surface to invert).

Ponded Area: Area occupied by ponded water atop the junction after flooding occurs (sq. feet or sq. meters). This parameter will allow ponded water to be stored and subsequently returned to the conveyance system when capacity exists.

<u>Outfalls</u>

Invert El.: Invert elevation at the outfall (feet or meters).

Type: Type of outfall boundary condition.

Free: Outfall stage determined by minimum of critical flow depth and normal flow depth in the connecting conduit. (This type is used when there is a substantial change in elevation at the outfall).

Normal: Outfall stage based on normal flow depth in connecting conduit. (This type is used when there is no substantial change in elevation at the outfall).

Storage Nodes

Invert El.: Elevation of the bottom of the storage unit (feet or meters).

Max Depth: Maximum depth of the storage unit (feet or meters).

Storage Curve: Method of describing how the surface area of the storage unit varies with water depth. TABULAR method uses tabulated area versus depth curve. In either case, depth is measured in feet (or meters) above the bottom and surface area in sq. feet (or sq. meters).

*Stage-storage curves for the existing detention pond, the proposed expanded detention pond, the proposed pond located at 3rd Street and B Street, and the proposed pond located at 1st Street and B Street are provided in **Appendix D**.

3.6.2 Links

Conduits

Max Depth: Maximum depth of the conduit's cross section (i.e. pipe diameter / ditch depth).

Length: Conduit length.

Roughness: Manning's roughness coefficient. Typical values provided below.

Flow Type	Surface Type	Manning's n value	Source
Overland	Impervious (asphalt / concrete)	0.011	EPA SWMM User's Manual Version 5.1, (A.6 Manning's n – Overland Flow)
	Pervious (turf grass)	0.24	
	Woods (light underbrush)	0.40	
Open Channel	PVC Pipe	0.009	Engineeringtoolbox.com/mannings-roughness-d_799.html
	RCP (new)	0.013	EPA SWMM User's Manual Version 5.1, (A.7 Manning's n – Closed Conduits)
	RCP (old/existing)	0.014	Stormwater Drainage Manual: Table 4.2.1-I.
	Drainage Ditch (new)	0.018	Stormwater Drainage Manual: Table 4.2.1-III.
	Drainage Ditch (old/existing)	0.035	Stormwater Drainage Manual: Table 4.2.1-IV

Entry/Exit Loss Coefficient (K Value): Head loss coefficient associated with energy losses at the entrance/exit of the conduit. Typical values provided below.

Location	K Value
Culvert Entrance	0.5
Culvert Exit	0.3 (In-line)
	1.0 (Still-water)
Storm sewer (In-line)	0.2
Storm sewer inlet	0.2
90° bend	1.1
45° bend	0.4

Source: Journal of Water Management Modeling

<u>Weirs</u>

Height: Vertical height of weir opening.

Length: Horizontal length of weir opening.

Side Slope: Slope (width-to-height) of side walls for a V-Notch or Trapezoidal weir.

Inlet Offset: Depth or elevation of bottom of weir opening from invert of inlet node.

Discharge Coeff.: Discharge coefficient for flow through the central portion of the weir.

TAB 4

CIVIL DESIGN

The proposed civil design features include site demolition, earthwork and grading, stormwater conveyance improvements, utility relocations, detention ponds, a rain garden, and erosion control.

4.1 Landfills

There are two existing landfills located on Facility property, Landfills #5 and #6. Both landfills are operated and maintained by the 88th's Facility Realignment and Closure (BRAC) office. The Land Use Control Remedial Design (LUCRD) reports for both landfills are included in **Appendix H**. Additional details regarding the landfills are provided in the 100% Design Technical Report. Basic design information for each landfill, obtained from the LUCRD reports, is provided below. The Major Alternative is designed to minimize impacts to Landfills #5 and #6.

Landfill #5

Landfill 5 includes the following design features:

- Areas of the landfill already covered by asphalt, the asphalt and any underlying aggregate were removed to a depth that provided an appropriate compacted and smooth-rolled sub-base
- A geomembrane was placed over the sub-base and two feet of clay were placed over the geomembrane and compacted creating a low-permeability cover
- Depending on the use of the area, either six inches of asphalt/aggregate (for parking) or six inches of topsoil (for green space) were placed over the clay
- BRAC officials reiterated that two different cap types exist for this landfill. South of 1st St the cap is the asphalt of the Building 599 parking lot. North of 1st St the cap is a geosynthetic membrane liner. BRAC officials also noted that there may be low level contamination encountered when working within this landfill cap.

Landfill 5 Buffer Zone is essentially a 100-ft setback maintained around the fill material located on Facility property.

Landfill #6

Landfill 6 includes the following design features:

- Prairie and turf grass
- 6 inches of topsoil
- 3 feet of vegetative/protective cover soil layer
- Geo-composite (synthetic) drainage liner, consisting of a geonet with a geotextile fastened on both sides of the geonet
- 40-mm thick low-density polyethylene (LDPE), watertight, geomembrane to serve as the impermeable barrier portion of the cover

- A geo-composite clay liner layer
- Geo-composite vent layer to transfer landfill gases from underlying waste to the landfill gas collection system

Landfill 6 Buffer Zone is essentially a setback consisting of the following design features:

- 100-ft setback from the edge of the constructed liner
- 150-ft radial setback from several gas monitoring probes
- Surface water drainage system
- Two groundwater monitoring wells that are part of the long-term monitoring plan at the site
- A geo-composite clay liner layer
- Geo-composite vent layer to transfer landfill gases from underlying waste to the landfill gas collection system

4.2 Site Demolition/Disposal

Existing site features to be demolished and disposed of include, soils, asphalt pavement, concrete, and pipe materials. In past projects, the 88th elected to store excess soil onsite instead of offsite disposal. However, the 88th indicated during the 35% design review meeting the offsite disposal of all excess soil will be the preferred disposal method for the Project.

Facility personnel informed SCI that there are two landfills located on-site, both of which contain special waste soil, and are operated and maintained by the 88th's Facility Realignment and Closure (BRAC) office. One landfill is located on the northeast side of the Facility (Landfill #5) and the other at its southeast boundary (Landfill #6). Both landfills have a 100-ft buffer zone surrounding their caps and must remain undisturbed unless the Illinois Environmental Protection Agency (IEPA) concurs with any intrusive activities or changes in hydrology near them. Similarly, if any drainage or utility construction will affect surface water flow around the landfills, or impact stormwater utilities associated with the landfills, it must be approved by the IEPA and the Navy.

SCI has coordinated with the IEPA and BRAC environmental remediation points of contact (POC) regarding these landfills throughout the design process. An SCI representative partook in the BRAC personnel's monthly O&M teleconference to elaborate on the proposed improvements and obtain feedback to incorporate into the design. SCI has also corresponded with the IEPA remediation POC in conjunction with Sheridan's Environmental Protection Specialist regarding the Project.

During SCI's coordination with the BRAC office, BRAC officials have noted that any material that is removed during construction activities (soil, asphalt, construction debris, etc.) must be accounted for by the 88th's Remediation Department in their Solid Waste Annual Reporting Web (SWARWEB) tracking system. This would include quantifying approximate weights and material types of any material taken from the Facility. BRAC personnel also expressed their concerns regarding the proposed rain gardens surrounding Landfill #6. The purpose of the proposed rain gardens is to absorb stormwater runoff that cannot be redirected to the detention pond in an attempt to lower the Facility's stormwater release rates. BRAC personnel pointed out that this could have an unintended negative impact to the integrity of the landfill by raising groundwater elevations within the area. There are also gas monitoring probes that must not become submerged by potentially higher groundwater elevations. The results of the discussion were that the potentially negative effects of the proposed rain gardens outweigh their potential benefits. Given this, SCI has opted to omit the proposed rain gardens in this area.

SCI's coordination with the IEPA remediation POC regarding the design of the proposed improvements resulted in their request that a geotextile membrane be added to the design of the proposed detention pond located at 1st St and B St. The purpose of this is to prevent infiltration of detained stormwater within the vicinity of Landfill #5. SCI incorporated this into the design.

Specification 02 61 13, Excavation and Handling of Contaminated Materials, address the handling and disposal of contaminated soils.

SCI recommends that the 88th RD conduct pre-construction soil investigations in the areas that will be disturbed for the Project and develop a plan for handling and disposing of contaminated soils encountered during excavation activities. The purpose of this will be to identify all waste codes applicable to each hazardous waste stream based on requirements in 40 CFR 261 or applicable state or local law or regulation and to identify applicable treatment standards in 40 CFR 268 and state land disposal restrictions to make a determination as to whether or not the waste meets or exceeds the standards. If the 88th opts to perform the pre-construction soil investigation, then it should be included as an appendix to this Design Analysis Report prior to the bidding of this Project. If the 88th opts to not perform the pre-construction soil investigation, then the Excavation of Handling of Contaminated Material specification section, Specification 02 61 00, should update Section 3.5 Confirmation Sampling and Analysis and omit references to the pre-construction soil investigation.

SCI recommends that the 88th contract with SCI to provide Engineering During Construction to address soil disposal issues.

4.3 Conveyance Conduits

The conveyance conduits such as drainage ditches and storm sewers were designed to convey stormwater flowrates associated with the 100-year, 2-hour storm. The LCWDO requires stormwater conveyance systems to be designed only for a 10-year storm but also requires that overland flow paths be designed for the 100-year storm. A majority of the proposed improvements utilize overland flow paths via drainage ditches and integrate these with storm sewers which is why the conveyance system was designed for a 100-year storm.

The designed conveyance conduits include drainage ditches and storm sewers. The conveyance conduits were designed based on results from the EPA SWMM model (Model). One of the results that the Model generates is called Sub-catchment Runoff. This result reports peak flowrates of stormwater runoff generated from the sub-watersheds that were input into the Model. Peak flowrates associated with the 100-year, 2-hour design storm were used to size the proposed drainage ditches and storm sewers. The flowrates of the proposed conveyance conduits were calculated by applying Manning's Equation for open channel flow.

The flowrates calculated based on the equation for the proposed conveyance conduits is the flowrate capacity (Q_{cap}). The sub-catchment runoff flowrate reported by the Model is the flowrate required (Q_{req}). The design of the proposed conveyance conduits was performed by ensuring that the flowrate capacity exceeded the flowrate required in all cases. The conveyance conduit calculations are provided in **Appendix C**.

Drainage Ditches are proposed for roadside conveyance. Drainage ditches include both trapezoidal and triangular channels. Typical side slopes have been specified at 4:1 (H:V) where spaces allows for ease of maintenance. Steeper side slopes are proposed where there is inadequate room to accommodate a 4:1 side slope. Cross sections of the drainage ditches are displayed on Sheet CG-503 of the plan set.

4.4 Utility Relocation

An extensive utility network consisting of Communication, Electrical, Gas, Water, Wastewater, and Stormwater utilities is present throughout the entirety of the Facility. This network is disorderly, fragmented, and potentially not fully accounted for. Facility personnel have reported that there is uncertainty regarding the location and elevation for much of the utilities, including both dead and live lines. Due to this uncertainty, it is anticipated that utility conflicts and subsequent relocations during the construction process may occur.

SCI recommends that the 88th contract with SCI to provide Engineering During Construction to address likely utility conflicts.

4.5 Manhole / Catch Basins

Manholes and catch basins are proposed at storm sewer pipe junctions and changes in slope. Typical manhole and catch basins will be precast concrete. Typical manhole and catch basin diameters will be 48 inches, unless otherwise noted. Where unusual pipe geometries necessitate, larger manholes and catch basins will be required.

4.6 Detention Pond Design

Six detention ponds are proposed for the Major Alternative. These include expansion of the existing detention pond, which includes an upper and lower pond, in the southwest portion of the Facility, and four proposed detention basins: 1st Street and B Street, 2nd Street and B Street, 3rd Street and B Street, and 3rd Street and Eisenhower Street.

The detention ponds were designed to incorporate water quality features. Each detention pond contains dead storage below the outlet elevation to promote infiltration of stormwater. Additionally, each detention pond proposes native grasses to provide water quality benefits.

All proposed detention ponds were designed to manage the volume associated with the 100-year, 24-hour design storm (Updated Bulletin-70 Rainfall Data with Huff Quartile Rainfall Distributions) and peak flowrates associated with the 100-year, 2-hour design storm. Pond volumes were calculated with contour averaging.

Detention Pond	**Storage Volume (ac-ft)**
Southwest Pond – Upper	1.78
Southwest Pond – Lower	4.69
1st Street and B Street	3.05
2nd Street and B Street	1.16

3rd Street and B Street	2.23
3rd Street and Eisenhower Street	1.04

4.7 Rain Garden

The major alternative proposes a rain garden located at the southeast portion of the Facility. The location of this rain garden is displayed on sheet C-101 of the plan set. This proposed rain garden is intended to improve water quality through infiltration before discharging stormwater off the Facility property.

This rain garden is designed as a low lying depressional area with 4-inch diameter perforated underdrains. The intent is to capture and infiltrate stormwater during frequent storm events. This rain garden allows for nine inches of ponding. This rain garden will be planted with native plantings to further improve water quality. A detail of the rain garden is included as DT-002 on plan sheet CG-502.

4.8 Surface Restoration / Pavements

Disturbed areas will be restored with either pavement or seeding.

Parking lots around Buildings 147, 149, 698, and 699 are proposed for reconstruction. Parking lot pavement will be bituminous asphalt cement. Additional pavement restoration is required for utility work areas. Where new asphalt will abut existing asphalt, a key-in section is detailed to maintain the integrity of the joint. Existing 6” curb adjacent to reconstructed asphalt areas will be removed and replaced in kind. Pavement details are shown on plan sheet CG-301.

Disturbed areas will be reseeded with an IDOT grass seed mix. All detention ponds with clean soil will use the IDOT Low Profile Grass Seed mix and all detention ponds with dirty soils, and all other disturbed areas that require seeding, will use the IDOT Low Maintenance Lawn Mixture.

4.9 Erosion Control

The Stormwater Pollution Prevention Plan (SWPPP) is included on the Erosion Control Plan Sheets.

Erosion control measures include:

- Silt Fence
- Stabilized Construction Entrances
- Inlet Protection
- Erosion Control Blankets
- Sediment Tubes

4.10 Traffic Control / Phasing of Project

Traffic control and phasing of the project will be within the means and methods of the Contractor. The Contractor should coordinate traffic control and project phasing with the 88th Readiness Division.

TAB 5

APPENDICES

- **APPENDIX A – SURVEY FILE**
- **APPENDIX B – REGULATORY REVIEW**
- **APPENDIX C – TECHNICAL REPORT**
- **APPENDIX D – DESIGN ANALYSIS CALCULATIONS**
- **APPENDIX E – EPA SWMM FILES**
- **APPENDIX F – LAND USE CONTROL REMEDIAL DESIGN DOCUMENTS**
- **APPENDIX G – WEB SOIL SURVEY REPORT**

APPENDIX A

ANDERSON ENGINEERING SURVEY FILE

(SEE DWG FILE PROVIDED WITH THE 100% DESIGN SUBMITTAL)

APPENDIX B

REGULATORY REVIEW

Regulatory Review

Philip H. Sheridan United States Army Reserve Center

88th Readiness Division
Highwood, Illinois

July, 2019

Stanley Consultants INC.

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Table of Contents

1.0 Introduction

This report summarizes a regulatory review conducted for a stormwater runoff, drainage survey, and design for the Philip H. Sheridan United States Army Reserve Center (Sheridan USARC) located at 3155 Blackhawk Drive in Fort Sheridan, Illinois 60037. Specifically, Stanley Consultants, Inc. (SCI) evaluated Federal, State, and Local stormwater regulations.

Sheridan USARC is a 91.8 acre site located within the City of Highwood (Highwood), Lake County, Illinois. It is located east of Sheridan Road (IL131), west of Patten Road, north of Walker Avenue, and south of Simonds Way. Figure 1 shows a map of Sheridan USARC.

Sheridan USARC floods historically, with significant ponding occurring throughout the site, even during relatively small storm events. SCI has been tasked to assess the existing stormwater drainage system, evaluate potential improvements, and develop construction documents for the recommended solution (Project). The following is a summary of relevant regulatory jurisdictions.

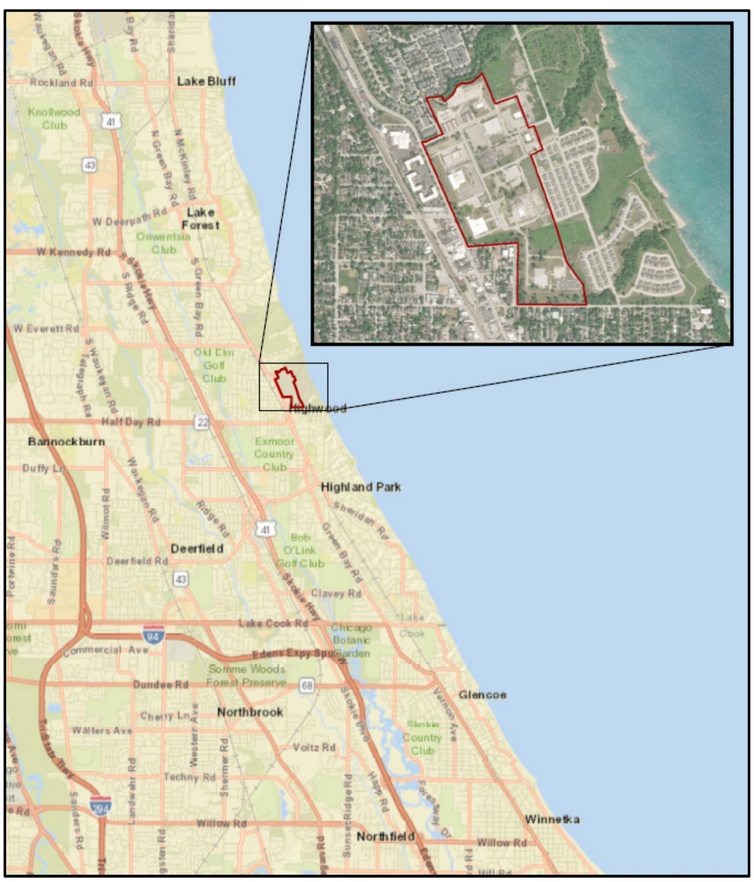

Figure 1. Project Area Map

2.0 Jurisdictions

This regulatory review summarizes Federal, State, and Local jurisdictions that may impact the design of this project.

2.0.1 Federal Requirements

2.0.1.1 Federal Emergency Management Agency (FEMA)

FEMA administers the National Flood Insurance Program (NFIP). The NFIP requires participating municipalities to adopt floodplain management standards.[1] Locally, Lake County Stormwater Management Commission establishes floodplain management standards in its adopted Lake County Watershed Development Ordinance (WDO).

FEMA's Flood Insurance Rate Map (FIRM) for Lake County, Illinois[2] shows Sheridan USARC in Zone X. Zone X is an area of minimal flood hazard, outside of the Special Flood Hazard Area (SFHA), and higher than the elevation of the 0.2-percent-annual-chance flood (500-yr floodplain). Sheridan USARC is not mapped within a SFHA. Two FIRMettes, one of the northside and one of the southside of Sheridan USARC, are shown below in Figures 2.1 and 2.2, respectively.

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[1] 44 C.F.R. § 59.2(b).

[2] FIRM Map No. 17097C0283K, Panel 283 of 295, Revised September 18, 2013

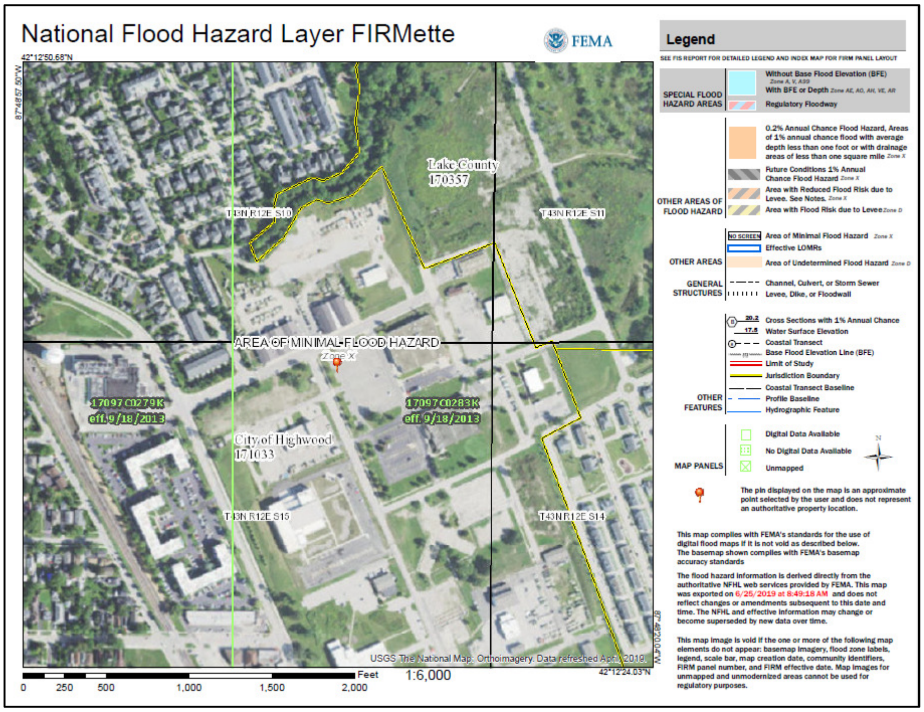

Figure 2.1. Sheridan USARC Northside FIRMette

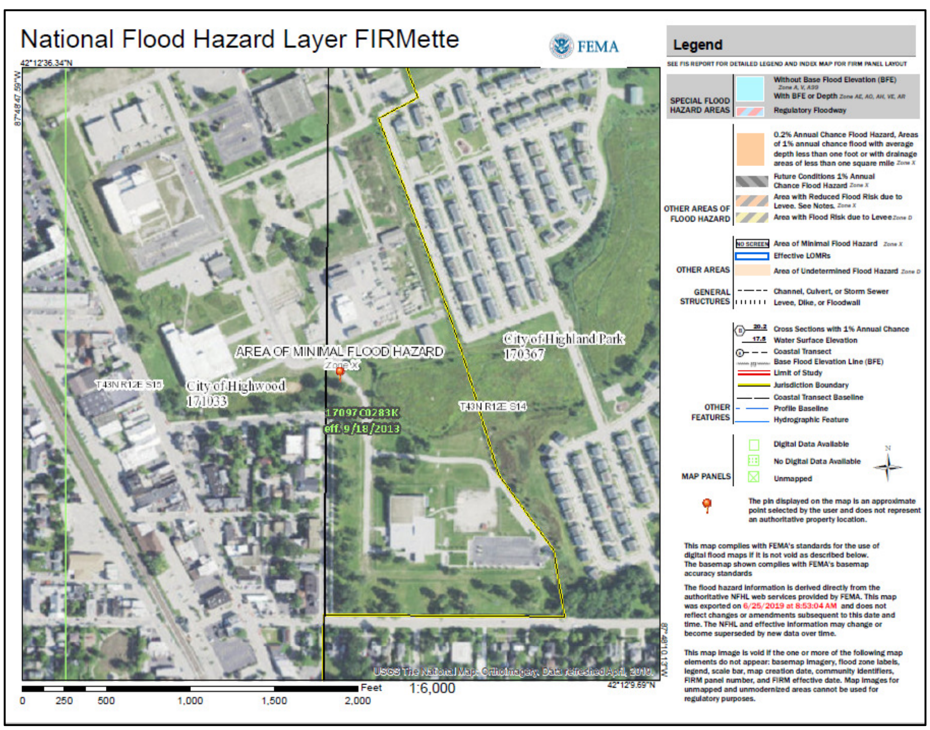

Figure 2.2. Sheridan USARC Southside FIRMette

2.0.1.2 United State Army Corps of Engineers (USACE)

The USACE regulates impacts to Waters of the United States (WOTUS), including wetlands. It is unlawful to discharge dredged or fill material into a navigable water without a permit.[3] The term "navigable waters" is defined as "waters of the United States" (WOTUS).[4] The U.S. Fish and Wildlife Service's National Wetland Inventory (NWI) map for Sheridan USARC is shown below as Figure 2.3. Based on the NWI, the FIRMettes, and a site visit on May 14, 2019, no wetlands have been identified at Sheridan USARC.

Figure 2.3. NWI Map of Sheridan USACE

[3] 33 U.S.C. §§ 1311(a), 1342(a).
[4] 33 U.S.C. § 1362(7).

2.0.1.3 U.S. Fish and Wildlife Service

Section 7 of the Endangered Species Act[5] requires Federal Agencies to consult with the U.S. Fish and Wildlife Service to determine the presence of threatened or endangered species in the vicinity of the proposed action. The USFWS should be consulted.

2.0.2 State Requirements

2.0.2.1 Illinois Department of Natural Resources (IDNR)

Floodways - Office of Water Resources (OWR)

The Illinois Department of Natural Resources, Office of Water Resources (OWR) requires permits for new construction within regulatory floodways.[6] The FIRM for Lake County, Illinois[7] does not show regulatory floodway at Sheridan USARC. Consequently, the proposed Project will not impact a regulatory floodway, and a floodway construction permit is not required.

Threatened and Endangered Species - Office of Realty & Environmental Planning (OREP)

The Illinois Endangered Species Protection Act[8] requires State Agencies to consider the potential adverse impacts of proposed actions on Illinois endangered and threatened species. Consultations with OREP are made through an online application called Ecological Compliance Assessment Tool (EcoCAT). Consultation with the OREP via EcoCAT will be necessary to obtain an NPDES general stormwater permit for construction activities, as described in Section 2.0.2.2.

Historic Preservation - Illinois State Historic Preservation Office (SHPO)

Consultation with the Illinois State Historic Preservation Office (SHPO) will be necessary for the project. The National Historic Preservation Act[9] and the Illinois State Agency Historic Resource Preservation Act[10] require State and Federal Agencies to consider the

[5] 16 U.S.C § 1531, *et seq.*
[6] 17 ILL. Adm. Code § 3708.30.
[7] FIRM Map No. 17097C0283K, Panel 283 of 295, Revised September 18, 2013
[8] 520 ILCS 10/11(b).
[9] 16 U.S.C. § 470, *et seq.*
[10] 30 ILCS 3420, *et seq.*

effects of their actions on historic properties listed or eligible for listing in the National Register of Historic Places. Actions that require consultation with the SHPO include State/Federal permits and funds. Consultation with the Illinois SHPO will be necessary to obtain an NPDES general stormwater permit for construction activities, as described in Section 2.0.2.2.

2.0.2.2 Illinois Environmental Protection Agency (IEPA)

National Pollution Discharge Elimination System (NPDES) Permit

The 88th will need to file a Notice of Intent (NOI) for coverage under the NPDES General Permit for Storm Water Discharges from Construction Site Activities because the proposed land disturbance is greater than one acre. The general permit covers discharges of stormwater associated construction site activities that disturb one or more acres of total land area.

A Notice of Intent (NOI) must be submitted to the IEPA for the project to become authorized under the general permit. NOIs are submitted online via the IEPA website. General project information, confirmation of compliance with other regulatory entities such as the IDNR or IHPA, a stormwater pollution prevention plan (SWPPP), are some of the key items included in the NOI. The application fee is waived because Sheridan USARC is a Federal entity. IEPA will notify the applicant of their decision after a 30-day review period. Once an NOI is submitted, it must be posted at the construction site.

A SWPPP must be developed for each construction site covered by this permit. The SWPPP shall identify potential stormwater pollution sources and describe and ensure the implementation of best management practices (BMP). SCI will prepare SWPPP maps and details to aid Sheridan USARC in obtaining an NPDES construction permit.

2.0.3 Local Requirements

2.0.3.1 Lake County Stormwater Management Commission

The Lake County Stormwater Management Commission (SMC) has adopted the Lake County Watershed Development Ordinance (WDO)[11]. The WDO establishes stormwater

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[11] Last amended October 13, 2015.

management standards for Lake County, Illinois and Sheridan USARC. While a Lake County Watershed Development Permit would be normally required, Lake County does not have regulatory authority over the 88th. Although a Watershed Development Permit is not required, the standards established by the WDO will be used as the basis of design.

2.0.3.2 City of Highwood

Sheridan USARC resides within City of Highwood, Illinois. The City of Highwood has adopted the Lake County Watershed Development Ordinance,[12] but the City is not certified by the Lake County Stormwater Management Commission to issue Watershed Development Permits locally.

3.0 Stormwater Management Design Requirements

3.0.1 Lake County Watershed Development Ordinance

The Lake Count Stormwater Management Commission has adopted the Lake County Watershed Development Ordinance (WDO).[13] The WDO establishes standards for site runoff requirements, release rates, runoff volume reduction, water quality treatment, stormwater conveyance systems, and stormwater facilities. The WDO design standards will provided a basis of design of stormwater alternatives.

3.0.1.1 Rainfall Data and Site Runoff

The WDO requires use of an SMC approved hydrograph method to determine runoff calculations for tributary drainage areas greater than 100 acres. An EPA SWMM hydraulic and hydrologic model will be created to meet this design requirement. The design storms that will be modeled include the 1.1-in water quality event and the 2-yr, 5-yr, 10-yr, 50-yr, and 100-yr storms. Three sources of rainfall data will be considered: Lake County WDO Rainfall Data, Updated Bulletin 70, and NOAA Atlas 14.

[12] City of Highwood, Illinois City Code, Title 10, Chapter 5-1.
[13] Last amended October 13, 2015.

Lake County WDO Rainfall Data

Lake County WDO rainfall data[14] will be used in the EPA SWMM model. The rainfall data includes *Huff Quartile Distributions*, shown in Figure 3-1. The Huff quartiles provide typical rainfall distributions for four different storm durations. Within the model, the rainfall distributions describe at what point during a storm a certain amount of rainfall occurs, (e.g. shorter storms tend to precipitate a lot of rain early on while the amount of precipitation for longer storms slowly builds throughout the storm duration). The 3rd quartile distribution will be applied during the design process since only the 24-hr storm will be analyzed for the project.

Updated Bulletin 70 Rainfall Data

Additional WDO rainfall data that will be used for the project comes from the *Rainfall Depth-Duration Frequency Tables for Lake County.* This data provides the predicted amount of volume associated with each design storm. The WDO rainfall data is based on the 1989 version of the Illinois State and Water Survey (ISWS) Bulletin 70.

An updated Bulletin 70 was released in March 2019 and reports significantly greater rainfall values for the region. It is expected that the updated Bulletin 70 will be amended into the WDO by summer 2020. Although not enforceable currently, Lake County SMC strongly recommends using the updated Bulletin 70 rainfall values.

NOAA Atlas 14 Rainfall Data

A third source of rainfall data that will be used is the *NOAA Atlas 14 Precipitation-Frequency Atlas of the United States.* NOAA Atlas 14 data is commonly used throughout the United States for stormwater design. However, it reports lower values than the WDO or the updated Bulletin 70.

The disparity between the WDO, the updated Bulletin 70, and NOAA Atlas 14 stems from each source utilizing different datasets that have been updated at different times. Each of these sources will be used for the project to create a major, moderate, and minor alternative. Table 3-1 provides rainfall values for each source.

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[14] WDO §501.03 & WDO Appendix I.

Table 3-1. Rainfall Frequency Data

Source	NOAA Atlas 14	Lake County WDO	Updated Bulletin 70
Publication Year	2006	1989	2019
Design Storm	**Rainfall (in)**		
1.1-in WQ Event	1.10	1.10	1.10
2-yr	2.66	2.80	3.34
10-yr	3.89	3.88	5.15
50-yr	5.30	5.50	7.50
100-yr	5.96	6.50	8.57

*Duration for all storms is 24-hrs

Depressional Storage

In addition to detaining a certain volume of water for a given design storm, existing depressional storage must also be maintained. If any low elevation areas that detain water already exist on-site then that volume of water will have to be added to the what's calculated from the SMC hydrograph method. Any existing depressional storage areas will be identified during the drainage study.

3.0.1.2 Site Release Rate

The WDO requires detention volumes to be calculated using a rating curve based on maximum release rates[15] of:

- 0.04 cubic feet per second (cfs) per acre for the 2-yr storm
- 0.15 cfs per acre for the 100-yr storm

This requirement applies to the hydrologically disturbed area of the site, which is defined as an area where the land surface has been cleared, grubbed, compacted, or otherwise modified to alter stormwater runoff, volumes, rates, flow direction, or inundation duration.

[15] WDO §501.06.

3.0.1.3 Runoff Volume Reduction (RVR)

The WDO includes Runoff Volume Reduction (RVR) requirements.[16] The purpose of RVR requirements is to incorporate design elements to minimize stormwater runoff volumes and address water quality impairments. Implementing BMPs and green infrastructure techniques into the project achieves both goals by promoting stormwater infiltration, evapotranspiration, and reuse. These will be discussed in further detail when the design alternatives are presented.

3.0.1.4 Water Quality Treatment

The WDO requires water quality treatment requirements.[17] The 'first flush' of a storm refers to the initial runoff, approximately 1 inch, generated by the storm. In urban areas the water pollution of this first inch of rainfall is more concentrated than the remaining stormwater runoff. The intent of the water quality treatment requirements is to mitigate the negative environmental effects of the first flush.

The WDO standard is to detain at least the first 0.2 inches of a storm. More specifically, a development must divert at least the first 0.01 inch of runoff for every 1% of impervious surface created by the project, with 0.2 inches as the minimum amount in any case.

3.0.1.5 Stormwater Conveyance System

Storm Sewer and Swales

The WDO requires that storm sewers, swales, and appurtenances be designed for at least the 10-yr design storm.[18] Additional requirements for storm sewers include is that they have a minimum diameter of 12 inches.[19] Storm sewer design analysis must be calculated under full flow conditions.

Overland Flow Paths

The WDO requires overland flow paths to be designed to accommodate the 100-year event. Overland flow comprises the major stormwater drainages system. An overland flow

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[16] WDO §503.02.
[17] WDO §504.02.
[18] WDO §506.01.A.
[19] WDO §506.01A.

path is an area of lands that can convey stormwater from a 100-yr storm, also known as a base flood event, without damage to structures or property. All developments within Lake County are required to provide overland flow paths. The flow rate for the base flood event shall include on-site and off-site tributary areas.

3.0.1.6 Stormwater Facility

Emergency Overflow

The WDO requires stormwater facilities to provide an emergency overflow which is designed to protect the property if the primary outlet malfunctions or a storm event greater than the system design occurs. The elevation of the emergency overflow is set at the design high water level of the detention pond which in turn must be at least 1 foot below the top of the detention pond.

Outlet Pipe

The diameter of the outlet pipe for a stormwater facility must be at least 12 inches. This measure is to prevent clogging of the outlet pipe. If design release rates require a smaller outlet than a diameter of 4 inches can be used in conjunction with an anti-clogging device.

4.0 Soil Erosion and Sediment Control (SESC) Requirements

4.0.1 Lake County Watershed Development Ordinance

4.0.1.1 Performance Standard Requirements

SESC measures are required for any land disturbance activities on the development site and to obtain the required NPDES permit. Generally, erosion control is achieved through soil stabilization through either temporary, during-construction, or permanent, post-construction, measures. Seeding is a common soil stabilization temporary and permanent practice. Sediment control is generally achieved by either providing sediment filters at outlet locations from the site, e.g. storm sewer inlet, or by providing barriers to outlet location and redirecting flow to a sediment basin.

SESC measures must also be taken for properties and channels adjoining the development site. Energy dissipation devices may be required downstream of stormwater outlets from the site to provide non-erosive velocity of flow.

All SESC devices must be properly maintained throughout construction. They can be disturbed during storm events and must be re-stabilized within 7 calendar days of an event.

5.0 Owner Supplied Data

5.0.1 Environmental

During the kickoff meeting and site visit, representatives of the 88th stated that there are two landfills on-site. The soil within these landfills is a remnant of previous construction projects throughout the site. The soil is likely special waste; therefore, we will not disturb it. The locations of the north and south area landfills are displayed on Figures 5.1 and 5.2, Respectively.

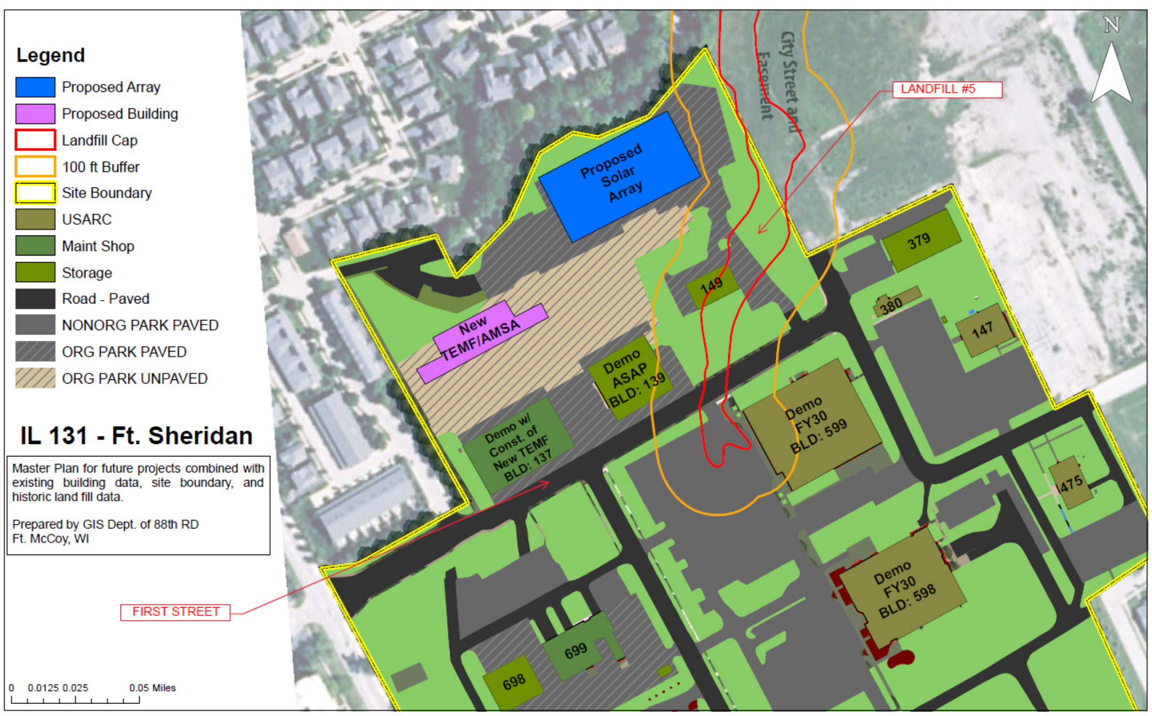

Figure 5.1. North Area Landfill Location

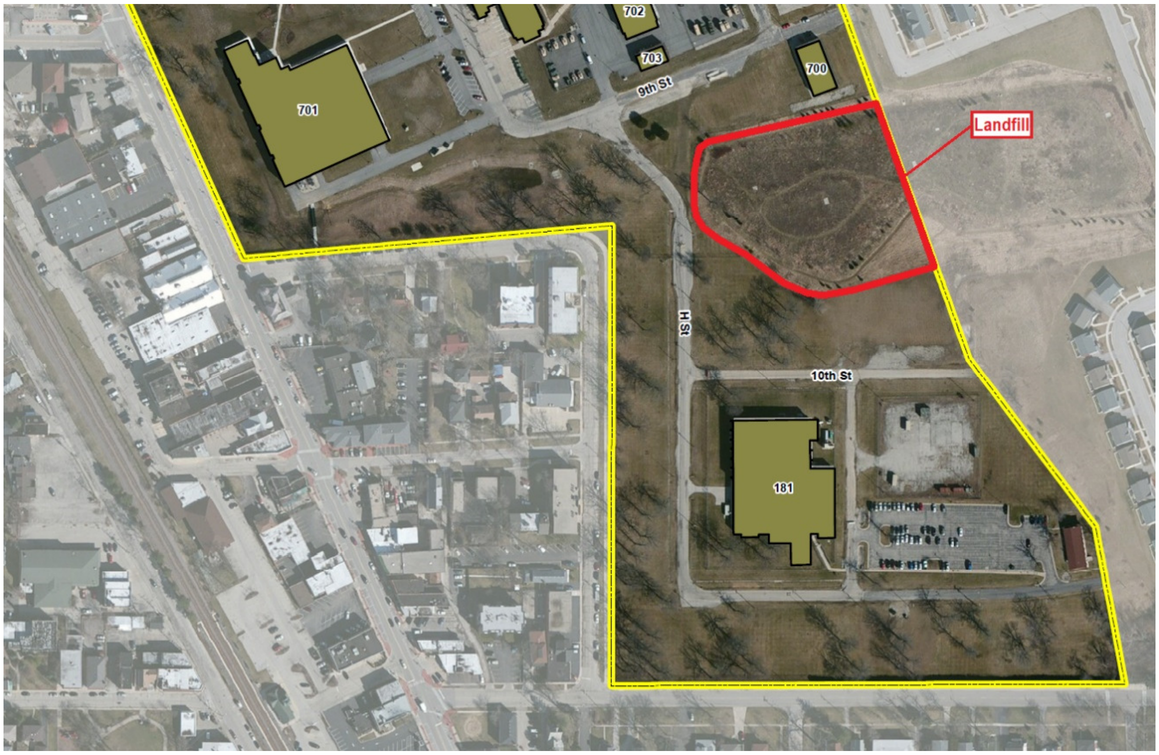

Figure 5.2. South Area Landfill Location

5.0.2 Installation Design Standards

The 88th Readiness Division's Installation Design Guide will be followed for the Project. Specifically, the Installation Design Guide contains site planning standards and landscape design standards.

6.0 Compliance Issues

Currently, Sheridan USARC does not meet the site releases rate, runoff volume reduction, or water quality treatment requirements of the WDO. While individual developments onsite have incorporated stormwater management features, SCI will develop a comprehensive stormwater management plan for the entire Sheridan USARC property. While Sheridan USARC is not required to comply with the Lake County WDO, SCI intends to base the design of alternatives on the design standards of the WDO.

7.0 Required Permits / Consultations

The following is a list of permits and approvals that will likely be required for the Project.

- U.S. Fish and Wildlife Consultation
- Illinois Historic Preservation Agency Consultation
- EcoCAT Consultation
- Notice of Intent - NPDES general permit for storm water discharges from construction site activities

APPENDIX C

100% DESIGN TECHNICAL REPORT

Phillip H. Sheridan Army Reserve Center Stormwater Drainage Improvement Project

100% Design Technical Report

Town of Fort Sheridan
September 2021

Stanley Consultants INC.

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Executive Summary

This 100% Design Technical Report (100% Report) summarizes the analysis and design for the Storm Water Runoff, Drainage Survey and Design for Fort Sheridan ARC 88th Readiness Division (Project). The objective of the Project is to assess the existing stormwater drainage system at the Philip H. Sheridan United States Army Reserve Center (Sheridan USARC or Facility), conduct a regulatory review, obtain topography and utility surveys, evaluate potential stormwater improvements, and develop construction documents for recommended stormwater improvements. Sheridan USARC is an approximate 92.6-acre site located within the Town of Fort Sheridan and City of Highwood (Highwood), Lake County, Illinois. It is located east of Sheridan Road (IL131), west of Patten Road, north of Walker Avenue, and south of Simonds Way.

Sheridan USARC experiences varying levels of flooding from relatively small storm events. Construction, demolition, and reconstruction of facilities throughout Sheridan USARC is relatively constant, with approximately 1 building constructed and/or demolished every 3-5 years. Each construction/demolition project was standalone and the stormwater drainage system for each newly constructed building was designed considering only the building site itself, not Sheridan USARC comprehensively. This has created a segregated stormwater management system at the Facility which is a primary cause of flooding throughout the Site.

Stanley Consultants, Inc. (SCI) has been tasked to develop stormwater drainage improvements for Sheridan USARC that will address localized areas of flooding while minimizing future costs and maintenance. A hydraulic and hydrologic model (H&H Model) of the Facility's existing conditions was developed using Environmental Protection Agency Storm Water Management Model (EPA SWMM) software, version 5.1.

The H&H Model was used to quantify, and better understand, problem areas throughout the Facility and develop conceptual solutions. These improvements are organized into three alternatives (Minor, Moderate, Major), with each alternative generally building upon the previous. Brief descriptions of the criteria for each alterative are provided below.

- Minor Alternative: Low-cost alternative to fix most problematic issues and address any major compliance issues
- Moderate Alternative: Includes solutions from the minor alternative but provides additional conveyance, detention, and water quality features to control storm water discharge and improve water quality
- Major Alternative: Includes solutions from the moderate alternative but provides significant detention and water quality features to maximize the site's potential detention and water quality improvements

Following the 65% design submittal the 88th opted for the Major Alternative to be developed to a 100% level of design. Details regarding the Minor and Moderate Alternatives are provided in the attachments.

Pavement construction is also being recommended as part of the overall recommendations to improve drainage throughout the Facility.

The ongoing construction and demolition throughout the Facility have resulted in a disorganized utility network. The network is present throughout the majority of the Facility. Based on 88th provided data it appears that there are many instances where the proposed improvements may conflict with the existing utilities. This creates numerous locations where existing utilities may be encountered while installing and constructing the proposed storm sewers and drainage ditches. The potential conflicts include all types of utilities (electrical, communication, etc.) and in-service and abandoned lines. If a utility conflict is detected during construction in the field, then a relocation of the existing utility or a redesign of the proposed improvement may be required.

Sheridan USARC has two IEPA capped landfills located at the north and southeast areas of the Facility. Given this, there is a potential for encountering contaminated soils (POLs and solvents) during the proposed earthwork. Any material that is removed during construction activities (soil, asphalt, construction debris, etc.) must be accounted for by the 88th's Remediation Department in their Solid Waste Annual Reporting Web (SWARWEB) tracking system. This would include quantifying approximate weights and material types of any material taken from the Facility. Specification 02 61 13, Excavation and Handling of Contaminated Materials, address the handling and disposal of contaminated soils.

A 100% design cost estimate was developed for the proposed improvements and is included with this submittal. The cost estimate utilizes MII which is the second generation of the micro-Computer Aided Cost Estimating System. MII provides an integrated cost estimating system that meets the USACE requirements for preparing cost estimates.

1.0 Background Information

Sheridan United States Army Reserve Center (Sheridan USARC or Facility) is an approximate 92.6-acre site located at 3155 Blackhawk Drive in Fort Sheridan, Illinois. It is located east of Sheridan Road (IL131), west of Patten Road, North of Walker Avenue, and south of Simonds Way.

Figure 1.0, provided below, shows the Facility location relative to the surrounding cities, and a close-up image of the Facility itself. The Facility is the former Fort Sheridan which was decommissioned in May 1993. Facility activities still occur, however, and construction and demolition of Facility buildings is ongoing.

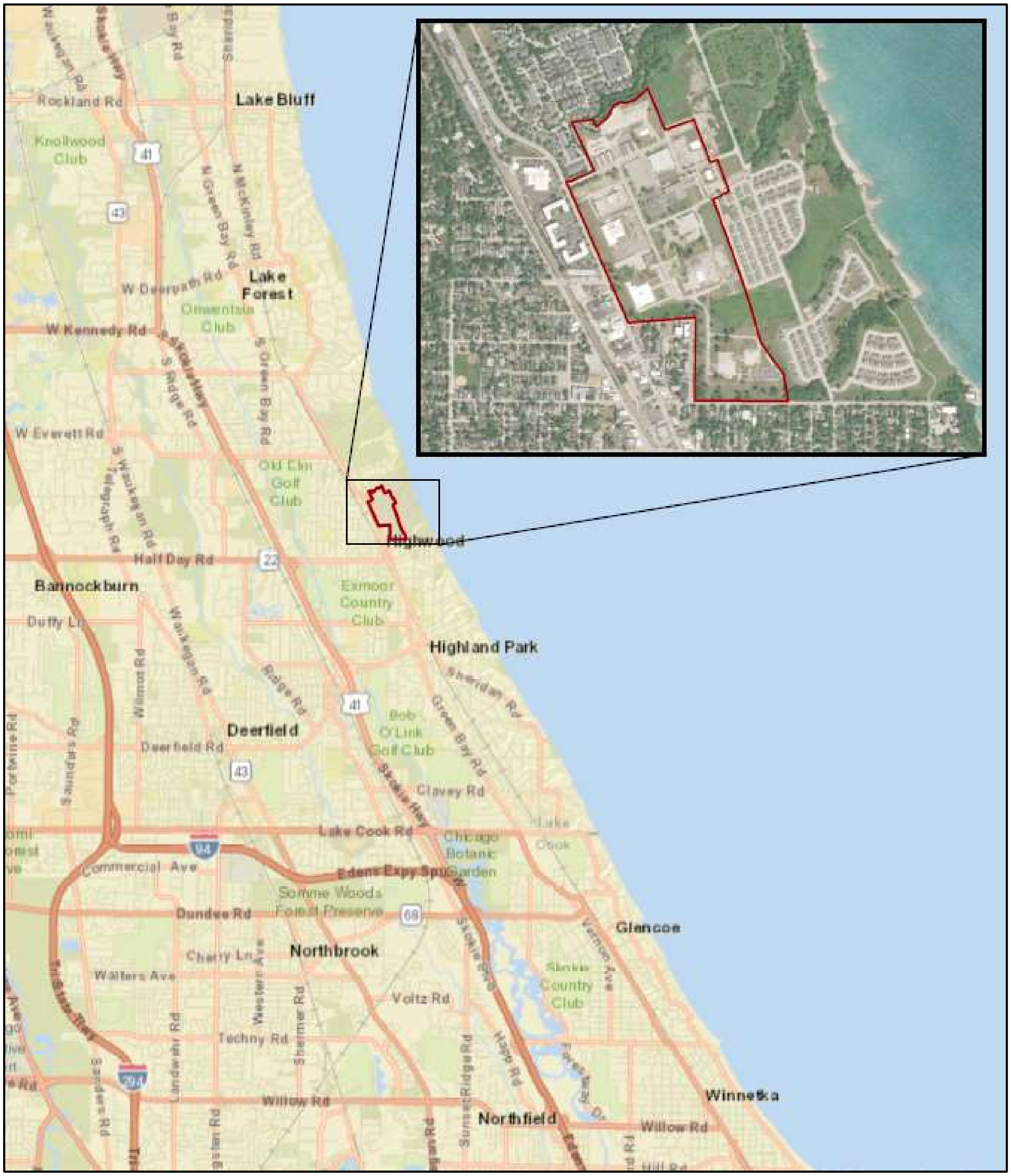


Figure 1.0. Project Area Map

1.1 Ponding Locations

Representatives from SCI met on-site with Facility personnel on May 14, 2019 to become familiar with the Facility and to visually inspect the various flood-prone areas. Meeting minutes from the May 14, 2019 meeting, along with minutes from subsequent meetings throughout the duration of the Project, are included as attachments to this report.

The entire Facility was toured, and Facility personnel provided insight into areas where localized flooding is most prominent. Figure 1.1-1, shown below, displays a high-level overview of the various ponding areas throughout the Facility. Four of these ponding areas have been labeled (P1, P2, P3, P4). These labels correspond to photographs that were taken at each location shortly after a relatively small storm event that occurred in October 2019.

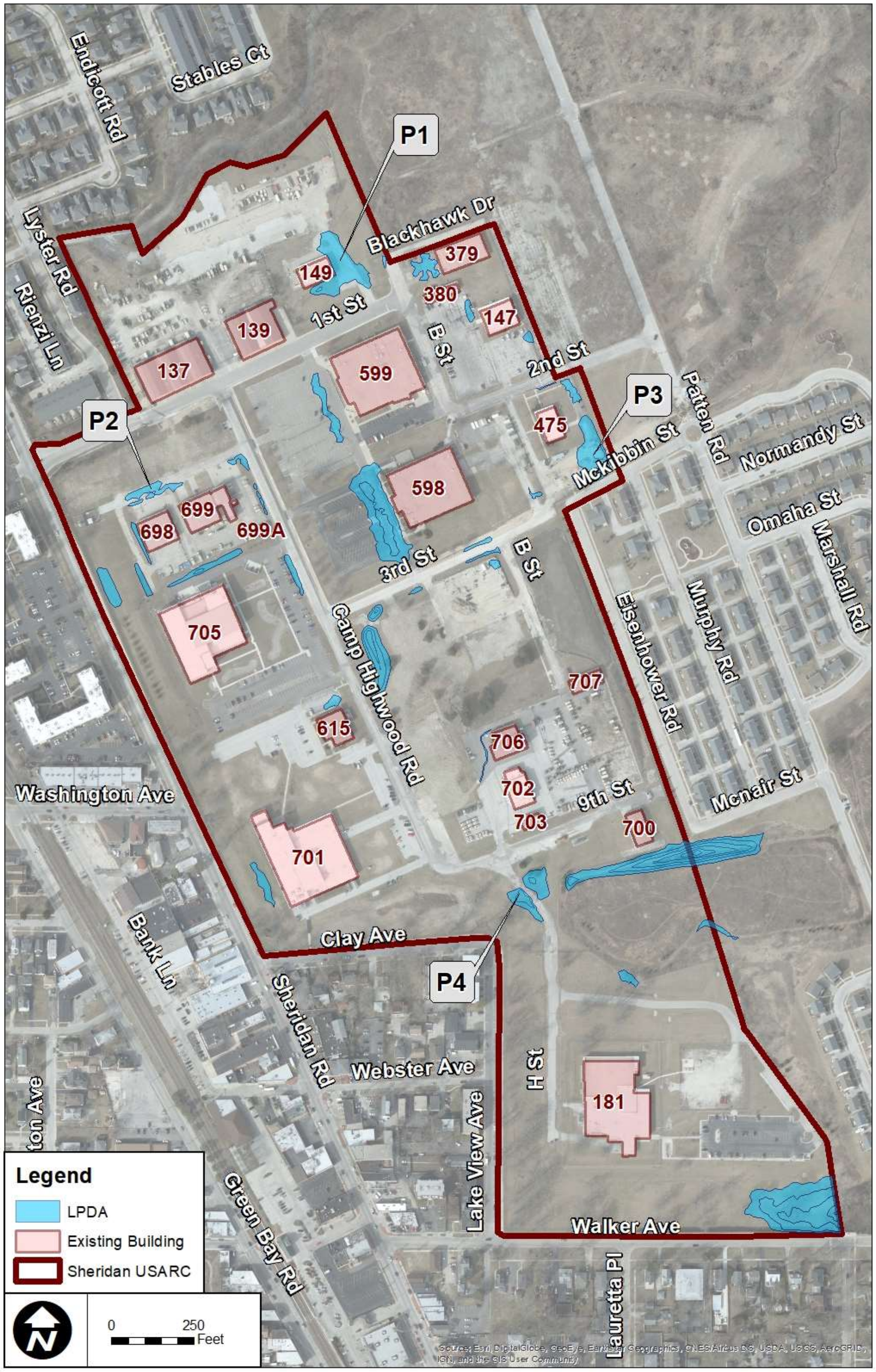


Figure 1.1-1. Flood-prone (Ponding Areas) Locations Map

Figures 1.1-2-1.1-5 show photographs of four of the ponding areas that are labeled in Figure 2.

Figure 1.1-2. P1 – Building 149 Driveway (North Facing)

Figure 1.1-3. P2 – Building 698 Driveway (West Facing)

Figure 1.1-4. P3 – Building 475 Driveway (South Facing)

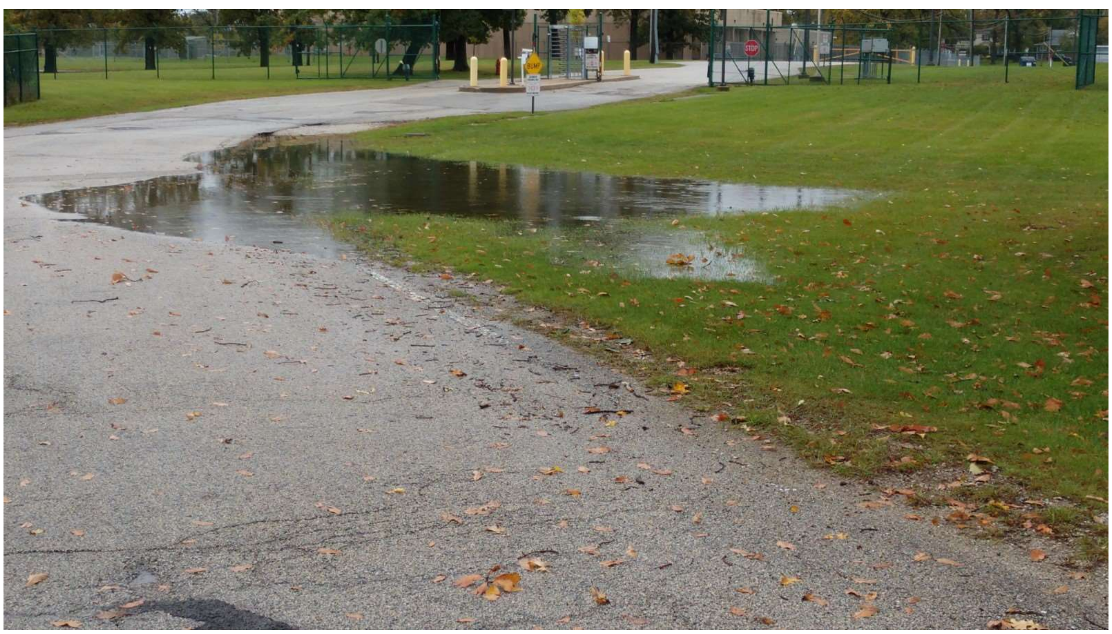


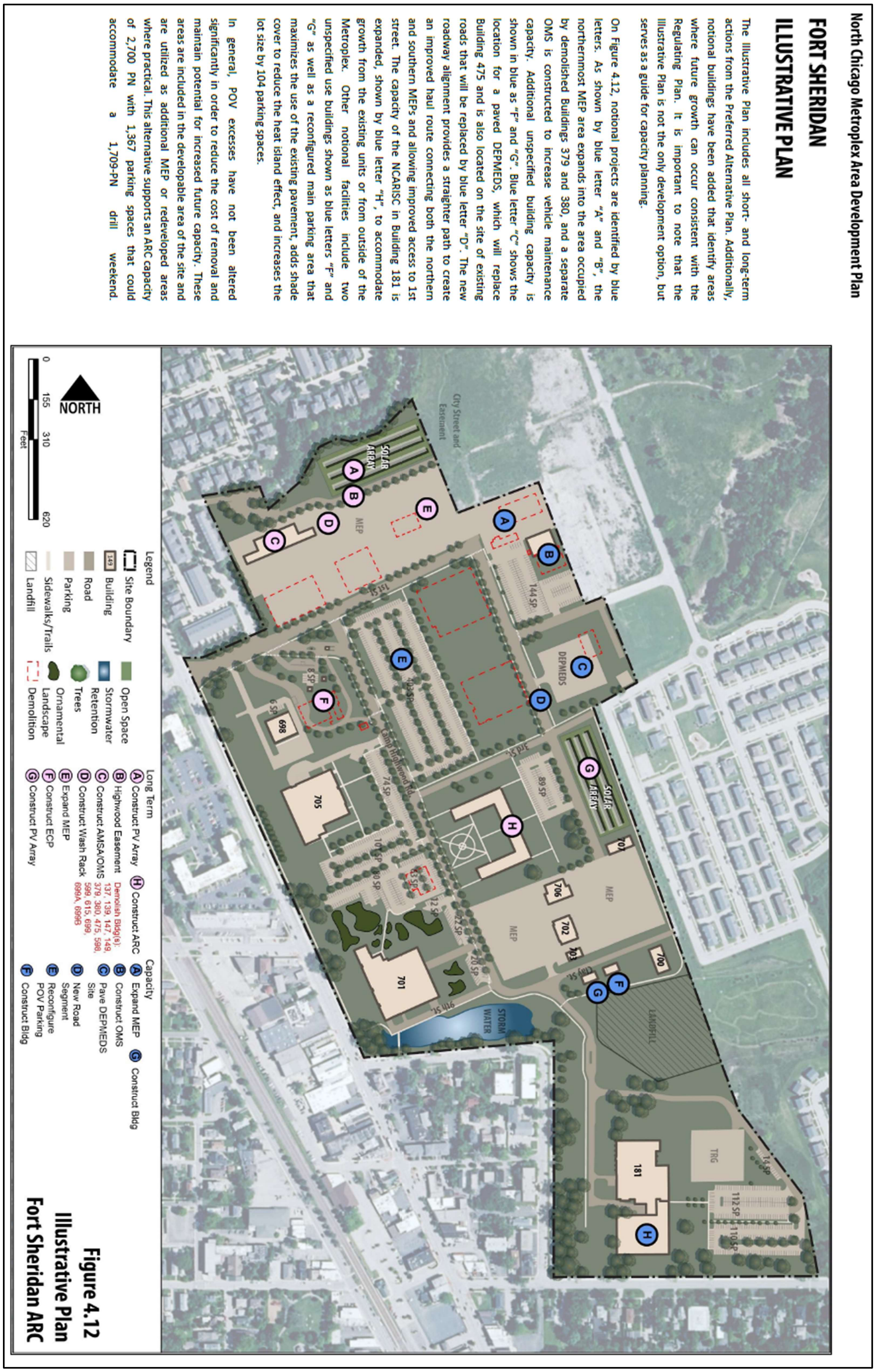
Figure 1.1-5. P4 – H Street (South Facing)

Although photographs weren't taken of all the ponding areas, the above photos are representative of the historical nuisance flooding that occurs throughout the Facility. Facility personnel have noted that the driveway for Building 149 (Figure 1.1-2) has been a location of prominent nuisance flooding, although it has somewhat resolved since being re-graded in the Fall of 2019. It was also noted that much of the Facility experiences ponding similar to what's shown in Figure 1.1-3. The Building 475 driveway (Figure 1.1-4) leads to a sanitary lift station. The lift station and associated parking lot are situated at the downstream end of one of the Facility's sub-watersheds. This location experiences the worst amount of flooding relative to the rest of the Facility. It was reported that extreme storm events can result in ponding up to car's bumpers, which is anywhere from 14-18 inches. A substantial amount of stormwater runoff crosses and ponds along H St. via overland flow, shown in Figure 1.1-5.

The amount of flooding at the locations shown in the figures was caused by a relatively small storm event. As will be shown in Section 4.2.4, this storm event corresponds to between a 2-year and 5-year storm. Therefore, the Facility generally has a 2-year to 5-year level of service (LOS).

1.2 Facility Development

As noted in Section 1.0, there is ongoing construction and demolition (C&D) of Facility buildings. The C&D is part of a long-term Area Development Plan (ADP) for the Facility. The ADP has two C&D categories, long-term and capacity. The long-term C&D has a tentative timeline of 10-20+ years and the Capacity C&D does not have a timeline and is more of a notional goal. Figure 1.2-1, shown below, provides an image of the ADP that was provided to SCI.



North Chicago Metroplex Area Development Plan

FORT SHERIDAN ILLUSTRATIVE PLAN

The Illustrative Plan includes all short- and long-term actions from the Preferred Alternative Plan. Additionally, notional buildings have been added that identify areas where future growth can occur consistent with the Regulating Plan. It is important to note that the Illustrative Plan is not the only development option, but serves as a guide for capacity planning.

On Figure 4.12, notional projects are identified by blue letters. As shown by blue letter "A" and "B", the northernmost MEP area expands into the area occupied by demolished Buildings 379 and 380, and a separate OMS is constructed to increase vehicle maintenance capacity. Additional unspecified building capacity is shown in blue as "F" and "G". Blue letter "C" shows the location for a paved DEPMEDS, which will replace Building 475 and is also located on the site of existing roads that will be replaced by blue letter "D". The new roadway alignment provides a straighter path to create an improved haul route connecting both the northern and southern MEPs and allowing improved access to 1st street. The capacity of the NCARISC in Building 181 is expanded, shown by blue letter "H", to accommodate growth from the existing units or from outside of the Metroplex. Other notional facilities include two unspecified use buildings shown as blue letters "F" and "G" as well as a reconfigured main parking area that maximizes the use of the existing pavement, adds shade cover to reduce the heat island effect, and increases the lot size by 104 parking spaces.

In general, POV excesses have not been altered significantly in order to reduce the cost of removal and maintain potential for increased future capacity. These areas are included in the developable area of the site and are utilized as additional MEP or redeveloped areas where practical. This alternative supports an ARC capacity of 2,700 PN with 1,367 parking spaces that could accommodate a 1,709-PN drill weekend.

Figure 1.2-1. Sheridan USARC Illustrative ADP

On average, C&D of a Facility building occurs every three to five years. The tentative C&D for the Facility is as follows. Two buildings, Buildings 139 and 379, are scheduled for demolition in the Fall of 2020. Any C&D after this Spring is tentative and subject to change. The current timeline has the next round of demolition, Building 137, and construction, a new Area Maintenance Support Activity / Tactical Equipment Maintenance Facility (AMSA/TEMF), tentatively scheduled from 2025 to 2027. Following this, six buildings, Buildings 147, 380, 475, 598, 599, and 615, are scheduled for demolition which will be done in conjunction with the construction of a new Army Reserve Center (ARC) Building; the timeline for this work is from 2030 to 2035. There is also a tentative plan for C&D in 2040 with the demolition of Buildings 149, 699, and 699A, and the construction of a new Entry Control Point (ECP) within the footprint of Building 699. The remaining structures to be built as part of the Capacity C&D include two solar arrays, an Organizational Maintenance Shop (OMS), and the expansion of Building 181. Figures 1.2-2 to 1.2-7 visually represent the tentative schedule described above. Below is a bulleted list of the tentative C&D schedule described above.

- Fall 2020 – Demolition of Buildings 139 and 379
- 2025-2027 – Demolition of Building 137
  Construction of an AMSA/TEMF
- 2030-2035 – Demolition of Buildings 147, 380, 475, 598, 599, and 615
  Construction of a new ARC Building
- 2040 – Demolition of Buildings 149, 699, and 699A
  Construction of a new ECP
- Capacity – Construction of two solar arrays and an OMS
  Expansion of Building 181.

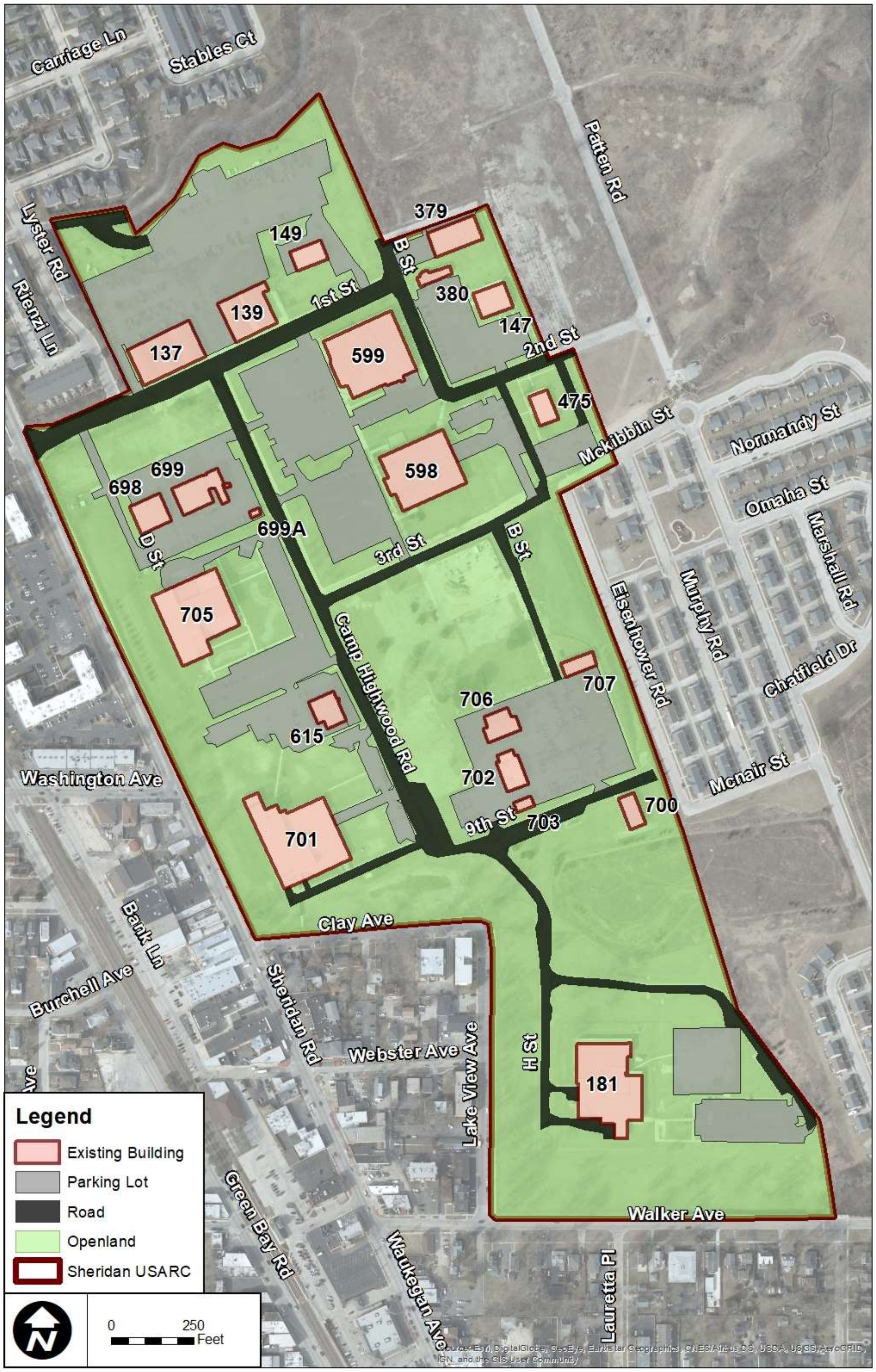


Figure 1.2-2. Sheridan USARC Existing Conditions Infrastructure

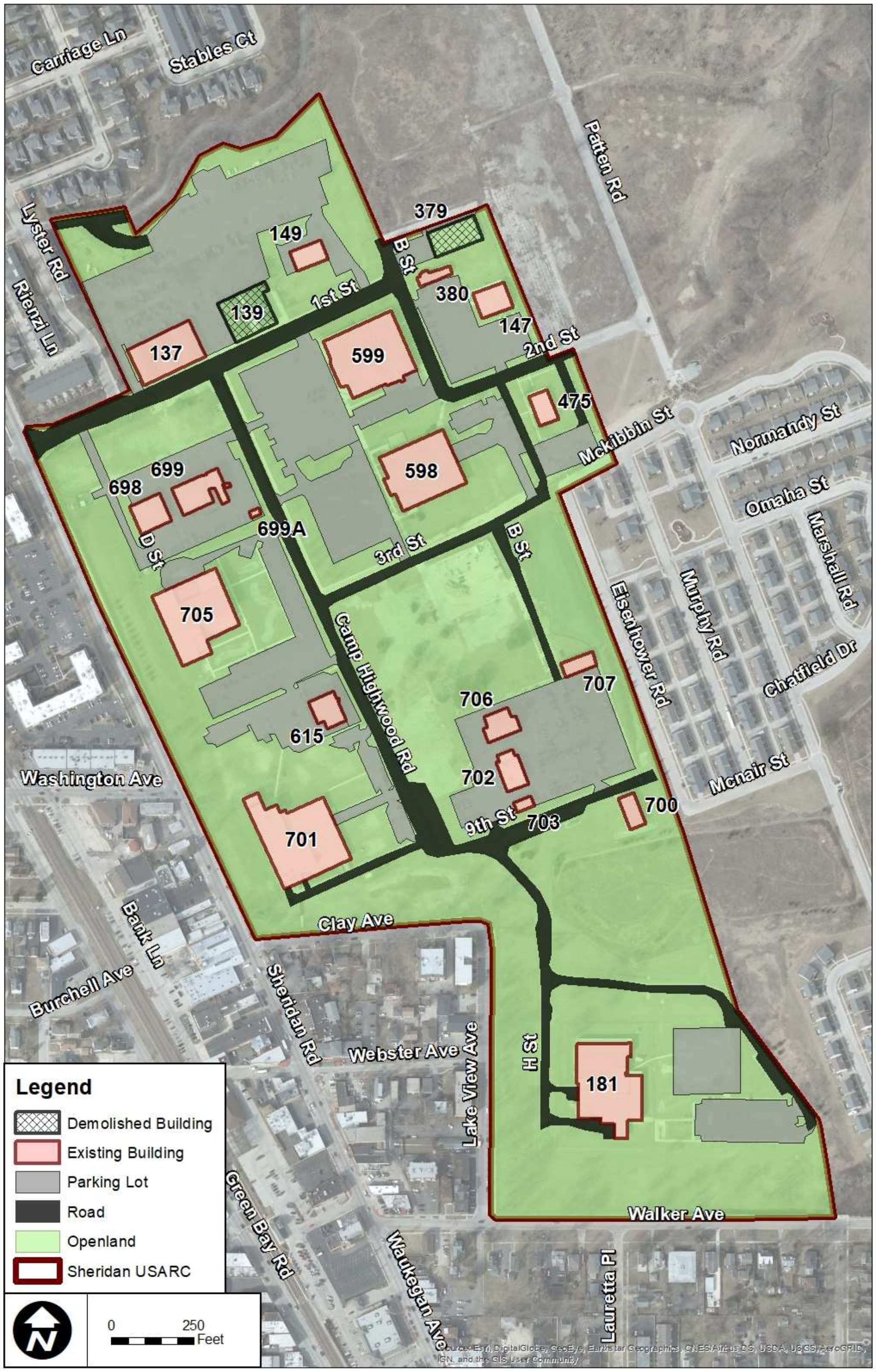


Figure 1.2-3. Sheridan USARC post-Spring 2020 Infrastructure

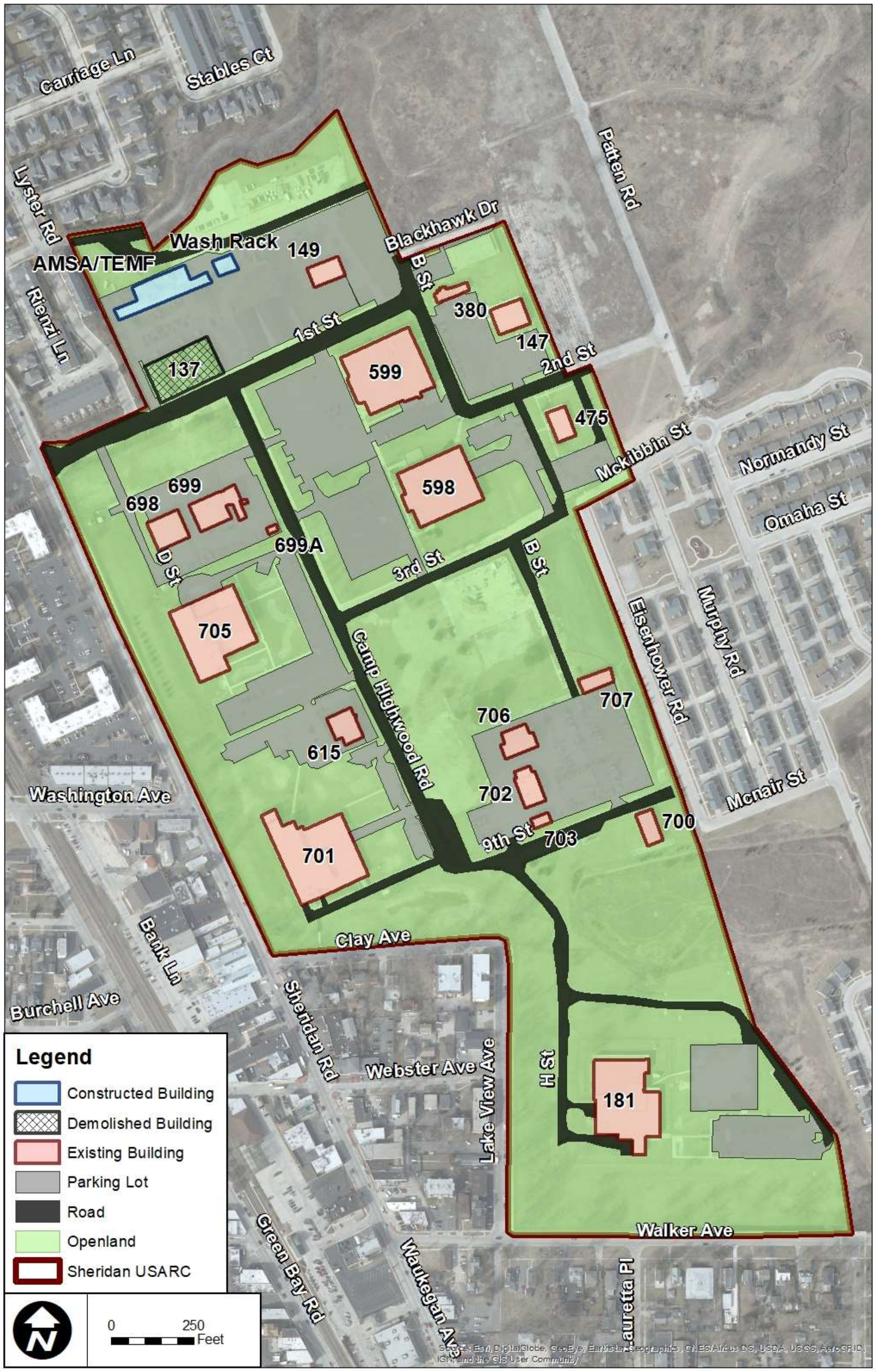


Figure 1.2-4. Sheridan USARC 2025-2027 Infrastructure

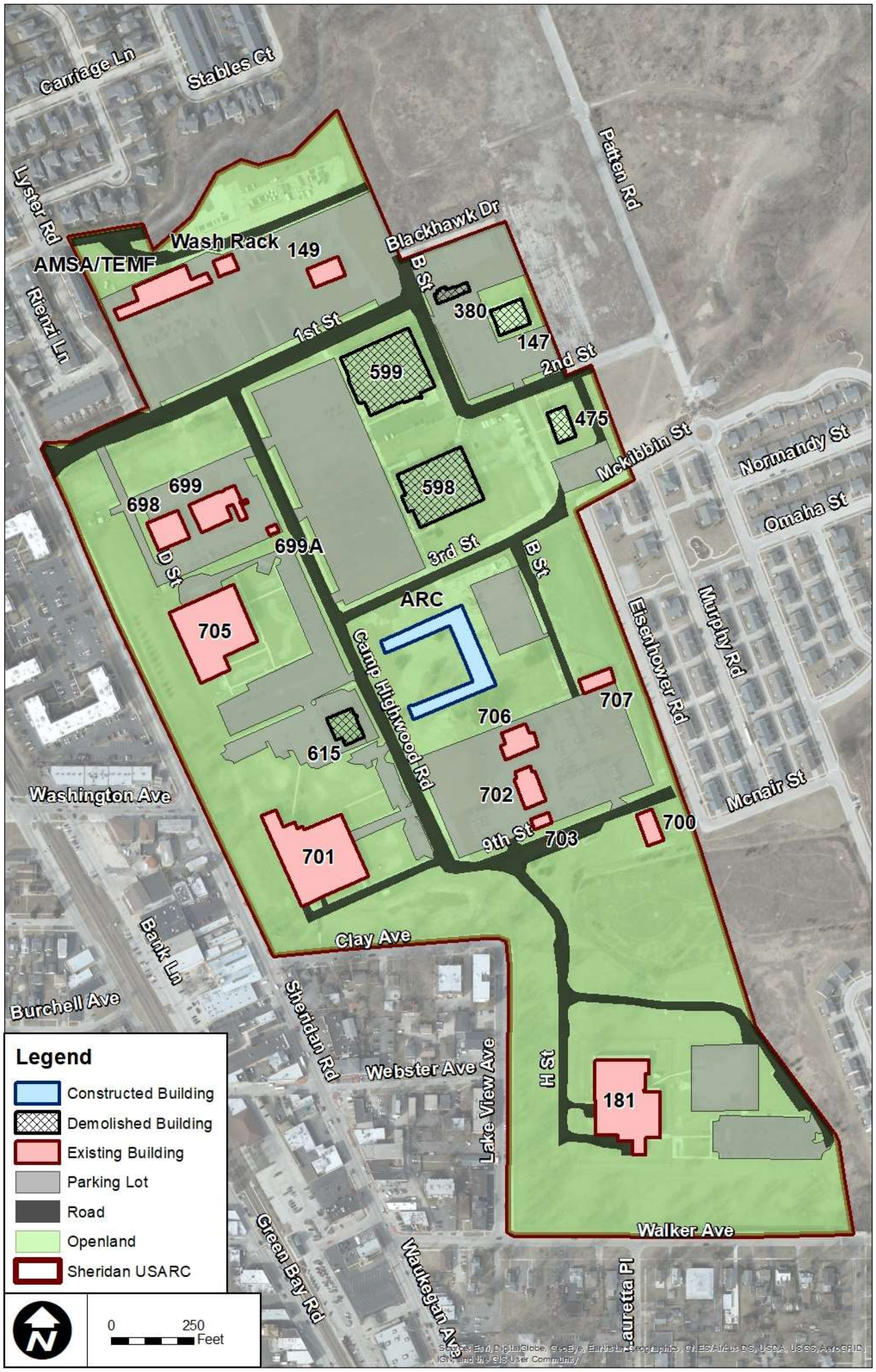


Figure 1.2-5. Sheridan USARC 2030-2035 Infrastructure

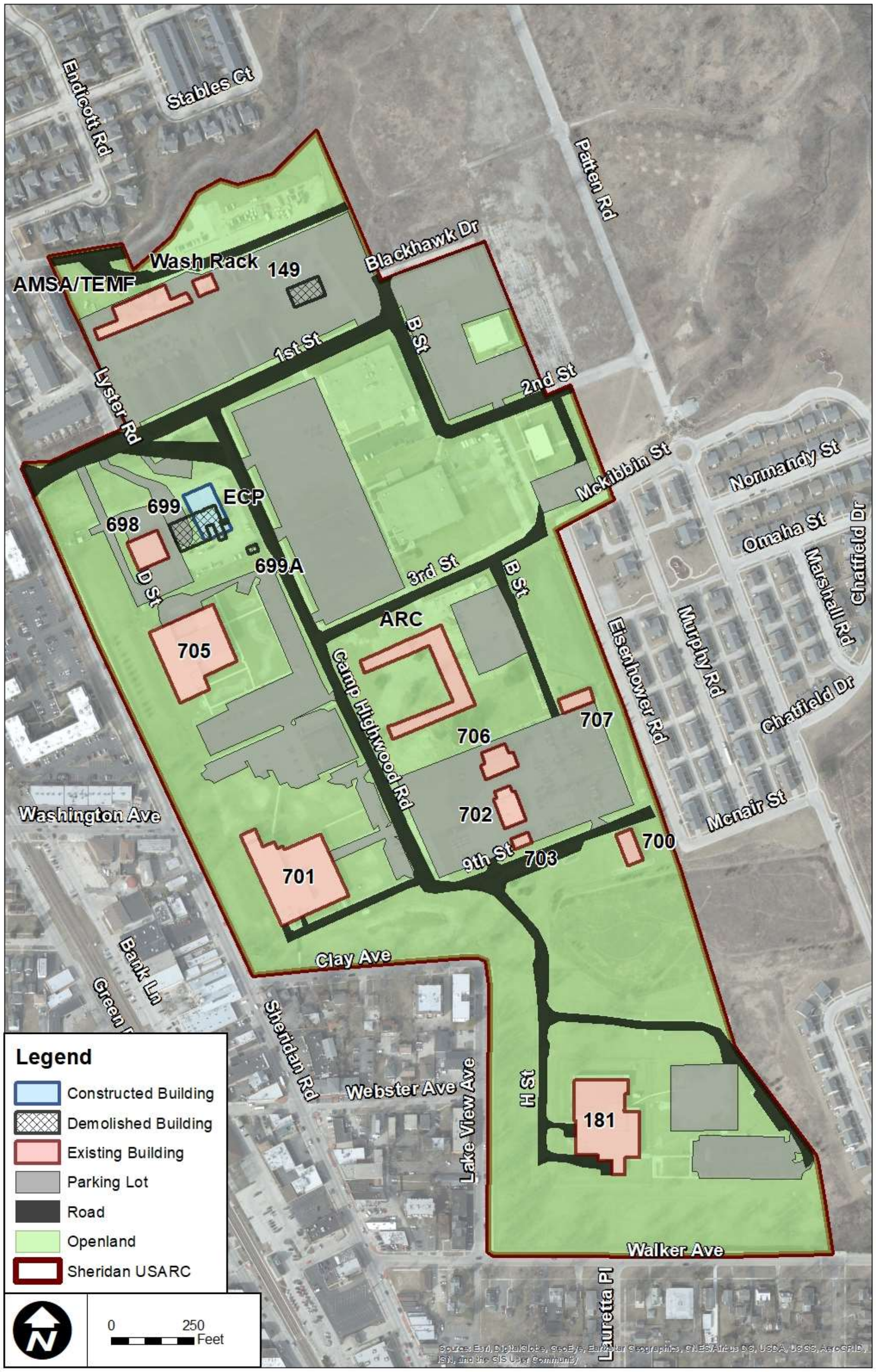


Figure 1.2-6. Sheridan USARC 2040 Infrastructure

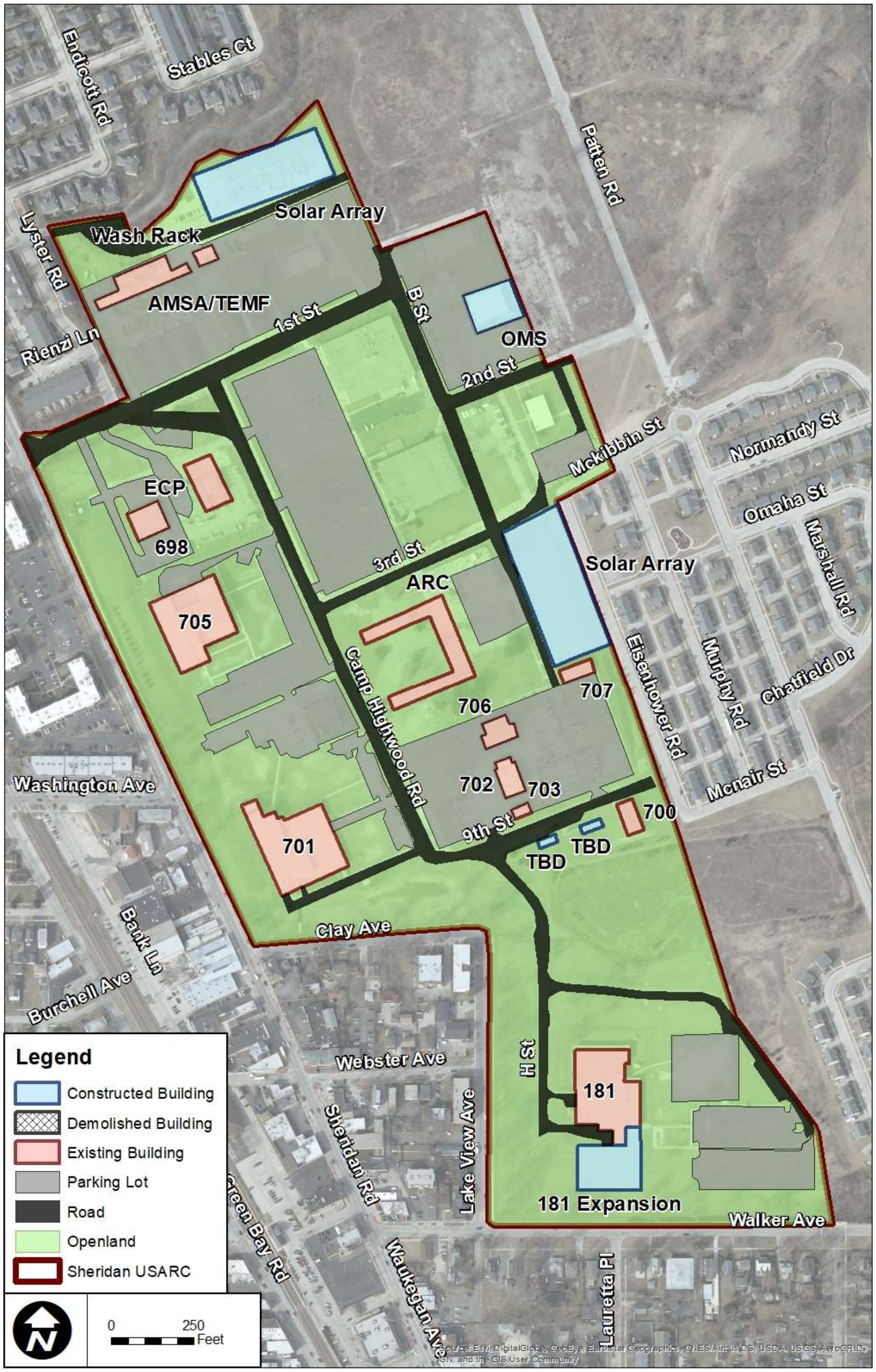


Figure 1.2-7. Sheridan USARC Full Capacity Infrastructure

The stormwater drainage for each C&D project until now has been designed with only the project itself in mind and not the Facility as a whole. This design approach has led to a segregated stormwater management system, which is one of the reasons for the Facility's poor drainage conditions. Therefore, an understanding of the Facility's tentative C&D plans, and schedule, is crucial to developing stormwater improvements that will have a long-lasting beneficial impact and not hinder the planned developments.

1.3 Landfills

Facility personnel informed SCI that there are two landfills located on-site, both of which contain special waste soil, and are operated and maintained by the 88th's Facility Realignment and Closure (BRAC) office. One landfill is located on the northeast side of the Facility (Landfill #5) and the other at its southeast boundary (Landfill #6). Both landfills have a 100-ft buffer zone surrounding their caps and must remain undisturbed unless the Illinois Environmental Protection Agency (IEPA) concurs with any intrusive activities or changes in hydrology near them. Similarly, if any drainage or utility construction will affect surface water flow around the landfills, or impact stormwater utilities associated with the landfills, it must be approved by the IEPA and the Navy.

SCI has coordinated with the IEPA and BRAC environmental remediation points of contact (POC) regarding these landfills throughout the design process. An SCI representative partook in the BRAC personnel's monthly O&M teleconference to elaborate on the proposed improvements and obtain feedback to incorporate into the design. SCI has also corresponded with the IEPA remediation POC in conjunction with Sheridan's Environmental Protection Specialist regarding the Project.

During SCI's coordination with the BRAC office, BRAC officials have noted that any material that is removed during construction activities (soil, asphalt, construction debris, etc.) must be accounted for by the 88th's Remediation Department in their Solid Waste Annual Reporting Web (SWARWEB) tracking system. This would include quantifying approximate weights and material types of any material taken from the Facility. BRAC personnel also expressed their concerns regarding the proposed rain gardens surrounding Landfill #6. The purpose of the proposed rain gardens is to absorb stormwater runoff that cannot be redirected to the detention pond in an attempt to lower the Facility's stormwater release rates. BRAC personnel pointed out that this could have an unintended negative impact to the integrity of the landfill by raising groundwater elevations within the area. There are also gas monitoring probes that must not become submerged by potentially higher groundwater elevations. The results of the discussion were that the potentially negative effects of the proposed rain gardens outweigh their potential benefits. Given this, SCI has opted to omit the proposed rain gardens in this area. SCI is currently re-evaluating this design aspect and determining what, if any, alternative measures should be taken. SCI will keep BRAC and IEPA officials apprised of design updates as the Project progresses.

SCI's coordination with the IEPA remediation POC regarding the design of the proposed improvements resulted in their request that a geotextile membrane be added to the design of the proposed detention pond located at 1st St and B St. The purpose of this is to prevent infiltration of detained stormwater within the vicinity of Landfill #5. SCI will incorporate this into the design.

SCI recommends that the 88th RD conduct pre-construction soil investigations in the areas that will be disturbed for the Project and develop a plan for handling and disposing of contaminated soils encountered during excavation activities. The purpose of this will be to identify all waste codes applicable to each hazardous waste stream based on requirements in 40 CFR 261 or applicable state or local law or regulation and to identify applicable treatment standards in 40 CFR 268 and state land disposal restrictions to make a determination as to whether or not the waste meets or exceeds the standards. If the 88th opts to perform the pre-construction soil investigation, then it should be included as an appendix to this Design Analysis Report prior to the bidding of this Project. If the 88th opts to not perform the pre-construction soil investigation, then the Excavation of Handling of Contaminated Material specification section, Specification 02 61 00, should update Section 3.5 Confirmation Sampling and Analysis and omit references to the pre-construction soil investigation.

The test results will impact the seed type used for the detention ponds and whether or not a geomembrane will be utilized, see additional information below in the Native Grass Seeding section.

Figure 1.3. Sheridan USARC Landfill Locations

1.4 Installation Design Guide Standards

The 88th Readiness Division's Installation Design Guide (IDG) provides design guidance for new construction projects. The IDG was considered in the development of stormwater improvements. The relevant sections of the IDG regarding the Project include Part V – Circulation Standards and Part VI – Landscape Design Standards, which is summarized below.

1.4.1 Installation Design Guide Part V – Circulation Standards

Part V of the IDG contains relevant subsections including Circulation System Design, Parking Lot Location and Design, and Stormwater Management. A bulleted list of the relevant design points is provided below.

<u>Circulation System Design</u>

- Road drainage ditches, swales and channels were blended into the natural landform.

<u>Parking Lot Location and Design</u>

- Landscaping buffer have been provided where practicable between privately owned vehicle parking lots and roads/drives.
- Curb and gutter are not proposed around parking lots, except when required to accommodate site grading and drainage concerns, to accommodate snow removal.
- In areas of infiltration basins curb cuts may be required to allow drainage to pass through the curb line. In bituminous/hot mix asphalt parking lots concrete edges may be used instead of curb cuts. Top of edger should be flush with asphalt.
- POV parking lots that are proposed to be replaced with paved surfaces. Parking spaces shall be striped.

<u>Stormwater Management</u>

- Stormwater management systems have been designed to local standards, particularly the Lake County Watershed Development Ordinance.
- Low Impact Development (LID) Best Practices, have been added where practicable. Examples include vegetated swales, rain gardens, and extended detention.

Within the IDG, several army standards are cited at the end of the Circulation Standards section. The cited standards that will be met for the Project include the following.

- UFC 3-201-01, Civil Engineering.
- UFC 3-210-10, Low Impact Development.

1.4.2 Installation Design Guide Part VI – Landscape Design Standards

Part VI of the IDG includes Landscape Design Standards. As will be discussed in Section 5.2, the conceptual improvements involve traditional stormwater management techniques such as providing adequate detention storage and improved conveyance capacity in addition to implementing Low Impact Development (LID) techniques wherever possible. Many of the LID techniques involve rain gardens that utilize native plants. Given this, there are several landscaping objectives and principles that will be followed. A bulleted list of the relevant design standards from Part VI is provided below.

<u>Landscape Objectives and Principles</u>

- Landscape design and landscape materials must be sustainable, low maintenance, conserve energy and require minimal use of potable water for irrigation, pesticide, and herbicide application. The objective of our design is to minimize maintenance of landscape areas.
- Maintenance must be minimized maintenance using native plant materials that require less maintenance.
- Ease of maintenance and frequency must be a primary consideration. Native landscapes (i.e. native grass and forb groundcovers, native trees, shrubs and perennials) should be

emphasized to reduce maintenance activities due to limited resources. Native plants are proposed to be incorporated into the rain garden.

- A Landscape Maintenance Plan (LMP) is required. The general objective of an LMP is to ensure an orderly and efficient care of the grounds.

Within the IDG, several army standards are cited at the end of the Landscape Design Standards section. The pertinent cited standards that will be met for the Project include the following.

- UFC 2-100-01, Installation Master Planning, Chapter 3-7.3 Landscape Standards
- UFC 3-201-02, 2009 Landscape Architecture

2.0 Summary of Regulatory Review

A Regulatory Review (RR) for the Project was performed by SCI and submitted to Sheridan USARC in July 2019, and is provided in Appendix B. The RR was performed to ensure that the designed stormwater management system adheres to the requirements of all relevant regulatory entities. There are regulatory entities at the Federal, State, and Local level of government to consider for the Project.

The Lake County Stormwater Management Commission (SMC) is the local regulatory authority and implements the Lake County Watershed Development Ordinance (WDO). The design work for the Project is based on the stormwater requirements of the WDO.

There are three State entities that will need to be corresponded with during the Project. Two State entities, the Illinois Historic Preservation Agency – Illinois State Historic Preservation Office (IHPA-SHPO) and the Illinois Department of Natural Resources – Office of Realty and Environmental Planning (IDNR-OREP), will need to be consulted with during the Project. Both consultations are required to obtain a National Pollutant Discharge Elimination System (NPDES) general permit. The NPDES general permit covers stormwater discharges from construction site activities and is required by the third state entity, the IEPA. The purpose of the IHPA-SHPO consultation is to determine if construction activities will impact any historic properties listed in the National Register of Historic Places, if present. The purpose of the IDNR-OREP consultation is to determine if construction activities may adversely impact Illinois endangered and threatened species, if present.

Although not noted in the original Regulatory Review document, additional consultation with the IEPA will be required for the Project. As noted in Section 1.3, two landfills are located on Facility property that contain special waste soil. Both landfills have 100-ft buffer zones. Land use restrictions are in place for both landfills which prohibit intrusive activities of any kind within the landfill buffer zones or construction that will impact surface water flow near the landfills without permission from the Army, IEPA, and the Army Reserve or the Navy. The appropriate entities will be coordinated with to ensure adherence to the land use restrictions.

There is one Federal entity, the United States Fish and Wildlife Services (USFWS) that will also need to be consulted during the Project. Similar to the IDNR-OREP consultation, the purpose of the USFWS consultation is to determine if any threatened or endangered species are in the vicinity of any proposed construction activities.

A list of the required permits and consultations is provided in Section 2.1 below. Pertinent details from the RR are summarized in this section.

2.1 Required Permits / Consultations

As described in the preceding section, the following is a list of permits and consultation approvals that will be required for the Project.

- USFWS Consultation
- IHPA Consultation
- IDNR-OREP - EcoCAT Consultation
- IEPA NPDES General Permit
- IEPA Landfill Land Use Restrictions

2.2 Lake County WDO Requirement Compliance

The Lake County WDO establishes standards for site runoff requirements, release rates, runoff volume reduction (RVR), water quality treatment, stormwater conveyance systems, stormwater facilities, and soil erosion and sediment control (SESC). The WDO standards were used as a basis of design for the Project. Key features of these standards are provided below.

2.2.1 Runoff Calculations

The WDO requires the use of an SMC approved hydrograph method to determine runoff calculations for sites with a drainage area greater than 100 acres. Although the Facility has a drainage area of only approximately 92.6 acres this rule will still be followed. The hydrograph method used was done through EPA SWMM software, version 5.1; although this method is not explicitly stated in the WDO, it was verified by SCI that it is acceptable. The SMC also requires that rainfall frequency data be obtained from the Illinois State and Water Survey (ISWS) Bulletin 70. Bulletin 70 is a document that contains rainfall frequency data based on studies done for Illinois as well as the Midwest. An updated Bulletin 70 was released in March 2019 and is expected to be amended by Lake County by the summer of 2020. The updated Bulletin 70 rainfall data was used for the Project.

2.2.2 Release Rates

The WDO requires detention volumes to be calculated using a rating curve based on maximum release rates of:

- 0.04 cubic feet per second (cfs) per acre for the 2-yr storm
- 0.15 cfs per acre for the 100-year storm

2.2.3 Runoff Volume Reduction (RVR)

The purpose of RVR requirements is to incorporate design elements to minimize stormwater runoff volumes and address water quality impairments. Implementing BMPs and green infrastructure techniques into the project achieves both goals by promoting stormwater infiltration, evapotranspiration, and reuse. Lake County SMC does not require any quantified volume of stormwater runoff to be reduced, only that attempts are made throughout the design process to reduce runoff to the maximum extent practicable.

2.2.4 Water Quality Treatment

The WDO's water quality requirements pertain to what's referred to as the 'first flush'. The first flush is the first inch of stormwater runoff which, in urban areas, has a greater concentration of pollutants than subsequent stormwater runoff. The intent of the water quality requirements is to mitigate the negative environmental impacts of the first flush. The WDO standard is for a development to divert and detain at least the first 0.01 inch of runoff for every 1% of impervious surface created by the Project, with 0.2 inches as the minimum amount treated. For example, if a development consists of 20% or less new impervious area then 0.2 inches must be diverted and detained. Similarly, if a development consists of 50%, 90%, or 100% impervious area then 0.5-inch, 0.9-inch, or 1.0 inch must be diverted and detained, respectively.

There is an additional water quality treatment requirement that pertains to vehicle sourced pollutants. The WDO states that hydrocarbon (e.g. oil and grease) removal technology is required for developments that are classified as either vehicle fueling and servicing facilities or parking lots with more than twenty-five (25) new stalls. The first 0.5 inch of runoff must be treated for developments such as these. The hydrocarbon removal technology must meet a minimum 70% removal rate for the described developments.

2.2.5 Stormwater Conveyance System

WDO requirements regarding the stormwater conveyance system include that the minor stormwater conveyance system, consisting of storm sewers, swales, and appurtenances, must be designed for at least the 10-yr design storm. Storm sewers must have a minimum diameter of 12 inches. The major stormwater conveyance system consists of overland flow paths which must be sized for the 100-year storm.

2.2.6 Stormwater Facility

Per the WDO, a stormwater facility's primary outlet pipe must be at least 12 inches to prevent clogging. A secondary outlet must also be provided in the form of an emergency overflow weir

(EOW). The EOW must be capable of passing the peak flowrates generated by a 100-yr storm, which are determined as described in Section 4.2.3-2.

2.2.7 Soil Erosion and Sediment Control

SESC measures are required for any land disturbance activities on the development site and to obtain the required NPDES permit. Generally, erosion control is achieved through soil stabilization through either temporary, during-construction, or permanent post-construction measures. All SESC devices must be properly maintained throughout construction. If they are disturbed during storm events, then they must be re-stabilized within 7 calendar days of an event.

3.0 Survey Data

Topographic and utility surveys of the Facility were collected by Anderson Engineering of Minnesota (Anderson). Both types of survey-work are standard for stormwater drainage analyses. Details about the topographic and utility surveys are provided below.

3.1 Topographic Survey

The scope of work specified a topographic survey by an Unmanned Aerial Vehicle (UAV); however, the Department of Army grounded UAV operations at the Facility. In lieu of collecting UAV survey data, Lake County topographic data was used for hydrologic analysis and the preliminary design of the stormwater improvements. The data is comprised of one-foot contours that were developed from Light Detection and Ranging (LIDAR) data. The LIDAR data was obtained between April 16, 2007 and May 7, 2007. It conforms to the American Society for Photogrammetry and Remote Sensing (ASPRS) Specifications and Standards Committee, 1990, ASPRS Accuracy Standards for Large-Scale Maps, CLASS 1 map accuracy. The United States Army Corps of Engineers (USACE) recommends that the data be used for preliminary project planning. This was supplemented with surveyed topographic data that was obtained by Anderson throughout approximately half of Sheridan USARC and focused on areas of the proposed improvements.

3.2 Utility Survey

Anderson performed the utility survey with robotic total stations. The utilities that were surveyed include storm sewer structures and lines, as well as drainage ditches. The extent of the survey-work was within the boundaries of the Facility although storm sewer lines or drainage ditches that crossed the Facility boundary line were identified when possible.

Anderson was unable to verify pipe connections or determine the upstream/downstream end of a given pipe in several locations. This occurred for several reasons. Generally, this can happen when a pipe within a manhole is significantly offset. The surveyors obtain pipe information from the surface and when a pipe is offset far enough it can impede their ability to determine the necessary pipe information. In addition to this, the storm sewer pipes are somewhat scattered throughout the Facility which created additional problems. For example, there a several instances where a storm sewer pipe is observed entering/exiting manhole A in some direction toward manhole B, but is absent within manhole B. This is attributed to storm sewer lines that may have been abandoned during the ongoing construction and demolition.

The incomplete survey data did not hinder the initial high-level analysis nor the development of the existing conditions H&H model. Within the H&H model, several assumptions were made regarding storm sewer configurations. Section 4.2.2 provides detailed descriptions and figures of the assumptions that were made. Several utility unknowns were verified through SCI's correspondence with the 88th's GIS department. Following the 35% design submittal, SCI personnel met Facility personnel on-site to perform dye testing. The dye tested was done in an attempt to verify the unknown utility connections. The results of the dye testing and current status of the utility unknowns is provided in Section 4.2.2.

4.0 Hydrology Drainage Study – Existing Conditions Model

The H&H analysis of Sheridan ARC was partitioned into two distinct categories, a hydrologic analysis and a hydraulic analysis. Generally, stormwater hydrology pertains to stormwater while it's still in the air and stormwater hydraulics relates to stormwater once it's on the ground. A discussion of the H&H analyses is provided within Sections 4.1 and 4.2, respectively. The results of the H&H analysis were input into EPA SWMM version 5.1 to create an Existing Conditions model, the results of which are summarized in Section 4.3.

4.1 Hydrologic Analysis

A stormwater hydrologic analysis involves characterizing the type of rainfall to expect for a given site. Rainfall characterization entails obtaining precipitation data for different sized storm events (i.e. 1-year storm, 2-year storm, up to a 100-year storm). Additional hydrology data includes the time distribution of rain throughout the course of a given storm event. Generally, for northeast Illinois, shorter storms precipitate the most rainfall at the beginning of a storm whereas longer storms precipitate more rainfall near the end of a storm. Quantification of these hydrologic characteristics helps to predict the volume of rainfall to expect for a given storm event. Accurate prediction of the volume of stormwater to expect for a given storm event aids in properly designing and sizing a detention basin.

4.1.1 Precipitation Data

As noted in Section 2.2.1, the Lake County SMC requires that the updated version of the ISWS Bulletin 70 is used as the source of precipitation frequency data. The precipitation frequency data represents the magnitude of stormwater volume to expect from a given storm event (e.g. the precipitation frequency values for a 2-year, 24-hour design storm and a 100-year, 24-hour design storm is 3.34-inch and 8.57-inch, respectively). The updated Bulletin 70 contains precipitation frequency values that are greater than the previously published values for northeast Illinois. The previous version of Bulletin 70 was published in 1989 and was based on data from 1901 to 1983. The updated precipitation frequency values are based on National Oceanic and Atmospheric Administration (NOAA) data from 1948 to 2017 and Cook County Precipitation Network (CCPN) data from 1989 to 2016. The precipitation frequency data was used to model design storm events within the H&H Model.

4.1.2 Temporal Distribution Data

It is necessary to also consider the time distribution of rainfall throughout a design storm in addition to the total volume generated by the storm. As noted, in northeast Illinois shorter duration storms generally precipitate the most rainfall near the beginning of a storm whereas longer duration storms generally precipitate more rainfall near the end of a storm. Research was done by Floyd A. Huff on time distributions of heavy rainstorms in Illinois. One result of this research is what is known as Huff Quartiles. Huff Quartiles describe the cumulative distribution of rainfall throughout a design storm and is based on the storm's duration. As the name suggests, there are four Huff Quartiles (I, II, III, and IV). Huff Quartiles increase as storm durations increase. For example, Huff Quartile I represents the distribution of rainfall for short duration storms and Huff Quartile IV represents the distribution of rainfall for long duration storms. Figure 4.1-1, shown below, provides a visual aid to help describe this concept which was obtained from the ISWS Time Distribution of Heavy Rainstorms in Illinois.

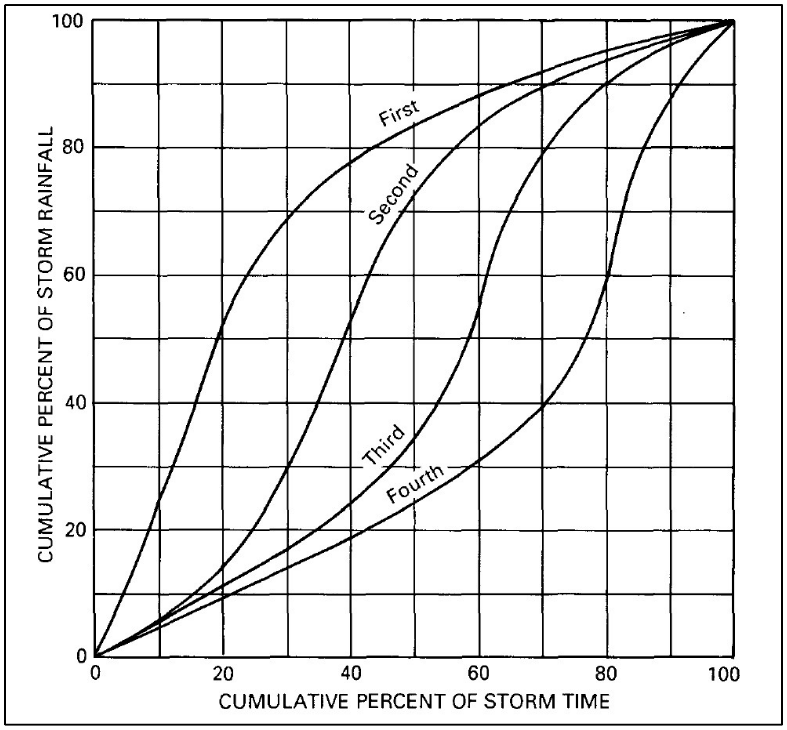


Figure 4.1-1. Huff Quartiles
Source: ISWS Time Distribution of Heavy Rainstorms in Illinois

To summarize, based on Huff's research:

1. Storm durations of 6 hours or less correspond to a first-quartile distribution.
2. Storm durations from 6.1-12 hours correspond to a second-quartile distribution.
3. Storm durations from 12.1-24 hours correspond to a third-quartile distribution.
4. Storm durations greater than 24 hours correspond to a fourth-quartile distribution.

This analysis utilizes the third-quartile distribution for the 24-hour duration of the 2-year, 10-year, 50-year, and 100-year design storms. All four quartile distributions are applied to the appropriate duration when used for the critical duration analysis which is discussed in further detail in Section 4.1.3-2.

4.1.3 Design Storm Events

Design storm events are used during hydrologic analyses to predict the volume of rainfall that can be expected from several different types of storms, from very small events to very large ones. A design storm is described in terms of the probability of occurring once within a given number of years. For example, a 10-year storm event has a 10 percent chance of being exceeded in any given year (i.e. 1 exceedance / 10 years = 10 percent). A 10-year storm event can also be thought of having a return period of 10 years. Design storms are used as guidance for predicting the magnitude of rainfall that must be managed when designing stormwater drainage improvements. As stated in the Scope of Work (SOW), the design storms that will be analyzed include:

- 1.1-inch Water Quality Storm Event
- 2-year, 24-hour Storm Event
- 10-year, 24-hour Storm Event
- 50-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event

4.1.3-1 1.1” Water Quality Storm Event

The 1.1-inch water quality storm event is not an actual design storm event to be modeled but rather a benchmark to be met. As noted in Section 2.2.4, the Lake County WDO requires that the initial stormwater runoff that is generated by a storm event be treated to improve the effluent water quality. This is because the initial runoff has a greater pollutant concentration than whatever remaining runoff is generated. The two requirements to be met are:

- Divert, detain, and treat the first 0.01 inch of runoff for every 1% of impervious surface created by a development.
- Divert, detain, and treat the first 0.5 inch of runoff for developments classified as either vehicle refueling stations or parking lots with more than 25 new stalls to meet a 70% hydrocarbon removal rate.

The 1.1-inch water quality storm event is listed to highlight these requirements. Verification of meeting these requirements will be done through the analysis of the other storm events.

4.1.3-2 Critical Duration Analysis

As required by the WDO, several other storm durations will be modeled in addition to the 24-hour duration design storms. More specifically, a critical duration analysis will be performed as part of the requirements for both Runoff Calculations and Stormwater Facilities (WDO Sections §501 and §507, respectively). A critical duration is a design storm duration for a given frequency storm which produces the greatest peak flow, volume, or stage. The frequency storm used during a critical duration analysis is the 100-year storm. The storm durations that will be analyzed include the 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, 18-hour, 24-hour, and 48-hour storms. Generally, shorter duration storms will yield the highest peak flowrates and longer duration storms will yield the highest volume of rainfall. The resultant peak flowrate from the critical duration analysis will be used to properly size the stormwater conveyance system (e.g. storm sewers and drainage ditches) and the EOW.

4.1.3-3 Design Storm Data

The required design storm data that was obtained through the hydrologic analysis has been established. Precipitation frequency data, temporal distribution data, and the various storm durations required to perform a critical duration analysis have all been quantified so they can be input into the H&H Model. A summary of the pertinent design storm data to be applied to the Model is provided in Table 4.1-1. These values were obtained from the updated ISWS Bulletin 70.

Table 4.1-1. Design Storm Data

Return Period (yr)	Duration (hr)	Huff Quartile	Precipitation Frequency Value (in)
2	2*	I	1.94
	24	III	3.34
10	24	III	5.15
50	24	III	7.50
100	1	I	4.03
	2	I	4.97
	3	I	5.49
	6	I	6.43
	12	II	7.46
	18	II	8.06
	24	III	8.57
	48	IV	9.28

*Section 4.2.4 notes that a 2-yr, 2-hr real-world storm event occurred in October 2019. This design storm is included for Model verification purposes.
Source: ISWS Updated Bulletin 70

As noted in Section 4.1.3, design storm events are used within the H&H model as guidance for predicting the magnitude of rainfall that must be managed when designing stormwater drainage improvements. Real-world storm events can also be input into the Model and are used to verify the accuracy of the simulated design storms. Verification is done by comparing actual water surface elevations (WSE) that result from real-world storm events to WSEs from similar size and duration storm events that are reported by the Model. Model verification is performed to ensure that the Model is accurately simulating real-world behaviors.

4.1.4 Real-World Storm Event

As noted in Section 1.1, the October 2019 storm event that caused nuisance flooding throughout the Facility was determined to be an approximate 2-year, 2-hour storm. Rainfall data of the storm event was obtained from Weather Underground (Wunderground), a commercial weather service provider that contains historical precipitation data. Rain gages within the vicinity of Sheridan USARC reported precipitation values as the storm occurred. These values were compared to ISWS precipitation frequency and temporal distribution data. The result indicates that the October 2018 storm event was a 2-year, 2-hour storm. Additional information regarding this analysis is provided in Appendix C.

With the hydrologic analysis complete, the next step is to quantify the hydraulics of the Facility. The hydraulic analysis is described in Section 4.2.

4.2 Hydraulic Analysis

A stormwater hydraulic analysis involves characterizing how stormwater runoff travels throughout a given site. The flow-path and amount of stormwater runoff is influenced by several parameters including site topography and the presence or absence of stormwater utilities. Quantification of the Facility's hydraulic characteristics helps to predict the peak flowrates of stormwater runoff for a given storm event. Accurate prediction of the peak flowrates for a given storm event aids in properly designing and sizing a stormwater conveyance system.

4.2.1 Facility Topography

The hydraulic analysis began with studying the topography of the Facility. Lake County LiDAR topographic data, comprised of one-foot contours, was used for the preliminary analysis and design of the Project. This was supplemented with surveyed topographic data that was obtained by Anderson throughout approximately half of Sheridan USARC and focused on areas of the proposed improvements. Generally, the topography of the Facility is such that stormwater runoff drains easterly toward Lake Michigan. The topography is shown in Figure 4.2-1. For clarity, only 5-foot contours are labeled and represented in black while the other contours have been faded and left unlabeled.

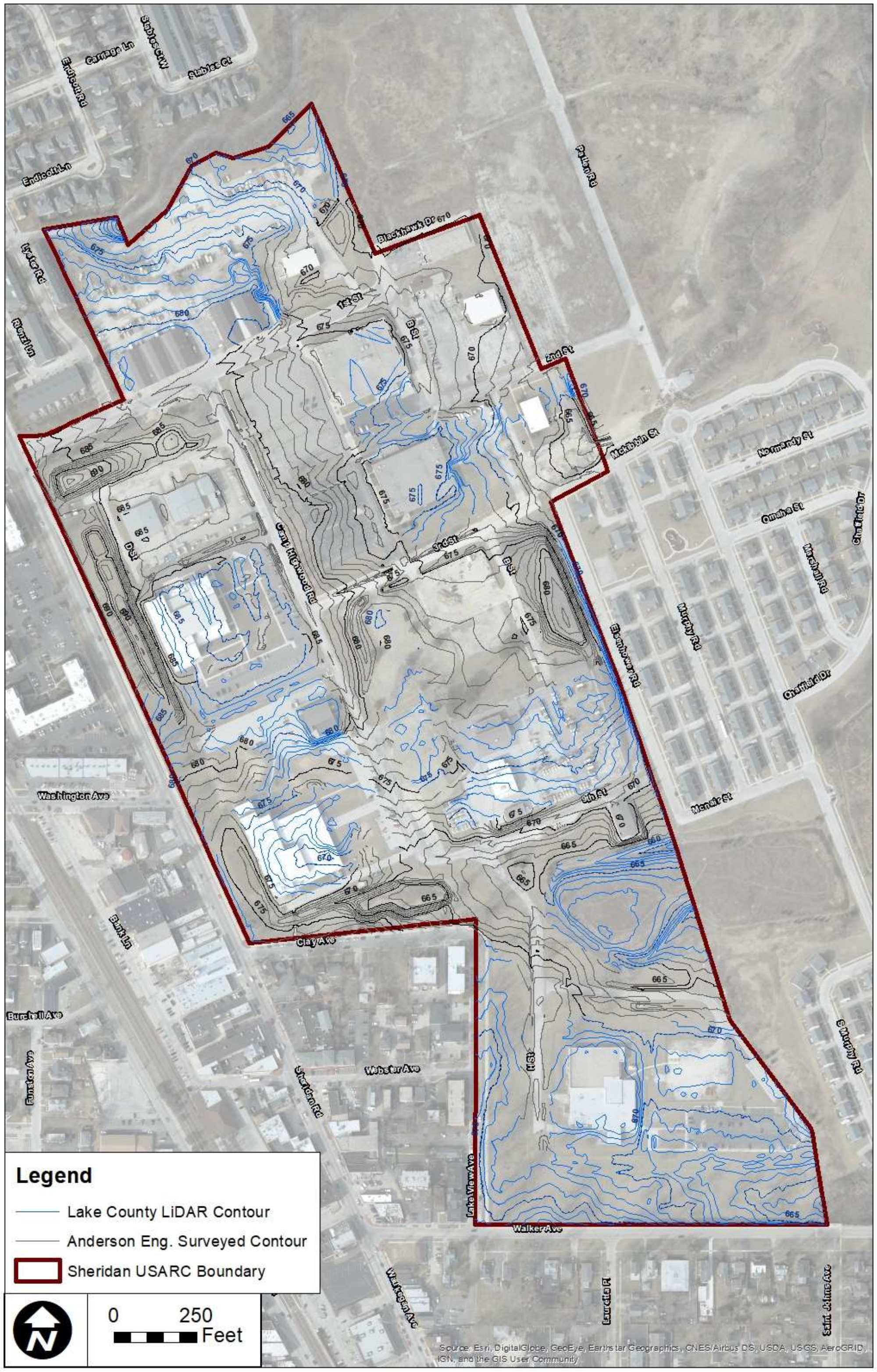


Figure 4.2-1. Sheridan USARC Topography

4.2.2 Facility Utilities

The surveyed storm sewer utilities were analyzed in conjunction with the topographic review of the Facility. This was necessary because storm sewer inlets, and the storm sewer network to which they're connected, can direct the flow-path of stormwater runoff throughout a site. In some instances, stormwater flow-paths can be counter-intuitive based on-site topography because of storm sewers conveying stormwater runoff elsewhere than expected. Figure 4.2-2 provides an image of the Facility's stormwater utilities.

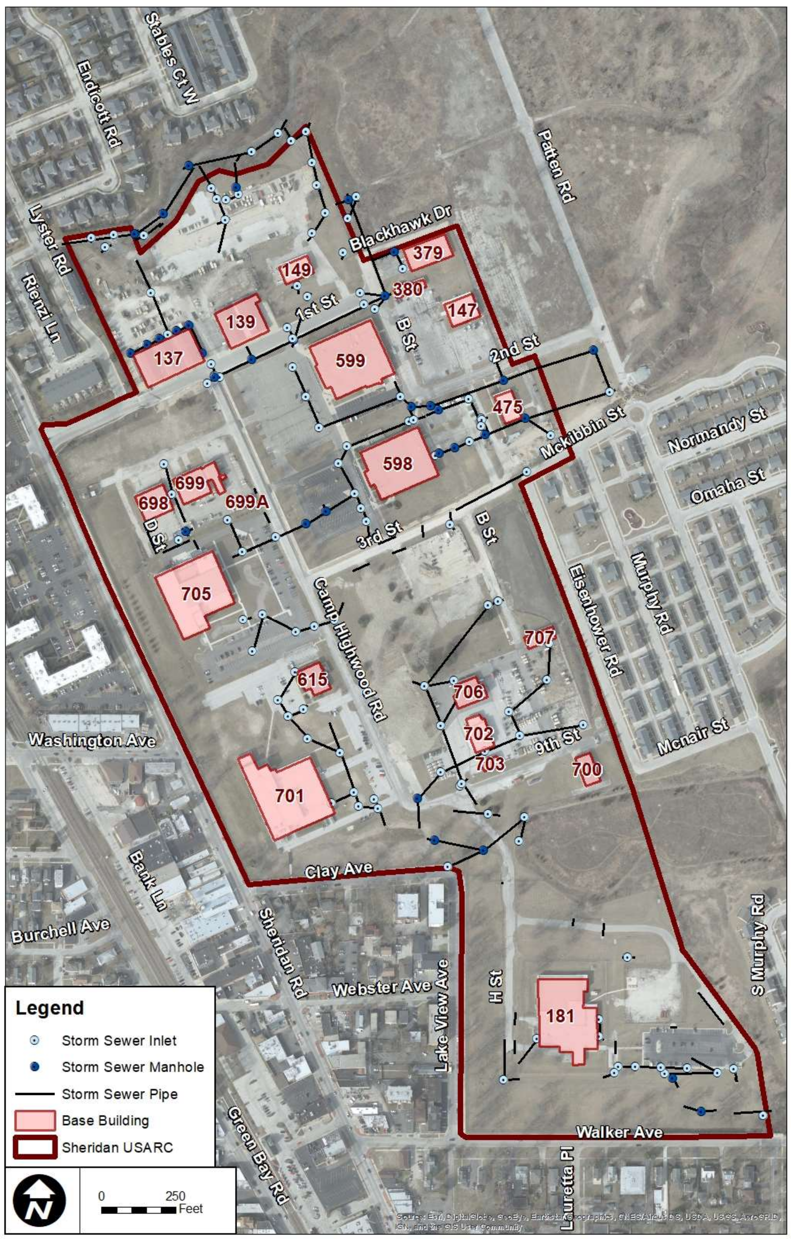


Figure 4.2-2. Sheridan USARC Utilities

4.2.2-1 Stormwater Utility Unknowns

As noted in Section 3.2, there are multiple locations where Anderson was unable to determine pipe connections, or the upstream/downstream location of a given pipe. As noted in Section 3.2, SCI reduced the number of utility unknowns between the 35% design and 65% design either through correspondence with the 88th's GIS department, on-site field inspection, or by dye testing. To perform the dye testing, an SCI member monitored a given downstream stormwater structure while a second SCI member administered a dye tracer and water from a garden hose into the closest upstream structure as a Facility representative turned on and off the water from the nearest building to which the hose was connected. The remaining utility unknowns and corresponding assumption that was made to route stormwater within the Model are listed in Table 4.2-1.

Table 4.2-1. Design Status of Stormwater Utility Assumptions

Item No.	Figure	Location	Unknown	Assumption	Design Status
1	4.2-3	Drainage ditch north of Building 705	North influent pipe	12-inch RCP	Resolved via GIS data
2	4.2-4	Parking lot north of Building 137	North outlet pipe	Overland Flow	Unresolved – Confirmation of status unnecessary for Project
3		Parking lot north of Building 139	Southern inlet pipe	Overland Flow	Unresolved – Confirmation of status unnecessary for Project
4		Lawns east and south of Building 149	Interconnection pipes	Overland Flow	Unresolved – No definitive confirmation from dye-testing
5		Outlet pipe northeast of Building 149	Northeastern outlet pipe	15-inch VCP	Unresolved – No definitive confirmation from dye-testing
6		Parking lot west of Building 379	Multiple connection points	8-inch VCP	Unresolved – No definitive confirmation from dye-testing
7		1st St, north of Building 599	Interconnection pipe	Overland Flow	Unresolved – No definitive confirmation from dye-testing
8	4.2-5	Mckibbin St and Eisenhower Rd	Eastern outlet pipe	Overland Flow	Unresolved – No definitive confirmation from dye-testing
9		Mckibbin St and Patten Rd	Interconnection pipe	24-inch RCP	Resolved via field inspection
10	4.2-6	Existing Detention Basin	Outlet pipe	15-inch RCP	Resolved vis GIS data and field inspection
11		H St and 9th St	Interconnection pipes	Overland Flow	Resolved via GIS data
12		Southeast of H St and 9th St	Eastern outlet pipe	42-inch RCP	Resolved via GIS data and field inspection
13	4.2-7	Field south of Building 181	Interconnection Pipes	Overland Flow	Unresolved – Confirmation of status unnecessary for Project

Most of the unknowns were able to be addressed by simply providing overland stormwater flow paths within the Model. As the name suggests, overland flow paths convey runoff from upstream to downstream through links that represent the ground surface instead of stormwater pipes. These overland flow paths have been adequate in high-level modeling the Facility's drainage patterns.

Several figures followed by brief descriptions are provided below which supplement the information shown in Table 4.2-1. Each figure has an (a) and (b) component, with the former illustrating the utility survey data and the latter showing how the location was represented in the Model. Brief descriptions are also provided following each set of figures.

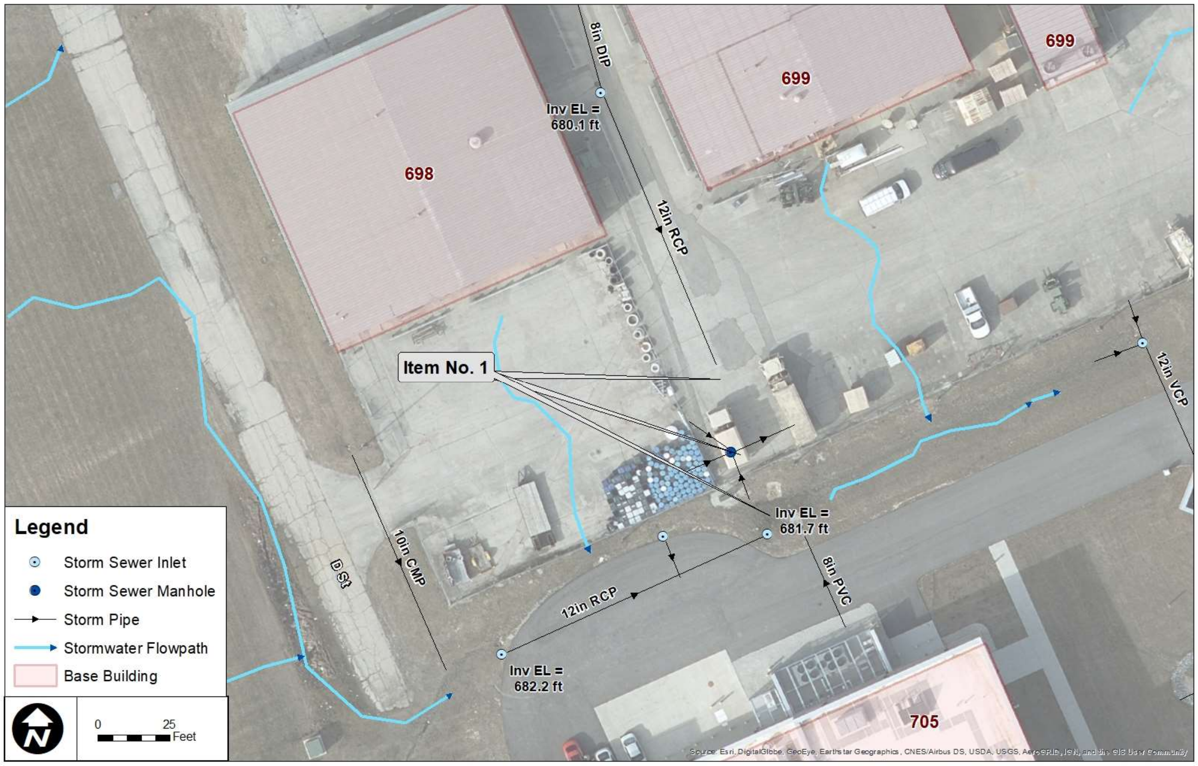


Figure 4.2-3a. Utility Survey Data - Drainage Ditch North of Building 705

Figure 4.2-3b. Supplemental Utility Data - Drainage Ditch North of Building 705
(Source: 88th Readiness Division)

Figure 4.2-3: Drainage Ditch North of Building 705

Figure 4.2-3a shows that the utility survey was unable to confirm the destination of the north-south spanning 12-inch RCP located north of the drainage ditch. A representative of SCI investigated the utility unknowns in the field and coordinated with the 88th's GIS technician that is currently in charge of updating the Facility's utility inventory. Through these efforts it was confirmed that the 12-inch RCP and storm sewer manhole located north of the drainage ditch are connected. A 10-inch VCP spans alongside the drainage ditch and connects this manhole to the 12-inch VCP that spans south to the BRC located east of Building 705. Through these efforts it was discovered that the 12-inch VCP is not connected to the storm sewer structure located within the center of the BRC, as shown in Figure 4.2-3c.

Figure 4.2-3c. Utility Survey Data – Bio-Retention Cell East of Building 705

SCI recommends that the 12-inch VCP be connected to the storm sewer structure as it appears it was originally intended to be. However, this recommendation is not currently a part of the proposed improvements. If Facility personnel wish to incorporate this recommendation then SCI can integrate it into the final design submittal.

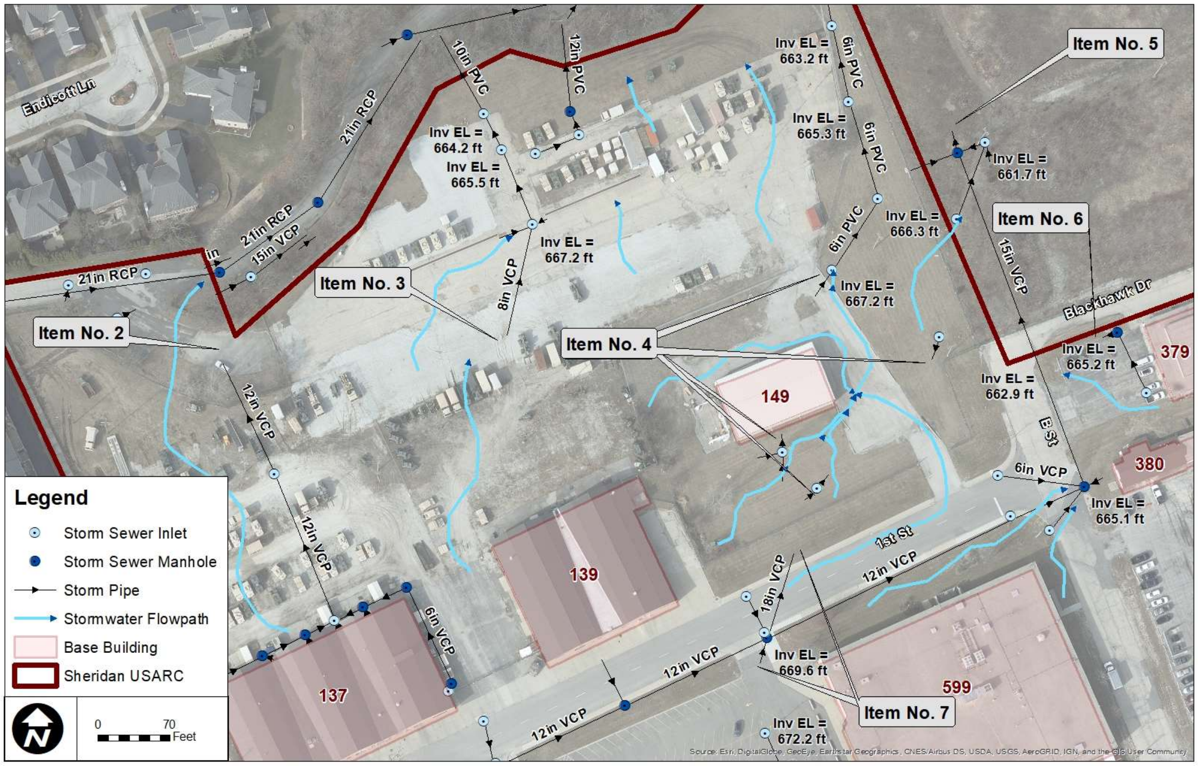


Figure 4.2-4a. Utility Survey Data – North Side of Facility

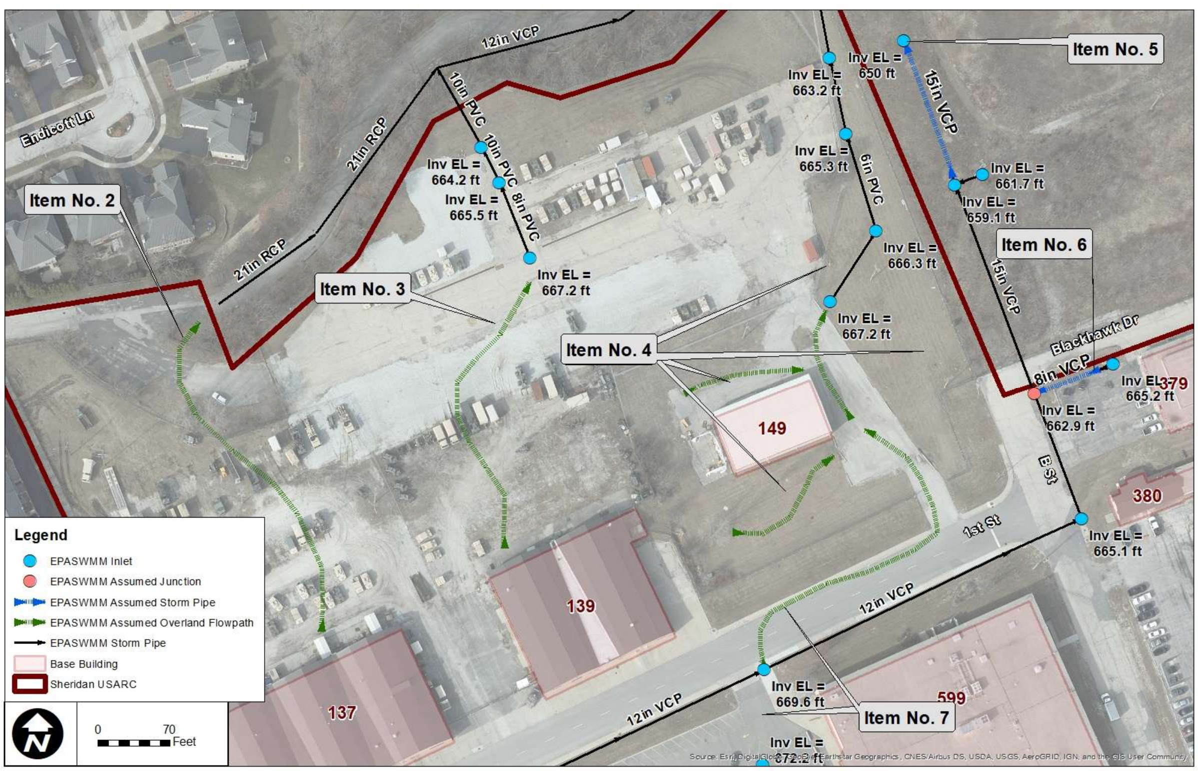


Figure 4.2-4b. EPA SWMM Modeled Utilities – North Side of Facility

Figure 4.2-4: North Side of Facility

Figure 4.2-4a shows the extent of the utility survey performed at the north side of the Facility, as well as stormwater flow paths which are based on the topography of this area. There are multiple unknowns throughout this area. Item Nos. 2, 3, 4, and 7 all pertain to unknown upstream or downstream connection points. Each of these were addressed by utilizing overland flow paths within the Model that are based on the topography in this area. Items No. 2 and 3 have not been resolved, although it was determined that their status does not impact the modeling or proposed improvements so these will not be further investigated. A representative of SCI investigated the utility unknowns in the field and coordinated with the 88th's GIS technician that is currently in charge of updating the Facility's utility inventory.

Dye testing was performed by SCI and Facility personnel in an effort to confirm the utility connections pertaining to Item Nos. 4, 5, and 7, among others. For all Items No. 4, 5, and 7, no dyed water was observed at each respective downstream structure during the testing period. For all cases, this confirms that the apparent upstream and downstream structures are not connected but does not confirm where the upstream structure drains too. It was determined that the status of Items 4 and 7 will not impact the proposed improvements. It was also determined that the status of Item No. 5 will not impact the proposed improvements as described below.

Item No. 5 pertains to outlet pipes that serve the northeastern part of the Facility. While the survey did determine that a 15-inch vitrified clay pipe (VCP) extends north from the storm sewer manhole at this location, no information was obtained regarding the VCP's length or invert at its destination point. As such, the 15-inch VCP was incorporated into the Model, provided a length of 400 feet, and a downstream invert elevation of 650-feet. As will be discussed in Section 5.0, a new detention pond is proposed at the location of Building 379 which is tentatively scheduled for demolition in Fall 2020. The current design of the proposed detention pond's outlet pipe has it tying into the existing 15-inch VCP. This tie-in to a proposed pond with a storage capacity of approximately 2.6 ac-ft is the reason that confirmation of the 15-inch VCP's outfall was desired. However, unobstructed flow from south to north was observed at the storm sewer manhole indicated by the Item No. 5 callout in Figure 4.2-4a. Additionally, the size of the proposed detention pond outlet pipe is 12 inches which will have a lower conveyance capacity then the 15-inch VCP. For these reasons it was determined that the status of Item No. 5 will not impact the proposed improvements.

Item No. 6 pertains to a storm pipe, an 8-inch VCP, that conveys stormwater from the parking lot of Building 379 to the outlet pipes that pertain to Item No. 5. The utility information indicates, but does not confirm, that the 8-inch VCP connects to the 15-inch VCP located on B St. It was assumed that these two pipes do indeed connect at this location. The connection point of the two pipes is an assumed junction with an invert of 662.9-feet. The invert of the junction was selected so that the overall longitudinal slope of the 15-inch VCP remains constant. Further confirmation of Item No. 6 is unnecessary as its removal is inherent in the construction of the proposed detention pond.

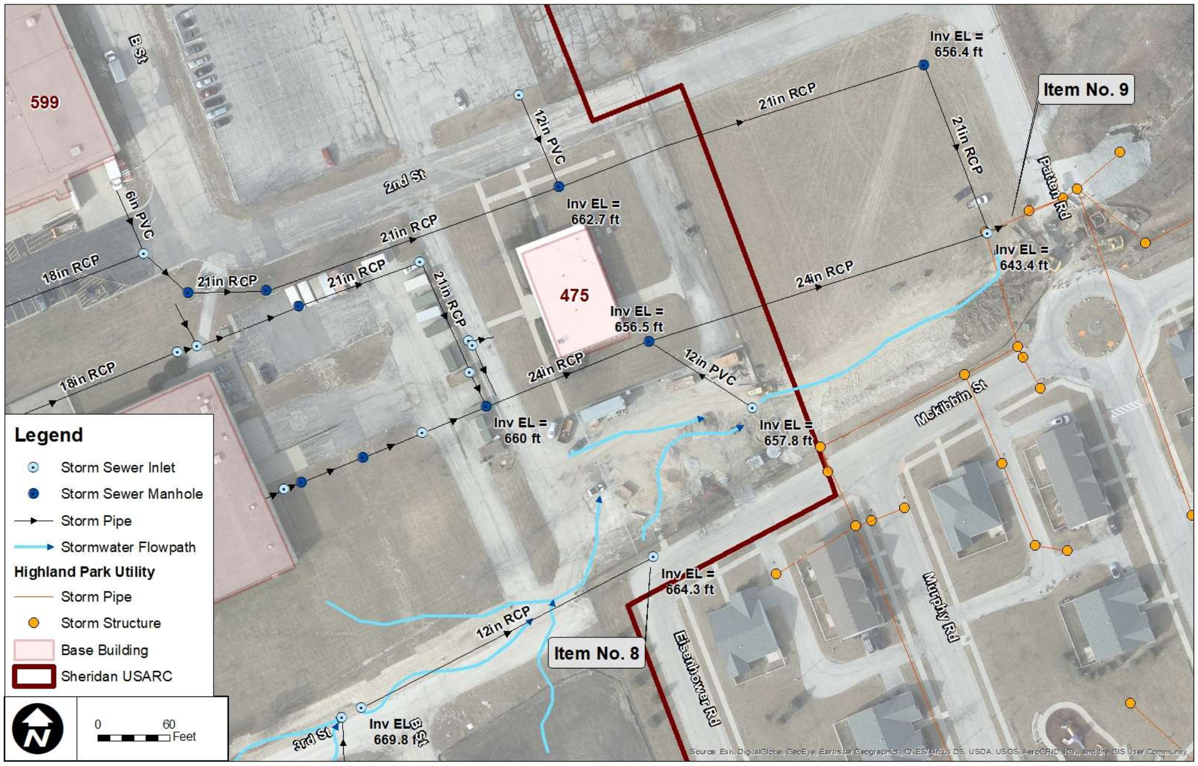


Figure 4.2-5a. Utility Survey Data – East Side of Facility

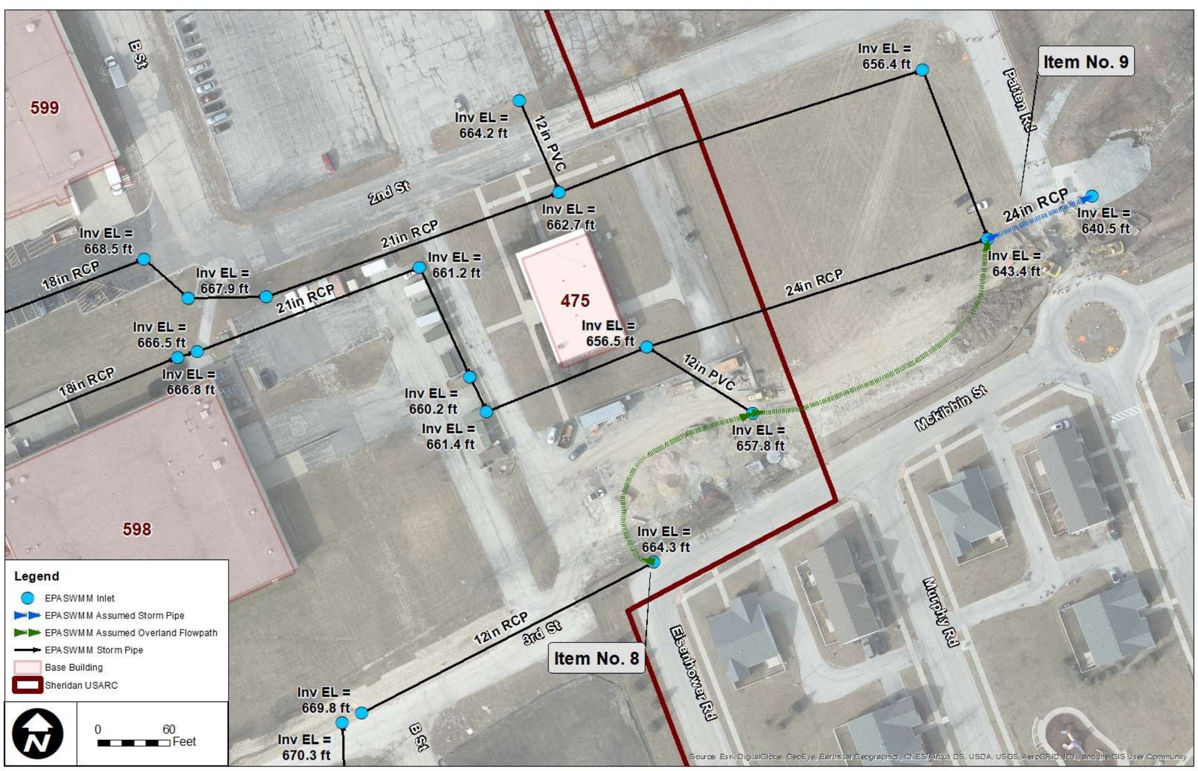


Figure 4.2-5b. EPA SWMM Modeled Utilities – East Side of Facility

Figure 4.2-5: East Side of Facility

Figure 4.2-5 shows the stormwater utilities located at the east side of the Facility near Building 475. There are two unknowns in this area. Item No. 8 pertains to a storm sewer inlet located on the northwest corner of Eisenhower Rd and McKibbin St. The inlet pipe to this storm sewer inlet is a 12-inch RCP that enters it from the west. However, Anderson was unable to determine any information regarding an outlet pipe for the storm sewer structure. A representative of SCI investigated the utility unknown in the field and coordinated with the 88th's GIS technician that is currently in charge of updating the Facility's utility inventory. Through these efforts it was confirmed that the existing 12-inch RCP (Item No. 8) does continue eastward from the storm sewer inlet. However, the next storm sewer inlet, located at the northwest corner of Murphy Rd and McKibbin St, does not have any pipes entering it from the west. Dye testing was performed at these two inlets, but no dyed water was observed at the likely downstream locations. These include two storm structures located at the northwest corner of McKibbin St and Patten Rd, the two inlets corresponding to Item No. 9, and the outfall into the ravine located east of Patten Rd. As will be discussed in Section 5.0, a new detention pond is proposed at the intersection of 3rd St and B St. The current design of the proposed detention pond's outlet pipe has it inevitably tie into the Item No. 8 12-inch RCP. e existing 15-inch VCP. This tie-in to a proposed pond with a storage capacity of approximately 1.7 ac-ft is the reason that confirmation of the 12-inch VCP's outfall was desired. However, unobstructed flow from west to east was observed at the storm sewer manhole indicated by the Item No. 8 callout in Figure 4.2-5a. For these reasons it was determined that the status of Item No. 8 will not impact the proposed improvements.

Item No. 9 pertains to the storm pipes crossing beneath Patten Rd. These pipes serve as the primary outlet for stormwater runoff on the east side of the Facility and are the property of the City of Highland Park (Highland Park). SCI obtained additional storm sewer utility information from Highland Park, however the data they have for this location is possibly incorrect. Highland Park's data indicates that 24-inch RCP crossing Patten Rd descends approximately 12-feet, then ascends 12-feet, before dropping 12-feet again. It was verified via field inspection that the 24-inch RCP (Item No. 9) does not drop, rise, and again drop 12-feet. It instead is located at the invert of the indicated structure and continues beneath Patten Rd.

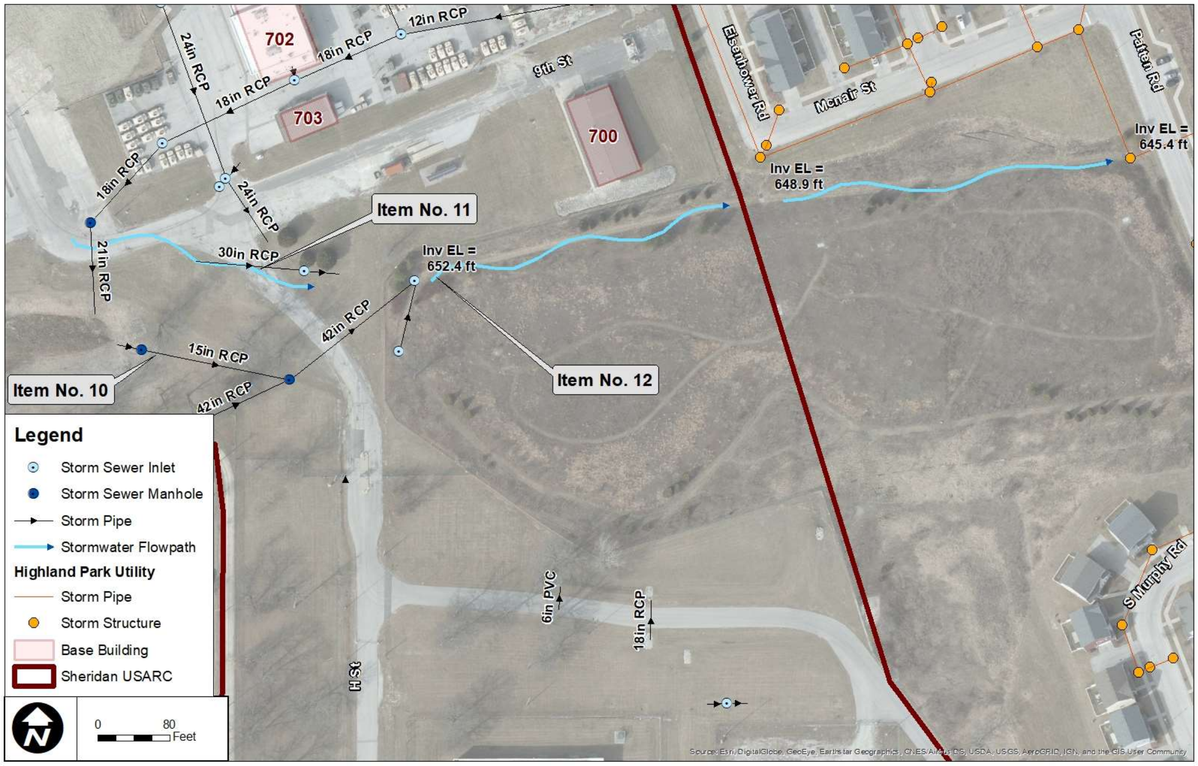


Figure 4.2-6a. Utility Survey Data – Southeast Side of Facility

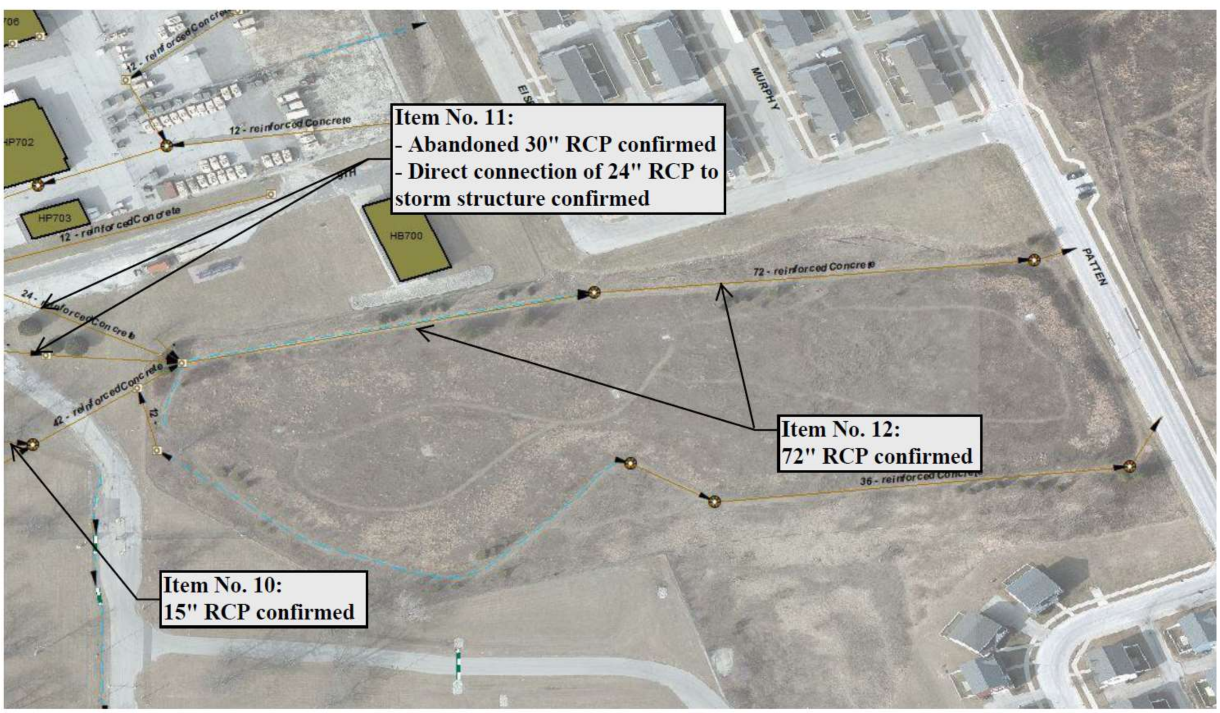


Figure 4.2-6b. Supplemental Utility Data – Southeast Side of Facility
(Source: 88th Readiness Division)

Figure 4.2-6: Southeast Side of Facility

Figure 4.2-6 shows the stormwater utilities located at the southeast side of the Facility, with three initial utility unknowns in this area that needed verification. Item No. 10 pertains to the outlet pipe for the existing detention basin. Anderson reported a 15-inch RCP at this location however the as-built drawings report that a 12-inch RCP is the size of the detention basin outlet pipe. A representative of SCI investigated the utility unknowns in the field and coordinated with the 88th's GIS technician that is currently in charge of updating the Facility's utility inventory. Through these efforts it was confirmed that the existing detention pond outlet pipe is indeed a 15-inch RCP.

Item No. 11 pertains to storm pipes at the intersection of H St and 9th St. The upstream and downstream connections of a 30-inch RCP, and the downstream connection of a 24-inch RCP, were initially unknown. It was confirmed via the 88th's GIS database that the 30-inch RCP (Item No. 10) is abandoned and no longer in use and that the 24-inch RCP spans southeasterly and ties directly into the storm structure located on the east side of H St with an invert elevation of 652.4-ft.

Item No. 12 pertains to the structure, with an invert elevation of 652.4 feet, that is called out in part (a) of this figure. Anderson reported two influent pipes to this structure that enter it from the west, however they did not observe an outlet pipe within this structure. It was confirmed via field inspection and through GIS data that a 72-inch RCP connects the indicated manhole in Figure 4.2-6 to Highland Park storm sewers located west of Patten Rd.

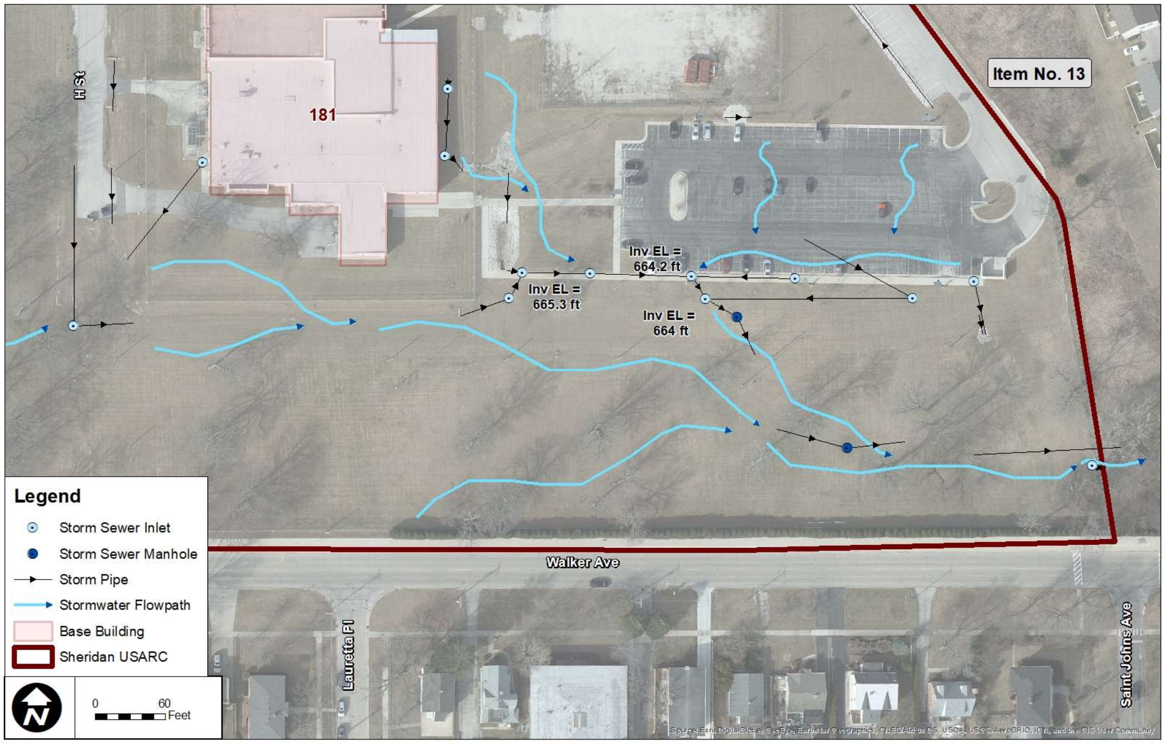


Figure 4.2-7a. Utility Survey Data – South Side of Facility

Figure 4.2-7b. EPA SWMM Modeled Utilities –South Side of Facility

Figure 4.2-7: South Side of Facility

Figure 4.2-7 shows the stormwater utilities that were reported by Anderson at the south side of the Facility. While the data for this location is mostly fragmented, enough was provided to incorporate the storm sewers that drain runoff from the parking lot into the south field. However, within the field itself there are several storm sewer structures with storm pipes that have unknown upstream and downstream connections. Given this, stormwater runoff from Building 181 to the parking lot or southern field, and from the parking lot to the south field was modeled using overland flowpaths. Since little to no drainage issues were reported for this area, and that minimal improvements are recommended, verification of the fragmented utility information may not be necessary as the project evolves into more detailed design. Due to the lack of flooding problems in this location, and that the only proposed improvement here is a rain garden located adjacent to the eastern Facility boundary, these utility unknowns were not investigated. They are not planned to be investigated as the design progresses for the same reasons stated above.

4.2.2-2 Potential Utility Relocations

In addition to unknowns regarding the storm sewer utilities, there are also unknowns regarding the Facility's other utilities including their water, electric, communication, and gas utility lines. The ongoing construction and demolition throughout the Facility has resulted in a disorganized utility network. This creates numerous locations where existing utilities may be encountered while installing and constructing the proposed storm sewers and drainage ditches. Any encountered existing utilities could be perpendicular or run parallel to the proposed storm sewer utilities. This could necessitate either the relocation of an existing utility or a redesign of a proposed stormwater utility. Figure 4.2-9 shows the existing utilities overlain by the proposed stormwater utilities.

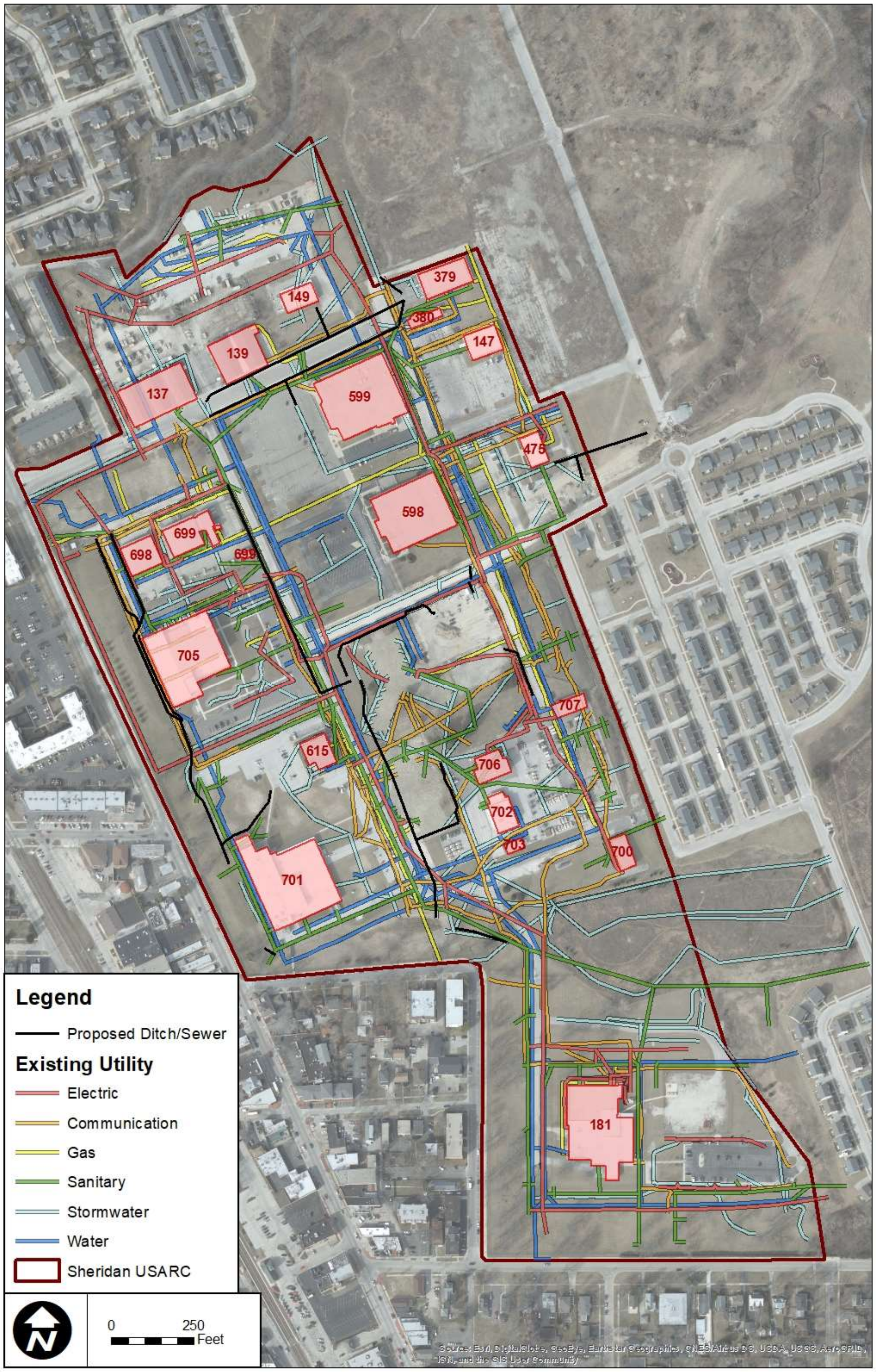


Figure 4.2-9. Sheridan USARC All Utilities

4.2.3 Facility Stormwater Drainage Patterns

The hydraulic analysis resulted in a high-level understanding of stormwater flow-paths throughout the Facility. Figure 4.2-10 provides a visual representation of SCI's current understanding of the Facility's drainage patterns.

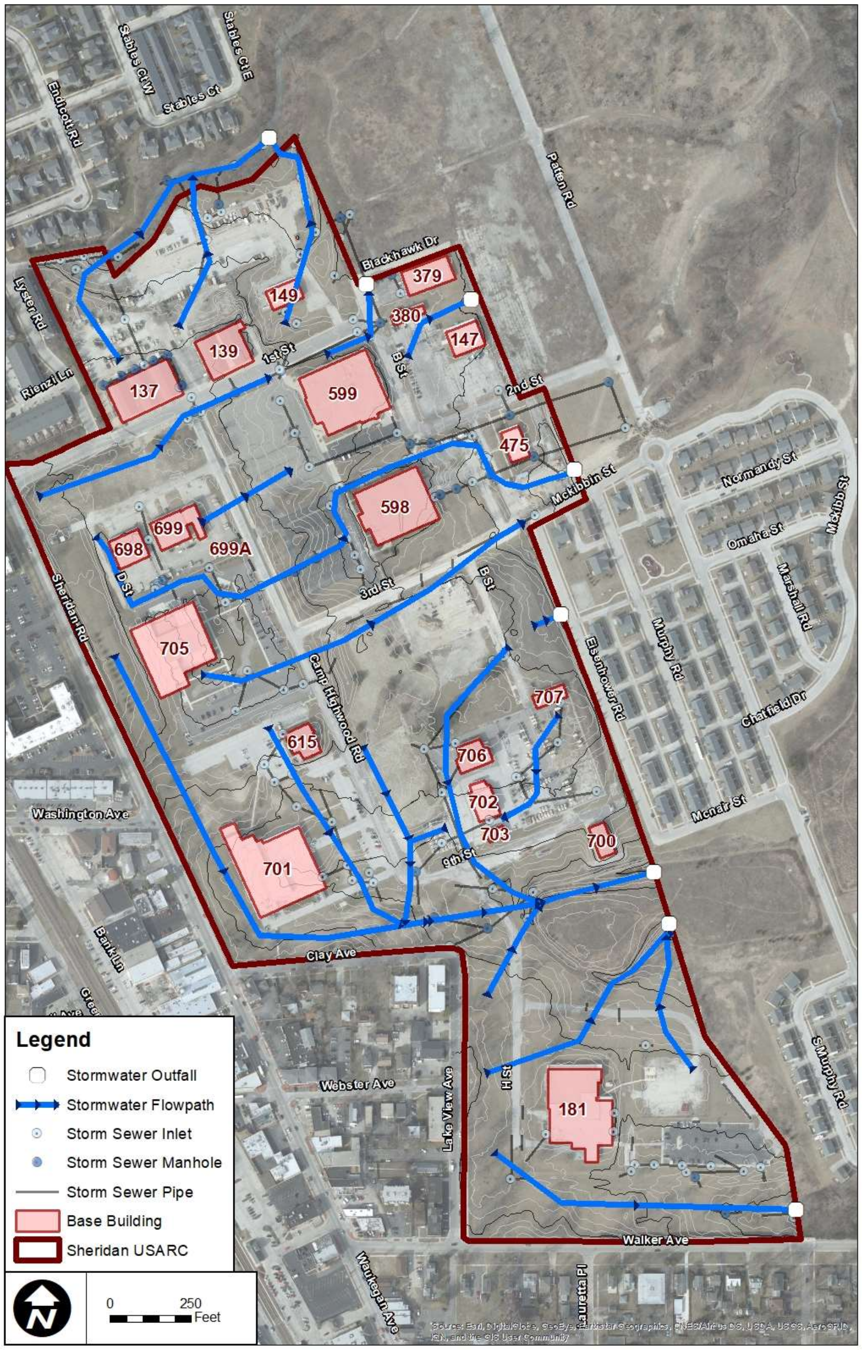


Figure 4.2-10. Sheridan USARC Drainage Map

Stormwater drainage was analyzed from the most upstream points of the Facility to the most downstream to determine the locations where stormwater exits the Facility, also known as a stormwater outfall. Based on the site topography and utilities, eight distinct stormwater outfalls were identified. These outfalls influenced the next step of the hydraulic analysis, the watershed delineation of the Facility.

4.2.4 Facility Watersheds and Sub-watersheds

The Facility topography, utilities, and stormwater flow-paths were used to partition the Facility into five distinct watersheds. Watersheds are areas of land that drain all stormwater runoff to a common point, or stormwater outfall. Figure 4.2-11 shows the delineated watersheds of the Facility.

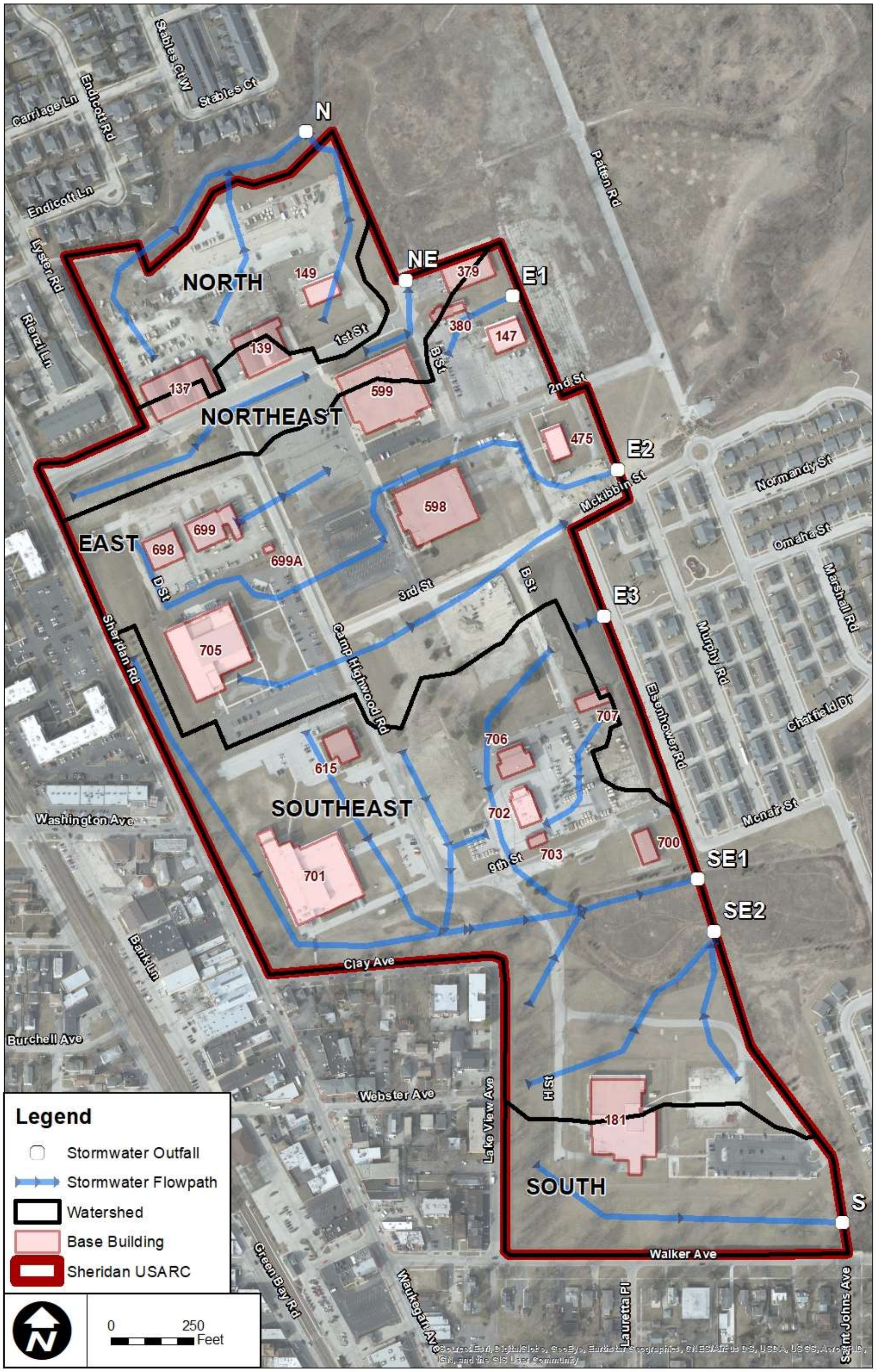


Figure 4.2-11. Sheridan USARC Watershed Map

At this stage, the stormwater outfalls were assigned labels based on their outfall direction. Stormwater drains from the Facility in five distinct directions (north, northeast, east, southeast, and south) through the eight identified outfalls. There is only one outfall for stormwater that drains at the north, northeastern, and southern locations of the Facility, respectively. There are two outfalls that drain stormwater at the southeast side of the Facility and three outfalls that drain stormwater along the Facility's eastern perimeter. The delineated watersheds were similarly named based on their outfall direction. The watersheds were further delineated into sub-watersheds and color-coded to further simplify the various information. The color-coded sub-watershed map is shown in Figure 4.2-12.

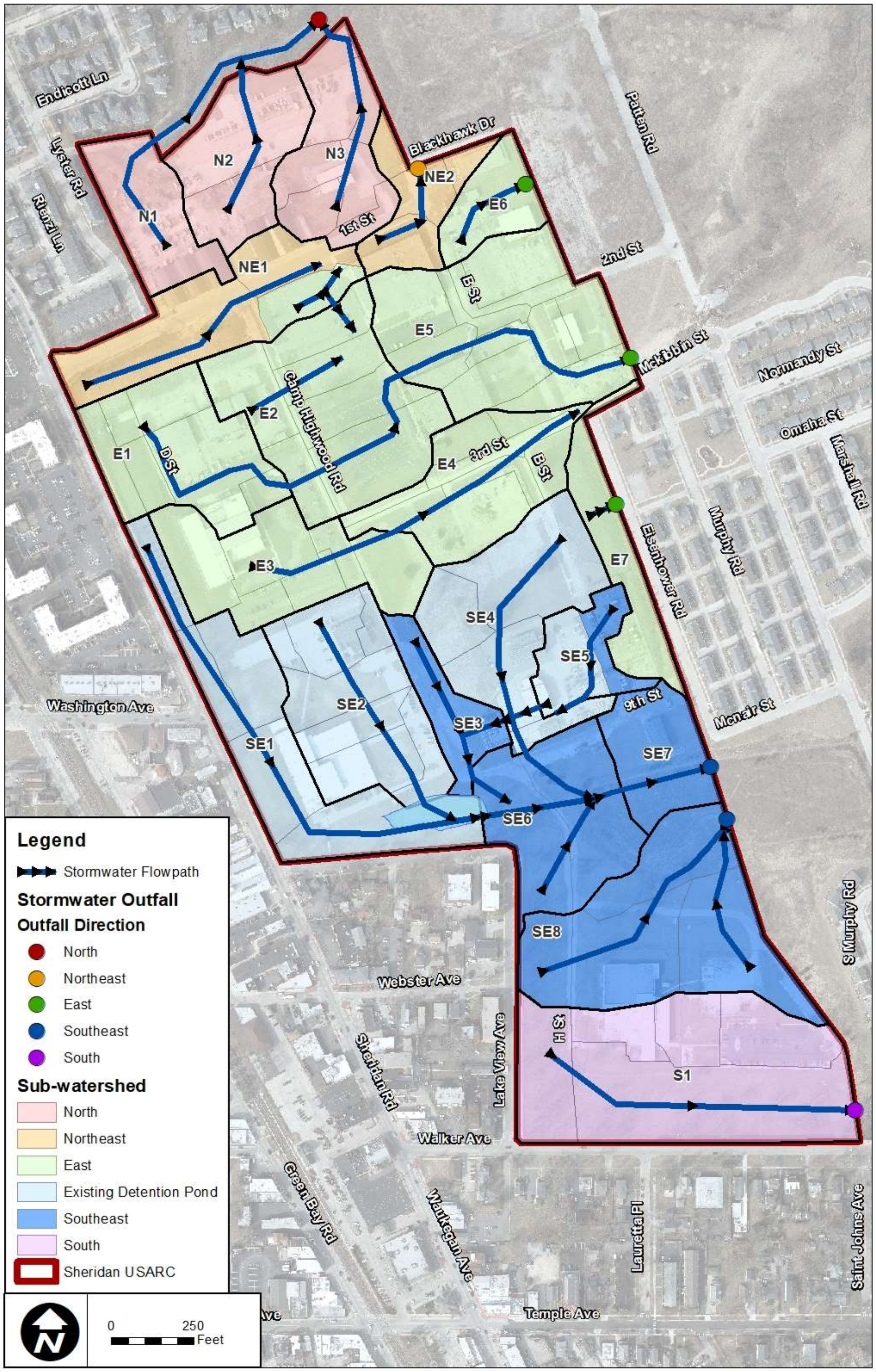


Figure 4.2-12. Sheridan USARC Sub-watersheds Color Coded Map

It was necessary to further delineate the watersheds into sub-watersheds for several reasons. The sub-watersheds provide a better level of detail regarding stormwater drainage patterns for their respective areas. The greater level of detail allows the H&H Model to more accurately simulate real world conditions in these areas. Better representation of real-world conditions translates to the ability to input specific locations into the Model. Having these specific locations within the model provides a means for assessing localized areas of flooding. For example, the ponding areas that were defined in Section 1.1 (P1, P2, P3, P4) are represented within the Model. Having these locations represented within the Model means that the amount of ponding that occurs at each of them under existing conditions can be verified. Once verified under existing conditions the conceptual improvements can be input into a proposed conditions model to gauge their effectiveness. Table 4.2-1, shown below, provides information about various sub-watershed parameters such as the area, average slope, and width of each sub-watershed, as well as the proportion of impervious land.

Table 4.2-1. Sub-watershed Parameters

No.	Watershed	Area	Sub-watershed	Area (ac)	Avg Width (ft)	Avg Slope (%)	Percent Impervious (%)
1	N	9.62	N1	2.52	225	2.4	67
2			N2	3.49	325	2.2	88
3			N3	3.61	200	1.7	42
4	NE	6.72	NE1	4.72	150	1.4	61
5			NE2	2.00	125	1.4	59
6	E	31.74	E1	4.56	200	1.5	53
7			E2	6.94	575	3.0	72
8			E3	4.82	150	0.2	46
9			E4	4.24	200	2.1	54
10			E5	7.36	200	1.9	69
11			E6	1.60	125	1.3	63
12			E7	2.22	600	10.4	21
13	SE	34.92	SE1	6.08	150	3.3	13
14			SE2	5.40	200	2.7	53
15			SE3	1.63	100	2.7	82
16			SE4	5.52	250	1.6	61
17			SE5	1.79	150	1.5	100
18			SE6	4.66	300	2.6	19
19			SE7	2.41	500	4.8	20
20			SE8	7.43	500	2.9	26
21	S	9.64	S1	9.64	250	1.1	27
Total Area		**92.64**					

Source: Stanley Consultants, Inc.

As will be shown in Section 4.3, these parameters will be input into the Model. With the H&H analysis complete, the next step is to develop the existing conditions model. The existing conditions model is described in the following section.

4.3 Existing Conditions Model

The H&H Model was created using EPA SWMM software, version 5.1. Hydraulic data such as Facility topographic and utility information was input into the Model to represent real-world existing conditions. Hydrologic information such as precipitation frequency data and temporal distribution data were input as well to simulate design storm events. Information regarding Model development, verification, and results are provided in this Section.

4.3.1 Model Development

4.3.1-1 General Model Inputs

The first step in developing the existing conditions model was to input the design storm data. The design storm events listed in Table 4.2-1 were generated within the Model by entering the return period, duration, Huff quartile, and precipitation frequency value for each event. After inputting the design storm data, the delineated sub-watersheds were created within EPA SWMM. Notable parameters that were input into the Model include the area, average slope, and width of each sub-watershed, as well as the percentage of impervious land.

Another important sub-watershed parameter is the infiltration method, which is used to simulate how stormwater percolates into the soil during a storm. This parameter is important because stormwater that infiltrates into the ground does not manifest as runoff and subsequently contribute to flooding. The infiltration method that was used is the Green Ampt Method. The Green Ampt Method is based on the assumption that water infiltrates into relatively dry soil as a sharp wetting front, and that the infiltration capacity decreases as the storm progresses and the soil becomes wetter.

With the sub-watersheds established, a series of nodes and links were created to represent the Facility's storm sewer network. The nodes represent storm sewer manholes and inlets while the links represent storm sewers and overland flow-paths. Other notable features that are represented in the Model include the existing detention pond, overland flow-paths, and drainage ditches. The overland flow-paths represent locations where there are no storm sewers, for example the grassy strip of land located west of Buildings 698, 705, and 701. Overland flow-paths are also used at locations where the storm sewers surcharge to convey the excess stormwater from upstream to downstream. The modeled drainage ditches include those located north and east of Building 705 as well as the ditches along 3rd St.

4.3.1-2 Energy Losses

Stormwater that flows through storm sewers is subjected to energy, or friction, losses that have a substantial effect on resultant flowrates and WSEs. These friction losses occur when stormwater enters or exits a pipe, transitions from one sewer segment to another, changes direction, or enters a storm sewer inlet. This is an important parameter to include in the Model because when energy is lost from flowing stormwater due to friction at these locations, additional ponding can occur than what would be reported if these friction losses weren't included. The friction losses are represented in the Model through what are known as K values, which are coefficients that address the loss in energy at the locations noted above. K values range from 0 to 1, with 0 representing no loss in energy and 1 representing a total loss in energy. Table 4.3-1, shown below, provides a list of the K values used at their respective locations. The K values were obtained in part from the Journal of Water Management Modeling.

Table 4.3-1. K Values

Location	K Value
Culvert Entrance	0.5
Culvert Exit	0.3 (In-line)
	1.0 (Still-water)
Storm sewer (In-line)	0.2
Storm sewer inlet	0.2
90° bend	1.1
45° bend	0.4

Source: Journal of Water Management Modeling

4.3.1-3 EPA SWMM Sub-watersheds

As noted in Section 4.1, the drainage area of the Facility was delineated into 21 sub-watersheds. The size and scale of the 21 sub-watersheds is appropriate for the purposes of analysis, design, formulating recommendations and solutions, and discussion. For the purposes of H&H modeling, however, further delineation of the 21 sub-watersheds is necessary to provide an adequate degree of autonomy throughout the modeling process. For example, one of the conceptual improvements entails re-routing a portion of the stormwater runoff within sub-watershed E1. Thus, it was necessary to partition E1 into sub-components, hereafter referred to as EPA SWMM Sub-watersheds. Discretizing the sub-watersheds into EPA SWMM sub-watersheds fosters precise manipulation of stormwater drainage patterns throughout the Facility. Furthermore, it was necessary to perform this step while developing the existing conditions Model so that it's as similar to the proposed conditions Model as possible. The two Models need to be as similar as possible to properly gauge the efficacy of the proposed improvements. Table 4.3-2, shown below, lists the EPA SWMM sub-watersheds and their pertinent parameters.

Table 4.3-2. EPA SWMM Sub-watershed Parameters

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
N1	2.52	1.68	67	N1	2.52	1.68	67	225	2.4
N2	3.49	3.07	88	N2-1	1.17	1.17	100	270	2.0
				N2-2	2.32	1.90	82	400	2.6
N3	3.61	1.52	42	N3-1	0.42	0.24	57	70	1.5
				N3-2	0.59	0.20	34	150	5.0
				N3-3	0.63	0.21	33	125	2.4
				N3-4	0.54	0.23	43	100	1.4
				N3-5	0.33	0.00	0	560	1.1
				N3-6	1.10	0.64	58	145	2.7
NE1	4.72	2.89	61	NE1-1N	0.84	0.73	87	30	1.2
				NE1-1S	2.01	0.63	31	130	1.2
				NE1-2N	0.72	0.70	98	30	1.7
				NE1-2S	0.35	0.22	62	30	1.7
				NE1-3	0.80	0.67	84	110	2.3
NE2	2.00	1.18	59	NE2-1	0.80	0.52	65	330	4.5
				NE2-2	0.28	0.25	89	75	0.5
				NE2-3	0.62	0.41	66	175	1.5
				NE2-4	0.30	0.00	0	230	1.6
E1	4.56	2.41	53	E1-1	0.66	0.08	12	375	3.3
				E1-2	0.32	0.05	16	180	4.0
				E1-3	0.78	0.42	54	450	0.4
				E1-4	0.46	0.05	11	220	4.4
				E1-5	2.02	1.74	86	600	1.2
				E1-6	0.32	0.07	22	100	1.0

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
E2	6.94	5.02	72	E2-1	1.26	0.88	70	315	0.5
				E2-2	0.66	0.45	68	275	2.7
				E2-3	0.94	0.87	93	110	3.0
				E2-4	0.88	0.71	81	100	3.0
				E2-5	1.14	0.77	68	110	3.4
				E2-6	2.06	1.34	65	200	3.4
E3	4.82	2.21	46	E3-1	1.27	0.49	38	720	5.5
				E3-2	0.44	0.34	77	360	0.7
				E3-3	1.19	0.31	26	265	1.2
				E3-4	0.48	0.4	83	350	0.7
				E3-5	0.39	0.28	72	220	1.5
				E3-6	1.05	0.39	37	530	5.8
E4	4.24	2.29	54	E4-1	0.41	0.16	39	40	2.1
				E4-2	1.38	1.34	98	200	1.1
				E4-3	0.43	0.26	60	50	1.25
				E4-4	0.22	0.13	59	40	2.8
				E4-5	0.50	0.02	4	205	1.3
				E4-6	0.25	0.02	8	50	2.1
				E4-7	0.47	0.08	17	110	3.3
				E4-8	0.58	0.28	48	40	1.6
E5	7.36	5.09	69	E5-1	1.14	1.08	95	240	1.7
				E5-2	1.17	1.08	92	200	1.6
				E5-3	0.45	0.30	67	45	1.8
				E5-4	0.72	0.24	33	410	1.4
				E5-5	0.78	0.33	42	520	0.9
				E5-6	0.31	0.28	90	70	2.9
				E5-7	0.98	0.69	70	140	4.2
				E5-8	0.36	0.22	61	35	1.4
				E5-9	0.47	0.20	43	200	1.0
				E5-10	0.98	0.67	68	100	2.9
E6	1.60	1	63	E6	1.60	1.00	63	125	1.3
E7	2.22	0.46	21	E7	2.22	0.46	21	600	10.4
SE1	6.08	1	13	SE1-1	0.62	0.10	16	360	1.0
				SE1-2	0.64	0.00	0	75	2.6
				SE1-3	1.22	0.20	16	150	2.4
				SE1-4	1.42	0.39	27	600	1.4
				SE1-5	2.18	0.31	14	1,200	1.7
SE2	5.40	2.94	53	SE2-1	0.24	0.17	71	70	2.7
				SE2-2	1.04	0.87	84	120	2.3
				SE2-3	0.30	0.10	33	60	2.2
				SE2-4	1.21	0.27	22	200	3.0
				SE2-5	0.80	0.46	58	100	0.6
				SE2-6	1.13	0.65	58	130	2.5
				SE2-7	0.68	0.42	62	75	1.5
SE3	1.63	1.34	82	SE3	1.63	1.34	82	100	2.7
SE4	5.52	3.35	61	SE4-1	2.62	0.98	38	320	0.9
				SE4-2	1.00	0.70	70	190	1.1
				SE4-3	1.45	1.26	87	125	1.7
				SE4-4	0.45	0.41	91	40	1.1

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
SE5	1.79	1.79	100	SE5-1	0.31	0.31	100	110	1.5
				SE5-2	0.35	0.35	100	40	1.4
				SE5-3	1.13	1.13	100	180	1.8
SE6	4.66	0.89	19	SE6-1	2.14	0.42	20	450	2.2
				SE6-2	2.52	0.47	19	950	2.9
SE7	2.41	0.49	20	SE7	2.41	0.49	20	500	4.8
SE8	7.43	1.91	26	SE8-1	0.98	0.13	13	290	2.6
				SE8-2	2.26	0.79	35	325	1.4
				SE8-3	2.43	0.99	41	250	2.5
				SE8-4	1.76	0.00	0	550	2.6
S1	9.64	2.59	27	S1-1	1.64	0.18	11	550	1.1
				S1-2	0.77	0.60	78	240	0.5
				S1-3	0.93	0.31	33	200	2.0
				S1-4	1.44	1.25	87	370	1.6
				S1-5	4.86	0.25	5	230	1.2
Total	**92.64**	**45.12**	**48**						

Source: Stanley Consultants, Inc.

Figure 4.3-3, shown below, provides a visual representation of the EPA SWMM sub-watersheds.

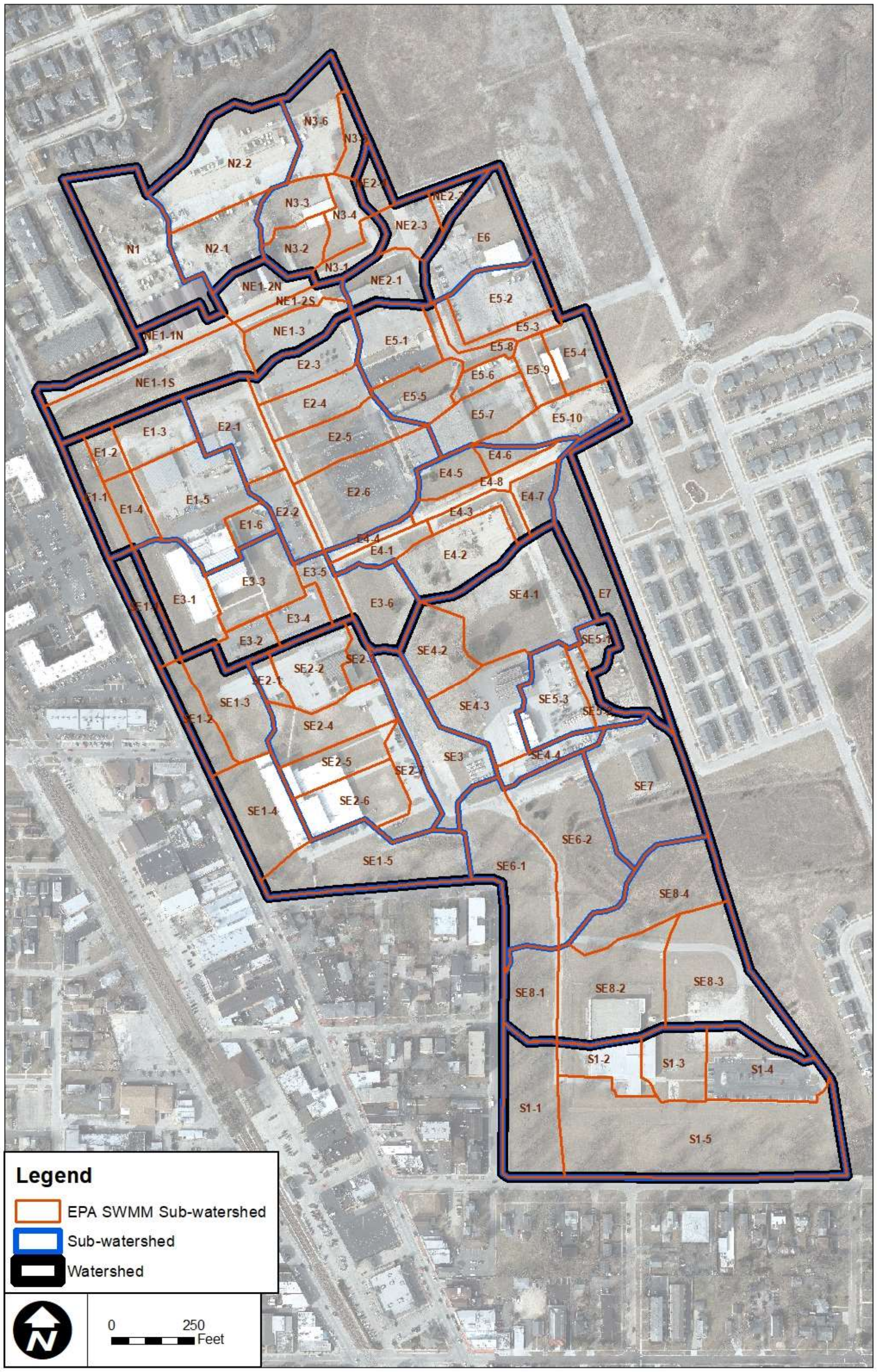


Figure 4.3-3. Sheridan USARC EPA SWMM Sub-watersheds Map

The delineation of the EPA SWMM sub-watersheds was done to obtain a greater level of definition while modeling existing and proposed conditions. The EPA SWMM sub-watersheds have been described, quantified, and shown in this section for informative purposes. For simplicity, the original 21 sub-watersheds will be referenced throughout the remainder of the Report unless discussion of an EPA SWMM sub-watershed is necessary.

4.3.2 Model Results

Within this Report flooding will be defined as water surface depths (WSD) equal to or greater than 3 inches. Generally, the EPA SWMM modeling results indicate that relatively shorter duration storms, from 1-hour to 3-hours, cause flooding throughout the Facility. In addition to WSDs, the outfall release rates are another parameter that EPA SWMM provides modeling outputs for and will be reported.

Several areas of interest (AOI) were selected to monitor WSDs for the simulated design storms. These AOIs serve as proxy nodes to verify the accuracy of the Model, quantify the LOS of the Facility under existing conditions, and gauge the efficacy of the proposed improvements. Figure 4.3-5 displays the locations of the AOIs throughout the Facility. Note that the four locations discussed in Section 1.1 (P1, P2, P3, P4) are represented in the figure as AOIs 1, 2, 11, and 13, respectively. Brief descriptions of the AOIs are also provided below.

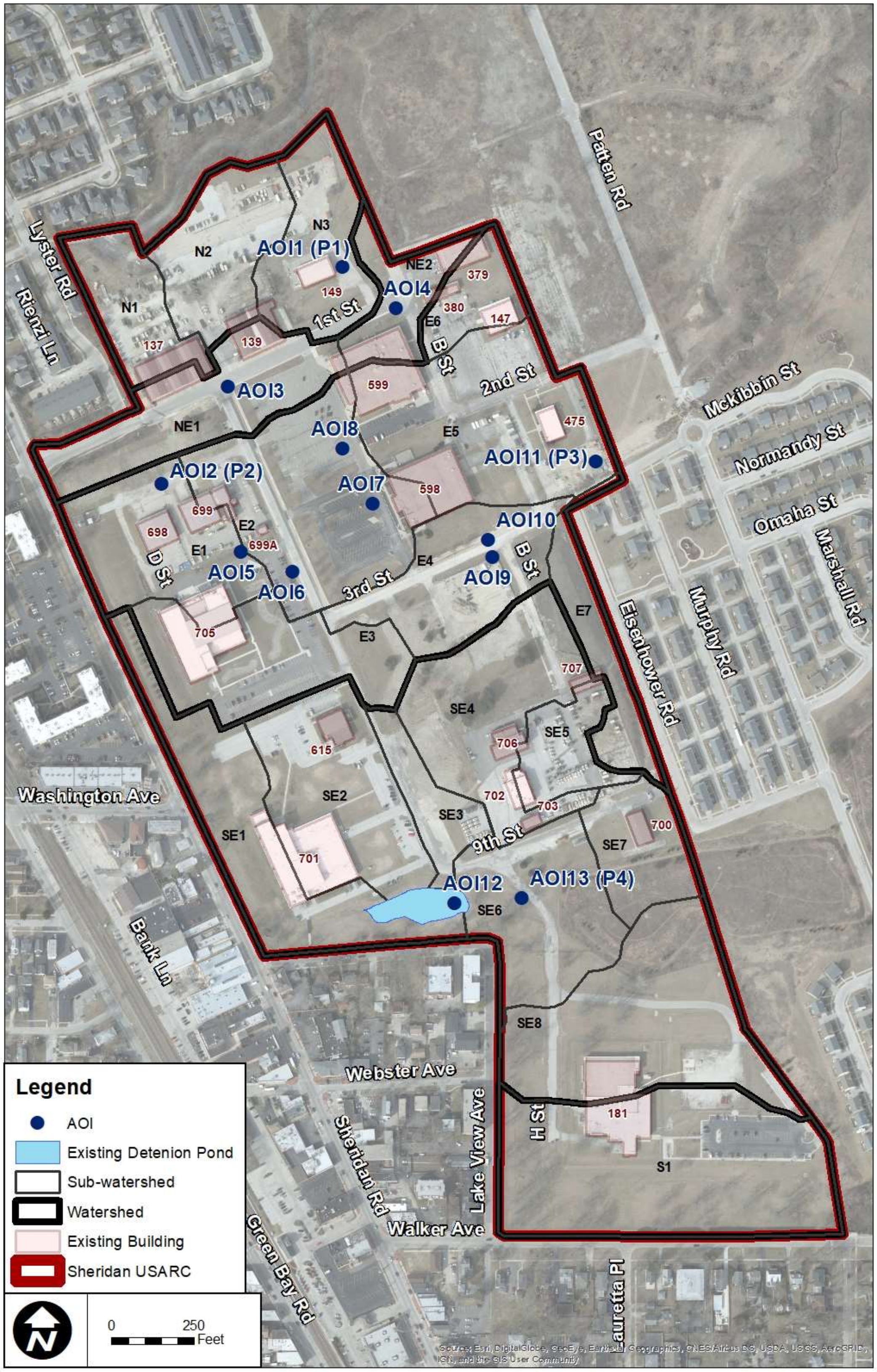


Figure 4.3-5. AOI Locations Map

AOI1 (P1). AOI1 represents the low point of the driveway located east of Building 149. WSDs of 3 inches or greater are considered flooding at this location.

AOI2 (P2). AOI2 represents the parking lot located north of Buildings 698/699. WSDs of 3 inches or greater are considered flooding at this location.

AOI3. AOI3 represents the curb at the southeast corner of 1st St. and C St. The longitudinal slope of the road at this location is such that high WSDs are not expected. WSDs of 3 inches or greater are considered flooding at this location.

AOI4. AOI4 represents the eastern curb at the intersection of 1st St and B St. The longitudinal slope of the road at this location is such that high WSDs are not expected. WSDs of 3 inches or greater are considered flooding at this location.

AOI5. AOI5 represents the drainage ditch located north of Building 705. Based on the topographic and utility data the ditch has a total height of approximately 2.1 feet. WSDs of 2.2 feet and greater are considered flooding at this location.

AOI6. AOI6 represents the drainage ditch located east of Building 705. Based on the topographic and utility data the ditch has a total height of approximately 2.3 feet. WSDs of 2.4 feet and greater are considered flooding at this location.

AOI7. AOI7 represents the low point of the parking lot of Building 598. WSDs of 3 inches or greater are considered flooding at this location.

AOI8. AOI7 represents the low point of the parking lot of Building 599. WSDs of 3 inches or greater are considered flooding at this location.

AOI9. AOI10 represents the drainage ditch at the southwest corner of 3rd St and B St. Based on the topographic and utility data the ditch has a total height of approximately 2.7 feet. WSDs of 2.8 feet and greater are considered flooding at this location.

AOI10. AOI11 represents the drainage ditch on the north side of 3rd St at the intersection of 3rd St and B St. Based on the topographic and utility data the ditch has a total height of approximately 1.7 feet. WSDs of 1.8 feet and greater are considered flooding at this location.

AOI11. AOI12 represents the low point of the Building 475's parking lot which is the location of the sanitary sewer lift station. WSDs of 3 inches or greater are considered flooding at this location.

AOI12. AOI14 represents the existing detention pond located at the southwest corner of the Facility. Based on the as-built drawings of Building 701 which were provided by Facility personnel, the total height of the detention pond is 6 feet. WSDs of 5.5 feet or greater are considered flooding at this location. 5.5 feet was selected to maintain a freeboard of at least 6 inches.

AOI13. AOI15 represents the ponding area located on the west side of C St, east of the existing detention pond. WSDs of 6 inches or greater are considered flooding at this location.

With the AOIs and their respective flooding WSDs defined, the modeling results will be discussed in more detail. The following sub-sections will report the modeling results of the real-world storm 2-year, 2-hour storm event, outfall release rates, and WSDs at the AOIs for the various design storms.

4.3.2-1 Model Verification (2-year, 2-hour storm)

As discussed in Section 4.2.4, an approximate 2-year, 2-hour storm occurred in October 2019. This real-world storm event was used to verify the results of the existing conditions Model. The peak WSDs at the 15 AOIs for a 2-year, 2-hour design storm are provided below in Table 4.3-3. These values are compared against what the flood depth is at each AOI. For example, the existing detention pond has a maximum height of 6-feet and WSDs greater than this will result in flooding and the modeling results of the October 2019 storm event report a WSD of 2.6-feet in the pond which corresponds to no flooding. In contrast, flooding occurs at the drainage ditch on the south side of 3rd St and B St because WSDs exceed 0.4-feet.

Table 4.3-3. 2-year, 2-hour storm Peak WSDs

AOI	Location	Flood Depth (ft)	WSD (ft)
1 (P1)	Bldg 149 Driveway	0.3	0.3
2 (P2)	Bldg 698/699 Parking Lot	0.3	0.3
3	1st St and C St	0.3	0.0
4	1st St and B St	0.3	0.0
5	Bldg 705 North Drainage Ditch	2.1	1.7
6	Bldg 705 East Drainage Ditch	2.3	0.9
7	Bldg 598 Parking Lot	0.3	0.1
8	Bldg 599 Parking Lot	0.3	0.1
9	3rd St and B St Drainage Ditch (South)	0.4	0.5
10	3rd St and B St Drainage Ditch (North)	1.7	1.7
11 (P3)	Sanitary Sewer Lift Station	0.3	0.2
12	Detention Pond	6.0	2.6
13 (P4)	H St and 9th St (Southwest Corner)	0.5	0.6

Flooding
No Flooding
Source: Stanley Consultants, Inc.

4.3.2-2 Outfall Release Rates

As noted in Section 2.2, Lake County requires maximum release rates of 0.04 cfs/acre and 0.15 cfs/acre for the 2-year, 24-hour and 100-year, 24-hour storms, respectively. The drainage area of the Facility is approximately 92.64 acres. Given this, the required maximum stormwater release rates for the Facility are:

- 100-year, 24-hour required release rate = 0.15 cfs/ac * 92.64 ac = 13.90 cfs
- 2-year, 24-hour required release rate = 0.04 cfs/ac * 92.64 ac = 3.71 cfs

The outfall release rate output is how the existing release rates will be estimated to determine the reduction necessary to meet the county's requirement. Table 4.3-4, shown below, provides the average and peak release rates reported by the Model for the two design storms.

Table 4.3-4. Existing Conditions Outfall Release Rates

Outfall	2-yr, 24-hr Storm		100-yr, 24-hr Storm	
	Average Release Rate (cfs)	Peak Release Rate (cfs)	Average Release Rate (cfs)	Peak Release Rate (cfs)
N	0.58	3.20	2.08	9.17
NE	0.23	1.14	0.63	3.42
E1	0.16	0.47	0.46	1.40
E2	1.20	7.25	3.92	23.68
E3	0.26	0.62	0.62	1.80
SE1	0.88	5.74	3.49	20.10
SE2	0.11	0.96	0.97	5.14
S	0.21	1.30	0.98	7.01
Total	3.63	20.68	13.15	71.72
Required Release Rate	3.71	3.71	13.90	13.90
Required Reduction	0	16.97	0	57.82

Source: Stanley Consultants, Inc.

Based on the Model results the average release rate of the 2-year, 24-hour and 100-year, 24-hour storms meet Lake County's maximum release rate requirements. However, the peak release rates are in exceedance by approximately 16.97 and 57.82 cfs for the 2-year and 100-year storms, respectively.

4.3.2-4 Water Surface Depths

Design storm events were simulated within the existing conditions model which yielded resultant WSDs at the previously mentioned AOIs. As noted, the results indicate that relatively shorter duration storms, from 1-hour to 3-hours, cause flooding throughout the Facility. Table 4.3-5 reflects the modeling results which led to that conclusion. The results pertain to the 2-year, 10-year, 50-year, and 100-year design storms for a duration of 24 hours.

Table 4.3-5. 24-hour Design Storm WSDs

AOI	Location	Flood Depth (ft)	Design Storm			
			2-yr	**10-yr**	**50-yr**	**100-yr**
1 (P1)	Bldg 149 Driveway	0.3	**0.2**	**0.2**	**0.3**	**0.3**
2 (P2)	Bldg 698/699 Parking Lot	0.3	**0.0**	**0.0**	**0.2**	**0.3**
3	1st St and C St	0.3	**0.0**	**0.0**	**0.0**	**0.0**
4	1st St and B St	0.3	**0.0**	**0.0**	**0.0**	**0.0**
5	Bldg 705 North Drainage Ditch	2.1	**0.0**	**0.0**	**0.0**	**0.2**
6	Bldg 705 South Drainage Ditch	2.3	**0.0**	**0.0**	**0.0**	**0.0**
7	Bldg 598 Parking Lot	0.3	**0.0**	**0.0**	**0.0**	**0.0**
8	Bldg 599 Parking Lot	0.3	**0.0**	**0.0**	**0.0**	**0.0**
9	3rd St and B St Drainage Ditch (South)	0.4	**0.0**	**0.0**	**0.4**	**0.4**
10	3rd St and B St Drainage Ditch (North)	1.7	**0.5**	**0.7**	**1.6**	**1.6**
11 (P3)	Sanitary Sewer Lift Station	0.3	**0.0**	**0.0**	**0.0**	**0.0**
12	Detention Pond	6.0	**0.7**	**1.1**	**2.3**	**2.8**
13 (P4)	H St and 9th St (Southwest Corner)	0.5	**0.5**	**0.5**	**0.6**	**0.6**

Source: Stanley Consultants, Inc.

As shown, flooding only occurs at the intersection of 3rd St and B St, the low point on the west side of Building 701, and at the southwest corner of H St and 9th St. Based on the modeling results, more substantial flooding occurs for shorter duration storms. Table 4.3-6, shown below, lists the results of the critical duration analysis of the 100-year storm. These results include 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, 18-hour, 24-hour, and 48-hour durations.

Table 4.3-6. 100-year Design Storm WSDs

AOI	Location	Flood Depth (ft)	Design Storm							
			1-hr	2-hr	3-hr	6-hr	12-hr	18-hr	24-hr	48-hr
1 (P1)	Bldg 149 Driveway	0.3	**0.4**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**
2 (P2)	Bldg 698/699 Parking Lot	0.3	**0.4**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**0.0**
3	1st St and C St	0.3	**0.3**	**0.3**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
4	1st St and B St	0.3	**0.5**	**0.5**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
5	Bldg 705 North Drainage Ditch	2.1	**2.7**	**2.8**	**2.7**	**1.8**	**2.2**	**0.8**	**0.2**	**0.0**
6	Bldg 705 East Drainage Ditch	2.3	**2.1**	**2.1**	**2.1**	**0.7**	**1.4**	**0.0**	**0.0**	**0.0**
7	Bldg 598 Parking Lot	0.3	**0.7**	**0.6**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
8	Bldg 599 Parking Lot	0.3	**0.1**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
9	3rd St and B St Drainage Ditch (South)	0.4	**0.5**	**0.5**	**0.5**	**0.4**	**0.5**	**0.4**	**0.4**	**0.0**
10	3rd St and B St Drainage Ditch (North)	1.7	**1.8**	**1.8**	**1.8**	**1.6**	**1.6**	**1.6**	**1.6**	**0.7**
11 (P3)	Sanitary Sewer Lift Station	0.3	**1.3**	**1.3**	**1.1**	**0.1**	**0.3**	**0.0**	**0.0**	**0.0**
12	Detention Pond	6.0	**5.4**	**6.0**	**6.0**	**4.1**	**4.2**	**3.2**	**2.8**	**1.1**
13 (P4)	H St and 9th St (Southwest Corner)	0.5	**0.7**	**0.7**	**0.7**	**0.6**	**0.6**	**0.6**	**0.6**	**0.5**

Source: Stanley Consultants, Inc.

As shown, flooding is more widespread throughout the Facility for storm durations ranging from 1 to 3 hours. This is due to the shorter duration storms precipitating more stormwater in a shorter amount of time which inundates the Facility's storm sewer system. Although longer duration storms yield a greater total volume of stormwater it precipitates over a longer timeframe and is therefore less intense and more manageable for the storm sewer system than the shorter, more intense storms.

With the existing conditions model established and the locations of nuisance flooding quantified, the next step is to develop conceptual improvements for the Facility. Section 5.0 reports the conceptual improvements and how they're partitioned into the three alternatives.

5.0 Proposed Improvements

5.1 Proposed Improvement Criteria

As part of the Project, SCI has been tasked to formulate stormwater drainage improvements for the Facility. There are several purposes and functions that the potential improvements must serve, which are listed below.

- Address localized areas of flooding or insufficient capacity
- Minimize future cost and maintenance
- Reduce stormwater runoff rates (provide detention storage)
- Improve water quality (utilization of native grasses for absorption/filtration benefits)

The potential improvements were conceptualized with these criteria in mind and are described further in the following sections.

5.1.1 Localized Areas of Flooding

Much of the Facility experiences ponding similar to what's shown originally in Figure 1.1-3, shown again below as Figure 5.1-1. In several instances, grinding and re-surfacing of driveways and parking lots to provide positive drainage toward storm sewer inlets can alleviate this type of nuisance flooding.

Figure 5.1-1. P2 – Building 698 Driveway (West Facing)

In contrast to nuisance flooding that is created by poor grading, there are locations such as Building 475's parking lot and driveway that endure flooding for additional reasons. This location is at the downstream end of the Facility's east sub-watershed and experiences the worst amount of flooding relative to the rest of the Facility. The Building 475 parking lot, shown originally as Figure 1.1-4 and again below as Figure 5.1-2, is the location of the sanitary lift station.

Figure 5.1-2. P3 – Building 475 Driveway (South Facing)

Despite some parts of the Facility experiencing localized flooding, Facility personnel report that the existing detention pond is not utilized to its full extent. Storm events can cause flooding in one area of the Facility, like the Building 475 parking lot or the parking lots surrounding Building's 698 and 699, yet still not fill up the detention pond. This indicates that areas of the Facility which could be served by the existing detention pond aren't due to poor hydraulic connectivity. This is attributed to drainage ditches and/or storm sewers that have become sediment laden, are improperly sized, and/or have settled or changed orientation such that they no longer provide positive drainage. General maintenance and repair work such as cleaning and flushing of these storm pipes and drainage ditches can increase their hydraulic capacity to its full potential. This can also be due to the Facility's current storm sewer system draining excessive stormwater to some locations and too little to others. Redirection of stormwater flow-paths to more evenly disperse stormwater runoff can alleviate this problem.

Four areas where localized flooding is prominent were previously noted in Section 1.1 of this report. They include P1 (Building 149 driveway), P2 (Buildings 698/699 parking lot), P3 (Building 475 driveway/parking lot), and P4 (portion of H St located east of existing detention pond). The recommended improvements for these locations are described in the following sections.

5.1.1-1 Building 149 Driveway

Facility personnel reported that the Building 149 driveway has been a location of prominent nuisance flooding but that it has somewhat resolved since it was repaved in the Fall of 2019. However, the existing grade of the parking lot directs stormwater runoff to the southeast corner of the building which is where much of the ponding occurs. Also, slopes are minimal throughout the parking lot which creates ponding areas throughout it. Due to the presence of Landfill #5 at this location, any proposed earthwork would entail raising ground elevations so as not to disturb the underlying contaminated soil.

There has been a redesign of the proposed improvements throughout the design process. The initial design involved grinding and re-surfacing the parking lot so that it drained to its east perimeter into a proposed drainage ditch that then conveyed the runoff to an existing beehive inlet located at the northeast corner of the parking lot. It was decided to instead utilize and enhance the existing drainage patterns by grinding and re-surfacing the parking lot so that runoff drains to the southeast corner of the building more effectively. Slopes would be increased throughout the parking lot to prevent ponding throughout it. A newly proposed storm sewer inlet would be situated at the southeast corner of the building, just west of the parking lot, and would receive and convey the stormwater through new storm sewers to a new detention pond (Pond 1B). The outlet pipe for Pond 1B would tie into the existing 15-inch VCP located on B St. There are two existing stormwater inlets located south of Building 149 that were dye tested by SCI. The downstream structures for both inlets were not confirmed by the testing. Since the outfalls for these structures remains unknown it is proposed that the inlet lids are replaced by manhole lids. The stormwater runoff that previously entered them would now drain into the newly proposed stormwater inlets. The proposed improvements for this location are listed below.

- Reconstruct and regrade driveway
- Install two stormwater inlets
- Install 15” RCP and 30” RCP to tie into proposed detention pond
- Install 12” RCP outlet pipes to tie into existing 15” VCP

Figure 5.1-3 shows the proposed improvements for this location.

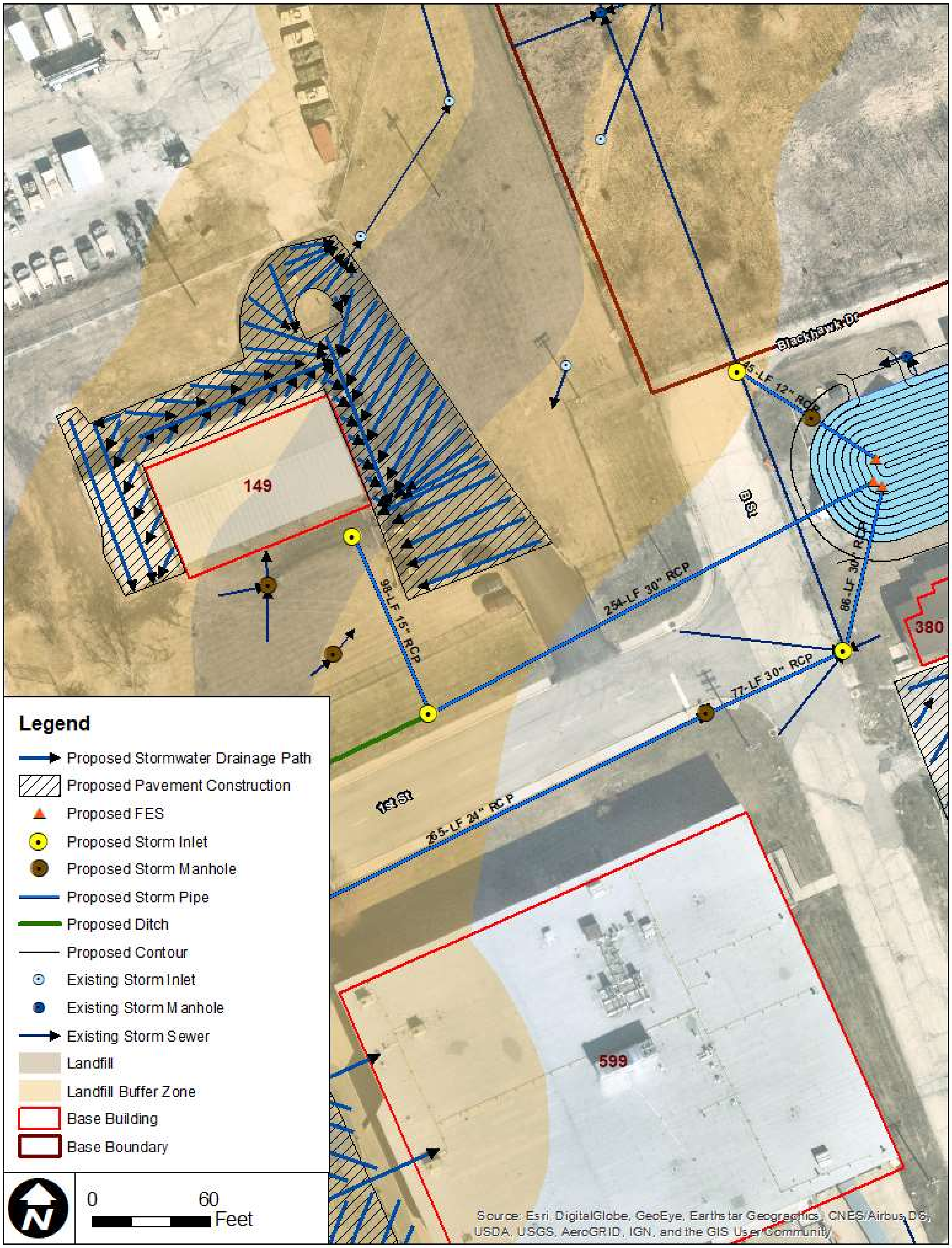


Figure 5.1-3. Building 149 Driveway Proposed Improvements

5.1.1-2 North-central Region of Facility

Facility personnel report observing stormwater runoff travelling via overland flow from the northwest side to the northeast side of the Facility. Generally, the described route is from the parking lots of Buildings 698 and 699, east across C St and through the parking lots of Buildings 598 and 599, then north across 1st Street and into the driveway of Building 149. The purpose of the proposed improvements for this region is to prevent this overland flow from occurring and better control the flow-path when overland flow does occur. Cleaning and re-grading the drainage ditches and flushing of the culverts surrounding Building 705 is the strategy for preventing overland flow. This will increase their hydraulic capacity, allowing them to effectively convey more stormwater runoff than they can under existing conditions. Better control of overland flow-paths can be achieved by reconstructing and regrading the parking lots of Buildings 698, 699, 598, and 599. The purpose of this is to promote drainage to the existing storm inlets within each parking lot. This will yield a more controlled flow-path when overland flow does occur. The proposed improvements for this location are listed below.

- Clean/re-grade existing drainage ditches and flushing culverts/storm pipes
- Grade new drainage ditches and install new storm pipes
- Reconstruct and regrade parking lots

Figure 5.1-4 shows the proposed improvements for this location

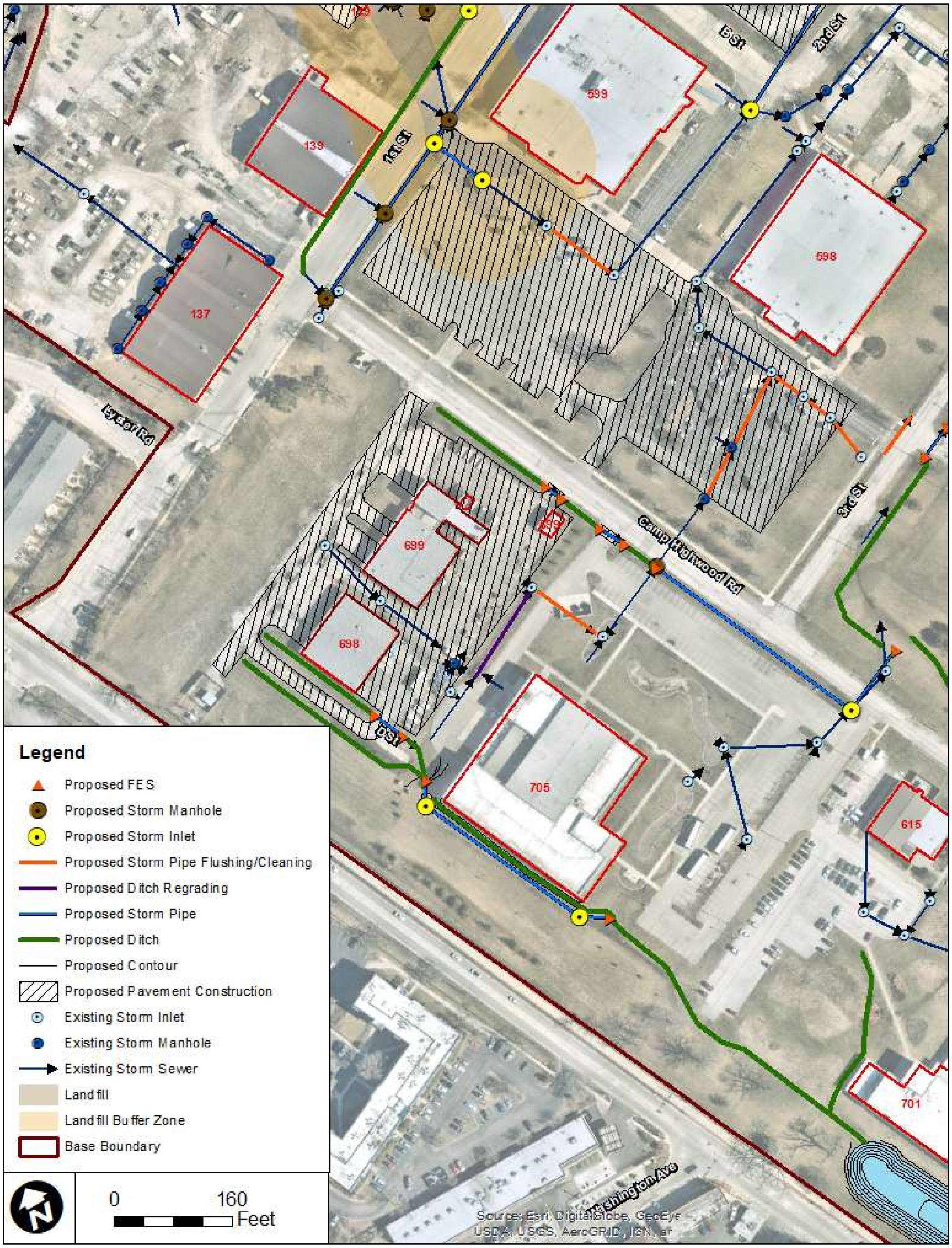


Figure 5.1-4. North-central Regional of Facility Proposed Improvements

5.1.1-3 Building 475 Parking Lot & 3rd Street

The Building 475 parking lot endures worse flooding than the rest of the Facility due to too much influent stormwater runoff to this location and insufficient conveyance capacity to properly drain the stormwater. Additionally, it is not uncommon for the drainage ditches along 3rd St, which are located west of the Building 475 parking lot, to overtop and spill excess stormwater across 3rd St during storm events. The proposed improvements for this location involve improving the conveyance capacity of the drainage ditches and culverts along 3rd St and the storm pipes beneath and downstream of the Building 475 parking lot. Cleaning and re-grading the drainage ditches and flushing the culverts along 3rd St will increase their hydraulic capacity thereby allowing them to better convey stormwater. Currently, stormwater drains un-detained from the central portion of the Facility. Three new detention ponds are recommended to mitigate this and reduce peak release rates. The pond at 2nd and B St (Pond 2B) receives stormwater runoff from Buildings 599 and 147 and their surrounding areas. The pond at 3rd and B St (Pond 3B) receives runoff from between C & B Streets and between 3rd St & Buildings 706/707. The pond at 3rd and Eisenhower St (Pond 3I) receives runoff from part of the area surrounding Building 705, and the areas surrounding Buildings 598 and 475. The proposed improvements for this location are listed below.

- Clean/re-grade drainage ditches along 3rd St
- Reconstruct and regrade the Buildings 147 and 475 parking lots
- Install 3 new detention ponds

Figure 5.1-5 shows the proposed improvements for this location.

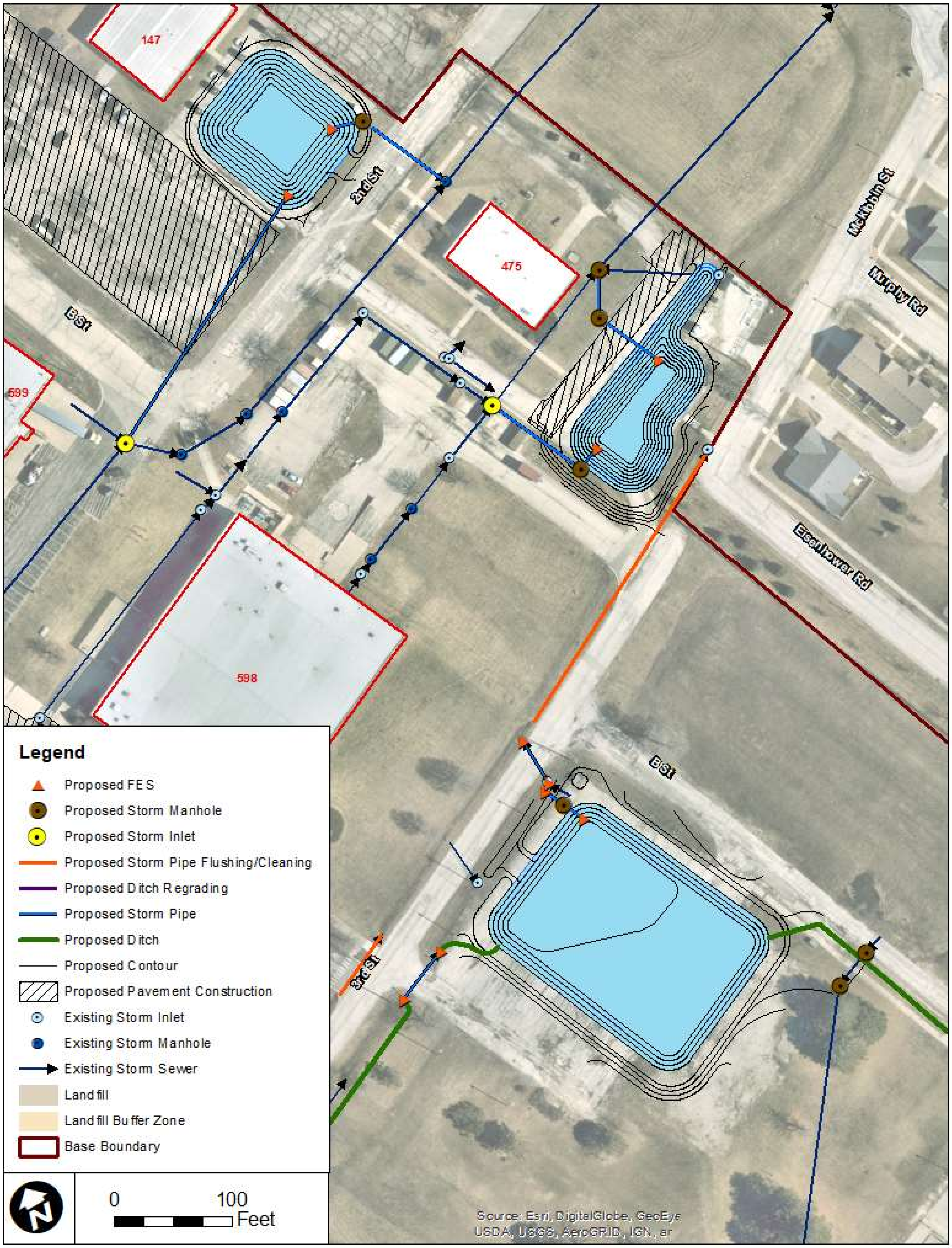


Figure 5.1-5. Building 475 Parking Lot and 3rd Street Proposed Improvements

5.1.1-4 H Street and 9th Street

The segment of H St located east of the existing detention pond experiences excessive ponding for small to large storm events. The ponded stormwater collects on the west side of H St and overtops the road before draining into an existing stormwater inlet located on the east side of H St.

There has been a redesign of the proposed improvements between the 35% and 65% design stage. The initial design involved installing a new stormwater inlet on the west side of H at the low point where stormwater already accumulates. A 24-inch RCP was also recommended and would have connected the proposed storm structure to the existing structure with an invert of 652.4-ft located on the east side of H St. It was decided that formerly proposed pipe installation yielded unnecessary earthwork within the landfill buffer zone, and that improving the drainage in this area could be accomplished in in a more minimally invasive manner. The proposed improvements now involve grading earthwork and grinding/re-surfacing of H St to promote positive drainage from the west side of the street to the existing inlets on the east side of the street. The existing depressional area located west of H St would be raised so that stormwater can no longer accumulate in this area. The proposed improvements for this location are listed below.

- Grind and re-surface H St
- Re-grade pervious area west of H St

Figure 5.1-6 shows the proposed improvements for this location.

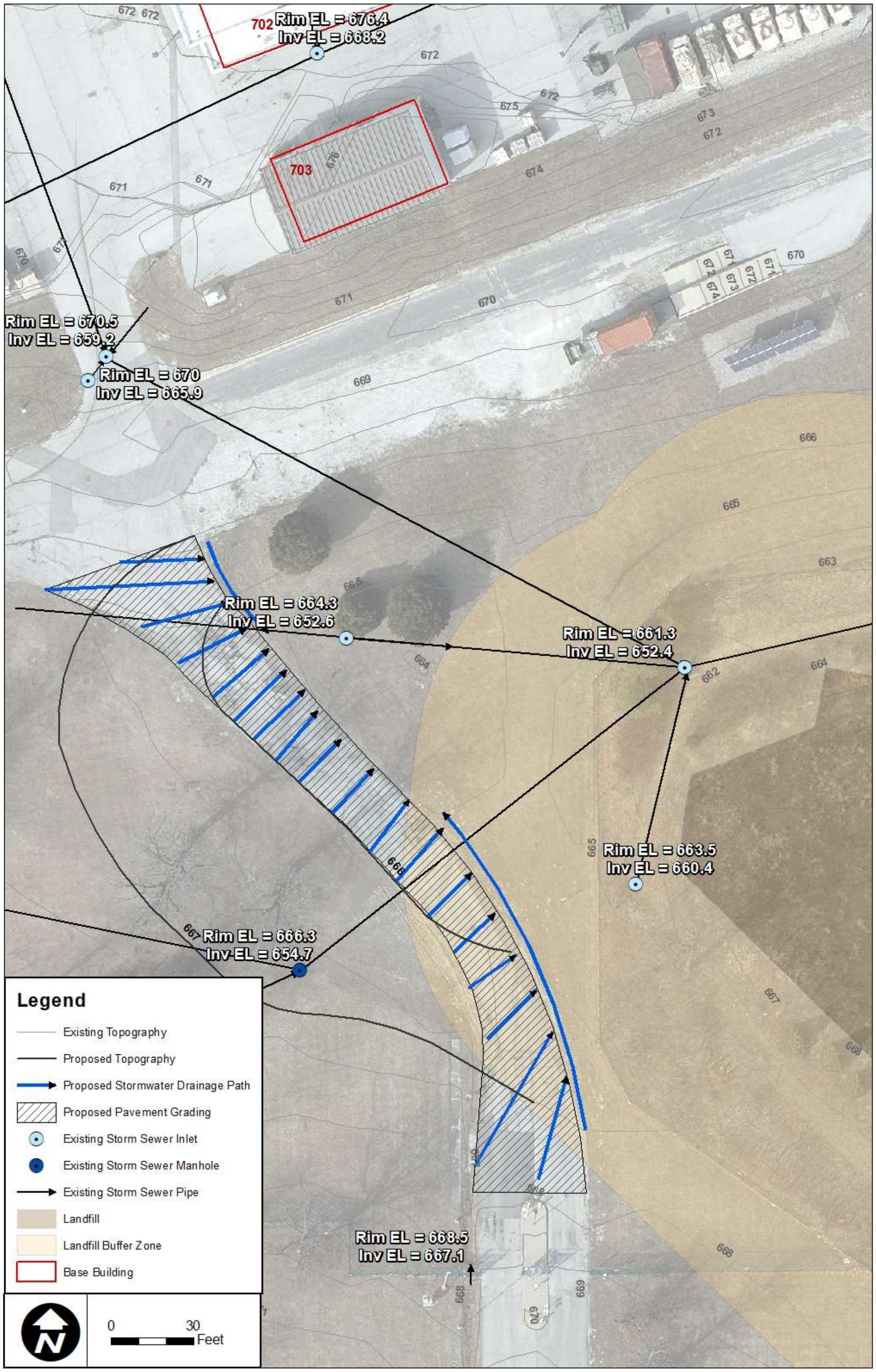


Figure 5.1-6. P4 Proposed Improvements

5.1.2 Minimize Future Cost and Maintenance

The Facility undergoes constant construction and demolition, and in some instances Facility buildings are reconstructed in new locations. Given this, it was essential that any recommended conveyance improvements provide a level of flexibility for future construction. This is so development can continue unimpeded and was accomplished by locating the potential improvements in areas that aren't affected by the ongoing construction.

To provide flexibility it's recommended that drainage ditches be utilized and located adjacent to main roads (1st St, 3rd St, 9th St, B St, and C St). Construction of drainage ditches will yield lower costs now, and in the future when the Facility undergoes further construction. It is believed that although there's a maintenance cost associated with drainage ditches, re-orienting and/or relocating them will be cheaper than removing and reconstructing new storm sewer pipes.

There are several locations, however, where the use of storm pipes will be necessary for reasons such as utility conflicts, elevation difference limitations, and locations with culverts beneath roadways or large outlet pipes that drain stormwater from the Facility. Furthermore, the updated design now has several locations where drainage ditches were previously recommended now utilizing proposed storm sewers because of the limitations listed above.

These proposed drainage ditches are widespread throughout the Facility and are meant to serve as the primary stormwater conveyance system for the Facility. Additionally, drainage ditch cleaning and re-grading and culvert flushing was recommended along C St and 3rd St in Sections 5.1.1-2 and 5.1.1-3. Should the Facility decide to proceed with these proposed drainage ditches then they would supersede simple cleaning and re-grading. Instead, the existing drainage ditches would be modified to match the newly designed drainage ditches which are sized to handle the peak flowrates indicated by the Model. Figure 5.1-7 shows the extent of the of the proposed drainage ditches and storm pipes.

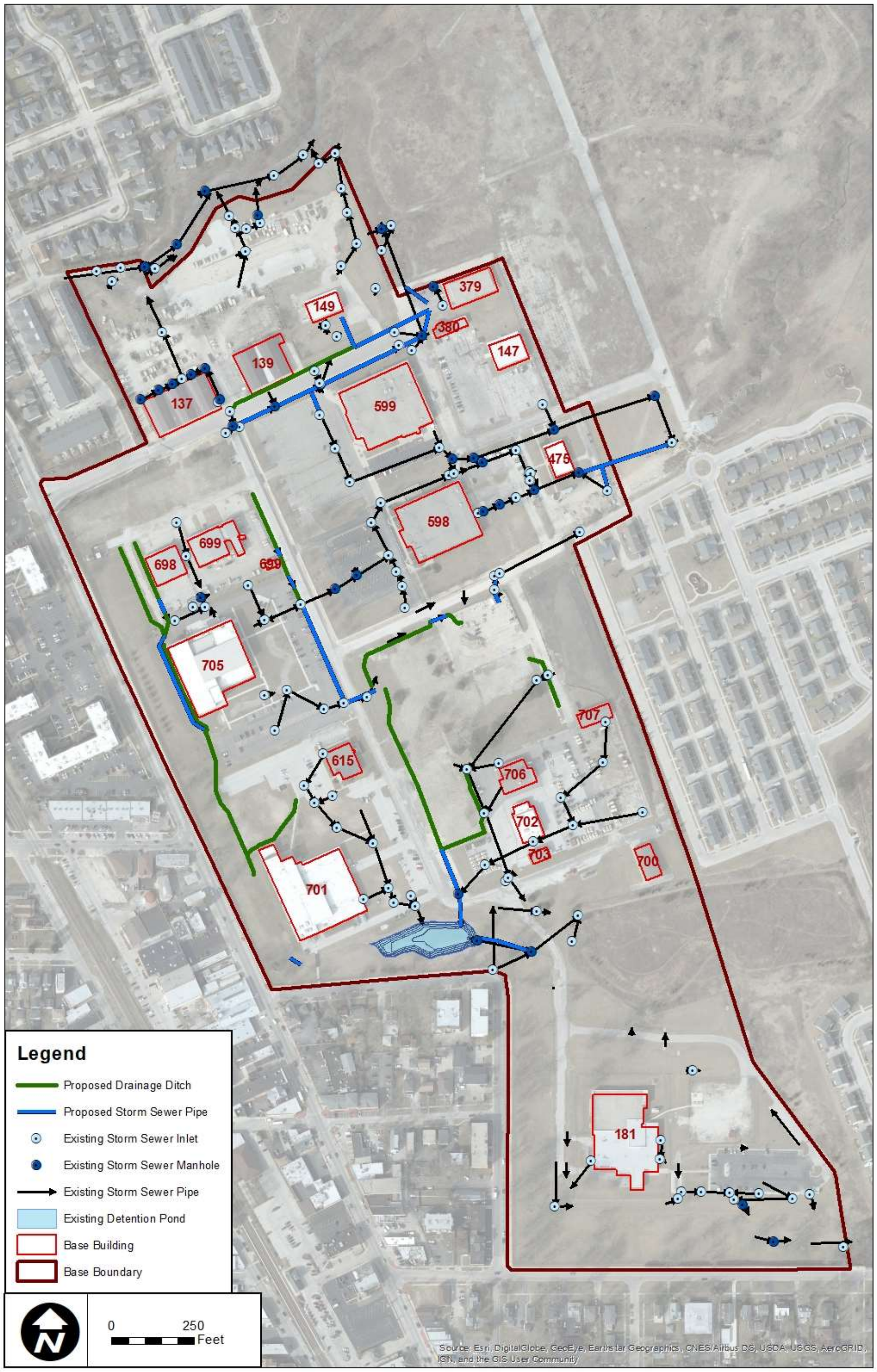


Figure 5.1-7. Proposed Drainage Ditches

5.1.3 Reduce Stormwater Runoff Rates

Currently, there are two primary obstacles for the Facility to meet the stormwater release rates required by Lake County. The first obstacle is that the majority of the Facility's stormwater is not directed to the existing detention pond. This contributes to the pond not being fully utilized, to other areas of the Facility being over inundated with stormwater runoff and flooding, and the Facility as a whole exceeding the required release rates. The second obstacle is that the existing detention pond cannot serve the entire Facility because of its size and location.

Facility personnel reported that the existing pond does not fill up entirely during storm events. However, the current Model results indicate that short, 1-hour to 3-hour, intense storms do have the potential to fill the pond to capacity. Therefore, redirecting stormwater to the pond will require its expansion to accommodate any excess volume redirected to it. Additionally, the detention pond location at the southwest corner of the Facility makes it unfeasible to redirect stormwater to it from many parts of the Facility. For example, stormwater runoff located anywhere north of 1st St and northeast of 3rd St and C St cannot be redirected to the detention basin without a pump. The proposed improvement to address this issue is the construction of two additional detention ponds to serve the central and northeast areas of the Facility.

Figure 5.1-8 shows the expanded detention pond overlain by the existing detention pond.

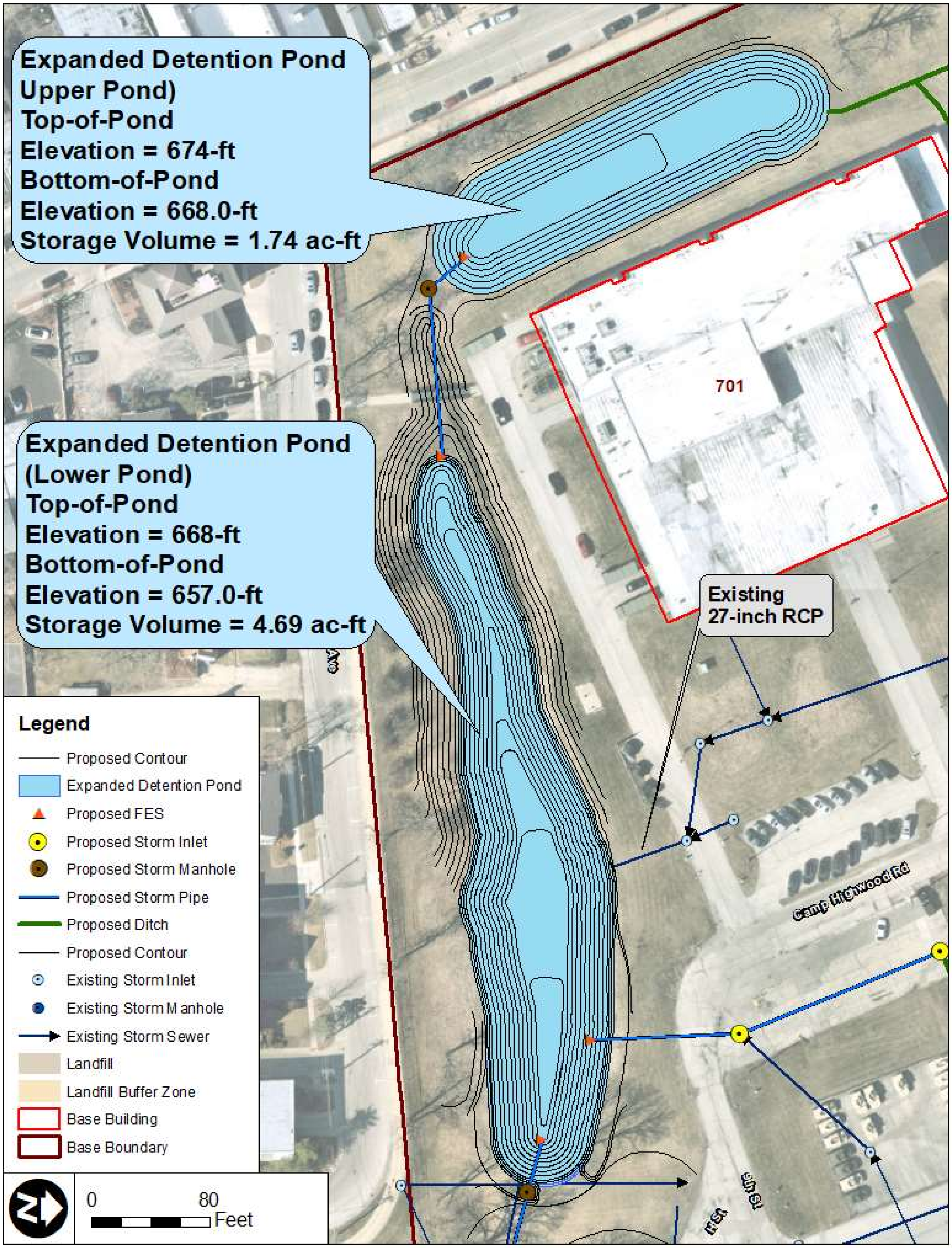


Figure 5.1-8. Expanded Existing Detention Pond

As shown in the figure the existing pond has a storage volume of 1.74 ac-ft. The expanded detention pond is actually two in-line detention ponds consisting of an upper pond located west of Building 701 that drains southeast into the lower pond. The upper and lower ponds have storage volumes of 1.78 ac-ft and 4.69 ac-ft, respectively, for a total of 6.47 ac-ft. The upper pond receives stormwater runoff that is conveyed by the proposed north-south spanning drainage ditches located on the west side of the Facility. A relatively flat pond bottom and native grasses situated within the pond would intentionally promote infiltration in the upper pond for water quality benefits. The two ponds are connected by a 12-inch RCP and an approximately 30-ft wide emergency overflow weir. The lower pond is also designed to utilize native grasses, similar to the existing pond, for water quality benefits but would have a minimal longitudinal slope of 1%. The design updates have minimized utility conflicts to one north-south spanning gas line located southwest of 9th St and H St. The existing pond bottom of 662.5-ft does not conflict with this utility but the proposed deepening of the pond to a bottom elevation of 657.0-ft could result in a utility conflict. Two new storm pipes associated with the lower pond include an influent 4-ft by 2-ft RCP box culvert and an effluent 12-inch RCP. The grading of the pond is designed so that the existing and proposed topography tie into each other at the location of the existing influent 27-inch RCP on the north side of the pond.

Figure 5.1-9, provided below, shows the proposed detention pond at the intersection of 3rd St and B St.

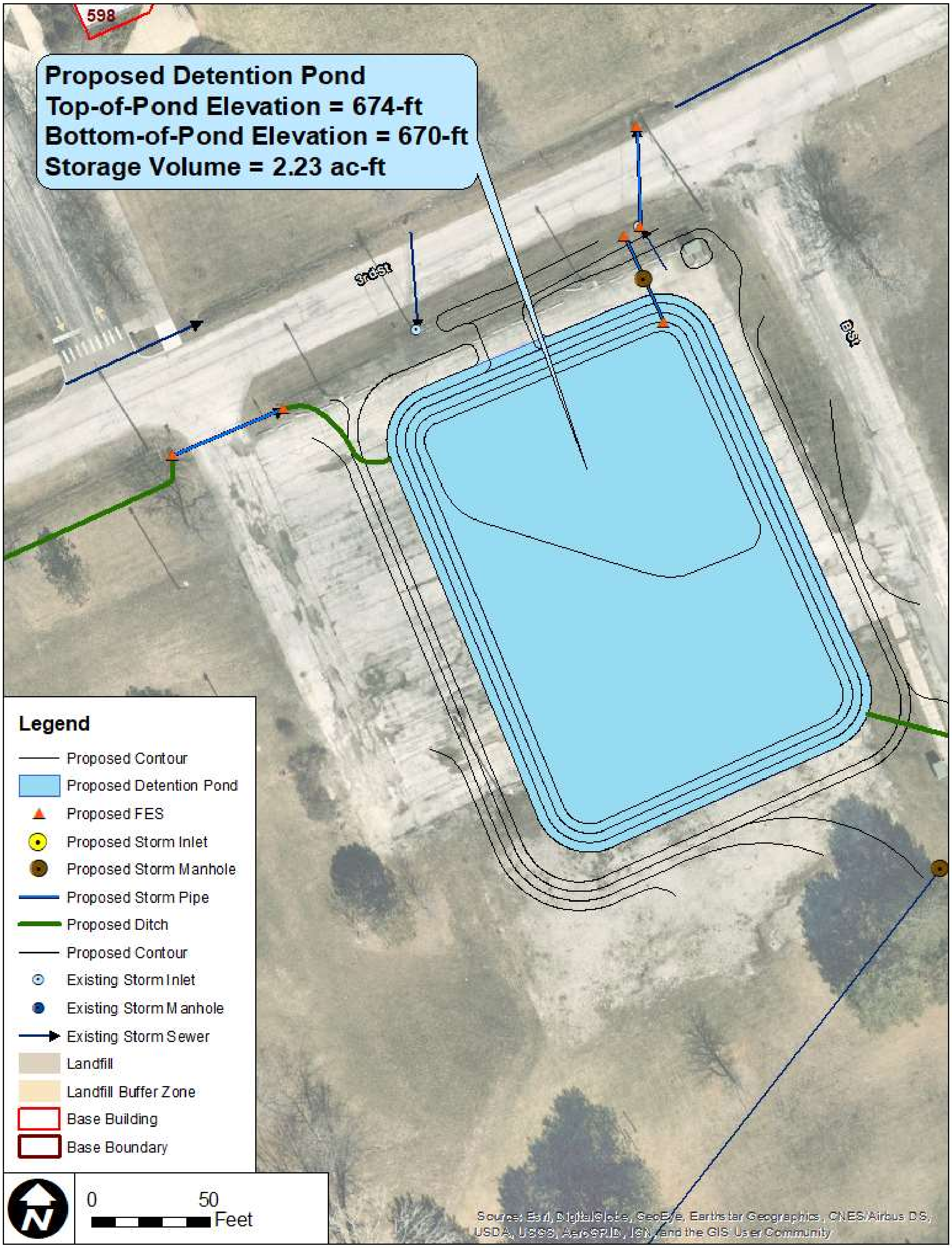


Figure 5.1-9. Proposed Detention Pond, 3rd St and B St

As shown, this is a relatively shallow pond with a total depth of 4.0 feet and a storage volume of approximately 2.23 ac-ft. The detention pond is meant to serve the northeast half of the parcel of land located in between 3rd and 9th St, and B and C St. Proposed drainage ditches convey stormwater from the south side of B St and west side of 3rd St to the pond. There are several existing utility lines shown going through the area of the pond, however based on Facility provided GIS data these are listed as abandoned and it is SCI's understanding that they correspond to the recently demolished ARC building and are indeed no longer in use. The grading of the proposed pond is designed so that the existing utility poles and electric transformers near the proposed earthwork will be unaffected. There are two existing storm sewer inlets located near the center of B St that drain into a storm sewer which conveys stormwater southwest. Inherent in this proposed pond is the abandonment of these utilities so that the runoff can be redirected to the pond.

Figure 5.1-10, provided below shows the proposed detention pond at the intersection of 1st St and B St.

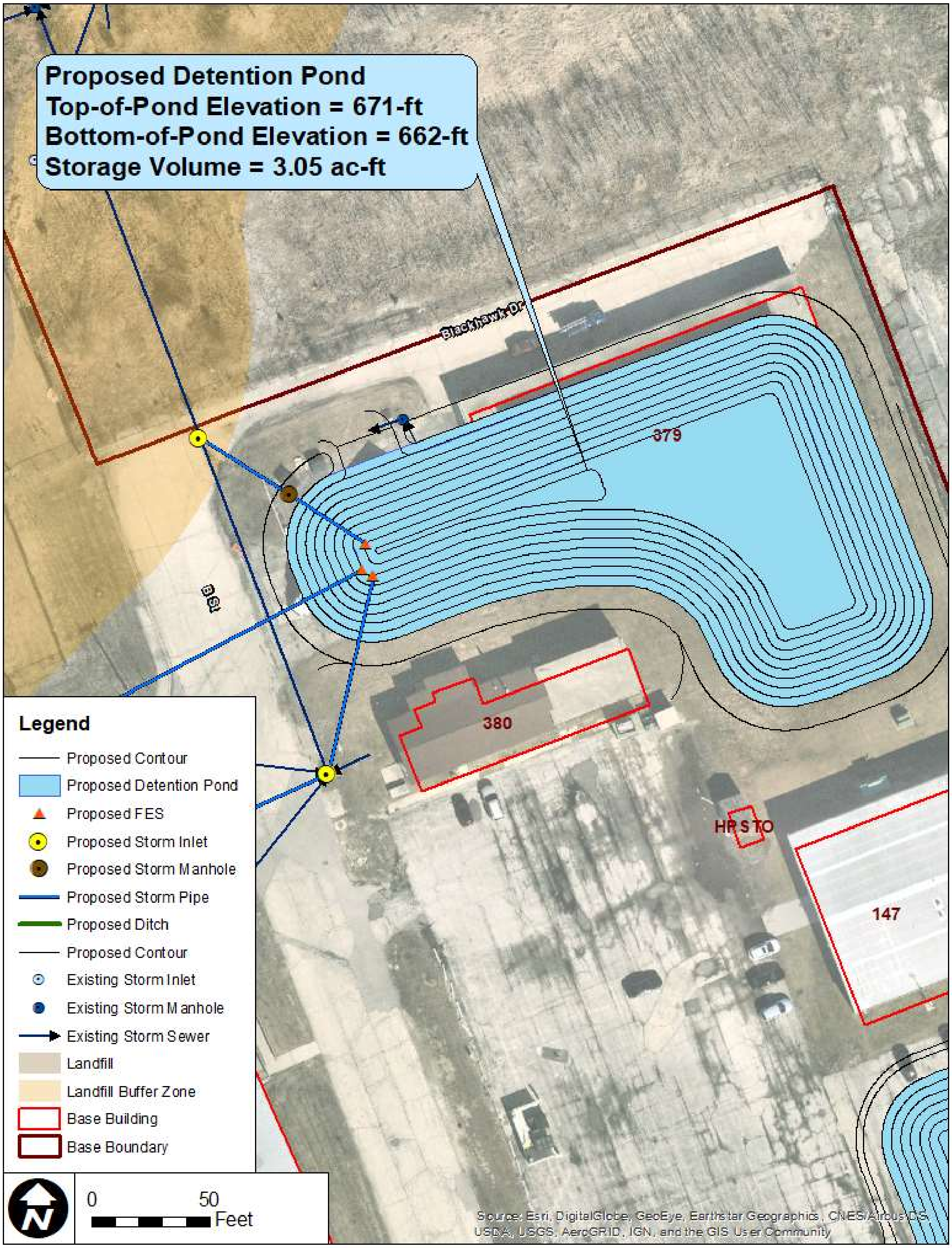


Figure 5.1-10. Proposed Detention Pond, 1st St and B St

As shown, this pond is currently designed with a total height of 9.0 ft and a storage volume of 3.05 ac-ft. The detention pond is meant to serve the northeast sub-watershed of the Facility, primarily the stormwater runoff along 1st St and that which drains into the newly proposed storm inlets located south of Building 149. The outlet pipe for this pond is currently a 12-inch RCP that ties into the existing 15-inch RCP that already drains runoff for the northeast sub-watershed of the Facility. This pond's construction is dependent upon the tentative demolition of Building 379. The majority of existing utilities shown going through the area of the proposed pond correspond to Building 379 and will be abandoned in conjunction with its demolition.

Figure 5.1-11, provided below shows the proposed detention pond at the intersection of 2nd St and B St.

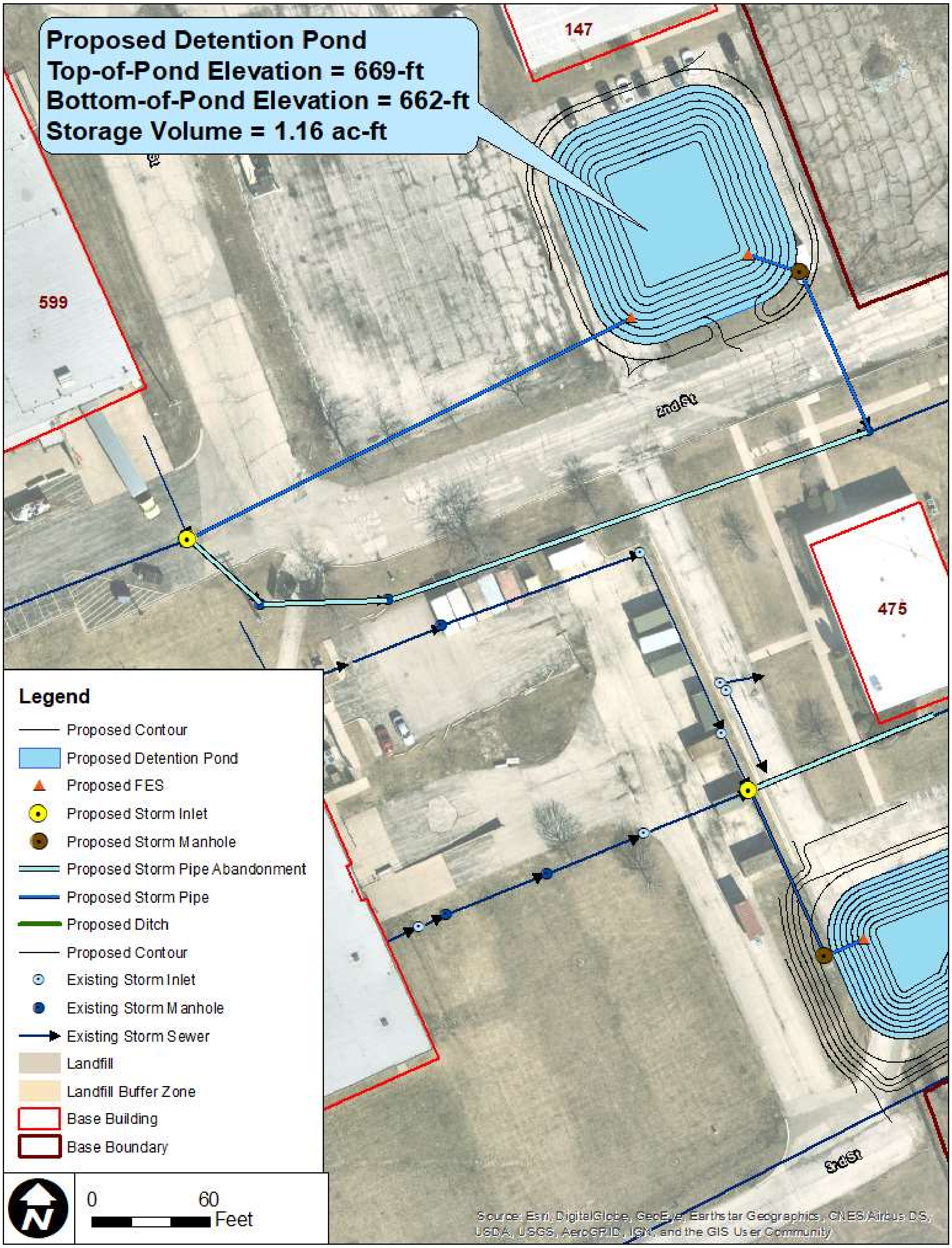


Figure 5.1-11. Proposed Detention Pond, 2nd St and B St

As shown, this pond is currently designed with a total height of 7.0 ft and a storage volume of 1.16 ac-ft. The detention pond is meant to serve the east sub-watershed of the Facility, primarily the stormwater runoff from Buildings 599 & 147 and their surrounding areas.

Figure 5.1-12, provided below shows the proposed detention pond at the intersection of 3rd St and Eisenhower St.

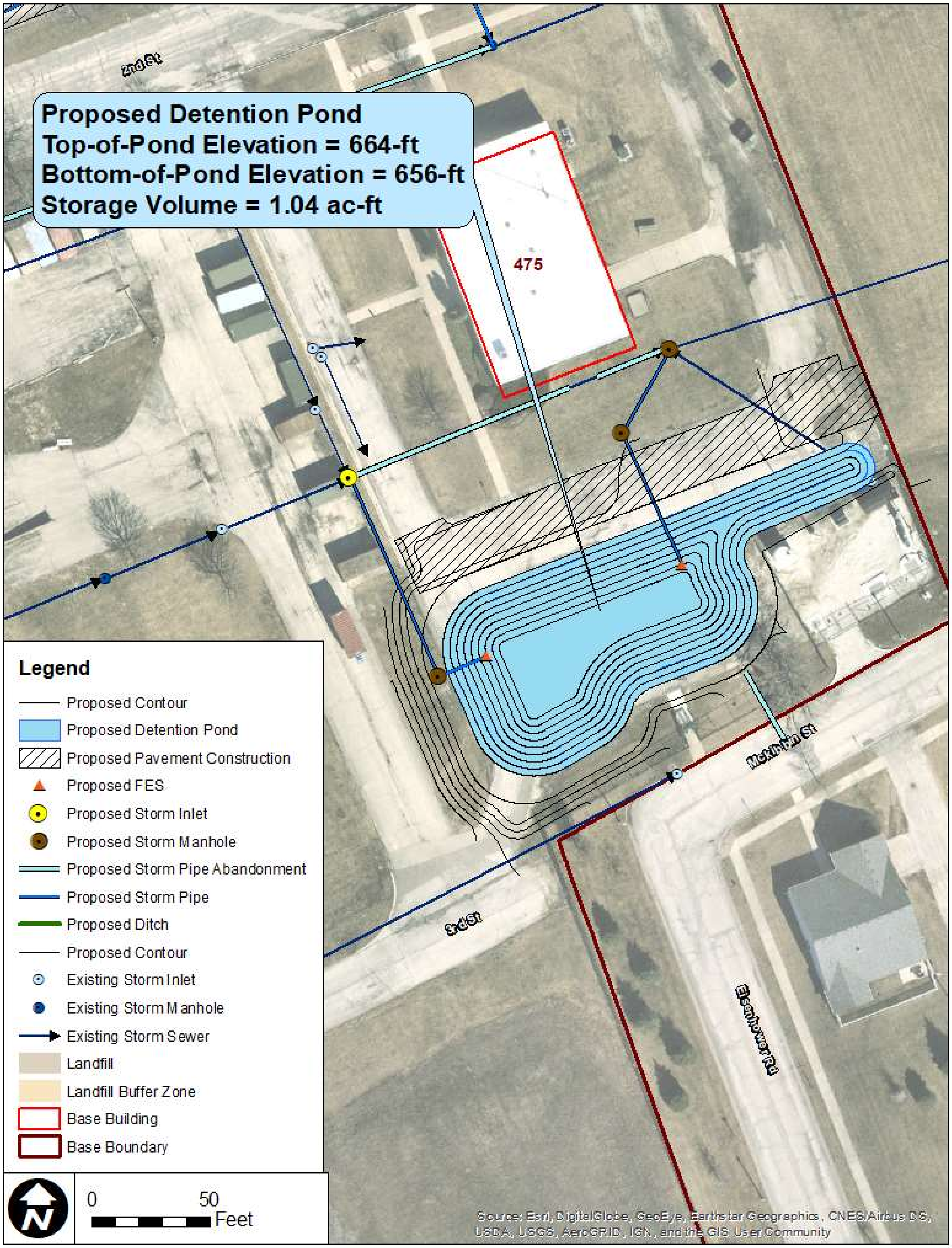


Figure 5.1-12. Proposed Detention Pond, 3rd St and Eisenhower St

As shown, this pond is currently designed with a total height of 8.0 ft and a storage volume of 1.04 ac-ft. The detention pond is meant to serve the east sub-watershed of the Facility, primarily the stormwater runoff from Buildings 598 & 475 and their surrounding areas.

The proposed drainage ditches and detention ponds have resulted in a significant change to the Facility's hydrology. Stormwater drainage patterns have been redirected in an effort to more evenly disperse stormwater runoff throughout the Facility. Approximately 50% of the stormwater runoff that drained eastward has been redirected northeast or southeast. In addition to the redirection of stormwater runoff, much of it is now intercepted by the proposed detention ponds. This should result in lower peak flowrates which will allow for stormwater to drain through and from the Facility in a more orderly, manageable manner. The drainage patterns under existing and proposed conditions are shown in Figures 5.1-11 and 5.1-12.

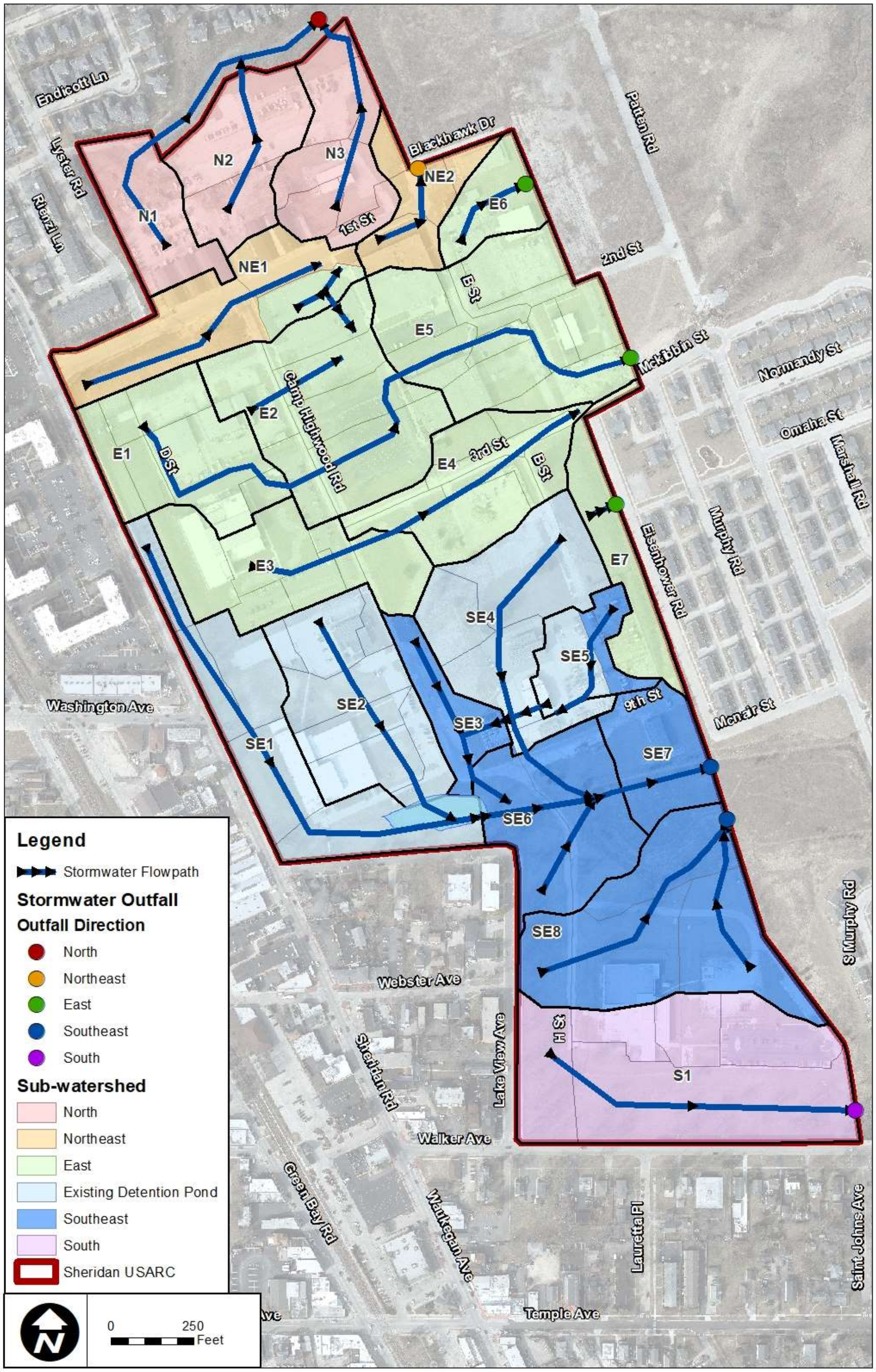


Figure 5.1-11. Existing Conditions Drainage Patterns

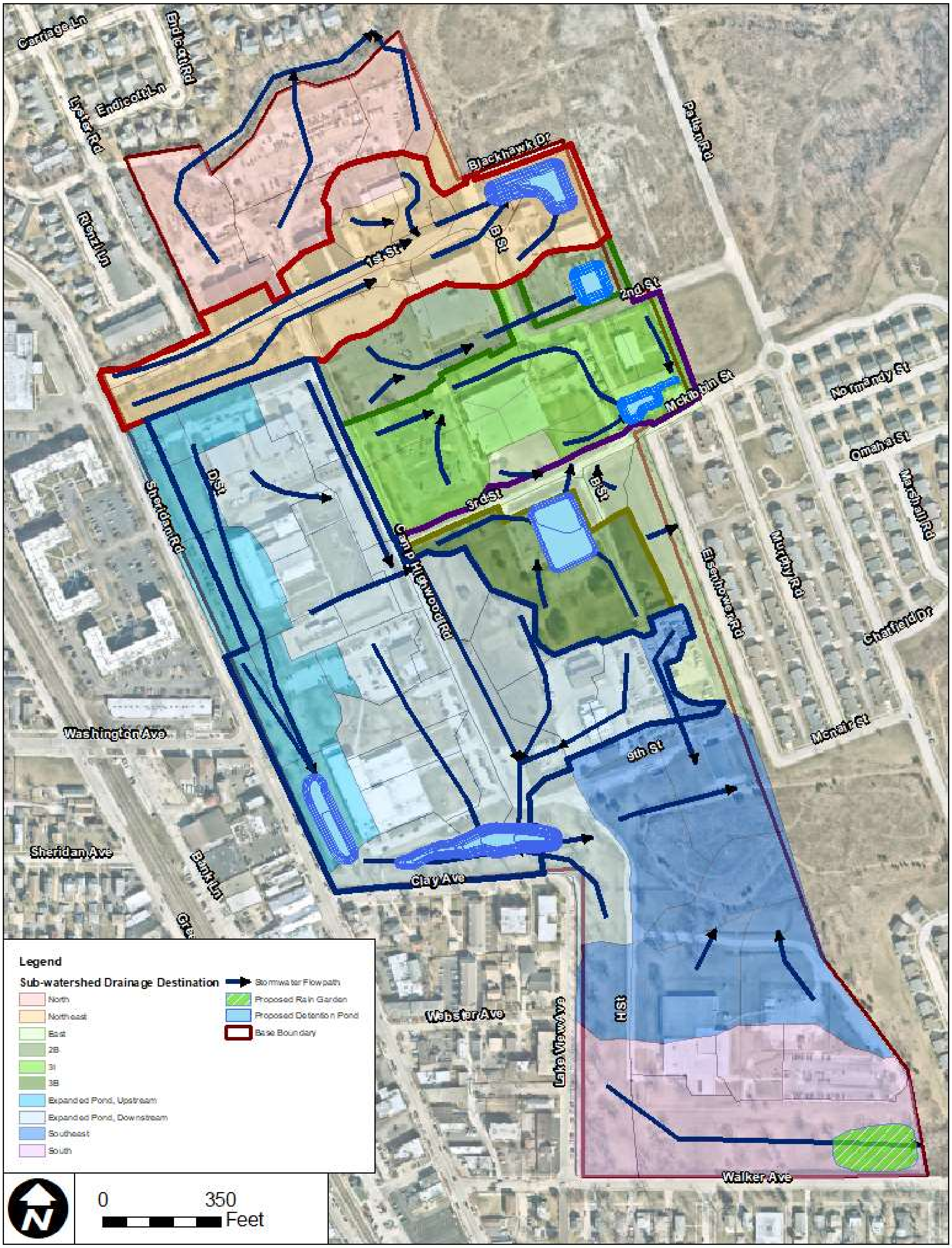


Figure 5.1-12. Proposed Conditions Drainage Patterns

5.1.4 Improve Water Quality

The remaining criteria to address is improving the quality of effluent stormwater from the Facility. This is especially important considering the number of ravines located immediately east of the Facility, many of which have been recently rehabilitated by the USACE. SCI's initial design concept for addressing this involved locating rain gardens throughout the Facility and incorporating native grasses into the proposed drainage ditches which would have turned them into bio-swales.

The majority of the proposed rain gardens were situated around Landfill #6. As described in Section 1.3.1, however, this proposal could have potentially negative impacts to Landfill #6 and has since been omitted from the proposed improvements. One proposed rain garden remains and is located at the southeast corner of the Facility with an area of approximately 0.70 ac. The southern rain garden has been situated at the location of the south outfall. Minimal to no flooding issues were reported for this location, although it was noted that water can pond in the field that is south of Building 181. The intent of this rain garden is to better absorb and clean the ponded stormwater before it drains from the Facility.

The proposed bio-swales were removed from the design after it was determined that the presence of dense, tall native grasses within the drainage ditches would decrease their conveyance capacity too much. An alternative to situating native grasses within the drainage ditches is to place them within the detention ponds, which was incorporated into the current design.

With the proposed improvements addressed, the next step is to organize them into the three different alternatives. Section 5.2 describes how these improvements have been partitioned into separate categories.

5.2 Proposed Improvement Alternatives

The proposed improvements described in Section 5.1 have been compartmentalized into three alternatives. Brief descriptions of the criteria for each alternative are provided below.

- **Minor Alternative**: Low-cost alternative to fix most problematic issues and address any major compliance issues.
- **Moderate Alternative**: Includes solutions from the minor alternative but provides additional conveyance, detention, and water quality features to control storm water discharge and improve water quality.
- **Major Alternative**: Includes solutions from the moderate alternative but provides significant detention and water quality features to maximize the site's potential detention and water quality improvements.

Additional details regarding each alternative are provided in the following sections.

5.2.1 Minor Alternative

The purpose of the Minor Alternative was to mitigate flooding due to stormwater at the locations where it is most prominent. This includes the four locations described in Section 5.1.1, which are:

- Building 149 Driveway
- North-central region of Facility
- Building 475 parking lot and 3rd St
- H St and 9th St

Additional details regarding the Minor Alternative are provided in Attachment 1.

5.2.2 Moderate Alternative

There are several purposes of the Moderate Alternative which are listed below.

- Begin integrating areas of the Facility's storm sewer system
- Begin transitioning from utilizing storm sewer pipes to drainage ditches
- Redirect as much stormwater runoff as possible to the existing detention pond to reduce peak release rates
- Expand the existing detention pond as necessary to accommodate the additional stormwater

Integration of the Facility's storm sewer system is accomplished by redirecting stormwater runoff so that it is conveyed throughout the Facility in a more orderly manner. Additional details regarding the Moderate Alternative are provided in Attachment 7.

5.2.3 Major Alternative

There are several purposes of the Major Alternative which are listed below.

- Further integrate the Facility's storm sewer system
- Further transition away from using traditional storm sewer pipes in favor of drainage ditches
- Provide additional stormwater detention capabilities to meet the Lake County's release rate requirements
- Provide water quality benefits wherever practical

Additional integration of certain areas of the Facility's storm sewer system is achieved by redirecting stormwater at two other locations on the Facility. These include 1st St and the plot of land located in between 3rd and 9th St and C and B St. Drainage ditches have been designed in tandem with new detention ponds to serve these locations. The detention ponds will detain stormwater runoff that was unable to be redirected to the expanded existing detention pond.

Additional detention was achieved for the remainder of the Facility by providing detention ponds south of Building 147 (Pond 2B) and south of Building 475 (Pond 3I). Combined, these ponds serve Buildings 147, 475, 598, and 599.

The southeastern area of the Facility, southeast of 9th and H St, is another location where detaining stormwater is not possible. The alternative here is to provide rain gardens to better absorb stormwater. This is also proposed for field located south of Building 181. The rain gardens also provide a water quality improvement benefit by filtering the absorbed stormwater. Figure 5.2-3 shows all the recommended improvements for the Facility which are included in the Major Alternative.

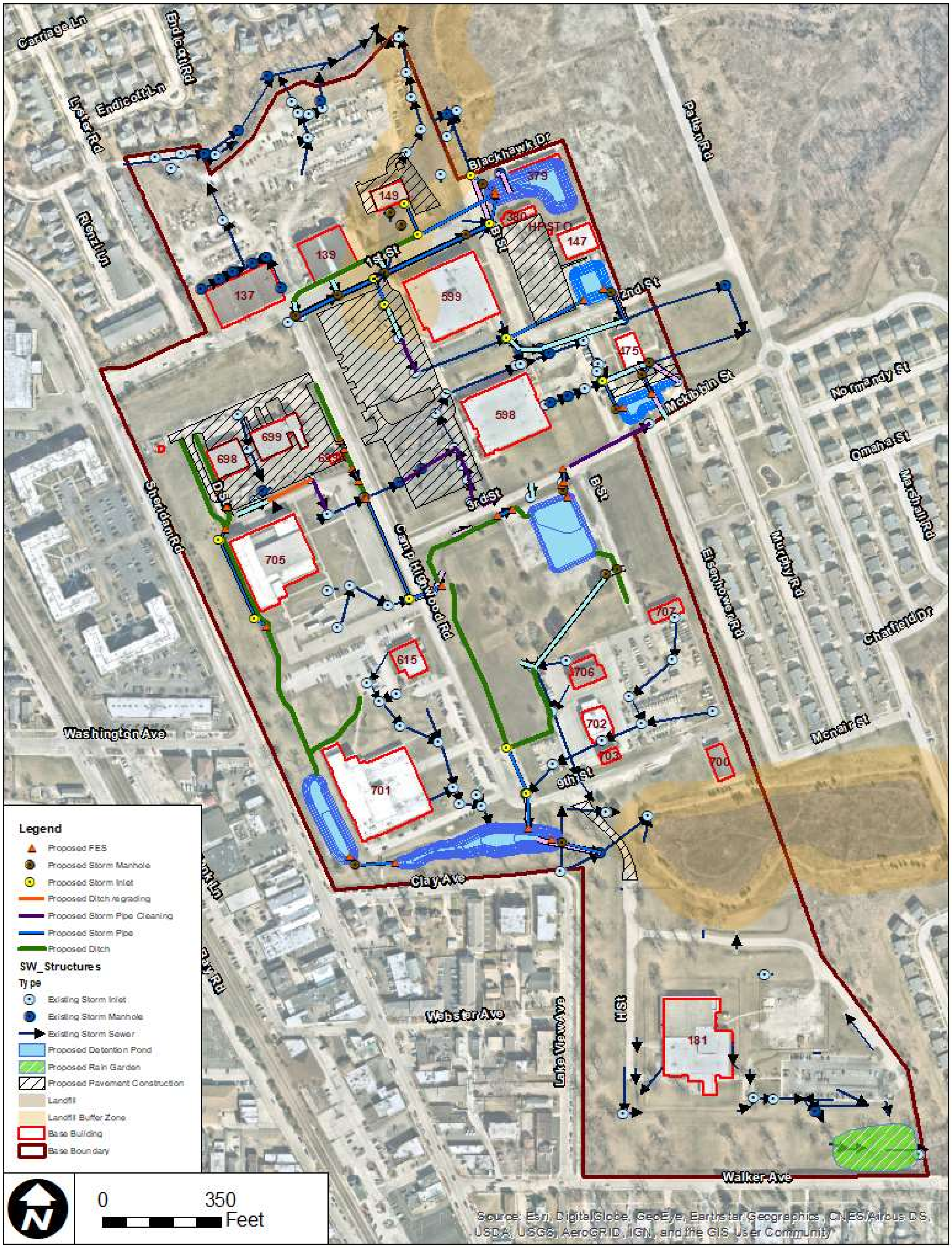


Figure 5.2-3. Major Alternative Proposed Improvements

7.0 References

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- Angel, J. & Markus, M (2019). *Frequency Distributions of Heavy Precipitation in Illinois Updated Bulletin 70.*
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8.0 Attachments

ATTACHMENTS

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ATTACHMENT 2: KICKOFF MEETING MINUTES

ATTACHMENT 3: DRAFT REPORT CLIENT COMMENTS

ATTACHMENT 4: 35% DESIGN REVIEW MINUTES

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ATTACHMENT 7: MODERATE ALTERNATIVE DESCRIPTION

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ATTACHMENT 9: ARMY BRAC LANDFILL MINUTES

ATTACHMENT 10: IEPA LANDFILL MINUTES

ATTACHMENT 11: 95% REVIEW MEETING MINUTES

ATTACHMENT 1 – 35% DESIGN MINOR ALTERNATIVE DESCRIPTION

The Minor Alternative proposed improvements were initially designed as a low-cost alternative to fix the Base's most problematic issues and address any major compliance issues. However, as the design progressed it was determined that due to the widespread drainage problems and segregated storm sewer system, addressing these peak release rates with Minor Alternative recommendations is unfeasible. The scale of the solution must match the scale of the problem and there are simply too many independent problematic locations that require substantial improvements to adequately detain the volume of stormwater associated with the design storms that yield these peak release rates. Currently, there are two primary obstacles for the Base to meet the stormwater release rates required by Lake County. The first obstacle is that the majority of the Base's stormwater is not directed to the existing detention pond. This contributes to the pond not being fully utilized, to other areas of the Base being over inundated with stormwater runoff and flooding, and the Base as a whole exceeding the required release rates. The second obstacle is that the existing detention pond cannot serve the entire Base because of its size and location. These issues are addressed in the Moderate and Major Alternatives.

The purpose of the Minor Alternative was to mitigate flooding due to stormwater at the locations where it is most prominent. This includes the four locations described in Section 5.1.1 of the 65% Design Technical Report. Descriptions and figures of the proposed improvements is provided below for each location.

Building 149 Driveway

Base personnel reported that the Building 149 driveway has been a location of prominent nuisance flooding. However, this has somewhat resolved since it was regraded in the Fall of 2019. A trench grated stormwater inlet in conjunction with further grinding and resurfacing of the driveway is recommended to provide better drainage for this location. The proposed stormwater inlet would be oriented east-west and span the width of the driveway. The grading would be done to promote drainage toward the proposed inlet. Due to the presence of Landfill #5 at this location any proposed earthwork would entail raising ground elevations so as not to disturb the underlying contaminated soil. It is expected that ground elevations could be raised in certain locations by up to 1-foot using a base-course of coarse aggregate. A drainage ditch is also recommended to convey stormwater from the proposed inlet to the existing beehive storm inlets located northeast of the driveway. The conceptual improvements for this location are listed below.

35% Design Proposed Improvements:

- Install driveway inlet frame and grate
- Re-grade driveway
- Construct drainage ditch on east side of driveway

Figure A1 shows the proposed improvements for this location.

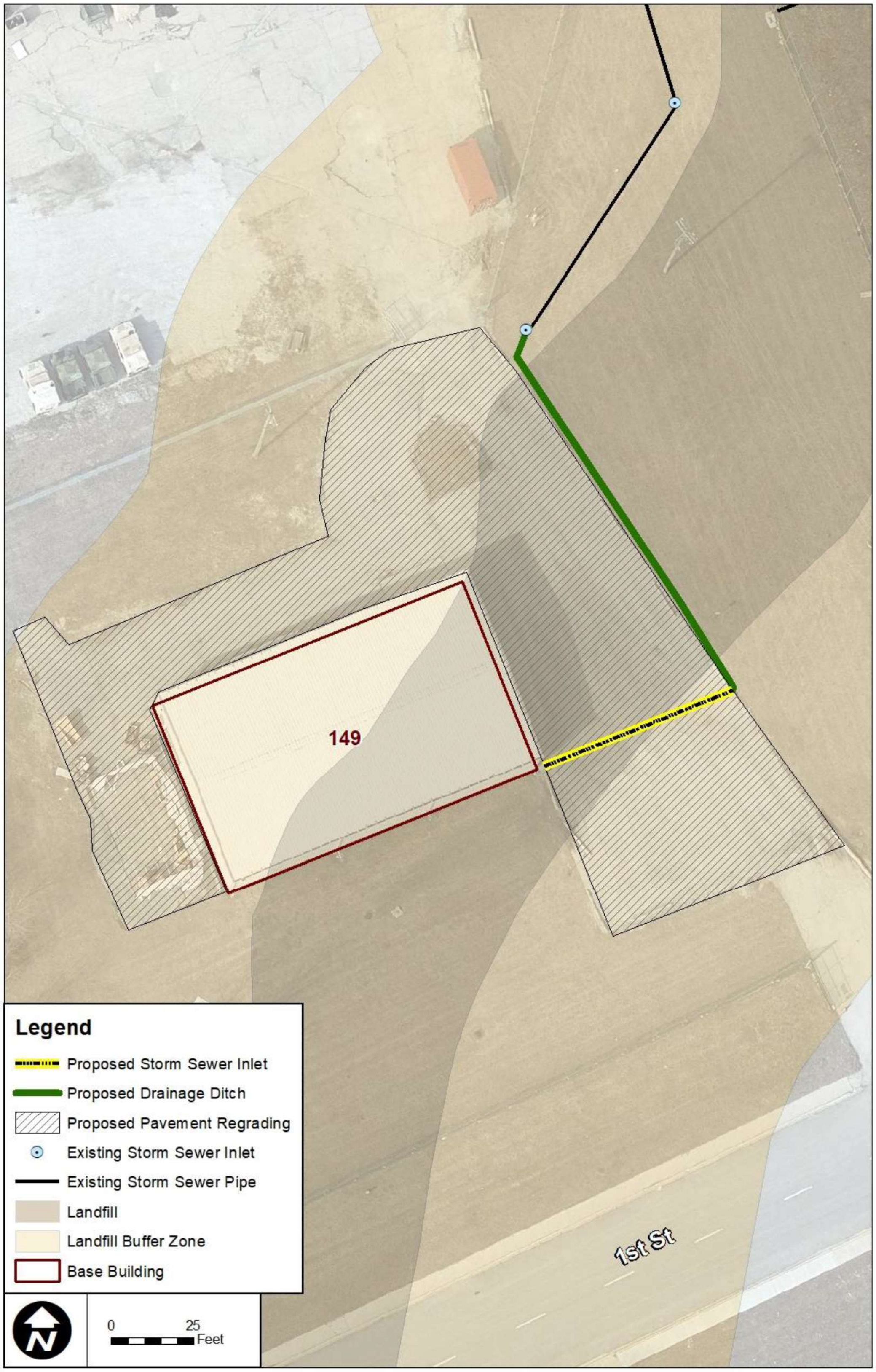

Figure A1. Building 149 Driveway Proposed Improvements

North-central Region of Base

Base personnel report observing stormwater runoff travelling via overland flow from the northwest side to the northeast side of the Base. The described route is from the parking lots of Buildings 698, 699, and to a lesser extent 705, across C St and through the parking lots of Building 599, and to a lesser extent Building 598, across 1st Street and into the driveway of Building 149. The purpose of the conceptual improvements for this region is to prevent this overland flow from occurring and better control the flow-path when overland flow does occur. Cleaning and re-grading the drainage ditches and culverts surrounding Building 705 is the strategy for preventing overland flow. This will increase their hydraulic capacity, allowing them to effectively convey more stormwater runoff than they can under existing conditions. Better control of overland flow-paths can be achieved by re-grading the parking lots of Buildings 698, 699, 598, and 599. The purpose of this is to promote drainage to the existing storm inlets within each parking lot. This will yield a more controlled flow-path when overland flow does occur. The conceptual improvements for this location are listed below.

35% Design Proposed Improvements:

- Clean/re-grade existing drainage ditches and culverts
- Re-grade driveways/parking lots

Figure A2 shows the proposed improvements for this location

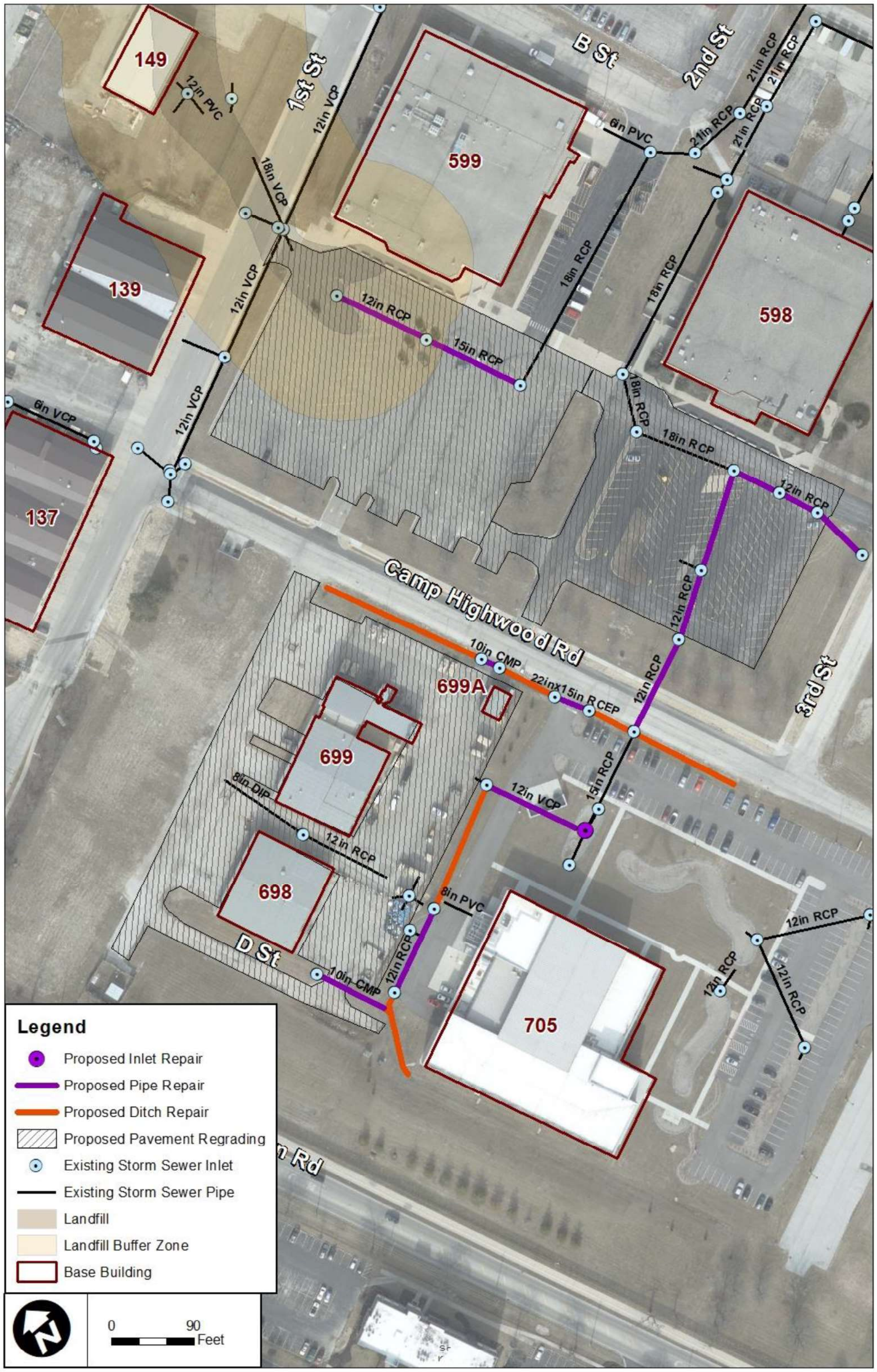

Figure A2. North-central Regional of Base Proposed Improvements

Building 475 Parking Lot & 3rd Street

The Building 475 parking lot endures worse flooding than the rest of the Base due to too much influent stormwater runoff to this location and insufficient conveyance capacity to properly drain the stormwater. Additionally, it is not uncommon for the drainage ditches along 3rd St, which are located west of the Building 475 parking lot, to overtop and spill excess stormwater across 3rd St during storm events. The conceptual improvements for this location involve improving the conveyance capacity of the drainage ditches and culverts along 3rd St and the storm pipes beneath and downstream of the Building 475 parking lot. Cleaning and re-grading the drainage ditches and culverts along 3rd St will increase their hydraulic capacity thereby allowing them to better convey stormwater. Regarding the Building 475 parking lot, there's currently a 12-inch PVC pipe that drains stormwater from the Building 475 parking lot. The 12-inch PVC pipe ties into a mainline 24-inch RCP that drains stormwater for the east sub-watershed of the Base. It is recommended to upsize the 12-inch PVC to a 24-inch RCP and the mainline 24-inch RCP to a 36-inch RCP. A new stormwater inlet structure is also recommended to provide adequate inlet capacity to the upsized storm pipes. Finally, grinding and resurfacing of the Building 475 parking lot is also recommended to promote drainage to the proposed inlet. The conceptual improvements for this location are listed below.

35% Design Proposed Improvements:

- Clean/re-grade drainage ditches and culverts along 3rd St
- Upsize the existing 12-inch PVC pipe to a 24-inch RCP
- Upsize the mainline 24-inch RCP to a 36-inch RCP
- Install new stormwater inlet
- Re-grade parking lot

Figure A3 shows the proposed improvements for this location.

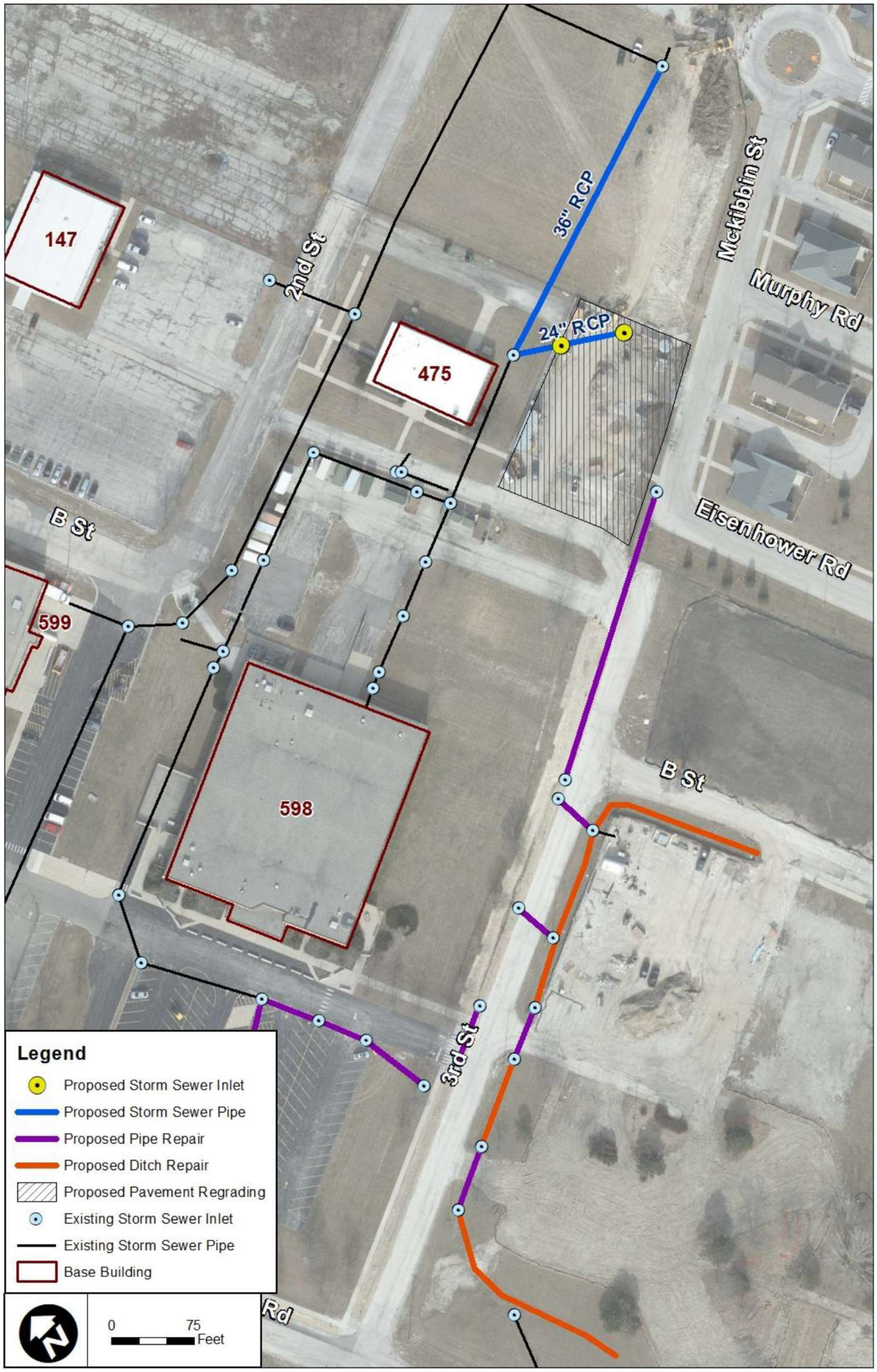

Figure A3. Building 475 Parking Lot and 3rd Street Proposed Improvements

H Street and 9th Street

The segment of H St located east of the existing detention pond experiences excessive ponding for small to large storm events. The ponded stormwater collects on the west side of H St and overtops the road before draining into an existing stormwater inlet located on the east side of H St. It is recommended to install a new stormwater inlet on the west side of H at the low point where stormwater already accumulates. A 24-inch RCP is also recommended to connect the proposed storm structure to the existing one located on the east side of H St. The conceptual improvements for this location are listed below.

35% Design Proposed Improvements:

- Install stormwater inlet at low point of west side of H St
- Install 24-inch RCP to convey stormwater from proposed inlet to the existing 30-inch RCP

Figure A4 shows the proposed improvements for this location.

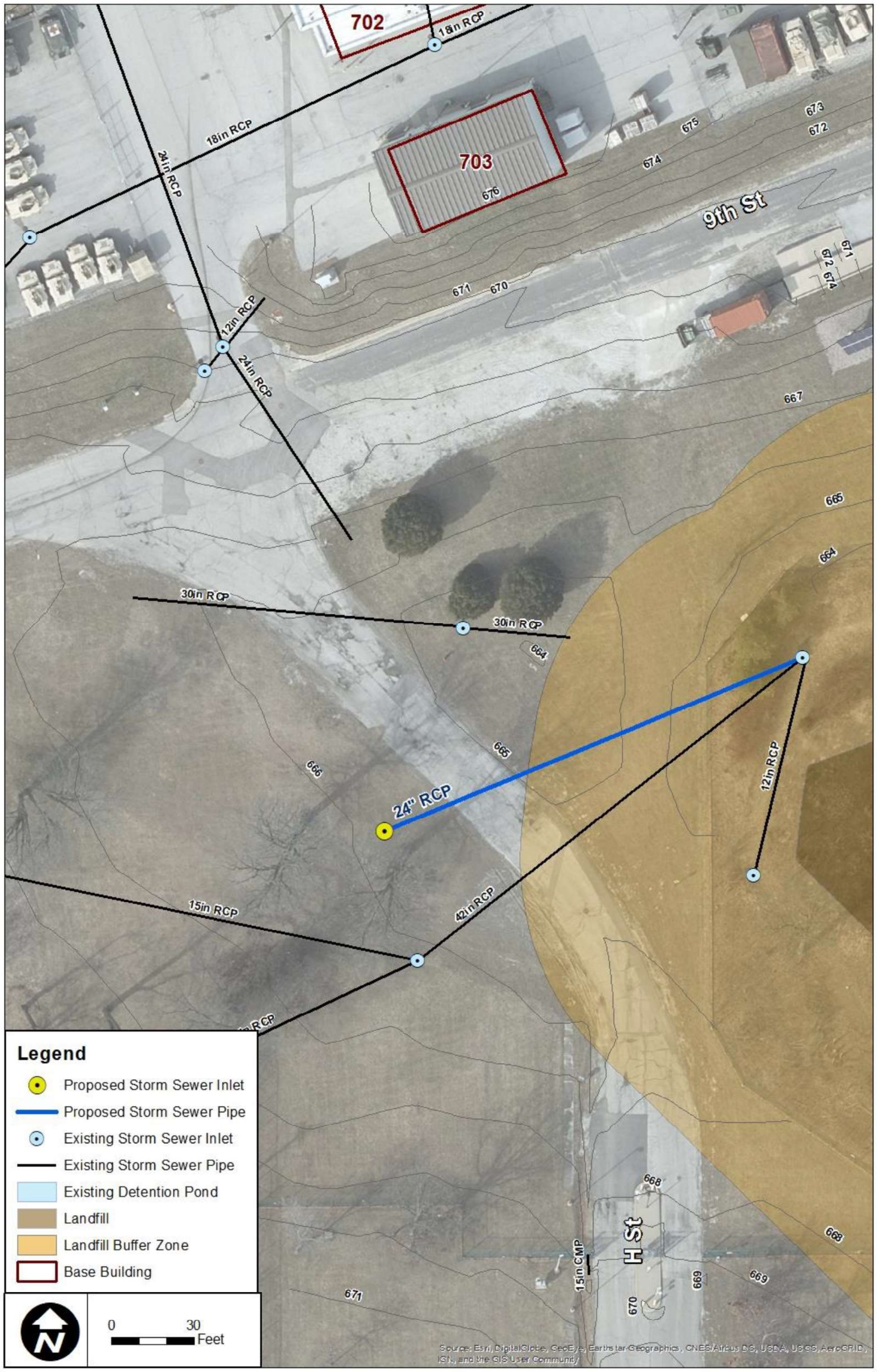

Figure A4. P4 Proposed Improvements

Figure A5 shows all of the recommended improvements that were a part of the Minor Alternative

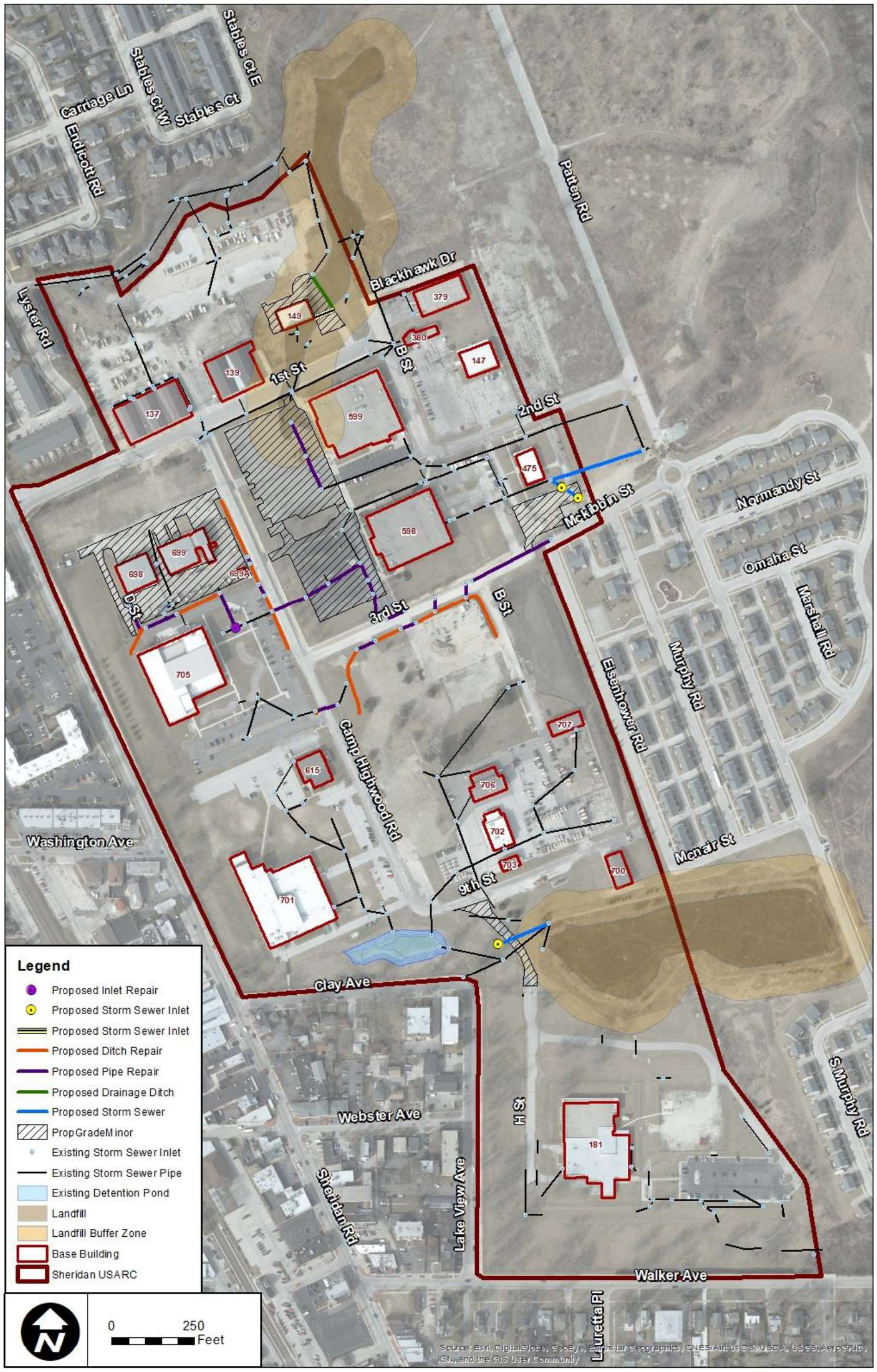

Figure A5. Minor Alternative 35% Design Improvements

<u>ATTACHMENT 2</u>: KICKOFF MEETING MINUTES

Stanley Consultants co.

MEETING MINUTES

Date: May 14, 2019

Location: Fort Sheridan

Purpose: Kickoff Meeting - Ft. Sheridan Storm Water Runoff, Drainage Survey and Design
88th Readiness Division (88th)

Attendees: Bud Berendes / 88th
Darrell Chambers / 88th
Craig Peters / 88th
Joe Villarreal / 88th
Dustin Dockins / 88th
Jason Meyer / Stanley Consultants
Mark Werner / Stanley Consultants
Brendon de Rosario / Stanley Consultants

Notes By: Jason Meyer

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If no objections, questions, additions, or comments are received within 5 working days from issuance of the meeting notes, we will assume that our understandings are correct. We are proceeding based on the contents of these meeting notes.

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1. **Introductions –** Members of the team introduced themselves and the project. Ft. Sheridan has many areas that pond during even small rainfall events. June-July 2017 rainfall flooded the area south of building 475, which rose to the depth of the grill on a full-size pickup truck. Onsite stormwater management has been piecemeal on Ft. Sheridan, and the 88th is seeking a comprehensive drainage plan for the entire base to integrate fragmented storm sewer systems.

2. **Land use** –
    a. Building Construction/Demolition – Six buildings have been demolished within the past few years. Additionally, the 88th will demolish additional buildings in the near future. Buildings 139 and 379 are slated for demolition this year. The 88th has plans to construct additional buildings. The 88th will provide a long-range master plan to identify future land uses.
    b. Land in litigation – Several areas of land located where buildings have been recently demolished are in litigation for 2019 and at least a part of 2020. As such this land should be considered off limits for the short-term but possibly usable in design for the long-term. The 88th will provide confirmation/documentation as to which lands are litigation.

3. **Land Ownership –** The northeast side of Fort Sheridan is unincorporated Lake County and is owned by the Navy who are looking to sell the property. There's a phone number for a Naval contact on the fence dividing the properties.

4. **Utilities –** Many utilities have been abandoned underground. When buildings are demolished, foundations and utilities are left in place approximately two feet underground. Utilities have been installed without documentation so there are existing, in-use utilities (gas, electric, etc.) whose locations are not known/documented. The 88th will coordinate utility conflicts during construction. New water mains installed approximately 3 years ago.
    a. Water Source: Village of Highwood
    b. Sanitary Sewer outlet – Great Lakes Naval Station
    c. Stormwater Outlet – Fragmented
    d. No irrigation systems onsite.

5. **Landfills –** Two landfills are located on Ft. Sheridan. The 88th will provide mapped locations of the landfills.

6. **Soils –** The 88th prefers to dispose of soils offsite. There are 2 locations of spoils from previous construction work that the 88th would like utilized somehow (grading). Most likely all of this is special waste soil which must be considered when handling/re-using. Berms are undesired along the property.

7. **Design Standards** – The 88th wants to comply with local stormwater management ordinances even if there are exemptions for federal facilities. Must consider LID improvements. The 88th wants a low maintenance design; for example there is currently no irrigation on site which should be considered throughout design. Stanley Consultants developed an "Installation Design Guide" that is an applicable design standard.

8. **Documents** – The 88th will provide documents they may have that may be useful in the analysis. Such documents include: long-range master plan, utility atlas, historical maps, as-built drawings, and landfill locations. Darrell Chambers and Craig Peters should be contacted for additional utility data.

9. **Onsite access –** Onsite access will be coordinated through Joe Villarreal and Dustin Dockins. Bud Berendes and Darrell Chambers should be copied on any emails requesting access.

10. **Site Visit –** A site visit was conducted. The 88th identified locations of stormwater ponding and highlighted buildings that have been and are scheduled to be demolished.

Attachment: Sign-in sheet

Name	Email	Phone Number
Joe Villarreal	Joseph.L.Villarreal.CTR@mail.mil	317-523-7127
Darrell Chambers	darrell.j.chambers6.ctr@.	608.343.7378
Bud Berendes	bud.f.berendes.civ@mail.mil	608-388-0386
CRAIG PETERS	craig.r.peters.ctr@ mail.mil	608-388-0706
Brendon de Rosario	~~bderosa~~ deRosarioBrendon@stanleygroup.com	(773) 714-2042
Jason Meyer	MeyerJason@stanleygroup.com	952-843-5517
Mark Werner	wernermark@stanleygroup.com	563-264-6462
Dustin Dockins	dustin.m.dockins.civ@mail.mil	815-601-1117

ATTACHMENT 3: DRAFT REPORT CLIENT COMMENTS

Questions and Document Comments for the Stanley Group on the DRAFT *Fort Sheridan Storm Water Drainage Improvements Report*

1. Will there be a recommendation or footprint to follow, or list of considerations and requirements available for all future (currently planned and unplanned TBD) construction and deconstruction at IL131/Ft Sheridan? i.e. a playbook of SW considerations and planning going forward for all projects considered by the 88th DPW Planning Team to maintain the final designed SW controls and flows?
   - Currently, there isn't a playbook as described above. Instead, the tentative construction/deconstruction plan was mapped out from now until completion, with each interim step included in between. The recommendations within the report are designed to be able to be implemented now. That is, all areas of disturbance were noted and the recommended improvements were designed around the to-be disturbed areas. That said, a general 'playbook' can be developed that would provide recommendation based on the location of the Base to be developed. For example, when the construction of the new ARC facility occurs at the southeast corner of 3rd St and C St recommendations could include:
     - Ensure that all grading slopes downward in the northwest/north/northeast directions. This is so runoff is intercepted by either the swales along 3rd St or the proposed detention pond.
     - Construction of the proposed detention pond at the southwest corner of 3rd St and B St can occur at the same time as construction of the new ARC facility.

2. There are three alternatives; Minor, Moderate, and Major. Each alternative builds on the other and costs are $4.58M, $5.40M, and $6.11M. Each cost is inclusive of the previous and not in addition to (i.e. if moderate alternative is built for $5.40M it would then cost $710K to build, at a later date, the additional projects to complete the major alternatives. Or is it $5.4 = $6.11 = $11.51M?
   - Costs are not cumulative.

3. Page 27, Sect 2.2.3 "Lake County SMC does not require any quantified volume of storm water runoff……"
   a. Addressed.

4. Section 2.2.4 Water Quality Treatment. Was this in the Regulatory Review previously? This appears new – treatment requirement for vehicle sourced pollutants. Important new requirements. Are we meeting this requirement?
    - This paragraph is not in the original regulatory review. I don't exactly recall but believe it was incorporated into this submittal after reviewing the Base's construction/demolition schedule. The construction of several parking lots led to its inclusion. Unknown but doubtful that this requirement is currently being met. There are hydrocarbon removal products that can be incorporated into the final design.

5. When modeling storm events and designing corresponding storm water controls, is there any consideration given to compounding storm events? It seems these days we get into periods of numerous, substantial storm events. In which case a 50 year storm event has x impact. But a 50 year storm event at the end of four week period where we just had five - 2 year storm events and two - 10 year storm events has a compounding effect of x + y impact due to saturated soils and things like storm water retention already at capacity.
    - The current modeling approach only considers design storms (i.e. the 10-yr 2-hr or the 100-yr 24-hr, etc.). There is a parameter within the model, maximum moisture deficit, that can be adjusted to reflect especially saturated soils. This will be analyzed.

6. Section 4.2.3. All designated SW 'exits' from the site are via designed overland flow paths or via a SW discharge outlet pipe, correct? Do we have any areas of SW flow off site occurring via a non-designed route (not one of the 8)?
    - Correct, all designated SW outfalls from the site are via overland flow paths or SW pipes.
    - Are there any other areas of SW flowing off from the site.
        - Short answer: No.
        - Long Answer: The 8 outfalls are somewhat aggregated/simplified, and can be considered as final outfall points. For example, the North watershed has 3 sub-watersheds (N1, N2, and N3). Each of these drain directly north

7. 4.3.3-1 The infiltration method, what soil types are assumed? Much of the sites soils are basically industrial landfill from decades of construction and deconstruction. Are current overland SW drainage ditches considered to be infiltrating at a certain rate? Do SW drainage ditches have a K value and loss of energy to SW flow? They are not listed in Table 4.3-1.
    - Soil data for the site was obtained from Web Soil Survey which reported Silt loam. This was the assumed soil type.
    - K value used for silt loam was 0.26 in/hr. Given that much of the site's soils are essentially industrial landfill that's been repeatedly compacted,

the effects of using a K value of 0.01in/hr (applicable to clay soils) will be analyzed.

- Overland SW drainage ditches are modeled with no infiltration.
- The drainage ditches have energy losses indirectly applied to them via the K values used for culverts that are upstream or downstream of the drainage ditches. For example, if a culvert drains into a drainage ditch then inline K value of 0.3 is applied to the culvert link as an exit loss. The exit loss of the culvert and entrance loss into the ditch are both accounted for with the 0.3 k value. Similarly, if a drainage ditch drains into a culvert then a K value of 0.5 is applied to the culvert as an entrance loss.

8. Table 4.3-3 is modeled from current conditions, correct? It shows only two points of flooding among the AOI's. But didn't we observe more than that? Is it underestimated? Same question in Table 4.3-5.
    - Table 4.3-3 – These results pertain to the 2-yr, 2-hr storm that occurred in October 2019. They seem representative of what's shown in the photos. If this seems inaccurate then let's discuss. More feedback is welcome and will help to better verify/improve the model
        - Model is more to obtain total volumes to detain and peak flowrates to reduce. Nuanced details like nuisance flooding shown in the October pictures is often too fine to pickup in a high-level H&H Model. These areas are being addressed through discussions with Base personnel and photos/documentation.
    - Table 4.3-5 – These results pertain to a 24-hour duration storm. The results were unexpected for SCI as well. The message this table sends is that longer drawn out storms, even large ones like a 50-yr or 100-yr, don't over inundate the capacity of the Base's storm sewer system. If this seems inaccurate then let's discuss.
    - Table 4.3-6 – Not included in question but thought to make the point that flooding is observed for the shorter duration storms, 1-hr to 3-hr, event. These flash-flood type events are known for over inundating conveyance systems. If this seems inaccurate then let's discuss.

9. Section 4.3.2-2 Isn't the average 100 yr storm release rate within county requirements?
        - Yes it is.

10. The rain garden around the southern landfill, does this have an outlet or is it considered to only retain water and infiltrate. Is there not currently a rain garden there?
    - Both. It is primarily considered to retain and infiltrate the stormwater. That said, the proposed rain gardens have been situated so that they surround

an existing stormwater inlet on the east side of H St just northwest of the landfill. No, no rain gardens here.

11. The minor alternative does not solve the county runoff peak release rate requirement?
    - Correct. SCI is aware that the SOW stated that the minor alternative is to fix the most problematic issues and address any major compliance issues. Based on the analysis so far, one of the conclusions noted in the report is that "Sheridan USARC's major compliance issue is its peak release rates of stormwater from the Base. Due to the widespread drainage problems and segregated storm sewer system, addressing these peak release rates with Minor Alternative recommendations is unfeasible. The scale of the solution must match the scale of the problem and there are simply too many independent problematic locations that require substantial improvements to adequately detain the volume of stormwater associated with the design storms that yield these peak release rates. The stormwater release rate compliance issues are addressed in the moderate and major alternatives."

12. Page 13 – Change bullet 2, Demo of 137 and Construction of TEMF, from 2027 to 2025-2027.
    - Addressed.

13. Page 22 – 1st paragraph under 1.4.1 references IDF should be IDG.
    - Addressed.

14. Page 52 – Sanitary sewer is not depicted on the map
    - Addressed.

15. Page 76 – Are the repairs around Building 149 even feasible due to the proximity to the Landfill?
    - To be discussed. If grading is done so that minimal soil is disturbed/removed and instead stone is added then this could be feasible.

ATTACHMENT 4: 35% DESIGN REVIEW MEETING MINUTES

Stanley Consultants INC.

Date: 17 July 2020
Time: 10:00am – 11:00am CST
Place: Teleconference

Project: Fort Sheridan Storm Water Runoff, Drainage Survey and Design
SCI Project No. 28691.02

Attendees: Jason Meyer, Mark Werner, Brendon de Rosario (Stanley Consultants, Inc, (SCI))
Darrell Chambers, Dustin Dockins, Craig Peters, Joseph Villarreal (88th Readiness Division, (88th))

Notes By: Jason Meyer and Brendon de Rosario, SCI

Notes:
Bud Berendes was unable to attend the teleconference. Darrell Chambers will relay the results of the meeting and discuss the 88th's decisions regarding topics covered.

1. **35% Design Comments** – The 88th will provide written comments regarding the 35% Design Analysis submittal, specifically the 35% Design Drawings.

2. **Major Improvements** – The Scope of Work states that Design Drawings are to be created for all three (Minor, Moderate, and Major) alternatives for the 35% Design Submittal, for two of the three alternatives at the 65% Design Submittal, and for one of the three alternatives at the 95% Design Submittal. The 88th has stated their desire to have the Moderate and Major Alternatives be the two developed to 65% Design and for the Major Alternative to carry through to the 95% Design. Since the Major Alternative includes the proposed improvements within the Moderate Alternative, SCI inquired what if the 88th believes a more effective use of time and budget to develop only the Major Alternative to 65% and omit the Moderate Alternative from that submittal. The 88th stated the following:
    a. This will be decided upon by Bud Berendes and that their decision will be somewhat based on if the Major Alternative can be constructed in phases which may be necessary for budgetary reasons.

3. **Design Drawings** – SCI asked for feedback from the 88th regarding the Design Drawings. They had the following comments:
    a. The proposed detention pond located southwest of 3rd St and B St on Sheet CN-106 of the 35% Design Drawings is overlaying an existing parking lot, please explain. SCI explained that:

i. The parking lot appears to be a remnant of the demolished building located immediately west of parking lot which is why SCI did not think it would be a problem to recommend a detention pond at this location. The 88th confirmed that this is parking lot is currently used for overflow parking but that they would confer internally to determine if removal/relocation of it is justifiable for the proposed improvement.

ii. The 65% Design Drawing would show this parking lot on a demolition sheet and omit it from the major alternative sheet.

iii. The Area Development Plan submitted by the 88th to SCI indicates that a new parking lot, associated with the 2030-2035 construction of a new Army Reserve Center building, is tentatively scheduled at this location. SCI stated that due to drainage/elevation constraints that placement of the proposed detention pond at this location could not be avoided and requested the 88th consider relocating the proposed parking lot immediately south of the proposed detention pond just north of Building's 706 and 707.

iv. Currently, there are no other feasible locations to stage a detention pond in this area due to the tentative construction schedule indicated in the Area Development Plan. This is due to:

1. A small amount of elevation difference limiting manipulation of drainage patterns.
2. The presence of Buildings 598 and 599.
3. The planned connection of B St from 2nd St to 3rd St.
4. SCI reiterated that the current location of the proposed detention pond at the corner of 3rd St and B St was not the primary choice and that placing a detention pond at the location of Building 598 could intercept more stormwater runoff thereby providing greater drainage benefits. This has not been explored further due to the Building 598's scheduled demolition not occurring until 2030-2035. SCI requested that the 88th discuss the removal of Building 598 relative to this Project. If they concur and confirm and/or schedule a sooner demolition date for Building 598 then they could request SCI to further explore this potential opportunity.

b. The sidewalk extending northeast from the north side of Building 701 is deteriorating. The 88th believes this is due to the existing rain gardens not functioning as intended and groundwater soaking beneath the sidewalk concrete slabs. The 88th requested that addressing this problem be incorporated into the design. SCI noted some initial thoughts on how to resolve this and agreed to analyzing this further and incorporating a proposed improvement into the design.

c. SCI confirmed that the proposed detention ponds are currently utilizing turf grass with no liner. The 88th requested that sizing of the drainage ditches be done with operation and maintenance in mind. The 88th recommended to size the drainage ditches large enough so that a common, commercial mower can function properly around and in the drainage ditches.

d. The service road located west of the Building 698 parking lot should not extend south of the entrance to the south side of said parking lot. SCI stated that this will be updated in the 65% Design Drawings.

4. **Standard Details** – SCI inquired if the 88^{th} has any Standard Detail that should be included in the Design Drawings. The 88^{th} said that whatever Standard Details SCI has will be suitable.

5. **General Notes** – SCI inquired if the 88^{th} has any General Notes that should be included in the Design Drawings. The 88^{th} stated that there may be some notes regarding Base Security to include, they will verify that and confirm with SCI.

6. **Front-End specifications** – SCI inquired if the 88^{th} has any Front-End Specifications that should be included in the Design Drawings. The 88^{th} said that whatever Front-End specifications SCI has will be suitable.

7. **Staging areas –** SCI inquired which areas of the Base would be best suited as construction staging areas. The Base stated that the overflow parking lot at the corner of 3^{rd} St and B St, immediately west, southwest, or south of the overflow parking lot, or the Building 475 parking lot are all viable options.

8. **Building Demolitions** – SCI inquired about the scheduled demolitions of Buildings 379 and 139. The 88^{th} stated that there are tentative start dates for the demolition during the Fall of 2020.

9. **Paving** –inquired again about the tentative demolition scheduled for Buildings 598/599, this time in relation to the proposed regrading and repaving of the parking lots associated with these buildings. SCI stated that original LiDAR topography and Site ponding reports are what contributed to SCI's initial recommendation of regrading/repaving these parking lots. Since then, however, the surveyed topographic data, continued Site observations, and consideration of the relatively soon schedule for demolition of Buildings 598 and 599 have contributed to SCI questioning the 88^{th} as to their thoughts on the proposed regrading/repaving at these locations. SCI is now of the belief that the benefits associated with the proposed regrading/repaving may not be worth costs.

10. **Excess material** – SCI inquired about locations within the Base where disposal of excavated material would be preferred. The 88^{th} stated that the berm located at the northwest corner of the Base should be the first used location followed by the berm located at the southeast corner of the Base.

11. **Building 475 improvements** – SCI elaborated on what the proposed improvements would entail at this location and also explained a newly recommended improvement based on observations made during a site visit in April 2020.
    a. The proposed upsizing of the 24-inch RCP to a 36-inch entails construction being done east of Base property. It was stated during the call that this property is owned by the City of Highwood. The 88th does not think it will be difficult to coordinate with the City to obtain the required permits, easements, or whatever else necessary to perform the work.
    b. It was observed during an April 2020 site visit made by SCI that the newly constructed drainage ditch located east of the sanitary lift station has a relative high point that could be contributing to the poor drainage of the Building 475 parking lot. The 88th stated that the drainage ditch is part of a Navy project and that coordination with them should be the first step in resolving the regrading of the drainage ditch.

12. **Flow testing** – SCI explained the to the Base the need to conduct flow testing to verify several remaining unknown storm pipe connections. These include:
    a. The 12-inch RCP exiting the east side of the Base along McKibbin St.
    b. The 18-inch VCP beneath 1st St between Buildings 599 and 149.
    c. Storm sewer inlets and pipes located in the lawn south of Building 149 and north of 1st St.
    d. Storm sewer inlets and pipes located in the lawn east of Building 149 and north of 1st St.
    e. The 15-inch VCP that serves as the outlet pipe for stormwater runoff within the northeast watershed of the Base. This pipe is located off Base property, northeast of Building 149.

Action Items

- 88^{th}
  - The 88^{th} will provide written comments to SCI regarding the 35% Design Analysis submittal.
  - The 88^{th} will inform SCI if they want SCI to provide Design Drawings for the Moderate and Major Alternatives just the Major Alternative for the 65% Design Submittal.
  - The 88^{th} will confirm their opinion about the location of the proposed detention pond located at the corner of 3^{rd} St and B St as it pertains to the overflow parking being in the same location.
  - The 88^{th} will inform SCI of their opinion regarding the demolition of Building 598 relative to stormwater drainage improvements.
  - The 88^{th} will inform SCI on if they believe the proposed regrading/repaving of the Building 598/599 parking lots are warranted and if they do or don't want SCI to further develop this proposed imoprovement.
  - The 88^{th} will check on any Base Security general notes that they would like included in the Design Drawings.

- SCI
  - SCI will analyze and develop a solution for the drainage problems along the sidewalk within the vicinity of Building 701.
  - SCI will consider operation and maintenance and the size of common commercial lawn mowers while continuing the design of the proposed drainage ditches.
  - SCI will update the layout of the service road located west of Building 698 in the Design Drawings.
  - SCI will begin exploring the necessary steps to perform the proposed construction east of Building 475, off Base property. SCI will collaborate with the 88^{th} on this matter.
  - SCI will begin exploring the necessary steps to perform the proposed drainage ditch improvements for the newly constructed ditch located east of Building 475, off Base property. SCI will collaborate with the 88^{th} on this matter.

- Both parties
  - SCI and the 88^{th} will meet onsite on Wednesday, July 22^{nd} at 9:00am CST to perform flow testing for the storm structures and sewers listed in Item 12 of this document. The 88^{th} purchased dye should it be needed in the event of rain.

ATTACHMENT 5 **35% DESIGN CLIENT COMMENTS**

- The 88th will inform SCI if they want SCI to provide Design Drawings for the Moderate and Major Alternatives just the Major Alternative for the 65% Design Submittal.
- As was discussed at the precon please provide the Major and Moderate 65% design submittal.

- The 88th will confirm their opinion about the location of the proposed detention pond located at the corner of 3rd St and B St as it pertains to the overflow parking being in the same location.
- The detention pond in the overflow parking lot location is acceptable.

- The 88th will inform SCI of their opinion regarding the demolition of Building 598 relative to stormwater drainage improvements.
- The demolition of B 598 &599 will require a lot of moving parts and are considered a "plan" only and should not be considered in your design.

- The 88th will inform SCI on if they believe the proposed regrading/repaving of the Building 598/599 parking lots are warranted and if they do or don't want SCI to further develop this proposed improvement.
- Please provide the regrading/repaving design for B 598&599.

- The 88th will check on any Base Security general notes that they would like included in the Design Drawings.
- There are no base security requirements above and beyond what is in the 1000 spec section.

ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Type of Submittal: 95% Design Analysis for the Stormwater Drainage Improvement Project, 08/06/2021

Reviewer(s): **Organization**: **Date:**

Action Legend: C-Concur D- Do not agree E- Exception (see comment) X- Delete comment				
No.	Reviewed by	Drawing or Page Number	Comment	Action
1.				
2.				
3.				
4.				

ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Action Legend: C-Concur D- Do not agree E- Exception (see comment) X- Delete comment				
No.	**Reviewed by**	**Drawing or Page Number**	**Comment**	**Action**
5.				
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9.				

ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Action Legend: C-Concur D- Do not agree E- Exception (see comment) X- Delete comment				
No.	**Reviewed by**	**Drawing or Page Number**	**Comment**	**Action**
10.				
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ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Action Legend: C-Concur D- Do not agree E- Exception (see comment) X- Delete comment				
No.	**Reviewed by**	**Drawing or Page Number**	**Comment**	**Action**
15.				
16.				
17.				
18.				
19.				

ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Action Legend: C-Concur D- Do not agree E- Exception (see comment) X- Delete comment				
No.	**Reviewed by**	**Drawing or Page Number**	**Comment**	**Action**
20.				
21.				
22.				
23.				
24.				

ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Action Legend: C-Concur D- Do not agree E- Exception (see comment) X- Delete comment				
No.	**Reviewed by**	**Drawing or Page Number**	**Comment**	**Action**
25.				
26.				
27.				
28.				
29.				

ATTACHMENT 6 - PROJECT REVIEW COMMENTS FORM

Project Name: Sheridan USARC Stormwater Drainage Improvement Project, Town of Fort Sheridan, IL

Action Legend: **C-Concur** **D- Do not agree** **E- Exception (see comment)** **X- Delete comment**

No.	Reviewed by	Drawing or Page Number	Comment	Action
30.				
31.				
32.				
33.				
34.				

ATTACHMENT 7 – 65% DESIGN MODERATE ALTERNATIVE DESCRIPTION

There are several purposes of the Moderate Alternative which are listed below.

- Begin integrating areas of the Base's storm sewer system
- Begin transitioning from utilizing storm sewer pipes to drainage ditches
- Redirect as much stormwater runoff as possible to the existing detention pond to reduce peak release rates
- Expand the existing detention pond as necessary to accommodate the additional stormwater

Integration of the Base's storm sewer system is accomplished by redirecting stormwater runoff so that it is conveyed throughout the Base in a more orderly manner. For example, the stormwater runoff emanating from Buildings 698, 699, and 705 currently drains northeastward, eastward, and southeastward. The proposed drainage ditches and disconnection of the 12-inch RCP beneath C St immediately east of Building 705 was done to redirect all stormwater runoff south to the expanded detention pond.

Drainage ditches were selected as the conveyance conduit for the majority of this alternative. There are several locations, however, where the use of storm pipes was necessary. This includes culverts along the drainage ditches on the west side of C St, north of 3rd St. There's also a storm that conveys stormwater from the west side of C St to the east side, immediately south of 3rd St. This pipe has been upsized from a 12-inch RCP to a 24-inch RCP. The final location where a pipe was utilized for this alternative is at the corner of C St and 9th St. This is the location of a 21-inch pipe that currently serves Buildings 702, 706, and 707. It is proposed to upsize this pipe to a 48-inch RCP to adequately convey the additional runoff that's been re-routed to this location.

As noted in Section 5.1.3, the existing detention pond has been expanded and raised to accommodate the additional runoff that's been redirected to it. Its total height has been increased from 6-feet to 8.5-feet and its storage volume has been increased by approximately 6.1 ac-ft to a total of 7.8 ac-ft.

Figure 5.2-2 shows the recommended improvements that are a part of the Moderate Alternative.

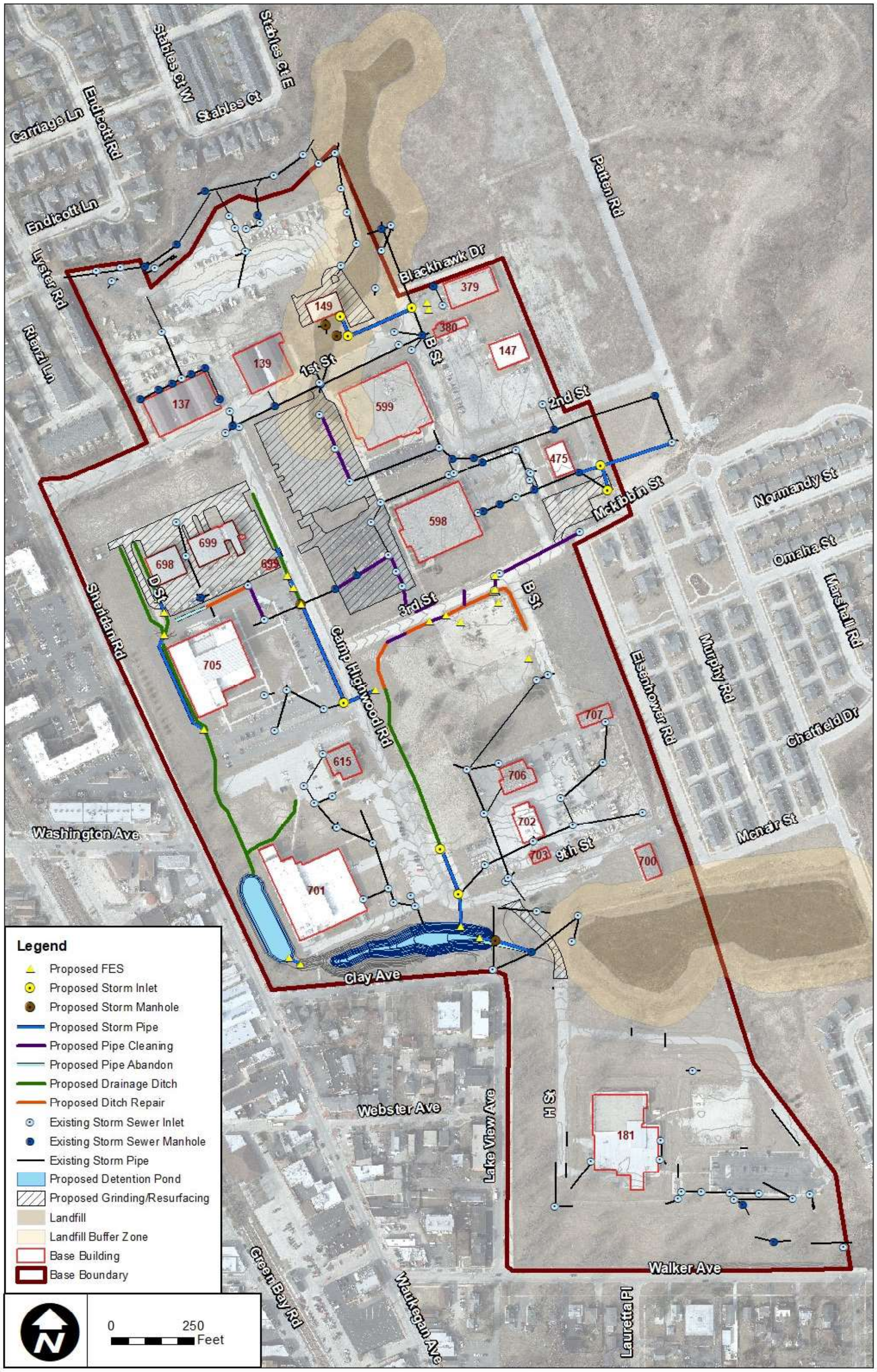


Figure A7. Moderate Alternative Proposed Improvements

ATTACHMENT 8 DESIGN UPDATES MEETING MINUTES

Stanley Consultants INC.

Date:	29 December 2020
Time:	2:00pm – 3:00pm CST
Place:	Teleconference
Project:	Fort Sheridan Storm Water Runoff, Drainage Survey and Design
SCI Project No.	28691.02.00
Attendees:	Bud Berendes, Craig Peters, Darrell Chambers, Joseph Villareal (88th Readiness Division) Jason Meyer, Brendon de Rosario (Stanley Consultants, Inc, (SCI))

Meeting Notes:

1. Patten Place Project Update

   One of SCI's action items from the 65% Design Review Meeting was to confirm the property owner of the parcel of land located immediately east of Building 475 (Disposition Property) to begin construction coordination efforts for the proposed upsizing of the storm pipe that spans off Base property. The 88th connected SCI with a private military housing developer, who's in the preliminary stages of the Patten Place Project which is a 100-unit residential development that will be situated east of Fort Sheridan, west of Patten Road, north of McKibbin St, and south of the Bartlet Ravine.

   Due to the proposed storm pipe spanning directly through the Disposition Property, SCI held a teleconference meeting on 12/01/2020 with a representative from the buyer's engineer, from Cemcon, to coordinate design efforts. During the teleconference Cemcon stated that upsizing the existing storm pipe, with the proposed pipe to be installed along the same alignment, would result in disturbance and unconsolidation of soils within a close proximity to several of the proposed homes which could be detrimental to their project due to a propensity for settlement of the newly disturbed soils. One alternative discussed was to tie in the proposed pipe to a new storm structure that would be located east of Building 475 on the east side of the Fort Sheridan property line. From there, the rerouted stormwater runoff from Fort Sheridan would drain into a new detention pond located on the Disposition Property. Cemcon noted that due to the existing concrete, gravel, and rubble on the Patten Place property that there will be less impervious area under proposed conditions and because of this they do not need to detain their stormwater and are therefore able to use a large pipe (tentatively noted as 42-inch diameter) for their pond's outlet pipe. Because of this it was believed that they could effectively treat Fort Sheridan's runoff as bypass flow by routing it through their pond.

   SCI followed up with the 88th on 12/03/2020 and they expressed their desire to instead detain runoff on their property before sending it downstream to the new housing development. Prior to the realization of this housing development project the design rationale for this part of the Base was to improve conveyance of stormwater runoff through the previously proposed upsized storm pipe to provide greater capacity to the Base's storm sewer system to reduce localized flooding. This design intent stemmed from a lack of usable space in the central area of the Base to locate a detention pond due to existing and planned infrastructure. Due to this development, however, SCI and the 88th re-examined this area of the Base to develop another alternative. The 88th advised SCI to analyze the detention benefits that could be realized by utilizing the Building 475 parking lot and the southeast portion of the Building 147 parking lot, which were previously considered as unusable areas.

2. Openlands Update

The private military housing developer informed SCI that they've been coordinating with Openlands for the Patten Place project because Openlands is in the preliminary stages of a restoration project for the Bartlet Ravine. SCI partook in a teleconference with representatives of the Openlands project on 12/21/2020, during which they stated their design goal of reducing flowrates into the ravine as much as possible. They have several locations within the vicinity of Fort Sheridan where they are planning restoration efforts, one of which is the north side of the military equipment parking (MEP) lot on the north side of the Base. SCI stated that providing detention in this area was investigated in the preliminary stages of the project but was decided against due to the presence of an IEPA landfill, the 88th's desire to not reduce the size of the MEP lot, future plans for expansion of the parking lot and additional infrastructure in this area, and a lack of localized flooding in this area. SCI stated that they would relay Openlands design goals to the 88th but that these same design constraints would likely remain and prevent work from being done in this location.

3. Design Update

   a. New Detention Pond located in the Building 147 parking lot

   SCI developed a preliminary design for a detention pond located within the parking lot of Building 147. SCI noted the presence of existing utilities along B St and on the east side of the Building 147 parking lot along Fort Sheridan's property line as a potential for utility conflicts. The 88th requested that the pond be moved east approximately 10 feet and have its width reduced so that it does not encroach upon the west portion of the parking lot. SCI noted that moving the pond 10-ft east will conflict with the presence of an existing gas utility line and communication utility line. The 88th stated that they would prefer to relocate the existing utilities and proceed with moving the pond 10-ft east. SCI will update the pond's footprint and location and obtain final approval from the 88th's before progressing the design.

   b. New Detention Pond located in the Building 475 parking lot

   SCI developed a preliminary design for a detention pond located within the parking lot of Building 475. SCI noted that an existing wastewater utility located beneath the parking lot would have to be re-routed. The 88th approved of the pond's footprint and location. However, they noted the presence of a vestibule that provides access to the Base from McKibbin St for Navy personnel to manage the sanitary sewer lift station located at the southeast corner of the Building 475 parking lot. Due to this SCI redesigned the pond's footprint to maintain access from the vestibule to the lift station without sacrificing storage volume. SCI requires the 88th's approval of this revision before progressing the design.

4. Project Outcome Update (Release Rate and Low Impact Design Requirements)

Lake County's stormwater release rate and the Army's Low Impact Design requirements were discussed. These requirements pertain to new developments but one of the primary drivers of this project is to meet compliance with these requirements. Throughout the project it's been realized that the location, and amount of, the Base's existing infrastructure hinder the ability to fully meet compliance with these requirements as the site is already fully developed. Therefore, these requirements are being met to the maximum extent practicable based on available space and existing site conditions.

Action Items:

SCI

1. SCI will update the footprint of the Building 147 parking lot detention pond and obtain approval from the 88th before progressing the design.

2. Regarding the pond in the Building 475 parking lot. The 88th mentioned about the Navy's need to access the lift station from the vestibule located on McKibbin St. While reviewing the design after the meeting it was determined that the proposed pond extended too far south and conflicted with the vestibule and adequate access to the lift station. To provide this access while not sacrificing storage volume the width of the east half of the pond was reduced by approximately 20 feet, the width of the west half of the pond was increased by approximately 6 feet, and the pond was extended approximately 10 feet west. The driveway from 3rd St to the parking lot located east of Building 598 was considered and the required grading should not be impede this driveway. SCI will update the footprint of the Building 475 parking lot detention pond and obtain approval from the 88th before progressing the design.

Stanley Consultants co.

ATTACHMENT 9 MEETING MINUTES

Date: January 12, 2021

Location: Conference Call

Purpose: Ft. Sheridan – Landfill Discussion with Army BRAC

Invitees: Jason Meyer / Stanley Consultants
Brendon de Rosario / Stanley Consultants
Heather Elliott / Calibre Systems
David Klatt / Jacobs
Ian Thomas /
Richard Kennard / Army
Lou Ehrhard / Army

1. **Stanley Consultants provided updates from last meeting.**
2. **New detention Basins –** Two new detention basins are proposed along the east side of base. Neither proposed detention basin is located near Landfills 5 or 6.
3. **North Landfill (Landfill 5) –** Stanley Consultants is proposing to upsize storm sewers that traverse through Landfill 5. If this work impacts the liner of Landfill 5, the liner must be replaced. To the maximum extent practicable any disturbed material (soil, asphalt, etc.) within the landfill buffer zone and cap is to be put back in its original location. Any soil or waste disturbed would be returned to the excavation and any other materials, asphalt, concrete, etc., would be replaced in kind. This approach will be implemented for the installation of the storm pipes along 1st St within the Landfill #5 buffer zone and cap. The BRAC office is amenable with this approach. The BRAC office noted that the proposed 15" RCP that spans from Building 149 to 1st St may encounter an existing liner and if so then the liner will have to be repaired/replaced.
4. **South Landfill (Landfill 6) –** Stanley Consultants removed proposed rain gardens around Landfill 6 and instead will promote drainage away from landfill. Minor grading of the buffer zone is proposed to improve drainage. The BRAC office is amenable with this approach.
5. **Work within Landfill Areas -** Proper protective gear and construction methods will be utilized for work done within the landfill buffer zones and caps.
6. **Illinois Environmental Protection Agency (IEPA) –** Stanley Consultants met with the IEPA on January 11, 2021 to discuss our design. The IEPA is amenable with the proposed design. Stanley Consultants will send meeting minutes from January 11, 2021 meeting with the Illinois EPA.
7. **Invasive Species -** The IEPA forewarned about an existing problem with an invasive plant, Teasel, that is proliferating in the fields located off Base property northeast of Building 149. The teasel is a problem on and off-base, especially on the open areas of the landfills.

Action Items

1. Army to check landfill as-builts and forward them to Stanley Consultants.
2. Stanley Consultants will send meeting minutes from January 11, 2021 meeting with the Illinois EPA.

Stanley Consultants co.

ATTACHMENT 10 MEETING MINUTES

Date: January 11, 2021

Location: Conference Call

Purpose: Ft. Sheridan – Landfill Discussion

Invitees: Jason Meyer / Stanley Consultants
Brendon de Rosario / Stanley Consultants
Brian Conrath / Illinois Environmental Protection Agency (IEPA)

1. **North Landfill (Landfill 5) –** Ft. Sheridan is proposing to upsize a storm sewer that traverses the north landfill. IEPA is amenable to this approach as it improves drainage and conveyance. The specifications will include methods to dispose of special and hazardous waste. Ft. Sheridan is proposing a detention basin within the vicinity of the north landfill. This detention basin will include a liner to prohibit infiltration into the landfill. The IEPA is amenable to this approach. Stanley Consultants will forward the pond liner specification of this liner to the IEPA.
2. **South Landfill (Landfill 6) –** Ft. Sheridan is proposing a detention basin within the vicinity of the south landfill. There is adequate horizontal distance between the proposed expanded detention pond and landfill #6 buffer zone and cap such that a geotextile membrane unnecessary for the expanded pond.
3. **Coordination with BRAC –** Stanley Consultants will coordinate its proposed design with the Army's BRAC office.

IEPA had the following comments:

1. Ensuring proper protective gear and construction methods are utilized for work done within the landfill buffer zones and caps.
2. To the maximum extent practicable any disturbed material (soil, asphalt, etc) within the landfill buffer zone and cap is to be put back in its original location. This was brought up while discussing the installation of the storm pipes along 1st St within the Landfill #5 buffer zone and cap and for the earthwork grading & grinding and resurfacing of H St within the vicinity of the Landfill #6 buffer zone and cap.
3. The IEPA forewarned about an existing problem with an invasive plant, Teasel, that is proliferating in the fields located off Base property northeast of Building 149. This was brought up while discussing successful establishment of vegetation for the project.

Action Items

1. Stanley Consultants will forward the pond liner specification of this liner to the IEPA.

ATTACHMENT 11
95% DESIGN REVIEW MEETING MINUTES

Stanley Consultants INC.

Date:	August 19, 2021
Time:	2:00pm – 3:00pm CST
Place:	Teams Meeting
Project:	Fort Sheridan Storm Water Runoff, Drainage Survey and Design
SCI Project No.	28691.02
Attendees:	Jason Meyer, Mark Werner (Stanley Consultants, Inc, (SCI)) Bud Berendes, Darrell Chambers, Craig Peters, Joseph Villarreal, Dustin Dockins (88th Readiness Division, (88th))
Notes By:	Jason Meyer

Notes:

1. **95% Design Comments**
   a. Change all references from "Base" to "Facility."
   b. The 88th does not anticipate additional comments

2. **Demolition / Excavated Material**
   a. 88th intends to keep the approach of the 95% specifications.
   b. Engineering during construction services may be helpful to deal with contaminated soils, because of the extent of contaminated soils is unknown.

3. **Potential Utility Conflicts**
   a. SCI used the best available data to identify potential utility conflicts; however, based on the nature of Ft. Sheridan there will likely be utility conflicts that are not yet identifiable.
   b. 88th intends to use SCI for engineering during construction to resolve potential utility conflicts that are not identifiable currently.

4. **Schedule**
   a. SCI intends to provide the final submittal by September 10, 2021, but hopefully sooner.

5. **Engineering During Construction.**
    a. The 88th would like SCI to provide a rough fee estimate (lump sum) for EDC services, including utility conflicts, submittal reviews, and contaminated soils.

6. **Other Items**
    a. This project will likely be funded through a Real Property Exchange (RPX) with an 88th property in Forest Park, Illinois. In exchange for the construction of the drainage improvements at Ft. Sheridan, the 88th will convey a property it owns in Forest Park, Illinois.

7. **Action Items**
    a. SCI will provide a rough fee estimate (lump sum) for EDC services, including utility conflicts, submittal reviews, and contaminated soils.
    b. SCI will deliver final documents by September 10, 2021.

APPENDIX D
DESIGN ANALYSIS CALCULATIONS

SUB-APPENDICES

APPENDIX D.1 – SUB-WATERSHED PARAMETERS

APPENDIX D.2 – STAGE-STORAGE CALCULATIONS

APPENDIX D.3 – DETENTION POND OUTLET RATING CURVE

APPENDIX D.4 – EMERGENCY OVERFLOW WEIR

APPENDIX D.5 – CONVEYANCE CONDUIT CALCULATIONS

APPENDIX D.6 – INLET CAPACITY CALCULATIONS

APPENDIX D.7 – RIPRAP SIZING

APPENDIX D.8 – PIPE STRENGTH

APPENDIX D.9 – LID 95th PERCENTILE RETENTION

APPENDIX D.1

SUB-WATERSHED PARAMETERS

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
N1	2.52	1.68	67	N1	2.52	1.68	67	225	2.4
N2	3.49	3.07	88	N2-1	1.17	1.17	100	270	2.0
				N2-2	2.32	1.90	82	400	2.6
N3	3.61	1.52	42	N3-1	0.42	0.24	57	70	1.5
				N3-2	0.59	0.20	34	150	5.0
				N3-3	0.63	0.21	33	125	2.4
				N3-4	0.54	0.23	43	100	1.4
				N3-5	0.33	0.00	0	560	1.1
				N3-6	1.10	0.64	58	145	2.7
NE1	4.72	2.89	61	NE1-1N	0.84	0.73	87	30	1.2
				NE1-1S	2.01	0.63	31	130	1.2
				NE1-2N	0.72	0.70	98	30	1.7
				NE1-2S	0.35	0.22	62	30	1.7
				NE1-3	0.80	0.67	84	110	2.3
NE2	2.00	1.18	59	NE2-1	0.80	0.52	65	330	4.5
				NE2-2	0.28	0.25	89	75	0.5
				NE2-3	0.62	0.41	66	175	1.5
				NE2-4	0.30	0.00	0	230	1.6
E1	4.56	2.41	53	E1-1	0.66	0.08	12	375	3.3
				E1-2	0.32	0.05	16	180	4.0
				E1-3	0.78	0.42	54	450	0.4
				E1-4	0.46	0.05	11	220	4.4
				E1-5	2.02	1.74	86	600	1.2
				E1-6	0.32	0.07	22	100	1.0
E2	6.94	5.02	72	E2-1	1.26	0.88	70	315	0.5
				E2-2	0.66	0.45	68	275	2.7
				E2-3	0.94	0.87	93	110	3.0
				E2-4	0.88	0.71	81	100	3.0
				E2-5	1.14	0.77	68	110	3.4
				E2-6	2.06	1.34	65	200	3.4
E3	4.82	2.21	46	E3-1	1.27	0.49	38	720	5.5
				E3-2	0.44	0.34	77	360	0.7
				E3-3	1.19	0.31	26	265	1.2
				E3-4	0.48	0.4	83	350	0.7
				E3-5	0.39	0.28	72	220	1.5
				E3-6	1.05	0.39	37	530	5.8
E4	4.24	2.29	54	E4-1	0.41	0.16	39	40	2.1
				E4-2	1.38	1.34	98	200	1.1
				E4-3	0.43	0.26	60	50	1.25
				E4-4	0.22	0.13	59	40	2.8
				E4-5	0.50	0.02	4	205	1.3
				E4-6	0.25	0.02	8	50	2.1
				E4-7	0.47	0.08	17	110	3.3
				E4-8	0.58	0.28	48	40	1.6
E5	7.36	5.09	69	E5-1	1.14	1.08	95	240	1.7
				E5-2	1.17	1.08	92	200	1.6
				E5-3	0.45	0.30	67	45	1.8
				E5-4	0.72	0.24	33	410	1.4
				E5-5	0.78	0.33	42	520	0.9

Sub-watershed	Area (ac)	Imp. Area (ac)	Imp. Perc. (%)	EPA SWMM Sub-watershed	Area (ac)	Imp. Area (ac)	Perc. Imp. (%)	Avg Width (ft)	Avg Slope (%)
				E5-6	0.31	0.28	90	70	2.9
				E5-7	0.98	0.69	70	140	4.2
				E5-8	0.36	0.22	61	35	1.4
				E5-9	0.47	0.20	43	200	1.0
				E5-10	0.98	0.67	68	100	2.9
E6	1.60	1	63	E6	1.60	1.00	63	125	1.3
E7	2.22	0.46	21	E7	2.22	0.46	21	600	10.4
SE1	6.08	1	13	SE1-1	0.62	0.10	16	360	1.0
				SE1-2	0.64	0.00	0	75	2.6
				SE1-3	1.22	0.20	16	150	2.4
				SE1-4	1.42	0.39	27	600	1.4
				SE1-5	2.18	0.31	14	1,200	1.7
SE2	5.40	2.94	53	SE2-1	0.24	0.17	71	70	2.7
				SE2-2	1.04	0.87	84	120	2.3
				SE2-3	0.30	0.10	33	60	2.2
				SE2-4	1.21	0.27	22	200	3.0
				SE2-5	0.80	0.46	58	100	0.6
				SE2-6	1.13	0.65	58	130	2.5
				SE2-7	0.68	0.42	62	75	1.5
SE3	1.63	1.34	82	SE3	1.63	1.34	82	100	2.7
SE4	5.52	3.35	61	SE4-1	2.62	0.98	38	320	0.9
				SE4-2	1.00	0.70	70	190	1.1
				SE4-3	1.45	1.26	87	125	1.7
				SE4-4	0.45	0.41	91	40	1.1
SE5	1.79	1.79	100	SE5-1	0.31	0.31	100	110	1.5
				SE5-2	0.35	0.35	100	40	1.4
				SE5-3	1.13	1.13	100	180	1.8
SE6	4.66	0.89	19	SE6-1	2.14	0.42	20	450	2.2
				SE6-2	2.52	0.47	19	950	2.9
SE7	2.41	0.49	20	SE7	2.41	0.49	20	500	4.8
SE8	7.43	1.91	26	SE8-1	0.98	0.13	13	290	2.6
				SE8-2	2.26	0.79	35	325	1.4
				SE8-3	2.43	0.99	41	250	2.5
				SE8-4	1.76	0.00	0	550	2.6
S1	9.64	2.59	27	S1-1	1.64	0.18	11	550	1.1
				S1-2	0.77	0.60	78	240	0.5
				S1-3	0.93	0.31	33	200	2.0
				S1-4	1.44	1.25	87	370	1.6
				S1-5	4.86	0.25	5	230	1.2
Total	**92.64**	**45.12**	**48**						

APPENDIX D.2

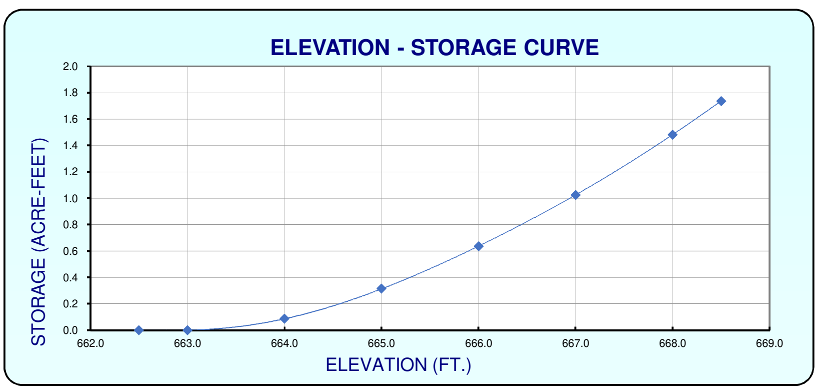
STAGE-STORAGE CALCULATIONS

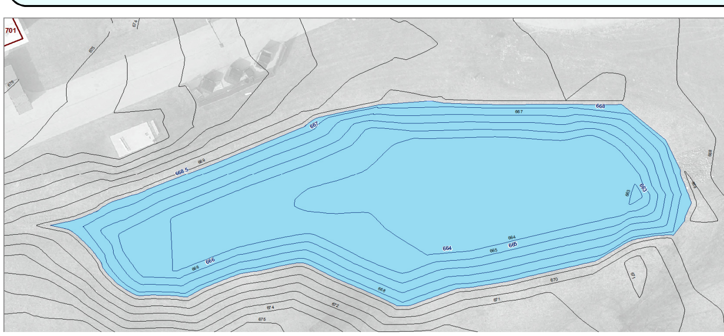
Stanley Consultants INC.

				Date	10/5/2020
			Subject	Sheridan USARC SW Drainage Project	
Computed by	BPD	Date	9/1/2020	28691.02.00	
Checked by	JM	Date	9/28/2020	Stage-Storage Calculations	
Approved by		Date			

POND:	**Existing Conditions - Existing Detention Pond**		
JOB NO.	28691.02	Side Slopes	Generally 4:1 but variable
PROJECT:	Sheridan USARC	Top of Pond (ft)	668.5
FILE:	Storage.xls	Bottom of Pond (ft)	662.5
DATE:	1/15/2021		

Elevation (ft)	Area (sq-ft)	Area (ac)	Average Aea (ac)	Incremental Storage (ac)	Cumulative Storage (ac-ft)
662.5	0	0			0.00
			0.00	0.00	
663.00	40	0.00			0.00
			0.09	0.09	
664.00	7,436	0.17			0.09
			0.23	0.23	
665.00	12,448	0.29			0.31
			0.32	0.32	
666.00	15,560	0.36			0.64
			0.39	0.39	
667.00	18,380	0.42			1.03
			0.46	0.46	
668.00	21,317	0.49			1.48
			0.51	0.26	
668.50	23,115	0.53			**1.74**



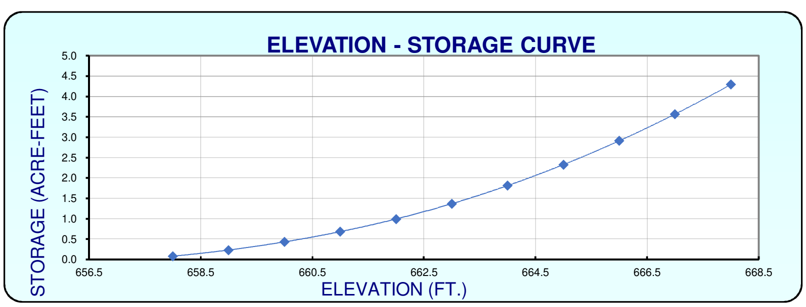


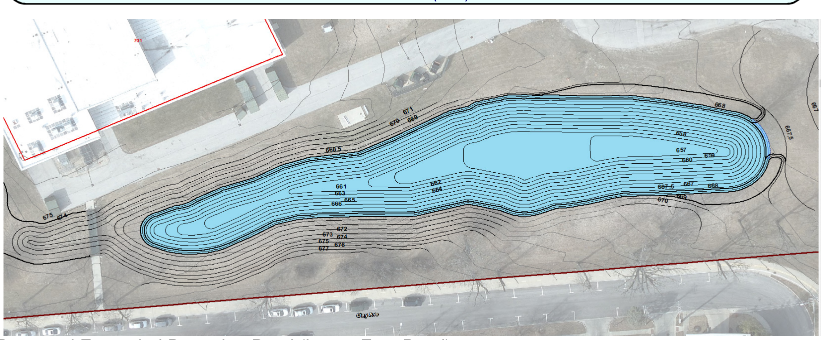
Existing Detention Pond

Stanley Consultants INC.

				Date	10/5/2020
			Subject	Sheridan USARC SW Drainage Project	
Computed by	BPD	Date	9/1/2020	28691.02.00	
Checked by	JM	Date	9/28/2020	Stage-Storage Calculations	
Approved by		Date			

POND:	**Proposed Conditions - Expanded Existing Detention Pond (Lower South Pond)**				
JOB NO.	28691.02		Side Slopes	3:1 or 4:1 dependent upon location	
PROJECT:	Sheridan USARC		Top of Pond (ft)	668.5	
FILE:	Storage.xls		Bottom of Pond (ft)	657	
DATE:	1/15/2021				
Elevation	Area		Average Aea	Incremental Storage	Cumulative Storage
	(sq-ft)	(ac)			
(ft)			(ac)	(ac-ft)	(ac-ft)
657	1417	0.03			0.00
			0.08	0.08	
658	5,423	0.12			0.08
			0.15	0.15	
659	7,774	0.18			0.23
			0.20	0.20	
660	9,698	0.22			0.43
			0.25	0.25	
661	12,088	0.28			0.68
			0.31	0.31	
662	14,924	0.34			0.99
			0.38	0.38	
663	17,888	0.41			1.37
			0.44	0.44	
664	20,867	0.48			1.81
			0.51	0.51	
665	23,929	0.55			2.33
			0.58	0.58	
666	27,010	0.62			2.91
			0.66	0.66	
667	30,148	0.69			3.57
			0.73	0.73	
668	33,342	0.77			4.30
			0.78	0.39	
668.5	34,961	0.80			**4.69**

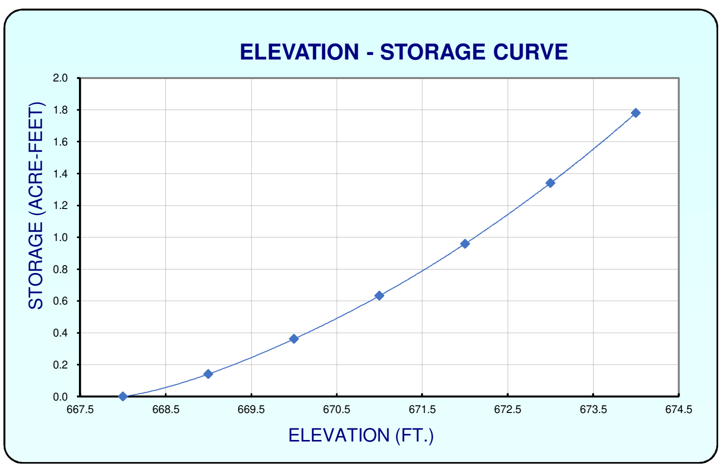


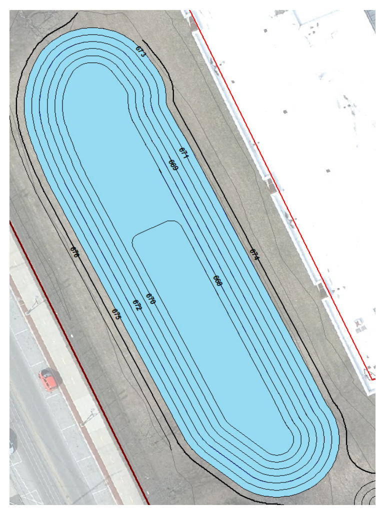


Proposed Expanded Detention Pond (Lower East Pond)

Stanley Consultants INC.				Date	10/5/2020
				Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/1/2020		28691.02.00
Checked by	JM	Date	9/28/2020		Stage-Storage Calculations
Approved by		Date			

POND:	**Proposed Conditions - Expanded Existing Detention Pond (Higher West Pond)**				
JOB NO.	28691.02		Side Slopes	4:1	
PROJECT:	Sheridan USARC		Top of Pond (ft)	674	
FILE:	Storage.xls		Bottom of Pond (ft)	668	
DATE:	1/15/2021				
Elevation	Area		Average Aea	Incremental Storage	Cumulative Storage
	(sq-ft)	(ac)			
(ft)			(ac)	(ac-ft)	(ac-ft)
668.0	3853	0.09			0.00
			0.14	0.14	
669	8481	0.19			0.14
			0.22	0.22	
670	10,680	0.25			0.36
			0.27	0.27	
671	12,980	0.30			0.63
			0.33	0.33	
672	15,381	0.35			0.96
			0.38	0.38	
673	17,882	0.41			1.34
			0.44	0.44	
674	20,484	0.47			**1.78**





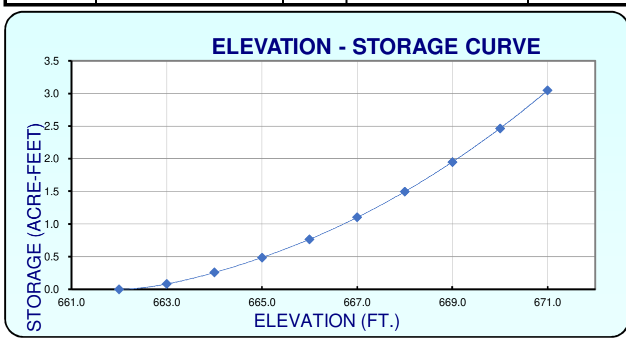
Proposed Expanded Detention Pond (upper West Pond)

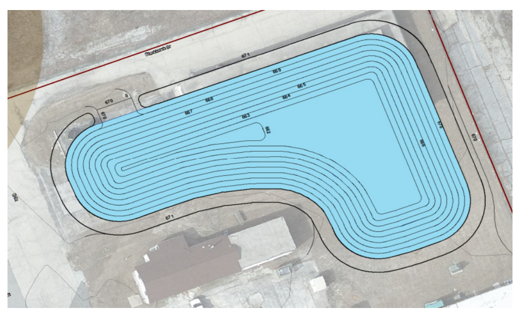
Stanley Consultants INC.

			Date 10/5/2020
		Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date 9/1/2020	28691.02.00
Checked by	JM	Date 9/28/2020	Stage-Storage Calculations
Approved by		Date	

POND:	**Proposed Conditions - New Detention Pond, 1st St and B St**		
JOB NO.	28691.02	Side Slopes	4:1
PROJECT:	Sheridan USARC	Top of Pond (ft)	671
FILE:	Storage.xls	Bottom of Pond (ft)	662
DATE:	1/15/2021		

Elevation	Area		Average Aea	Incremental Storage	Cumulative Storage
	(sq-ft)	(ac)			
(ft)			(ac)	(ac)	(ac-ft)
662.00	520	0.0119			0.00
			0.08	0.08	
663.00	6,594	0.15			0.08
			0.18	0.18	
664.00	8,774	0.20			0.26
			0.23	0.23	
665.00	11,038	0.25			0.49
			0.28	0.28	
666.00	13,403	0.31			0.77
			0.34	0.34	
667.00	15,868	0.36			1.10
			0.39	0.39	
668.00	18,434	0.42			1.50
			0.45	0.45	
669.00	21,101	0.48			1.95
			0.52	0.52	
670.00	23,868	0.55			2.47
			0.58	0.58	
671.00	26,735	0.61			**3.05**

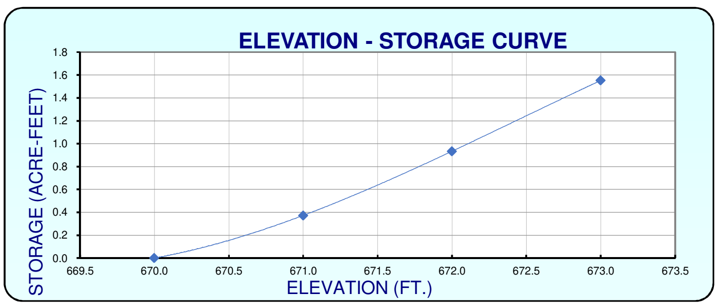


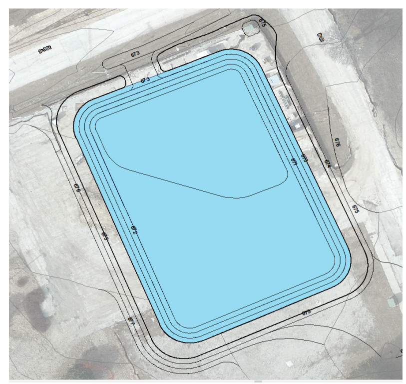


Proposed Detention Pond at B St and 1st St

			Date	10/5/2020
Stanley Consultants INC.			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/1/2020	28691.02.00
Checked by	JM	Date	9/28/2020	Stage-Storage Calculations
Approved by		Date		

POND:	**Proposed Conditions - New Detention Pond, 3rd St and B St**				
JOB NO.	28691.02		Side Slopes	4:1	
PROJECT:	Sheridan USARC		Top of Pond (ft)	674	
FILE:	Storage.xls		Bottom of Pond (ft)	669	
DATE:	1/15/2021				
Elevation	Area		Average Aea	Incremental Storage	Cumulative Storage
	(sq-ft)	(ac)			
(ft)			(ac)	(ac)	(ac-ft)
670.00	9,313	0.21			0.00
			0.37	0.37	
671.00	23,202	0.53			0.37
			0.56	0.56	
672.00	25,658	0.59			0.93
			0.62	0.62	
673.00	28,214	0.65			1.55
			0.68	0.68	
674.00	30,872	0.71			**2.23**



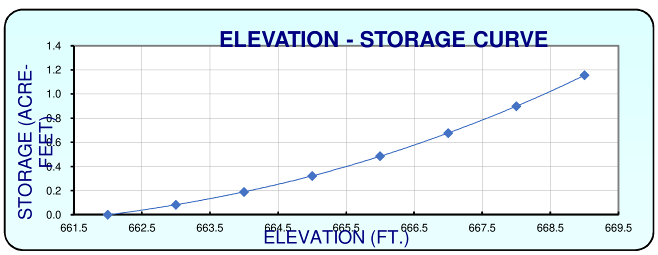


Proposed Detention Pond at the corner of 3rd St and B St

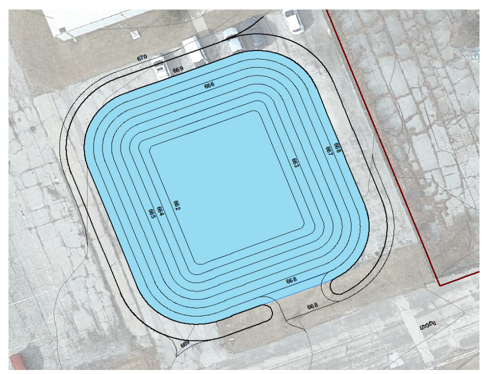
Stanley Consultants INC.

				Date	10/5/2020
			Subject	Sheridan USARC SW Drainage Project	
Computed by	BPD	Date	9/1/2020	28691.02.00	
Checked by	JM	Date	9/28/2020	Stage-Storage Calculations	
Approved by		Date			

POND:	**Proposed Conditions - New Detention Pond, 2nd St and B St**				
JOB NO.	28691.02		Side Slopes	4:1	
PROJECT:	Sheridan USARC		Top of Pond (ft)	669.00	
FILE:	Storage.xls		Bottom of Pond (ft)	662.00	
DATE:	1/15/2021				
Elevation	Area		Average Aea	Incremental Storage	Cumulative Storage
	(sq-ft)	(ac)			
(ft)			(ac)	(ac)	(ac-ft)
662.00	3,157	0.07			0.00
			0.08	0.08	
663.00	4,118	0.09			0.08
			0.11	0.11	
664.00	5,172	0.12			0.19
			0.13	0.13	
665.00	6,327	0.15			0.32
			0.16	0.16	
666.00	7,852	0.18			0.48
			0.19	0.19	
667.00	8,938	0.21			0.68
			0.22	0.22	
668.00	10,394	0.24			0.90
			0.26	0.26	
669.00	11,950	0.27			**1.16**



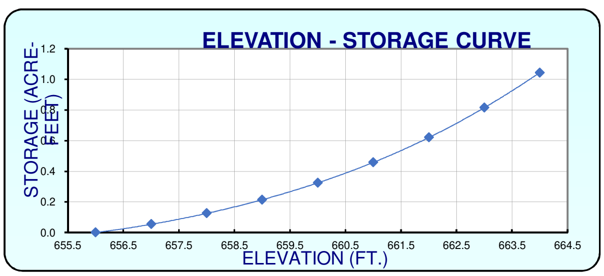
Proposed Detention Pond at the corner of 2nd St and B St

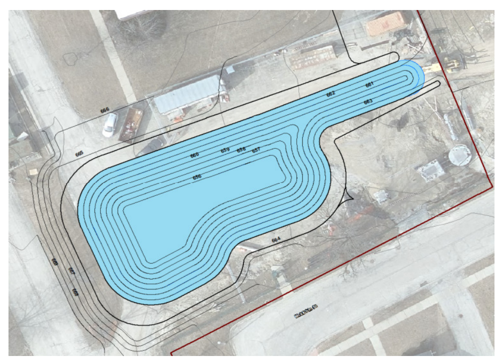


Stanley Consultants INC.

				Date	10/5/2020
			Subject	Sheridan USARC SW Drainage Project	
Computed by	BPD	Date	9/1/2020	28691.02.00	
Checked by	JM	Date	9/28/2020	Stage-Storage Calculations	
Approved by		Date			

POND:	Proposed Conditions - New Detention Pond, 3rd St and Eisenhower Rd				
JOB NO.	28691.02		Side Slopes	3:1	
PROJECT:	Sheridan USARC		Top of Pond (ft)	664	
FILE:	Storage.xls		Bottom of Pond (ft)	656	
DATE:	1/15/2021				
Elevation	Area		Average Aea	Incremental Storage	Cumulative Storage
	(sq-ft)	(ac)			
(ft)			(ac)	(ac)	(ac-ft)
656.00	1,997	0.05			0.00
			0.05	0.05	
657.00	2,708	0.06			0.05
			0.07	0.07	
658.00	3,483	0.08			0.13
			0.09	0.09	
659.00	4,325	0.10			0.21
			0.11	0.11	
660.00	5,239	0.12			0.32
			0.13	0.13	
661.00	6,394	0.15			0.46
			0.16	0.16	
662.00	7,775	0.18			0.62
			0.20	0.20	
663.00	9,214	0.21			0.82
			0.23	0.23	
664.00	10,708	0.25			**1.04**





Proposed Detention Pond at the corner of 3rd St and Eisenhower St

APPENDIX D.3

DETENTION POND OUTLET RATING CURVE

Stanley Consultants INC.

		Subject:	Sheridan US Army Reserve Center			
Computed by	BPD	Date	1/7/2021	Project #:	28691.02.00
Checked by	JJM	Date	1/11/2021	Calculation:	Release Rate
Approved by		Date			

Design Notes:

Lake County Release Rate Requirements	
100-yr, 24-hr storm	0.15 cfs/ac
2-yr, 24-hr storm	0.04 cfs/ac

Fort Sheridan is a fully developed property with minimal existing onsite stormwater detention. Due to the existing site conditions the Lake County release rates are being met to the maximum extent practicable.

Orifice Equation	Q = C*A*((2gH)^0.5)	
C =	Restrictor Entrance Coefficient =	0.61
A =	Area of Restrictor (ft2)	
g =	Acceleration due to gravity (ft/s2) =	32.2
H =	Head (ft)	

Pond	1B
Tributary/Developed Area (ac)	10.19
100-yr, 24-hr Max Allowable Release Rate (cfs)	1.53
2-yr, 24-hr Max Allowable Release Rate (cfs)	0.41
100-yr, 24-hr HWL (ft)	669.7
2-yr, 24-hr HWL (ft)	665.2
Proposed Restrictor Invert (ft)	663
Proposed Restrictor Diameter (in)	6
A (ft2)	0.196
Restrictor Centerline Elevation (ft)	663.25
100-yr, 24-hr H (ft)	6.45
2-yr, 24-hr H (ft)	1.95
100-yr, 24-hr Release Rate (cfs)	2.44
2-yr, 24-hr Release Rate (cfs)	1.34

Pond	2B
Tributary/Developed Area (ac)	4.13
100-yr, 24-hr Max Allowable Release Rate (cfs)	0.62
2-yr, 24-hr Max Allowable Release Rate (cfs)	0.17
100-yr, 24-hr HWL (ft)	667.7
2-yr, 24-hr HWL (ft)	664.5
Proposed Restrictor Invert (ft)	663
Proposed Restrictor Diameter (in)	6
A (ft2)	0.196
Restrictor Centerline Elevation (ft)	663.25
100-yr, 24-hr H (ft)	4.45
2-yr, 24-hr H (ft)	1.25
100-yr, 24-hr Release Rate (cfs)	2.03
2-yr, 24-hr Release Rate (cfs)	1.07

Pond	3B
Tributary/Developed Area (ac)	4.39
100-yr, 24-hr Max Allowable Release Rate (cfs)	0.66
2-yr, 24-hr Max Allowable Release Rate (cfs)	0.18
100-yr, 24-hr HWL (ft)	672.94
2-yr, 24-hr HWL (ft)	671.17
Proposed Restrictor Invert (ft)	671
Proposed Restrictor Diameter (in)	4
A (ft2)	0.087
Restrictor Centerline Elevation (ft)	671.17
100-yr, 24-hr H (ft)	1.77
2-yr, 24-hr H (ft)	0.003
100-yr, 24-hr Release Rate (cfs)	0.57
2-yr, 24-hr Release Rate (cfs)	0.02

Pond	3I
Tributary/Developed Area (ac)	8.99
100-yr, 24-hr Max Allowable Release Rate (cfs)	1.35
2-yr, 24-hr Max Allowable Release Rate (cfs)	0.36
100-yr, 24-hr HWL (ft)	662.34
2-yr, 24-hr HWL (ft)	658.04
Proposed Restrictor Invert (ft)	657
Proposed Restrictor Diameter (in)	12
A (ft2)	0.785
Restrictor Centerline Elevation (ft)	657.50
100-yr, 24-hr H (ft)	4.84
2-yr, 24-hr H (ft)	0.540
100-yr, 24-hr Release Rate (cfs)	8.46
2-yr, 24-hr Release Rate (cfs)	2.83

Pond	Expanded Southwest
Tributary/Developed Area (ac)	27.39
100-yr, 24-hr Max Allowable Release Rate (cfs)	4.11
2-yr, 24-hr Max Allowable Release Rate (cfs)	1.10
100-yr, 24-hr HWL (ft)	667.32
2-yr, 24-hr HWL (ft)	660.09
Proposed Restrictor Invert (ft)	657
Proposed Restrictor Diameter (in)	8
A (ft2)	0.349
Restrictor Centerline Elevation (ft)	657.33
100-yr, 24-hr H (ft)	9.99
2-yr, 24-hr H (ft)	2.757
100-yr, 24-hr Release Rate (cfs)	5.40
2-yr, 24-hr Release Rate (cfs)	2.84

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME: Fort Sheridan
PROJ. NO.: 28691.02.00
DESCRIPTION: Proposed Pond 1B
FILENAME: Orifice.xlsx
DATE: 2-Aug-21

OUTLET: ORIFICE: 6 IN. DIA. @ ELEV 663

ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.1963
ORIFICE DIAMETER (in)	6.00
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	663.00
TAILWATER OR CENTROID (ft-NAVD88)	663.250

ELEVATION-DISCHARGE RELATIONSHIP

Depth (feet)	Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
0	663.00	0.00	0.00	0.00
0.25	663.25	0.00	0.00	0.00
0.5	663.50	0.48	0.00	0.48
0.75	663.75	0.68	0.00	0.68
1	664.00	0.83	0.00	0.83
1.25	664.25	0.96	0.00	0.96
1.5	664.50	1.07	0.00	1.07
1.75	664.75	1.18	0.00	1.18
2	665.00	1.27	0.00	1.27
2.25	665.25	1.36	0.00	1.36
2.5	665.50	1.44	0.00	1.44
2.75	665.75	1.52	0.00	1.52
3	666.00	1.59	0.00	1.59
3.25	666.25	1.66	0.00	1.66
3.5	666.50	1.73	0.00	1.73
3.75	666.75	1.80	0.00	1.80
4	667.00	1.86	0.00	1.86
4.25	667.25	1.92	0.00	1.92
4.5	667.50	1.98	0.00	1.98
4.75	667.75	2.04	0.00	2.04
5	668.00	2.09	0.00	2.09
5.25	668.25	2.15	0.00	2.15
5.5	668.50	2.20	0.00	2.20
5.75	668.75	2.25	0.00	2.25
6	669.00	2.30	0.00	2.30
6.25	669.25	2.35	0.00	2.35
6.5	669.50	2.40	0.00	2.40
6.75	669.75	2.45	0.00	2.45
7	670.00	2.50	0.00	2.50
7.25	670.25	2.54	0.00	2.54
7.5	670.50	2.59	0.00	2.59
7.75	670.75	2.63	0.00	2.63
8	671.00	2.68	0.00	2.68

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME: Fort Sheridan
PROJ. NO.: 28691.02.00
DESCRIPTION: Proposed Pond 2B
FILENAME: Orifice.xlsx
DATE: 2-Aug-21

OUTLET: ORIFICE: 6 IN. DIA. @ ELEV 662

ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.1963
ORIFICE DIAMETER (in)	6.00
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	662.00
TAILWATER OR CENTROID (ft-NAVD88)	662.250

ELEVATION-DISCHARGE RELATIONSHIP

Depth (feet)	Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
0	662.00	0.00	0.00	0.00
0.25	662.25	0.00	0.00	0.00
0.5	662.50	0.48	0.00	0.48
0.75	662.75	0.68	0.00	0.68
1	663.00	0.83	0.00	0.83
1.25	663.25	0.96	0.00	0.96
1.5	663.50	1.07	0.00	1.07
1.75	663.75	1.18	0.00	1.18
2	664.00	1.27	0.00	1.27
2.25	664.25	1.36	0.00	1.36
2.5	664.50	1.44	0.00	1.44
2.75	664.75	1.52	0.00	1.52
3	665.00	1.59	0.00	1.59
3.25	665.25	1.66	0.00	1.66
3.5	665.50	1.73	0.00	1.73
3.75	665.75	1.80	0.00	1.80
4	666.00	1.86	0.00	1.86
4.25	666.25	1.92	0.00	1.92
4.5	666.50	1.98	0.00	1.98
4.75	666.75	2.04	0.00	2.04
5	667.00	2.09	0.00	2.09
5.25	667.25	2.15	0.00	2.15
5.5	667.50	2.20	0.00	2.20
5.75	667.75	2.25	0.00	2.25
6	668.00	2.30	0.00	2.30

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Fort Sheridan
PROJ. NO.:	28691.02.00
DESCRIPTION:	Proposed Pond 3B
FILENAME:	Orifice.xlsx
DATE:	2-Aug-21

OUTLET: ORIFICE: 4 IN. DIA. @ ELEV 671

ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.0873
ORIFICE DIAMETER (in)	4.00
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	671.00
TAILWATER OR CENTROID (ft-NAVD88)	671.167

ELEVATION-DISCHARGE RELATIONSHIP

Depth (feet)	Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
0	671.00	0.00	0.00	0.00
0.25	671.25	0.12	0.00	0.12
0.5	671.50	0.25	0.00	0.25
0.75	671.75	0.33	0.00	0.33
1	672.00	0.39	0.00	0.39
1.25	672.25	0.44	0.00	0.44
1.5	672.50	0.49	0.00	0.49
1.75	672.75	0.54	0.00	0.54
2	673.00	0.58	0.00	0.58
2.25	673.25	0.62	0.00	0.62
2.5	673.50	0.65	0.00	0.65
2.75	673.75	0.69	0.00	0.69
3	674.00	0.72	0.00	0.72

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME: Fort Sheridan
PROJ. NO.: 28691.02.00
DESCRIPTION: Proposed 3rd St and Eisenhower Pond
FILENAME: Orifice.xlsx
DATE: 2-Aug-21

OUTLET: ORIFICE: 12 IN. DIA. @ ELEV 657

ORIFICE FLOW EQUATION: $Q = C_d A(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.7854
ORIFICE DIAMETER (in)	12.00
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	657.00
TAILWATER OR CENTROID (ft-NAVD88)	657.500

ELEVATION-DISCHARGE RELATIONSHIP

Depth (feet)	Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
0	657.00	0.00	0.00	0.00
0.25	657.25	0.00	0.00	0.00
0.5	657.50	0.00	0.00	0.00
0.75	657.75	1.92	0.00	1.92
1	658.00	2.72	0.00	2.72
1.25	658.25	3.33	0.00	3.33
1.5	658.50	3.84	0.00	3.84
1.75	658.75	4.30	0.00	4.30
2	659.00	4.71	0.00	4.71
2.25	659.25	5.09	0.00	5.09
2.5	659.50	5.44	0.00	5.44
2.75	659.75	5.77	0.00	5.77
3	660.00	6.08	0.00	6.08
3.25	660.25	6.38	0.00	6.38
3.5	660.50	6.66	0.00	6.66
3.75	660.75	6.93	0.00	6.93
4	661.00	7.19	0.00	7.19
4.25	661.25	7.45	0.00	7.45
4.5	661.50	7.69	0.00	7.69
4.75	661.75	7.93	0.00	7.93
5	662.00	8.16	0.00	8.16
5.25	662.25	8.38	0.00	8.38
5.5	662.50	8.60	0.00	8.60
5.75	662.75	8.81	0.00	8.81
6	663.00	9.02	0.00	9.02
6.25	663.25	9.22	0.00	9.22
6.5	663.50	9.42	0.00	9.42
6.75	663.75	9.61	0.00	9.61
7	664.00	9.80	0.00	9.80

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME: Fort Sheridan
PROJ. NO.: 28691.02.00
DESCRIPTION: Proposed Southwest Pond
FILENAME: Orifice.xlsx
DATE: 2-Aug-21

OUTLET: ORIFICE: 6 IN. DIA. @ ELEV 669

ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.1963
ORIFICE DIAMETER (in)	6.00
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	669.00
TAILWATER OR CENTROID (ft-NAVD88)	669.250
WEIR LENGTH (ft)	12.00
WEIR COEFFICIENT	3.0
WEIR ELEV. (ft-NAVD88)	674.00

ELEVATION-DISCHARGE RELATIONSHIP

Depth (feet)	Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
0	669.00	0.00	0.00	0.00
0.25	669.25	0.00	0.00	0.00
0.5	669.50	0.48	0.00	0.48
0.75	669.75	0.68	0.00	0.68
1	670.00	0.83	0.00	0.83
1.25	670.25	0.96	0.00	0.96
1.5	670.50	1.07	0.00	1.07
1.75	670.75	1.18	0.00	1.18
2	671.00	1.27	0.00	1.27
2.25	671.25	1.36	0.00	1.36
2.5	671.50	1.44	0.00	1.44
2.75	671.75	1.52	0.00	1.52
3	672.00	1.59	0.00	1.59
3.25	672.25	1.66	0.00	1.66
3.5	672.50	1.73	0.00	1.73
3.75	672.75	1.80	0.00	1.80
4	673.00	1.86	0.00	1.86
4.25	673.25	1.92	0.00	1.92
4.5	673.50	1.98	0.00	1.98
4.75	673.75	2.04	0.00	2.04
5	674.00	2.09	0.00	2.09

PROPOSED CONDITIONS
ORIFICE/WEIR STRUCTURE RATING ANALYSIS

PROJECT NAME:	Fort Sheridan
PROJ. NO.:	28691.02.00
DESCRIPTION:	Proposed Southwest Pond
FILENAME:	Orifice.xlsx
DATE:	2-Aug-21

OUTLET: ORIFICE: 8 IN. DIA. @ ELEV 657

ORIFICE FLOW EQUATION: $Q = C_d A(2gH)^{0.5}$
WEIR FLOW EQUATION: $Q = 3.0L(H)^{1.5}$

HYDRAULIC DIMENSIONS

	# 1
ORIFICE AREA (ft^2)	0.3491
ORIFICE DIAMETER (in)	8.00
ORIFICE DISCHARGE COEFFICIENT	0.61
ORIFICE ELEV. (ft-NAVD88)	657.00
TAILWATER OR CENTROID (ft-NAVD88)	657.333

ELEVATION-DISCHARGE RELATIONSHIP

Depth (feet)	Elevation (feet)	Q-Orifice (cfs)	Q-Weir (cfs)	Q-Total (cfs)
0	657.00	0.00	0.00	0.00
0.25	657.25	0.00	0.00	0.00
0.5	657.50	0.70	0.00	0.70
0.75	657.75	1.10	0.00	1.10
1	658.00	1.40	0.00	1.40
1.25	658.25	1.64	0.00	1.64
1.5	658.50	1.85	0.00	1.85
1.75	658.75	2.03	0.00	2.03
2	659.00	2.21	0.00	2.21
2.25	659.25	2.37	0.00	2.37
2.5	659.50	2.52	0.00	2.52
2.75	659.75	2.66	0.00	2.66
3	660.00	2.79	0.00	2.79
3.25	660.25	2.92	0.00	2.92
3.5	660.50	3.04	0.00	3.04
3.75	660.75	3.16	0.00	3.16
4	661.00	3.27	0.00	3.27
4.25	661.25	3.38	0.00	3.38
4.5	661.50	3.49	0.00	3.49
4.75	661.75	3.59	0.00	3.59
5	662.00	3.69	0.00	3.69
5.25	662.25	3.79	0.00	3.79
5.5	662.50	3.88	0.00	3.88
5.75	662.75	3.98	0.00	3.98
6	663.00	4.07	0.00	4.07
6.25	663.25	4.16	0.00	4.16
6.5	663.50	4.24	0.00	4.24
6.75	663.75	4.33	0.00	4.33
7	664.00	4.41	0.00	4.41
7.25	664.25	4.49	0.00	4.49
7.5	664.50	4.57	0.00	4.57
7.75	664.75	4.65	0.00	4.65
8	665.00	4.73	0.00	4.73
8.25	665.25	4.81	0.00	4.81
8.5	665.50	4.88	0.00	4.88
8.75	665.75	4.96	0.00	4.96
9	666.00	5.03	0.00	5.03
9.25	666.25	5.10	0.00	5.10
9.5	666.50	5.17	0.00	5.17
9.75	666.75	5.24	0.00	5.24
10	667.00	5.31	0.00	5.31
10.25	667.25	5.38	0.00	5.38
10.5	667.50	5.45	0.00	5.45
10.75	667.75	5.51	0.00	5.51
11	668.00	5.58	0.00	5.58

APPENDIX D.4

EMERGENCY OVERFLOW WEIR SIZING

Stanley Consultants INC.

				Subject	Sheridan US Army Reserve Center
Computed by	BPD	Date	1/7/2021	Project #:	28691.02.00
Checked by	JJM	Date	1/7/2021	Calculation:	Emergency Overflow Weir
Approved by		Date			

Emergency Weir Calculations	
Discharge over a Broad-Crested Weir =	Q = Cw * L * H^1.5
Q =	Discharge in cfs
Cw =	Discharge coefficient for broad-crested weir
L =	Length of weir in ft
H =	Head in ft

*Note: There is no off-site flow present for all ponds

Detention Pond	1B
Inflow Source	Qp (cfs)
Subcatchment NE2-2	2.3
Subcatchment NE2-3	4.33
Subcatchment E6	7.03
Link 1Bi1	21.86
Link 1Bi2	25.06
Link C230	0
Link C231	0
Qp Total (cfs)*	60.58
Cw	2.5
H (ft)**	1
L (ft)***	24.23
L (ft)****	**25**

*(100-yr, 2-hr peak in-flow to detention pond)

**(1-ft of freeboard)

***L = 60.58 / (2.5*(1^1.5)) = 24.23

****(Weir length of 25 ft will be used for ease of construction)

Detention Pond	2B
Inflow Source	Qp (cfs)
Subcatchment E5-2	9.77
Link 2Bi1	15.01
Qp Total (cfs)*	24.78
Cw	2.5
H (ft)**	1
L (ft)***	9.91
L (ft)****	**20**

*(100-yr, 2-hr peak in-flow to detention pond)

**(1-ft of freeboard)

***L = 24.78 / (2.5*(1^1.5)) = 9.91

****(Weir length of 20 ft will be used to be conservative)

Detention Pond	3B
Inflow Source	Qp (cfs)
Subcatchment E4-2	10.65
Link 3Bi1	1.48
Link C205	8.26
Qp Total (cfs)*	20.39
Cw	2.5
H (ft)**	1
L (ft)***	8.16
L (ft)****	**20**

*(100-yr, 2-hr peak in-flow to detention pond)

**(1-ft of freeboard)

***L = 20.39 / (2.5*(1^1.5)) = 8.16

****(Weir length of 20 ft will be used to be conservative)

Detention Pond	3I
Inflow Source	Qp (cfs)
Subcatchment E4-5	1.85
Subcatchment E5-4	4.2
Subcatchment E5-9	2.72
Subcatchment E5-10	6.42
Link C78	1.96
Link C105	7.19
Link C158	0.7
Link C160	6.25
Link 3Ii1	27.3
Qp Total (cfs)*	58.59
Cw	2.5
H (ft)**	1
L (ft)***	23.44
L (ft)****	**25**

*(100-yr, 2-hr peak in-flow to detention pond)

**(1-ft of freeboard)

***L = 58.59 / (2.5*(1^1.5)) = 23.44

****(Weir length of 20 ft will be used for ease of construction)

Detention Pond	ExpUS
Inflow Source	Qp (cfs)
Subcatchment SE1-2	1.9
Subcatchment SE1-4	7.24
Link ExpUSi1	18.84
Qp Total (cfs)*	27.98
Cw	2.5
H (ft)**	1
L (ft)***	11.19
L (ft)****	**30**

*(100-yr, 2-hr peak in-flow to detention pond)

**(1-ft of freeboard)

***L = 27.98 / (2.5*(1^1.5)) = 11.19

****(Weir length of 30 ft will be used due to downstream grading tie-in requirements)

Detention Pond	ExpDS
Inflow Source	Qp (cfs)
Subcatchment SE1-5	10.35
Link ExpDSi1	2.09
Link WExp1	1.64
Link C136	0
Link C5	22.34
Link ExpDSi3	46.86
Qp Total (cfs)*	83.28
Cw	2.5
H (ft)**	1
L (ft)***	33.31
L (ft)****	**35**

*(100-yr, 2-hr peak in-flow to detention pond)

**(1-ft of freeboard)

***L = 83.28 / (2.5*(1^1.5)) = 33.31

****(Weir length of 35 ft will be used for ease of construction)

APPENDIX D.5

CONVEYANCE CONDUIT CALCULATIONS

Stanley Consultants INC.

			Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

TRACK:	Western Track											
Conduit Name	Conduit Type	Sub-watershed(s)	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq) (cfs)	Qcap (cfs)
W1	V0.67	E1-2	56	685	684.67	0.59%	5.36	685.67	685.34	1.8	1.8	2.8
W2	V1	E1-4	243	684.67	681.5	1.30%	8	685.67	682.5	2.3	4.0	12.0
W3	V0.75	E1-3	150	684	682.5	1.00%	6	684.75	683.25	4.8	4.8	4.9
W3b	15" RCP	E1-5	40	682.5	682	1.25%	1	683.5	683	2.5	7.3	7.2
W4	V1	E1-5	55	682	681.5	0.91%	8	683	682.5	2.5	9.8	10.0
W5a	30" RCP	E3-1	330	681.5	680.5	0.30%	n/a	684	683	-	13.8	22.6
W5b	V1	E3-1a	203	685	684	0.49%	8	686	685	4.8	4.8	7.4
W6	V1	E3-1b	80	684	680.5	4.38%	8	685	681.5	2.4	7.2	22.0
W7	T6-1.25	E3-1c	34	680.5	680.15	1.03%	16	681.75	681.4	2.4	23.5	53.0
W8	T6-1.25	SE1-3, SE1-2	373	680.15	675	1.38%	16	681.4	676.25	4.9	28.4	61.4
W9	V1	SE2-1, SE2-4	235	678.5	675	1.49%	8	679.5	676	2.7	2.7	12.8
W10	T6-1.25	SE1-4	63	675	674	1.59%	16	676.25	675.25	1.4	32.5	65.8

		Conduit Name	W1
		Conduit Type:	V0.67
Qreq	1.8	Qcap	2.8
		v	1.5
		n	0.035
		Bw	0
		z	4
		y	0.67
		A	1.7956
		P	5.52
		R	0.32
		S	0.59%

		Conduit Name	W2
		Conduit Type:	V1
Qreq	4.0	Qcap	12.0
		v	3.0
		n	0.035
		Bw	0
		z	4
		y	1
		A	4
		P	8.25
		R	0.49
		S	1.30%

		Conduit Name	W3
		Conduit Type:	V0.75
Qreq	4.8	Qcap	4.9
		v	2.2
		n	0.035
		Bw	0
		z	4
		y	0.75
		A	2.25
		P	6.18
		R	0.36
		S	1.00%

		Conduit Name	W3b
		Conduit Type:	15" RCP
Qreq	7.3	Qcap	7.2
		v	5.9
		n	0.013
		d	15
		A	1.227
		R	0.313
		S	1.25%

		Conduit Name	W4
		Conduit Type:	V1
Qreq	9.8	Qcap	10.0
		v	2.5
		n	0.035
		Bw	0
		z	4
		y	1
		A	4
		P	8.25
		R	0.49
		S	0.91%

Stanley Consultants INC.

			Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

Qreq 13.8

Conduit Name	W5a
Conduit Type:	30" RCP
Qcap	22.6
v	4.6
n	0.013
d	30
A	4.909
R	0.625
S	0.30%

Qreq 4.8

Conduit Name	W5b
Conduit Type:	V1
Qcap	7.4
v	1.8
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	0.49%

Qreq 7.2

Conduit Name	W6
Conduit Type:	V1
Qcap	22.0
v	5.5
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	4.38%

Qreq 23.5

Conduit Name	W7
Conduit Type:	T6-1.25
Qcap	53.0
v	3.9
n	0.035
Bw	6
z	4
y	1.25
A	13.75
P	16.31
R	0.84
S	1.03%

Qreq 28.4

Conduit Name	W8
Conduit Type:	T6-1.25
Qcap	61.4
v	4.5
n	0.035
Bw	6
z	4
y	1.25
A	13.75
P	16.31
R	0.84
S	1.38%

Stanley Consultants INC.

				Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project	
Computed by	BPD	Date	9/16/2020	28691.02.00	
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations	
Approved by	JJM	Date	10/2/2020		

Qreq 2.7

Conduit Name	W9
Conduit Type:	V1
Qcap	12.8
v	3.2
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.49%

Qreq 32.5

Conduit Name	W10
Conduit Type:	V1
Qcap	65.8
v	4.8
n	0.035
Bw	6
z	4
y	1.25
A	13.75
P	16.31
R	0.84
S	1.59%

Stanley Consultants INC.

			Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

TRACK:	C St Track											
Conduit Name:	Conduit Type	Sub-watershed	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq) (cfs)	Qcap (cfs)
C1	V1, z=3	E2-1a	150	682.35	680.5	1.23%	6.0	683.35	681.50	8.6	8.6	8.6
C2	19"x30" RCEP	E2-1b	32	680.5	680.4	0.31%	2.5	682.08	681.98	8.6	8.6	12.5
C3	V1.33, z=3	E2-1c	65	680.4	680	0.62%	8.0	681.73	681.33	8.6	8.6	13.0
C4	19"x30" RCEP	E2-2a	38	680	679.8	0.53%	2.5	681.58	681.38	8.6	8.6	16.3
C5	V1.75, z=2	E2-2b	54	679.8	679.4	0.74%	7.0	681.55	681.15	5.3	17.1	19.1
C6	24" RCP	E3-5c	327	679.4	676.25	0.96%	2.0	-	-	5.3	17.1	22.3
C7	30" RCP	E3-5	100	676.25	675	1.25%	2.5	678.8	677.5	7.1	24.3	46.0
C8	T6-1.25	E3-6	163	675	673.35	1.01%	16.0	676.25	674.60	7.2	31.5	52.6
C9	T6-1.25	SE3a	153	673.35	671.8	1.01%	16.0	674.60	673.05	7.2	31.5	52.6
C10	T6-1.25	SE3b	207	671.8	669.5	1.11%	16.0	673.05	670.75	3.3	34.8	55.1
C11	4' x 2' Box Culvert	SE3c	146	665.75	665	0.51%	4.0	-	-	13.5	48.3	65.7
C12	4' x 2' Box Culvert	SE3d	100	665	664	1.00%	4.0	-	-	21.1	69.4	91.7

Qreq 8.6

Conduit Name	C1
Conduit Type:	V1, z=3
Qcap	8.6
v	2.9
n	0.035
Bw	0
z	3
y	1
A	3
P	6.32
R	0.47
S	1.23%

Qreq 8.6

Conduit Name	C2
Conduit Type:	19"x30" RCEP
Qcap	13
v	4.0
n	0.013
d	24
A	3.109
R	0.500
S	0.31%
19	9.5
30	15

Stanley Consultants INC.					Date 9/16/2020
				Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020		28691.02.00
Checked by	JJM	Date	10/2/2020		Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020		

		Conduit Name	C3
		Conduit Type:	V1.33, z=3
Qreq	8.6	Qcap	13.0
		v	2.5
		n	0.035
		Bw	0
		z	3
		y	1.33
		A	5.3067
		P	8.41
		R	0.63
		S	0.62%

		Conduit Name	C4
		Conduit Type:	19"x30" RCEP
Qreq	8.6	Qcap	16
		v	5.2
		n	0.013
		d	24
		A	3.109
		R	0.500
		S	0.53%
		19	9.5
		30	15

		Conduit Name	C5
		Conduit Type:	V1.75, z=2
Qreq	17.1	Qcap	19.1
		v	3.1
		n	0.035
		Bw	0
		z	2
		y	1.75
		A	6.125
		P	7.83
		R	0.78
		S	0.74%

		Conduit Name	C6
		Conduit Type:	24" RCP
Qreq	17.1	Qcap	22.3
		v	7.1
		n	0.013
		d	24
		A	3.142
		R	0.500
		S	0.96%

		Conduit Name	C7
		Conduit Type:	30" RCP
Qreq	24.3	Qcap	46.0
		v	9.4
		n	0.013
		d	30
		A	4.909
		R	0.625
		S	1.25%

Stanley Consultants INC.

				Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project	
Computed by	BPD	Date	9/16/2020	28691.02.00	
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations	
Approved by	JJM	Date	10/2/2020		

Qreq 31.5

Conduit Name	C8
Conduit Type:	T6-1.25
Qcap	52.6
v	3.8
n	0.035
Bw	6
z	4
y	1.25
A	13.75
P	16.31
R	0.84
S	1.01%

Qreq 31.5

Conduit Name	C9
Conduit Type:	T6-1.25
Qcap	52.6
v	3.8
n	0.035
Bw	6
z	4
y	1.25
A	13.75
P	16.31
R	0.84
S	1.01%

Qreq 34.8

Conduit Name	C10
Conduit Type:	T6-1.25
Qcap	55.1
v	4.0
n	0.035
Bw	6
z	4
y	1.25
A	13.75
P	16.31
R	0.84
S	1.11%

Qreq 48.3

Conduit Name	C11
Conduit Type:	4' x 2' Box Culvert
Qcap	65.7
v	8.2
n	0.013
A	8.000
R	1.000
S	0.51%

Qreq 69.4

Conduit Name	C12
Conduit Type:	4' x 2' Box Culvert
Qcap	91.7
v	11.5
n	0.013
A	8.000
R	1.000
S	1.00%

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				Date 9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

TRACK:	Southeast Track											
Conduit Name:	Conduit Type	Sub-watershed	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq) (cfs)	Qcap (cfs)
SE1	V1	SE4-2	192	673	671	1.04%	8	674.00	672.00	10.2	10.2	10.7
SE2	V1.25	SE4-3	141	671	669.5	1.06%	10	672.25	670.75	10.2	10.2	19.7

Qreq 10.2

Conduit Name	SE1
Conduit Type:	V1
Qcap	10.7
v	2.7
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.04%

Qreq 10.2

Conduit Name	SE2
Conduit Type:	V1.25
Qcap	19.7
v	3.1
n	0.035
Bw	0
z	4
y	1.25
A	6.25
P	10.31
R	0.61
S	1.06%

Stanley Consultants INC.

				Date	9/16/2020
				Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00	
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations	
Approved by	JJM	Date	10/2/2020		

TRACK:	B St Track											
Conduit Name:	Conduit Type	Sub-watershed	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq) (cfs)	Qcap (cfs)
B1	V1	SE4-1	66	676.5	675.6	1.36%	8.0	677.50	676.60	8.5	8.5	12.3
B2	T1-1	SE4-1	25	675.6	675.26	1.36%	9.0	676.60	676.26	8.5	8.5	16.5
B3	T1.5-1	SE4-1	51	675.26	674.56	1.37%	9.5	676.26	675.56	8.5	8.5	18.7
B4	T2-1	SE4-1	41	674.56	674	1.37%	10.0	675.56	675.00	8.5	8.5	20.9

Qreq 8.5

Conduit Name	B1
Conduit Type:	V1
Qcap	12.3
v	3.1
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.36%

Qreq 8.5

Sub-watershed	B2
Conduit Type:	T1-1
Qcap	16.5
v	3.3
n	0.035
Bw	1
z	4
y	1
A	5
P	9.25
R	0.54
S	1.36%

Qreq 8.5

Sub-watershed	B3
Conduit Type:	T1.5-1
Qcap	18.7
v	3.4
n	0.035
Bw	1.5
z	4
y	1
A	5.5
P	9.75
R	0.56
S	1.37%

Qreq 8.5

Sub-watershed	B4
Conduit Type:	T2-1
Qcap	20.9
v	3.5
n	0.035
Bw	2
z	4
y	1
A	6
P	10.25
R	0.59
S	1.37%

Stanley Consultants INC.

			Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

TRACK:	3rd St Track											
Conduit Name	Conduit Type	Sub-watershed	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq)	Qcap (cfs)
3a	V1	E3-6*	112	680	678.3	1.52%	8.0	681.00	679.30	2.4	2.4	13.0
3b	V1	E4-1a**	211	678.3	674.75	1.68%	8.0	679.30	675.75	1.7	4.1	13.6
3c	24" RCP	E4-1b***	51	674.75	674.55	0.39%	2.0	-	-	7.0	11.1	14.2
3d	V1	E4-3****	55	674.55	674	1.00%	10.0	675.55	675.00	0.2	11.3	17.9

*Qpeak includes one third of E3-6

*Qpeak includes half the peak runoff from E4-1

**Qpeak includes half the peak runoff from E4-1 and from E4-2, total E4-2 peak runoff is 11.1

***Qpeak includes 10% runoff from E4-3

Qreq 2.4

Conduit Name:	3a
Conduit Type:	V1
Qcap	13.0
v	3.2
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.52%

Qreq 4.1

Conduit Name:	3b
Conduit Type:	V1
Qcap	13.6
v	3.4
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.68%

Qreq 11.1

Conduit Name:	3c
Conduit Type:	24" RCP
Qcap	14.2
v	4.5
n	0.013
d	24
A	3.142
R	0.500
S	0.39%

Qreq 11.3

Conduit Name:	3d
Conduit Type:	V1
Qcap	17.9
v	3.0
n	0.035
Bw	2
z	4
y	1
A	6
P	10.25
R	0.59
S	1.00%

Stanley Consultants INC.

			Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

TRACK:	1st St North Track											
Conduit Name	Conduit Type	Sub-watershed	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq) (cfs)	Qcap (cfs)
1Na	V1	NE1-1N	179	679	677	1.12%	8.0	680.00	678.00	5.6	5.6	11.1
1Nb	V1	NE1-2N	141	677	674.5	1.77%	8.0	678.00	675.50	5.5	11.1	14.0
1Nc	V1	N3-1*	105	674.5	672	2.38%	8.0	675.50	673.00	1.3	12.4	16.2
1Nd	30" RCP	N3-2, N3-3, N3-4	245	665	664	0.41%	2.5	-	-	9.6	22.0	26.3

*Qpeak is half the peak flow for N3-1 which equals 2.54cfs

Cumulative Qpeak for 1st St North Track is 12.9 cfs. Cumulative Qpeak for 1st St South Track is 28.9cfs. These tracks converge at the entrance to the proposed detention pond. Therefore the total Cumulative Qpeak for the inlet drainage ditch is (28.9+12.9)=41.8cfs

Qreq 5.6

Conduit Name	1Na
Conduit Type:	V1
Qcap	11.1
v	2.8
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.12%

Qreq 11.1

Conduit Name	1Nb
Conduit Type:	V1
Qcap	14.0
v	3.5
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	1.77%

Qreq 12.4

Conduit Name	1Nc
Conduit Type:	V1
Qcap	16.2
v	4.1
n	0.035
Bw	0
z	4
y	1
A	4
P	8.25
R	0.49
S	2.38%

Qreq 22.0

Conduit Name	1Nd
Conduit Type:	30" RCP
Qcap	26.3
v	5.4
n	0.013
d	30
A	4.909
R	0.625
S	0.41%

Stanley Consultants INC.

			Date	9/16/2020
			Subject	Sheridan USARC SW Drainage Project
Computed by	BPD	Date	9/16/2020	28691.02.00
Checked by	JJM	Date	10/2/2020	Conduit Sizing Calculations
Approved by	JJM	Date	10/2/2020	

TRACK:	**1st St South Track**												
Conduit Name	Conduit Type	Sub-watershed	Length (ft)	Apprx. Prop. Upstm Inv EL (ft)	Apprx. Prop. Dwnstm Inv EL (ft)	Slope (%)	Total Width (ft)	Apprx. Prop. Upstm TOD EL (ft)	Apprx. Prop. Dwnstm TOD EL (ft)	Qpeak (cfs)	Cumulative Qpeak (aka Qreq) (cfs)	Qcap (cfs)
1Sa	24" RCP	NE1-1S	250	672	671.25	0.30%	2.0	-	-	5.3	5.3	12.4
1Sb	24" RCP	NE1-3	83	670.75	670.5	0.30%	2.0	-	-	6.3	6.3	12.4
1Sc	24" RCP	NE1-2S, NE1-3	37	667.15	667	0.41%	2.0	-	-	8.4	13.7	14.4
1Sd	24" RCP	NE1-2S, NE1-3	265	666.75	665.5	0.47%	2.0	-	-	-	13.7	15.6
1Se	30" RCP	NE2-1	77	665	664.75	0.32%	2.5	-	-	6.2	19.9	23.4
1Sf	30" RCP	(NE2-3)/3	71	664.25	664	0.35%	2.5	-	-	1.4	21.3	24.4

*Qpeak is half the peak flow for NE2-1 which equals 6.21cfs

**Qpeak is half the peak flow for NE2-3 which equals 4.33cfs

***Qpeak is half the peak flow for E6 which equals 6.30cfs

Cumulative Qpeak for 1st St North Track is 12.9 cfs. Cumulative Qpeak for 1st St South Track is 28.9cfs. These tracks converge at the entrance to the proposed detention pond. Therefore the total Cumulative Qpeak for the inlet drainage ditch is (28.9+12.9)=41.8cfs

Qreq 5.3

Conduit Name	1Sa
Conduit Type:	24" RCP
Qcap	12.4
v	4.0
n	0.013
d	24
A	3.142
R	0.500
S	0.30%

Qreq 6.3

Conduit Name	1Sb
Conduit Type:	24" RCP
Qcap	12.4
v	4.0
n	0.013
d	24
A	3.142
R	0.500
S	0.30%

Qreq 13.7

Conduit Name	1Sc
Conduit Type:	24" RCP
Qcap	14.4
v	4.6
n	0.013
d	24
A	3.142
R	0.500
S	0.41%

Qreq 13.7

Conduit Name	1Sd
Conduit Type:	24" RCP
Qcap	15.6
v	5.0
n	0.013
d	24
A	3.142
R	0.500
S	0.47%

Qreq 19.9

Conduit Name	1Se
Conduit Type:	30" RCP
Qcap	23.4
v	4.8
n	0.013
d	30
A	4.909
R	0.625
S	0.32%

Qreq 21.3

Conduit Name	1Sf
Conduit Type:	30" RCP
Qcap	24.4
v	5.0
n	0.013
d	30
A	4.909
R	0.625
S	0.35%

APPENDIX D.6

INLET CAPACITY CALCULATIONS

Stanley Consultants INC.	Project Name:	Sheridan US Army Reserve Center Stormwater Drainage Improvement Project			
Computed by	BPD	Date	1/12/2021	Project #:	28691.02.00
Checked by	JJM	Date	1/12/2021	Calculation:	Inlet Capacity
Approved by		Date			

Design Notes:	
1	The inlet capacity calculations are based on a maximum ponding depth of 9 inches.
2	The Orifice Flow equation governs for ponding depths of 9 inches (0.75 ft), which will be used for the calculations
3	100-yr, 2-hr peak flowrates (Qp) were obtained from EPA SWMM model. Values are based on all pertinent subcatchments and/or links (storm pipes or overland flow) that converge on a given inlet.
4	Inlets with a 100-yr, 2-hr Qp of 0 cfs do not have any subcatchments and/or links draining directly to them. The inlets are located where they could potentially receive stormwater runoff which is why they're being designed as inlets instead of closed cover manholes. These inlets will be assigned the standard most widely used inlet that is assigned to the other inlets.
5	Inlets will be sized by entering the peak flowrate (Qp) to a given inlet into the Orifice Equation and solving for A to determine the required total open area. Frame and Grates will then be selected from Neenah Foundry with total open areas greater then the required value.

ORIFICE FLOW EQUATION: $Q = C_dA(2gH)^{0.5}$	
Cd = Orifice Discharge Coefficient =	0.61
g = Acceleration due to gravity (ft/sec^2) =	32.2
H = Head, or depth, of water over inlet opening (ft) =	0.75
A = Total Open Area (sq-ft)	varies
Q = Flowrate (cfs)	varies

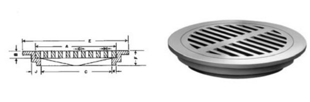
Inlet No.	Location Type	Frame Shape	Structure Size (in)	100-yr, 2-hr Qp (cfs)	Required Total Area, A (sq-ft)	Provided Total Open Area, A (sq-ft)	Neenah Product	Type
CB 4-1	Parking Lot	Circle	48	6.31	1.5	2.4	R-2565-J, Type G Grate	1
CB 3-1	Driveway	Circle	60	3.95	0.9	2.4	R-2565-J, Type G Grate	1
CB 2-2	Grass	Circle	60	11.0	2.6	2.5	R-4341-A, Beehive Grate	2
CB 2-1	Grass	Circle	48	9.55	2.3	2.5	R-4341-A, Beehive Grate	2
CB 3-2	Edge of Road	Circle	144	0	0.0	2.4	R-2565-J, Type G Grate	1
CB 1-1	Road	Circle	48	0	0.0	2.4	R-2565-J, Type G Grate	1
CB 18-1	Road	Circle	48	9.58	2.3	2.4	R-2565-J, Type G Grate	1
CB 5-1	Parking Lot	Curb and Gutter	72	7.09	1.7	1.8	R-3246-CC, Type C Grate	3
CB 8-1	Grass	Circle	60	0	0.0	1.3	R-4532, Beehive Grate	4
CB 8-2	Grass	Circle	72	0	0.0	1.3	R-4532, Beehive Grate	4
CB 11-1	Grass	Circle	48	3.20	0.8	1.3	R-4532, Beehive Grate	4
CB 15-1	Edge of Road	Rectangle	tbd	30.4	7.2	7.2	R-3475-G, Type C Grate	5
CB 15-2	Edge of Road	Circle	60	10.0	2.4	2.4	R-2565-J, Type G Grate	1

Type 1

R-2565 Series
Inlet Frame, Grate

Heavy Duty

CATALOG NUMBER	GRATE TYPE	SQ. FT. OPEN	WEIR PERIMETER LINEAL FEET
R-2565-A	G	0.8	5.5
R-2565-C	G	1.2	6.0
R-2565-E	G	1.8	7.1
R-2565-F	G	1.8	7.1
R-2565-G	G	1.6	7.1
R-2565-H	G	1.9	7.6
R-2565-J	G	2.4	8.5

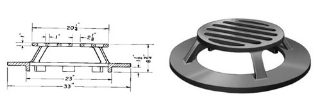


Type 2

R-4341-A
Ditch Grate, Stool Type

Heavy Duty

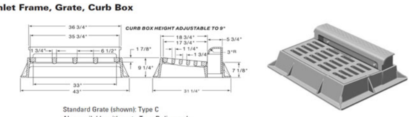
CATALOG NUMBER	GRATE TYPE	SQ. FT. OPEN	WEIR PERIMETER LINEAL FEET
R-4341-A	Beehive	2.5	6.0



Type 3

R-3246-CC
Combination Inlet Frame, Grate, Curb Box

Heavy Duty



Standard Grate (shown): Type C
Also available with grate Type R-diagonal.

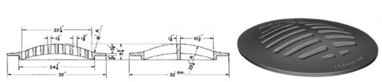
CATALOG NUMBER	GRATE TYPE	SQ. FT. OPEN	WEIR PERIMETER LINEAL FEET
R-3246-CC	C	1.8	5.8
R-3246-CC	R	1.9	5.8


Type R

Type 4

R-4352
Beehive Grate

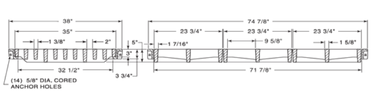
Heavy Duty

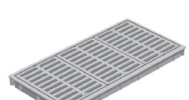


CATALOG NUMBER	GRATE TYPE	SQ. FT. OPEN	WEIR PERIMETER LINEAL FEET
R-4352	Beehive	1.3	5.8

Type 5

R-3475-G
Airport Drainage Inlet, Triple Ductile Iron Grate





Grates are bolted to frames.

CATALOG NUMBER	GRATE TYPE	SQ. FT. OPEN	WEIR PERIMETER LINEAL FEET
R-3475-G	C	7.2	17.8

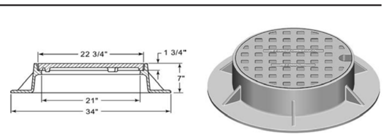
Each grate has a free open area of approximately 2.4 sq. ft.
Features easy to install one-piece frame.

The R-1772 Manhole Frame with solid lid is to be used for all closed lid manhole structures and lid replacements

R-1772
Manhole Frame, Solid Lid

Heavy Duty

Non-Rocking feature available, see p. 12.



Available Grate: **R-2502**

Stanley Consultants INC.

				Date	1/5/2021
				Subject	Sheridan US Army Reserve Center
Computed by	BPD	Date	1/4/2021	Project #:	28691.02.00
Checked by	KK	Date	1/22/2021	Calculation:	Riprap
Approved by		Date			

DESCRIPTION

Determine type and amount of riprap required for inlet/outlet proteciton of proposed pipes and emegrency overflow weirs for proposed detention ponds

REFERENCES

1. USACE, EM 1110-2-1601, 1994
2. IDOT Standard Specifications for Road and Bridge Construction, 2016
3. NRCS Illinois Urban Manual Practice Standard - Rock Outlet Protection
4. EPA SWMM, version 5.1

ANALYSIS

Step 1: Maximum velocity and normal depth determinations

1. Maximum velocities obtained from Flowmaster based on the 100-yr, 2-hr max flowrates reported by EPA SWMM version 5.1
2. Normal depths for emergency overflow weirs obtained for 100-yr, 2-hr storm from EPA SWMM version 5.1
3. Normal depths for riprap pads (RR#) obtained from Flowmaster software

Riprap Summary Table

Location	Riprap ID	D, or De (ft)	Roughness	Channel Slope (ft/ft)	Side Slopes	Bottom Width (ft)	100yr, 2hr Qp (cfs)	V - 100yr, 2hr V (fps)	d - Normal Depth (ft)	D_{30} (ft)	W_{50} (lb)	D_{50} (ft)	IDOT Gradation Number	Required Blanket Depth (ft)	Bedding Thickness (in)	L1 - Required Apron Length (ft)	L2 - Additional Length (ft)[4]	W1 - Short Width (ft)	W2 - Wide Width (ft)	Area (ft2)	Volume (cu yd)	Weight (TON)
Ditch to 15" RCP - Between D St and Bldng 698	RR1[1]	1.000	0.035	0.01	4	0	4.30	2.1	0.72	0.02	-	0.50	RR-3	1.25	-	10.0	2.0	3.0	11.0	116	5.4	10.7
15" RCP to Ditch -Between D St and Bldng 698	RR2[1]	1.000	0.013	0.0125	-	-	4.30	6.14	0.69	0.27	-	0.50	RR-3	1.25	-	10.0	2.0	3.0	11.0	116	5.4	10.7
Ditch to 30" RCP - Between D St and Bldng 705	RR3[1]	2.000	0.035	0.009	4	0	10.40	2.52	1.02	0.03	-	0.50	RR-3	1.25	-	10.0	2.0	7.5	12.5	140	6.5	13.0
SW of Bldng 705	RR4[1]	2.500	0.013	0.003	-	-	14.95	4.56	1.58	0.10	-	0.50	RR-3	1.25	-	10.0	12.0	7.5	14.5	235	10.9	21.8
W of Bldng 701	RR5[1]	3.330	0.035	0.016	4	6	18.83	3.35	0.65	0.06	-	0.50	RR-3	1.25	-	20.0	3.0	10.0	23.3	497	23.0	46.0
S of Bldng 701	RR6[1,2]	2.600	0.035	0.01	4	10	3.57	1.47	0.23	0.01	-	0.50	RR-3	1.25	-	10.0	-	-	-	3195	147.9	295.8
Between C St and Bldng 705	RR11	3.130	0.035	0.007	2	0	0.53	7.13	0.19	0.54	24	0.67	RR-4	1.67	6	10.0	2.0	6.0	6.0	72	4.4	8.9
SE of C St and 3rd St	RR12	2.500	0.013	0.012	-	-	11.35	7.74	0.85	0.46	24	0.67	RR-4	1.67	6	20.0	2.0	7.5	22.5	465	28.7	57.4
Exst 27" RCP on N side of expanded pond	RR13	2.250	0.013	0.015	-	-	22.34	9.93	1.24	0.78	81	1.00	RR-5	2.33	8	27.0	9.5	6.8	29.3	854	73.8	147.6
4'x2' RCBCs on NE side of expanded pond	RR14	4.000	0.013	0.01	-	-	46.86	9.53	1.23	0.70	81	1.00	RR-5	2.33	8	26.0	9.0	12.0	30.0	888	76.7	153.5
Pond 1B	RR15	2.500	0.013	0.004	-	-	25.06	5.62	0.01	0.62	-	0.50	RR-3	1.25	-	10.0	-	-	-	309	14.3	28.6
Pond 2B	RR16	2.000	0.013	0.01	-	-	21.43	8.19	1.55	0.45	24	0.67	RR-4	1.67	6	20.0	11.0	6.0	22.0	506	31.2	62.5
Pond 3I	RR21	2.5	0.013	0.012	-	-	27.30	9.6	1.41	0.69	81	1.00	RR-5	2.33	8	20.0	10.5	7.5	22.5	529	45.7	91.4
Pond 1B Outlet	O1B[3]	-	-	-	-	-	-	-	-	-	-	0.50	RR-3	1.25	-	-	-	-	-	29	1.3	2.7
Pond 2B Outlet	O2B[3]	-	-	-	-	-	-	-	-	-	-	0.50	RR-3	1.25	-	-	-	-	-	40	1.9	3.7
Pond 3B Outlet	O3B[3]	-	-	-	-	-	-	-	-	-	-	0.50	RR-3	1.25	-	-	-	-	-	38	1.8	3.5
Pond 3I Outlet	O3I[3]	-	-	-	-	-	-	-	-	-	-	0.50	RR-3	1.25	-	-	-	-	-	28	1.3	2.6
Pond ExpUS Outlet	OExpUS[3]	-	-	-	-	-	-	-	-	-	-	0.50	RR-3	1.25	-	-	-	-	-	36	1.7	3.3
Pond ExpDS Outlet	OExpDS[3]	-	-	-	-	-	-	-	-	-	-	0.50	RR-3	1.25	-	-	-	-	-	49	2.3	4.5
Pond 1B Weir	W1B[3]	-	-	-	4	25	3.91	0.2	0.16	0.00	10	0.50	RR-3	1.25	-	-	-	-	-	604	28.0	55.9
Pond 2B Weir	W2B[3]	-	-	-	4	20	6.28	0.2	0.22	0.00	10	0.50	RR-3	1.25	-	-	-	-	-	586	27.1	54.3
Pond 3B Weir	W3B[3]	-	-	-	4	20	0.00	0	0.00	0.00	10	0.50	RR-3	1.25	-	-	-	-	-	651	30.1	60.3
Pond 3I Weir	W3I[3]	-	-	-	4	25	35.90	0.9	0.86	0.00	10	0.50	RR-3	1.25	-	-	-	-	-	428	19.8	39.6
Pond ExpUS Weir	WExpUS[3]	-	-	-	4	30	1.64	0.1	0.08	0.00	10	0.50	RR-3	1.25	-	-	-	-	-	894	41.4	82.8
Pond ExpDS Weir	WExpDS[3]	-	-	-	4	35	7.64	0.2	0.19	0.00	10	0.50	RR-3	1.25	-	-	-	-	-	570	26.4	52.8
Totals																				D50 = 0.5 ft	**396.3**	**792.6**
																				D50 = 0.67 ft	**64.4**	**128.8**
																				D50 = 1.0ft	**196.2**	**392.5**

[1]The lowest D30 (min) value in Table 3-1 from Ref 1 is 0.37 ft. Many of the areas analyzed for a potential need for riprap yielded D30 values less than 0.37ft. Engineering judgement is that utilization of riprap in some, not all, of these areas is a reasonable precaution for erosion prevention. Minimum riprap sizes, depths, lengths, and apron widths will be selected for these areas.

[2]This is the area between the upper and lower expanded detention ponds which is the reason for the long length.

[3]These areas, either detention pond outlet pipes or detention pond overflow weirs, are different such that standard apron lengths and widths are not applicable. The areas for these locations were instead measured in Arcmap version 10.7

[4]Additional length pertains to the riprap required for encasing the sides and top of a given inlet or outlet pipe

Step 2: Determine riprap size required.

Riprap is sized using Equation 3-3 from Reference 1.

$$D_{30} = S_f C_s C_V C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{1/2} \frac{V}{\sqrt{K_1 g d}} \right]^{2.5} \qquad (3\text{-}3)$$

S_f	Safety Factor	=	1.1
C_s	Stability Coeff.	=	0.3
C_v	Velocity Distribution Coeff.	=	1
C_T	Thickness Coeff.	=	1
γ_w	Specific Weight of Water (lb/ft^3)	=	62.5
γs	Specific Weight of Stone (lb/ft^3)	=	155
K_1	Side Slope Correction Factor	=	1
g	Gravity Constant (ft/s^2)	=	32.2
d	Flow Depth (ft.)	=	Variable
V	Depth Averaged Velocity (ft/s)	=	Variable

D_{30} = **See table above for D30 results for each riprap item**

Step 3: Determine D50 based on D30

Table 3-1 from Ref 1 used to correlate D30 to W50.

Table 3-1
Gradations for Riprap Placement in the Dry, Low-Turbulence Zones

Limits of Stone Weight, lb[1], for Percent Lighter by Weight

D_{100}(max)	100		50		15		D_{30}(min)	D_{90}(min)
in.	Max	Min	Max[2]	Min	Max[2]	Min	ft	ft
Specific Weight = 155 pcf								
9	34	14	10	7	5	2	0.37	0.53
12	81	32	24	16	12	5	0.48	0.70
15	159	63	47	32	23	10	0.61	0.88
18	274	110	81	55	41	17	0.73	1.06
21	435	174	129	87	64	27	0.85	1.23
24	649	260	192	130	96	41	0.97	1.40
27	924	370	274	185	137	58	1.10	1.59
30	1,268	507	376	254	188	79	1.22	1.77
33	1,688	675	500	338	250	105	1.34	1.94
36	2,191	877	649	438	325	137	1.46	2.11
42	3,480	1,392	1,031	696	516	217	1.70	2.47
48	5,194	2,078	1,539	1,039	769	325	1.95	2.82
54	7,396	2,958	2,191	1,479	1,096	462	2.19	3.17

*The lowest D30 (min) value in Table 3-1 from Ref 1 is 0.37 ft. Many of the areas analyzed for a potential need for riprap yielded D30 values less than 0.37ft. Regardless, engineering judgement is that utilization of riprap in these areas is a reasonable precaution for erosion prevention. Minimum riprap sizes, depths, lengths, and apron widths will be selected for these areas.

W_{50} = **See table above for W50 results for each riprap item**

Equation 3-1 from Ref 1 used to correlate W50 to D50

$$D_{\%} = \left(\frac{6 W_{\%}}{\pi \gamma_s} \right)^{1/3} \qquad (3\text{-}1)$$

D_{50} = **See table above for D50 results for each riprap item**

Step 4: Determine riprap gradation and minimum blanket thickness.

Table 1 from Ref 3 used to correlate D50 to a riprap gradation.

See table above for IDOT gradations and minimum blanket thicknesses

TABLE 1

ROCK RIPRAP SIZES AND THICKNESS

IDOT Gradation Number	d50 (in.)	dmax (in.)	Minimum Blanket Thickness (in.)
RR-3 1/	5	10	15
RR-4	9	14	20
RR-5	12	19	28
RR-6	15	22	32
RR-7	18	27	32

Step 5: Determine bedding thickness from Table in Section 281.04 of Ref 2

See table above for bed thicknesses

Gradation	Min. Thickness	Bedding Thickness
RR 1 & RR 2	6 in. (150 mm)	-
RR 3	8 in. (200 mm)	-
RR 4	16 in. (400 mm)	6 in. (150 mm)
RR 5	22 in. (550 mm)	8 in. (200 mm)
RR 6	26 in. (650 mm)	10 in. (250 mm)
RR 7	30 in. (750 mm)	12 in. (300 mm)

Step 6: Determine riprap apron length Table 2 of Ref 3

See table above for riprap apron lengths

TABLE 2

MINIMUM IDOT ROCK SIZES AND APRON LENGTH
FOR MAXIMUM AND MINIMUM TAILWATER CONDITIONS

Culvert Dia. (in.)	Minimum Tailwater				Maximum Tailwater			
	5 fps 1/		10 fps 1/		5 fps 1/		10 fps 1/	
	Rock Gradation	La (ft.)	Rock Gradation	La (ft.)	Rock Gradation	La (ft.)	Rock Gradation	La (ft.)
12	No. 3	10	No. 3	12	No. 3	12	No. 3	15
18	No. 3	14	No. 4	16	No. 3	12	No. 3	16
24	No. 3	16	No. 4	20	No. 3	14	No. 4	17
30	No. 3	18	No. 4	22	No. 3	16	No. 4	20
36	No. 4	20	No. 5	24	No. 3	16	No. 4	22
48	No. 4	24	No. 6	28	No. 4	20	No. 4	24
60	No. 5	32	No. 6	36	No. 4	22	No. 5	26
72	No. 6	40	No. 6	44	No. 5	24	No. 5	29
96	No. 7	50	No. 7	54	No. 5	26	No. 5	32

Step 7: Determine riprap apron width based on Ref 3

Apron width - When the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less.

If the pipe discharges onto a flat area with no defined channels, the following criteria will be followed. Apron width will be 3 times the pipe diameter at the upstream location. The downstream width will be the pipe diameter plus the apron length for pipes with minimum tailwater conditions and the pipe diameter plus 0.4 times the apron length for pipes flowing under maximum tailwater conditions.

APPENDIX D.8

PIPE STRENGTH DETERMINATION

Stanley Consultants INC.

Computed by: M. Werner Date: 7-27-2021

Checked by: B. de Rosario Date: 8-2-2021

Approved by: J. Meyer Date: 8-3-2021

Purpose:

Check storm sewer concrete pipe strength and select the Class of pipe.

References:

1. Stanley Consultants, Fort Sheridan Drawings, Storm Sewer Profiles

2. American Concrete Pipe Association, LRFD Fill Height Tables For Concrete Pipe

3. American Concrete Pipe Association, LRFD Fill Height Tables For Horizontal Elliptical and Arch Concrete Pipe

Design Criteria:

See Reference 1 for storm sewer no., structure no., pipe size, rim elevation, and invert elevation. Data added to table below.

- Do not use headwall locations, since the slope meets the headwall.

- For culverts estimate the average fill height at the center of the culvert length.

Calculate fill height: rim elev - inv elev - pipe size = fill height

Use the tables in Reference 2 (RCP) and Reference 3 (arch pipe) to select pipe class based on computed fill height.

- Based on the bedding requirements (course sands and gravels compacted to 95%) for the project, select an Installation Type 2 in References 2 and 3 as the closest to the project requirements. Type 2 is conservative and allows for some tolerance in the installation.

- Standard pipe class is Class III, which will be used at all locations unless a Class IV or Class V is required.

Stanley Consultants INC.

Computed by: M. Werner Date: 7-27-2021
Checked by: B. de Rosario Date: 8-2-2021
Approved by: J. Meyer Date: 8-3-2021

Storm Sewer	Structure	Pipe Size	Rim Elev	Inv Elev	Fill Ht	Pipe Class
		ft	ft	ft	ft	
1	MH 1-1	1	671.00	662.90	7.1	III
1	CB 1-1	1	669.80	662.64	6.2	
2	CB 2-1	1.25	669.50	667.00	1.3	IV
2	CB 2-2	1.25	672.00	665.00	5.8	III
2	CB 2-2	2.5	672.00	665.00	4.5	
3	MH 3-1	2	680.30	672.00	6.3	III
3	MH 3-2	2	679.10	671.60	5.5	
3	CB 3-1	2	676.14	671.25	2.9	
3	CB 3-1	2	676.14	667.15	7.0	
3	MH 3-3	2	675.30	666.76	6.5	
3	MH 3-4	2	671.81	665.50	4.3	
3	MH 3-4	2.5	671.81	664.75	4.6	
3	CB 3-2	2.5	671.40	664.75	4.1	
3	CB 3-2	2.5	671.40	664.25	4.6	
4	CB 4-1	2	675.40	670.75	2.6	III
4	CB 3-1	2	676.14	671.25	2.9	
5	CB 5-1	2.5	667.20	660.00	4.7	III
5	MH 5-1	2.5	664.00	659.50	2.0	
5	MH 5-1	2.5	664.00	658.25	3.3	
6	MH 6-2	1	665.25	656.80	7.5	III
6	MH 6-1	1	666.50	656.60	8.9	
7	-	1	684.02	682.50	0.5	IV
8	CB 8-1	2.5	686.25	681.40	2.4	III
8	CB 8-2	2.5	686.00	680.65	2.9	
9	19" x 30"	1.583	682.50	680.50	0.4	IV
10	19" x 30"	1.583	682.00	680.00	0.4	IV
11	CB 11-1	2	682.90	676.25	4.6	III
11	CB 11-1	2.5	682.90	676.10	4.3	
12	-	1	673.00	670.25	1.8	IV
13	-	1	672.50	670.45	1.0	IV

Stanley Consultants INC.

Computed by: M. Werner Date: 7-27-2021
Checked by: B. de Rosario Date: 8-2-2021
Approved by: J. Meyer Date: 8-3-2021

14	-	2	677.50	674.65	0.9	III
16	MH 16-1	1	674.50	668.75	4.8	III
17	MH 17-1	1	668.50	657.00	10.5	III
17	EX MH 17-1	1	666.30	655.00	10.3	
18	CB 18-1	2	672.10	668.40	1.7	III
19	MH 19-1	1	669.00	662.90	5.1	III
19	EX MH 19-1	1	667.00	662.80	3.2	

APPENDIX D.9

LID 95TH PERCENTILE RETENTION DOCUMENTATION

Section A. Local and Contact Information						
Organization	88th Readiness Division					
Installation / Activity Name	Sheridan U.S. Army Reserve Center					
Street Address	3155 Blackhawk Drive					
Town	Fort Sheridan					
City	Highwood					
State	Illinois					
Zip Code	60037-1289					
GPS Coordinates of Center of Site (Decimal Format)						
Latitude	42.208833					
Longitude	87.809342					
Project Name	Storm Water Runoff, Drainage Survey and Design for Fort Sheridan ARC, 88th Readiness Divisior					
Project Description	The project includes the construction of stormwater management facilities to improvement drainage conditions and meet compliance with local regulations to the maximum extent practicable. The proposed stormwater facilities include expansion of an existing detention pond, construction of four new detention ponds, drainage ditches, storm pipes and structures, grinding, resurfacing, and regrading of four Privately Owned Vehicle (POV) lots and one Military Eqipment Parking (MEP) lot (all of which will utilize asphaltic pavement). Incidental work stemming from the proposed improvements include a wastewater utility relocation via the installation of a new sanitary sewer and structures, reinforcement and insulation of another wastewater utility line, the demolition of an existing parking lot and conversion of a portion of it into a drive-thru, relocation of a gas and communication line, and the potential for additional utility relocations depending on what the Contractor encounters in the field. Demolition will include clearing and grubbing, parking lot pavement removal, storm and sanitary sewer removal, and rough grading and excavation.					
DD139 Project Number						
Project Funding Source (e.g. MILCON, OMA, etc.)						
Installation Master Planner						
Name						
Email						
Phone Number						
USAGE Geographic District	Chicago					
USACE Project Manager						
Name						
Email						
Phone Number						
USACE or AE LID Design of Record						
Name	Jason Meyer					
Email	meyerjason@stanleygroup.com					
Phone Number	(952) 843-5517					
Section B. EISA Section 438 LID Calculations. To be provided by LID Designer of Record (Reference UFC 3-210-10, Army LID Technical User Guide, and Army LID Planning Tool, see Design Tools at Link)						
Project Limit of Disturbance (LOD) (acres)	16.65					
95th Percentile Rainfall Depth	1.3					
Pre-Project Site Runoff Curve Number (from LID Planning Tool)	90					
Pre-Project Runoff Volume (ft3) (from LID Planning Tool)	32074					
Post-Project Site Runoff Curve Number (from LID Planning Tool)	86					
Post-Project Runoff Volume (ft3) (from LID Planning Tool)	22052					
LID Volume to be Retained on Site (Difference between pre=project and post-project runoff, #17-#15, ft3)	0					
Total Volume Retained on Site by LID BMPS (Infiltrated or Reused, ft3)	1880					
Does project comply with EISA? YES if Runoff Volume Retained on site (#19) is greater than or equal to Volume Required (#18). (If NO, provide justification in #25)	YES					
Section C. LID BMPs Implemented (From LID Planning Tool)						
BMP Type	**BMP Location on Site (description)**	**LID BMP Area (SF)**	**Volume of Runoff Retained (cf)**	**BMP Cost**		
Grassy Swale	North side of 1st St between C St and B St, South side of 3rd St between C St and B St, C St between 1st St and 9th St, West side of Base between 1 St and 9th St, B St between 3rd St and Building 707	7404	1880	See associated Army LID Planning and Cost Tool Report		
Section D. Other Stormwater Management Requirements						
Name of Watershed project is located in (per State and/or EPA)	Lake Michigan					
Is the installation/activity required to comply with Total Maximum Daily Load regulations?	No					
Name of State and/or Local Stormwater Management Regulatory Authority	Lake County Stormwater Management Commission					
Section E. Technical Infeasibility						
If project does not fully comply with EISA, attach a technical infeasiblity report to this reporting form. *Note: Include all site constraints that prevent the project from full compliance (e.g.	not applicable					

Army LID Planning and Cost Tool Report

PROJECT INFO

Date	1/13/2021
Army Command	Army Reserve
Army Installation	Fort Sheridan
Project name	Storm Water Runoff, Drainag

Project description

The project includes expansion of an existing detention pond, construction of four new

User Name	Brendon de Rosa
Master Planner	

SITE INFO AND EISA VOLUME REQUIREMENT

Project limit of disturbance (ac)	16.65
95% rainfall depth (in)	1.3
Soil type	Silty-Loam
Hydrologic Soil Group (HSG)	C
Pre-project curve number (CN)	90
Post-project curve number (CN)	86
Pre-project runoff volume (cf)	32074
Post-project runoff volume (cf)	22052
EISA Section 438 retention volume requirement (cf)	**None**

LID PLANNING SUMMARY

Structural BMP	Surface area (sf)	Runoff volume retained (cf)
Bioretention:	0	0
Swale:	7404	1880
Permeable Pavement:	0	0
Rainwater Harvesting:	0	0
Green Roof:	0	0
Infiltration Practice:	0	0

Non-structural BMP	Surface area (ac)
Veg. Filter Strip (Slope >2%, Short Grass):	0.00
Veg. Filter Strip (Slope >2%, Tall Grass):	0.00
Veg. Filter Strip (Slope <2%, Short Grass):	0.00
Veg. Filter Strip (Slope <2%, Tall Grass):	0.00
Reforestation (Trees - Short Grass):	0.00
Reforestation (Trees - Shrubs and Tall Grass):	0.00

Total retention volume provided by BMPs (cf): **1880**

Project complies with EISA Section 438.

LID COST SUMMARY

Type	Surface Area (sf)	Estimated Construction Cost	Estimated Annual Maintenance Cost
Swale	25	$2,873.83	$237.48
Swale	54	$4,786.85	$512.95
Swale	56	$2,922.92	$531.95
Swale	65	$4,276.39	$617.44
Swale	66	$3,671.92	$626.94
Swale	71	$3,769.24	$674.43
Swale	82	$3,540.61	$778.92
Swale	102	$3,821.92	$968.91
Swale	102	$4,372.67	$968.91
Swale	104	$4,411.60	$987.90
Swale	105	$4,431.07	$997.40
Swale	110	$3,934.45	$1,044.90
Swale	141	$5,131.82	$1,339.37
Swale	141	$6,115.20	$1,339.37
Swale	179	$5,871.51	$1,700.33

Swale	180	$5,890.97	$1,709.83
Swale	183	$4,137.84	$1,738.33
Swale	192	$6,124.56	$1,823.82
Swale	203	$6,338.68	$1,928.31
Swale	204	$4,912.43	$1,937.81
Swale	221	$6,689.06	$2,099.30
Swale	235	$6,961.57	$2,232.28
Swale	243	$7,117.30	$2,308.28
Swale	378	$7,066.31	$3,590.65
Swale	846	$12,859.49	$8,036.22
Swale	1026	$15,087.64	$9,746.05
Swale	1242	$17,761.42	$11,797.85
Swale	2238	$30,090.50	$21,258.93
Total		**$194,969.79**	**$83,534.87**

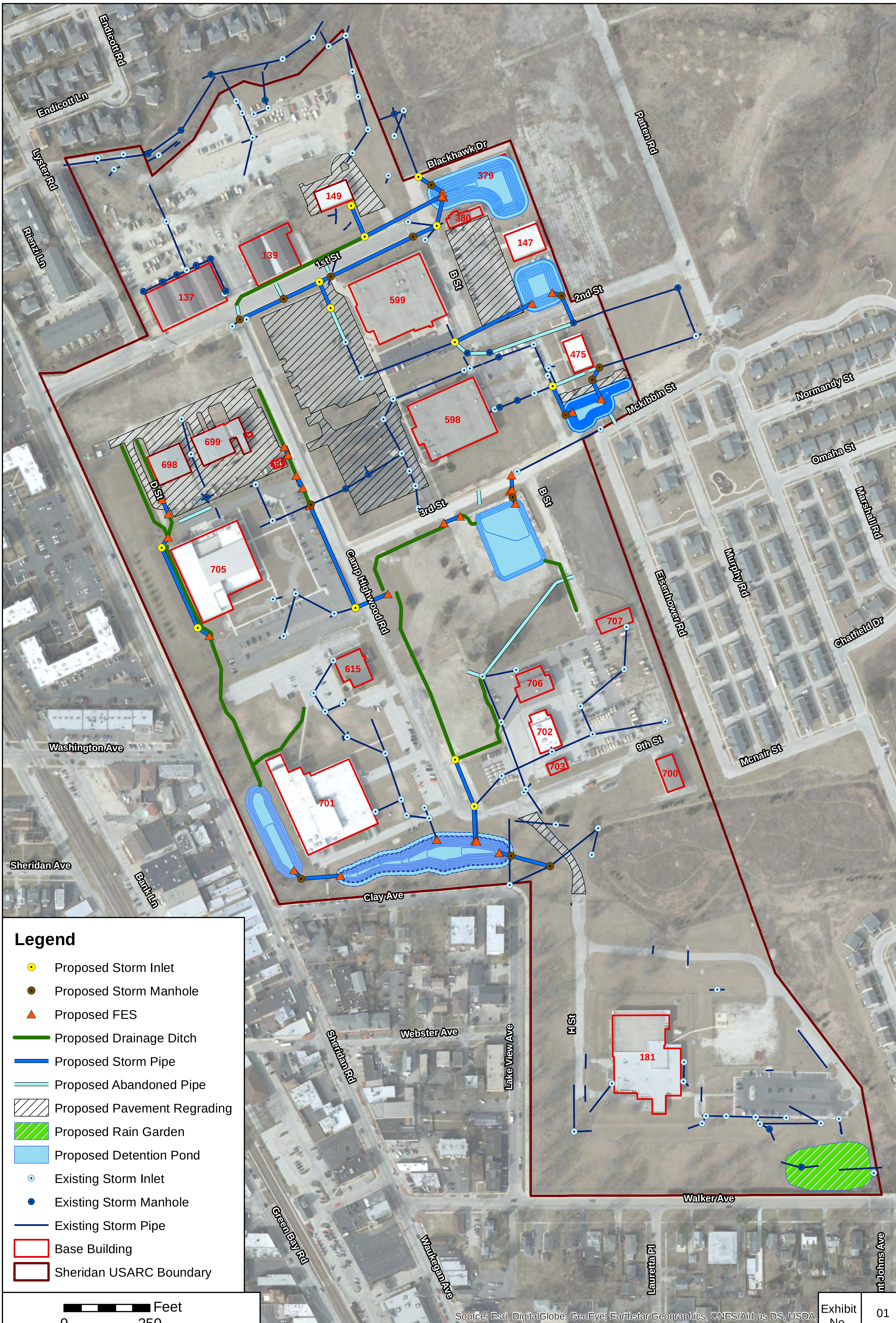
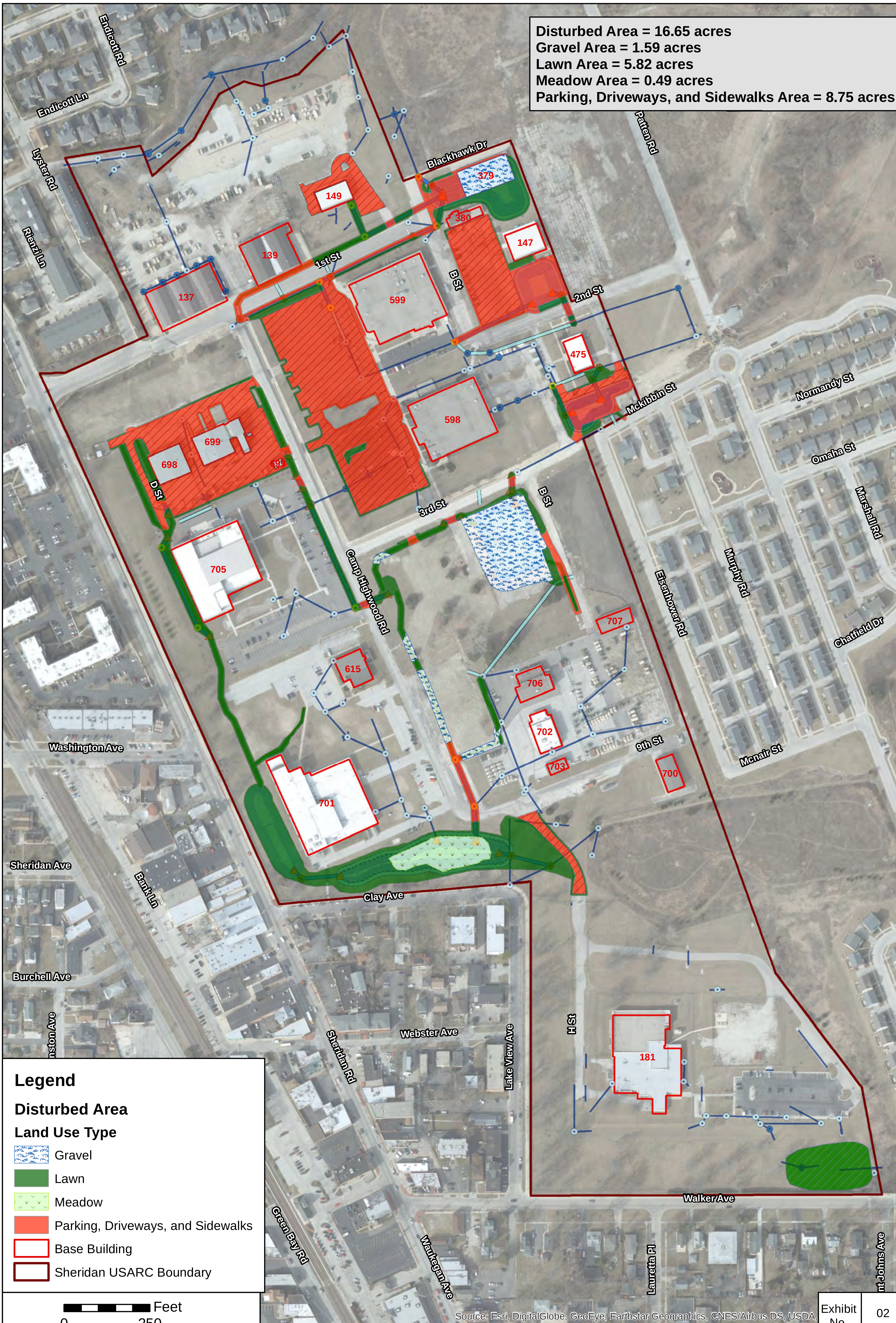


Exhibit No.	01		
Drawn by:	BPD	Checked by:	JJM
Exhibit Title:	Major Alternative Proposed Improvements	Project Title:	Storm Water Runoff, Drainage Survey and Design for Fort Sheridan, 88th Readiness Division
Filepath:	pw://SCI-PWINTEG-2.stanleygroup.com:Datasource-1/Documents/D{af212629-0e92-49c9-9980-7746bf5afea1}	Project No.:	28691.02.00

Stanley Consultants



Stanley Consultants	Exhibit Title:	Disturbed Area - Existing Conditions Land-Use Types	Exhibit No.	02
			Drawn by: BPD	Checked by: JJM
			Project Title:	Storm Water Runoff, Drainage Survey and Design for Fort Sheridan, 88th Readiness Division
	Filepath:	pw://SCI-PWINTEG-2.stanleygroup.com:Datasource-1/Documents/D{af212629-0e92-49c9-9980-7746bf5afea1}	Project No.:	28691.02.00

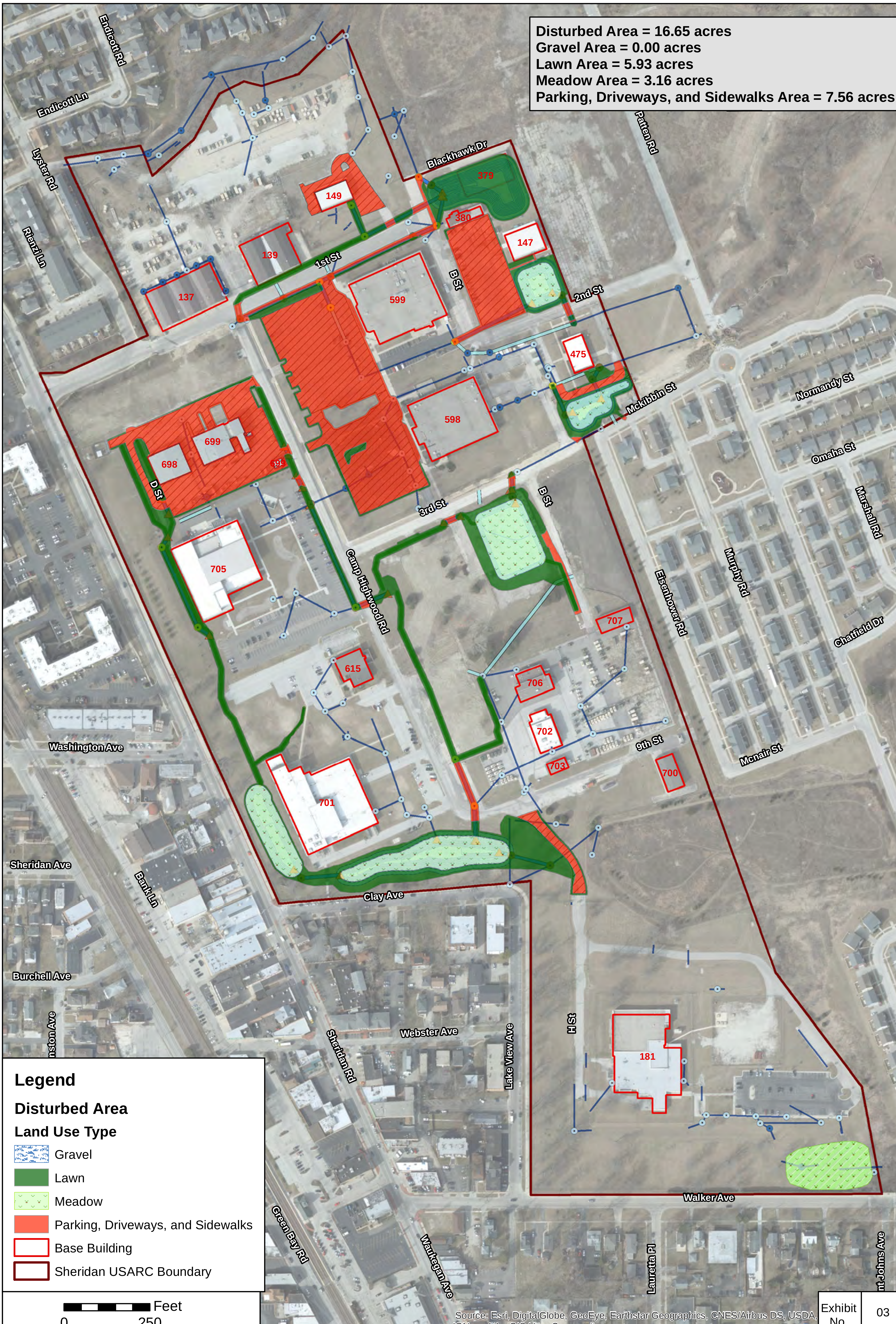


Exhibit No.	03	

Stanley Consultants

Exhibit Title:	Disturbed Area - Proposed Conditions Land-Use Types	Drawn by: BPD	Checked by: JJM
		Project Title:	Storm Water Runoff, Drainage Survey and Design for Fort Sheridan, 88th Readiness Division
Filepath:	pw://SCI-PWINTEG-2.stanleygroup.com:Datasource-1/Documents/D{af212629-0e92-49c9-9980-7746bf5afea1}	Project No.:	28691.02.00

APPENDIX E

EPA SWMM MODEL FILES

SUB-APPENDICES

APPENDIX E.1 – EXISTING CONDITIONS FILES

APPENDIX E.2 – MAJOR ALTERNATIVE FILES

APPENDIX E.1

EPA SWMM MODEL FILES

EXISTING CONDITIONS

(SEE .INI/.INP FILES PROVIDED WITH THE 65% DESIGN SUBMITTAL)

APPENDIX E.2

EPA SWMM MODEL FILES
MAJOR ALTERNATIVE CONDITIONS

(SEE .INI/.INP FILES PROVIDED WITH THE 65% DESIGN SUBMITTAL)

APPENDIX E.3

EPA SWMM MODEL FILES
MODERATE ALTERNATIVE CONDITIONS

(SEE .INI/.INP FILES PROVIDED WITH THE
65% DESIGN SUBMITTAL)

APPENDIX F

LAND USE CONTROL REMEDIAL DESIGN DOCUMENTS

SUB-APPENDICES

APPENDIX F.1 – LAND USE CONTROL REMEDIAL DESIGN FOR LANDFILL 5 AND COAL STORAGE AREA 3

APPENDIX F.2 – FORT SHERIDAN LADFILLS 6 & 7 LAND USE CONTROL REMEDIAL DESIGN

APPENDIX F.1

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

REPLY TO
ATTENTION OF

Base Realignment and Closure Division

AUG 0 8 2015

Mr. Brian Conrath
Illinois Environmental Protection Agency
1021 N. Grand Avenue
Springfield, IL 62794

RE: Final Land Use Control Remedial Design for Landfill 5 and Coal Storage Area 3 Fort Sheridan, IL

Dear Mr. Conrath:

The Department of the Army is providing the Illinois EPA with two hard copies of the Final Land Use Control Remedial Design for Landfill 5 and Coal Storage Area 3 for your file. If you have any questions, please contact Bill Millar at 703-545-2493.

Sincerely,

William O'Donnell
Chief, Reserve, Industrial
and Medical Branch

Enclosures

cc: Andrew Van Dyke - Army
Bill Millar - Fort Sheridan BEC
Dave Moore - Army Reserve
Bruce Mack – Navy
Bob Megquier – OpenLands
Colleen Reilly – CH2M Hill
Administrative Record
Information Repository

Printed on Recycled Paper

Final

Landfill 5 and Coal Storage Area 3
Land Use Control Remedial Design

Department of Defense Operable Unit

Fort Sheridan, Illinois

05 August 2015

Prepared by:

Headquarters, Department of the Army
Base Realignment and Closure Division
2530 Crystal Drive
Arlington, VA 22202

Table of Contents

Figure

Acronyms

BEC	BRAC Environmental Coordinator
bls	below land surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COC	chemical of concern
CSA	coal storage area
DD	Decision Document
DoD	Department of Defense
HQDA	Headquarters Department of the Army
ILCS	Illinois Compiled Statute
Illinois EPA	Illinois Environmental Protection Agency
LF	landfill
LUC	Land Use Control
LUC RD	Land Use Control Remedial Design
NCP	National Contingency Plan
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbons
POC	point of contact
RCRA	Resource Conservation and Recovery Act

1.0 Background

Landfill 5 (LF5) and Coal Storage Area 3 (CSA3) are located in the central portion of Fort Sheridan (Figure 1). LF5 was used to dispose of general refuse, including fill and construction debris, from about 1900 through the 1960s. LF5 is located on the east side of Bartlett Ravine in a north-south trending tributary of the ravine and covers 2.3 acres (Figure 2).

Former CSA3 was located on the west side of Bartlett Ravine and occupied 0.5 acres along Stables Court. This area is 410 feet long between the property line and the tree line immediately adjacent to the ravine, varying in width from about 8 to 16 feet. The densely wooded, steep ravine slope bounds the south area and private homes bound the north side of CSA3 (Figure 3).

Wastes encountered at LF5 have included cinders and other burned material along with trash dating back to the early 1900s. Construction rubble reportedly was disposed of at this site during the mid-1960s. No records are available that document the disposal of hazardous waste at the site. The landfill site is located in an area that currently is used for vehicle and equipment storage and shop activities and is surrounded by warehouse facilities. Some of the landfill area is paved with asphalt or concrete and a portion of the site is enclosed with fences. Army Reserve Building 149 is located within the landfill footprint. Three additional buildings are located within the currently-identified Army landfill buffer zone. Subsurface utilities are present within the landfill fill area and the buffer zones.

Remedial Investigation (RI) results (ESE 1992) indicated that risks for the current land use scenarios are within or below the target risk management range. RI results found that waste and contaminated subsurface soil within Landfill 5 are contaminated with PAHs and lead from the surface to about 22 feet bgs. While the Baseline Risk Assessment estimated that risks for the current land use scenario met U.S. EPA standards for public health protection; levels of PAHs and lead may present risk to future residential and recreational land users through direct contact with or ingestion of the substances if they are exposed. The maximum concentration of lead detected at Landfill 5 was 540 mg/kg in the subsurface soil and 3,600 mg/kg in the landfill waste. The RI found no evidence that the waste in Landfill 5 is contributing any contaminants to the underlying groundwater. In addition, the results for LF5 indicated that soil and waste within the estimated ravine tributary area is contaminated with lead, benzo(a)pyrene, and benzo(b)fluoranthene at concentrations that present unacceptable risk to potential future land users. Overall, the concentrations and number of detected compounds in the subsurface soil decreased with depth within the fill materials and were markedly lower in the undisturbed glacial soil. Analyses of the undisturbed, subsurface glacial soils (which underlie fill and waste materials at LF5) found no significant contamination.

CSA3 was an open area used to stockpile coal for industrial heating. Until 1999, CSA3 occupied land on the Surplus Operable Unit (OU) and the Department of Defense (DoD) OU. In 1999, a removal action (excavation and off-site disposal) was conducted to mitigate risks posed by polycyclic aromatic hydrocarbons (PAHs) related to coal at the western Surplus OU portion of CSA3 and part of the DoD OU portion of CSA3 up to the crest of the ravine. At the conclusion of the removal action, the Army recommended, and Illinois EPA concurred with, the conclusion of a "No Further Response Action Decision Paper" for the Surplus OU portion of CSA3. This property was subsequently transferred for redevelopment to the Town of Fort Sheridan and now contains three houses at the north end, a playground in the northwest end, and a storm water retention basin in its central portion.

The Remedial Investigation of the DoD OU portion of the CSA 3 parcel found PAH contamination in soils at depths up to 10 feet bgs. The human health risk assessment (HHRA) conducted as part of the RI estimated that that risks for the current land use scenarios for CSA 3 do not exceed U.S. EPA's standards for public health protection; however, subsurface levels of PAHs may present risk to future residential, industrial, and recreational land users through direct contact with or ingestion of PAHs if the receptors are exposed to landfill waste material. This area for potential exposure is confined to DoD property along the edge of the ravine and two areas at the northern end of CSA 3 where test pits excavated during the RI identified the presence of PAH contamination from the surface to about 2 feet bgs in portions of two cells. Additional refuse that was not removed during the 1999 removal action was found in portions of these cells.

Historical maps of the area identify a short branch of Bartlett Ravine that extended northwest into CSA3, straddling the Surplus OU and DoD OU. This branch had been filled with refuse, including paper, ceramics, and ash, from about 5 to 20 feet bls. During the removal action in 1999, much of the filled area was excavated to between 10 and 15 feet bls and soil from the top *5* feet was disposed of off-site; however, the volume of refuse on DoD property was too great for inclusion in the removal action and some of the refuse was returned to the excavation pit and covered with *5* feet of clean clay backfill.

Parts of CSA3 are on land that lies within the Town of Fort Sheridan and on land that belongs to Openlands. Openlands is an accredited land trust to which the Navy donated land along the bluffs and ravines at Fort Sheridan. The part of CSA3 that requires Land Use Controls (LUCs) is on the Openlands property. Parts of LF5 are on land that belongs to the Navy, the Army Reserve (Reserve) and Openlands. For the purposes of this document the “owners” include the Navy, Reserves and Openlands. Figure 4 shows the portions of the Openlands property that are on LF5 and CSA3 and require LUCs. If parcels containing parts of CSA3 and LF5 and associated buffer zones requiring LUCs are sold to other parties, the LUCs discussed in this document shall transfer with the ownership.

The U.S. Department of the Army’s (Army) presence at LF5 and CSA3 is solely for the purpose of implementing, operating and maintaining the remedial actions for LF5 and CSA3. The Army implemented the remedy including the construction of a cap at LF5 in accordance with Decision Document for LF5 and CSA3 (KEMRON 2004 c). The construction was done in accordance with the Remedial Design Document LF5 (KEMRON 2004a) and the Remedial Design Document (DD) Coal Storage Area 3 (KEMRON 2004 b) and was approved by the Illinois Environmental Protection Agency (Illinois EPA).

Key DD items

The key elements of the DD for LF5 included:

- Erosion controls were installed.
- Concrete cores were taken to determine the nature and thickness of the concrete roadway on 1st Street.

- For areas of the landfill already covered by asphalt, the asphalt and any underlying aggregate were removed to a depth that provided an appropriate sub-base. The sub-base was compacted and smooth-rolled. Grading was conducted to create proper elevations for drainage.
- A geomembrane was placed over the graded sub-base and two feet of clay were placed over the geomembrane and compacted creating a low-permeability cover.
- Depending on the use of the area, either six inches of asphalt/aggregate (for parking) or six inches of topsoil (for green space) were placed over the clay. Turf or prairie grass was planted on the top soil to minimize erosion.
- The ravine slope was thinned of excess, predominantly mid-story, non-native vegetation and seeded with a mix of native groundcover to improve erosion control along the slope. Army will consult with Openlands concerning native species prior to future pruning and seeding.
- The LUC objective is to prevent residential use or any intrusive activities. All LUCs will be included in the Five-Year Review required under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and National Contingency Plan (NCP). Until property transfer of LF5 occurs, physical engineered LUCs to contain contamination and restrict access to the site such as fences and signs will be used.

The key elements for the DD for CSA3 included:

- Erosion controls were installed.
- Confirmation sampling was conducted after excavation was complete to verify that risk had been reduced to an acceptable level, and the post-removal action was verified prior to completion of the cover.
- Two areas at the northern end of CSA3 were excavated and covered with topsoil.
- The ravine will be monitored to ensure the effectiveness of the remedial alternative, and maintenance or further improvement will be implemented as needed.
- The ravine slope was thinned of excess, predominantly mid-story, non-native vegetation and seeded with a mix of native groundcover to improve erosion control along the slope. Army will consult with Openlands concerning native species prior to future pruning and seeding.

1.1. Purpose

The purpose of this Land Use Control Remedial Design (LUC RD) is to present the LUC objectives; define the appropriate LUCs for each area; and describe the implementation process, including monitoring, enforcement, modification, and termination of LUCs. As recommended in the Decision Document (DD) for LF5 and CSA3, these areas have been identified for the implementation of LUCs.

2.0 Land Use Controls Objectives

The Army will implement LUCs to achieve the performance objectives listed below for LF5 and CSA3. Figure 5 depicts the LUC boundaries (e.g. Buffer Zone) for LF5.

The LUC objectives at LF5 and CSA3 are as follows:

1. Prevent unauthorized intrusive activity or excavation at LF5 or CSA3.
2. Prevent alteration, damage, or removal of any portion of the final remedy. This may include restrictions on surface activities and/or access restrictions to the property, as necessary to maintain the integrity of the cover system.
3. Maintain the facilities in accordance with the O&M Plan.
4. Prevent access to or use of groundwater.
5. At LF5, maintain a 100-foot buffer zone around the fill material adjacent to current Army Reserve and Openlands property. A 300-foot buffer zone will be maintained around the LF5 fill material adjacent to Navy property. No new construction can take place on LF5 or within the buffer zone without approval from the Army, and the Illinois EPA along with applicable landowners as necessary in the event the property is leased.

3.0 Land Use Controls

This section provides a description of the LUCs, the logic for their selection, and implementation actions. As previously noted, the parcels of land underlying LF5 are owned in part by the Navy, the Army Reserve and Openlands. Part of CSA3 is owned by Openlands. The Army is obligated, by the DD and this LUC RD, to operate and maintain the final remedy identified in the DD and to implement, inspect, report, and maintain the LUCs for LF5 and CSA3 pursuant to CERCLA. The Army and IEPA have a right to enforce the LUCs. The Army shall remain responsible for the O&M of the remedy as identified in the DD and for LUC integrity in the event of any future transfer of the property to a third party. The Army or its representative will monitor the LUCs. Should any LUC be violated, the Army will ensure that appropriate actions are taken to terminate the offending land use, and remedy the situation.

The Army shall survey the property extent subject to environmental LUCs (inclusive of buffer areas) and will provide this information to the Navy and Openlands. The survey shall clearly show not only the extent of property subject to LUCs, but also property ownership. The Navy, the Army Reserve, and/or Openlands will be responsible for notifying the, Army, and Illinois EPA if any party decides to transfer their respective property.

3.1. Land Use Restrictions

No unauthorized changes to the remedy will be permitted without Army, and Illinois EPA approval. LF5 and CSA3 pose no unacceptable threat to human health and the environment provided the following Land Use Restrictions are employed:

1. Operations and Maintenance of the remedy identified in the DD
2. Groundwater Restriction

Other than for the installation of and obtaining samples from groundwater monitoring wells, there shall be no access to or use of the groundwater on LF5 or CSA3, or within the buffer zone for any purpose without the prior written approval of the Illinois EPA and the Army, Army Reserve, Navy, or Openlands, as appropriate.

3. Buffer Zone Restrictions

Activities that are restricted within the buffer zone shall include:

- No new building foundations or structures of any kind.
- No intrusive activities of any kind without permission from the Army, and Illinois EPA.

4. Remedy Restrictions

- No digging or excavation shall be permitted on LF5 or CSA3 without prior written approval of the Army and the Illinois EPA, except:
  - Required remedy activities.
  - Other activities as verbally approved by the Illinois EPA, Army, and the owners as appropriate e.g. exigent circumstances. (Note: Utility work requires prior permission, verbal may be appropriate in the event of exigent circumstances the party performing the action would be expected to return the remedy to its original condition).
- The Army may restrict access to the property and/or restrict activities on the surface of LFA or CSA 3 as necessary to ensure protectiveness and to prevent damage to the integrity of the cover system.

5. Physical Land Use Controls

The Army has implemented and will maintain the following measures to prevent or minimize damages to the remedies:

- Warning signs placed along the boundary to limit intrusive activities within the landfill boundaries. The signs are placed within a line of sight distance from each other, in any event, no less than approximately every 250 feet along the boundaries on Army Reserve and Openlands property where there is unobstructed line of sight. For the landfill boundary on Navy property the signs will be installed no less than approximately every 100 feet along the boundary where there is unobstructed line of sight. A telephone number is posted to encourage people to call if any damage has been noticed.
- Army's contractor who is onsite to perform operation and maintenance activities will intervene with any potential violator of a LUC and/or report immediately to the BRAC Environmental Coordinator (BEC) and appropriate authorities (e.g. Highland Park Police, PPV, Navy, Army or Openlands points of contact (POCs)).

4.0 Modifications or Termination of LUCs

All remedy components, including LUCs for LF5 and CSA3 are expected to remain in place indefinitely, unless further action is taken to remove the waste and reduce the concentrations of hazardous substances in soil to levels that allow for unlimited use and unrestricted exposure.

No one shall, without Army and Illinois EPA approval, make any land use changes inconsistent with the LF5 and CSA3 remedy or this LUC RD. The Army shall provide at least a 14 day notice to the Illinois EPA and seek approval prior to commencing actions that may impact remedy integrity.

No one shall, without Army and Illinois EPA approval, terminate or modify any LUC or remedy component. The decision to terminate or modify LUCs will be documented consistent with the NCP process for post-DD changes.

5.0 Monitoring and Reporting

Monitoring of LUCs in the form of site inspections will be conducted by the Army to confirm whether the LUCs remain effective and meet LUC objectives for continued remedy protectiveness. Visual inspections will be conducted periodically and formal inspections will be performed quarterly. Monitoring frequency will be coordinated with and approved by Illinois EPA and the owners. The Army will provide the IEPA with a summary report on the condition of the site and the remedy annually. The State and owners will be notified of any remedy breach, LUCs included, within 24 to 72 hours of discovery.

The Army will prepare a Five-Year Review report that will evaluate the status and effectiveness of LUCs with a description of how any LUC deficiencies or inconsistent uses were addressed. As part of the Five-Year Review report, a written certification will be submitted stating the LUCs remain in place and are effective. Inspection reports and monitoring results will be submitted in the Five-Year Review report.

6.0 CERCLA 121(C) Five-Year Reviews

As required under CERCLA Section 121 (c) five-year remedy review process, the Army shall prepare a report evaluating the continued effectiveness of the remedy, including effectiveness of the LUCs. Also addressed will be an assessment of whether there is a need to modify the LUCs. Each remedy review will evaluate whether conditions have changed due to contaminant attenuation, migration or other factors such as land use. If risk levels have changed since initial LUC implementation, LUC modification will be considered. The five-year review will include the CERCLA required components: 1) community involvement and notification, 2) document review, 3) data review and analysis, 4) site inspection, 5) interviews, and 6) protectiveness determination.

7.0 Implementation Actions

The Army shall work with the Navy, Army Reserve, and Openlands to ensure that the following LUC objectives are met.

A. The Navy, Army Reserve or Openlands will consult the Illinois EPA, and the Army prior to any leasing or transfer of property as provided in Section 8.0 below. However, it is noted that the Navy, Army Reserve and Openlands have no current or future plans to release said property. LUCs shall remain in place until the Army, Illinois EPA and owner(s) agree, in writing, that the restrictions are no longer required to protect human health and the environment.

B. Army Enforcement - If the Army becomes aware of an action that interferes with or violates any portion of the selected remedy, including the LUCs, it will take immediate action to resolve the matter. The Army will notify Illinois EPA and the Navy, Army Reserve or Openlands within three days of becoming aware of the violation. If the matter is not resolved, the Army will notify Illinois EPA and the Navy, Army Reserves or Openlands of the results of its resolution efforts (e.g., any corrective action) or proposal to resolve the matter within ten (10) days of discovery of the violation.

C. Five-Year Certification - The Army shall every five-years, or within such time as may be allowed (with the consent of Illinois EPA), perform a physical inspection confirming that no changes or damages have been made to the remedy and submit a written statement certifying that the land use controls employed at LF5 and CSA3 are still effective and unchanged from the previous certification, or that any changes to the controls were approved by Illinois EPA and that nothing has occurred that would impair the ability of such controls to protect human health and the environment. The Army has provided the IEPA with an annual summary report on O&M activities and data collected at monitored environmental sites at Fort Sheridan, this practice will continue.

8.0 Leases and Property Transfers

If the LF 5 or CSA properties (defined as being inclusive of identified buffer areas) are ever transferred, the Navy, the Army Reserve and/or Openlands, as applicable, shall notify the Army and Illinois EPA prior to leasing or transferring its property. Such notification shall be given no later than sixty (60) days prior to the lease or transfer execution. The notice shall identify the proposed lessee or transferee and describe any additional mechanism(s) to be used for future LUC responsibilities after lease or transfer. This may include requiring the transferee or lessee and subsequent property owner(s) to assume certain responsibilities for LUC implementation actions. Any responsibilities assumed by transferee(s) and subsequent owner(s) and user(s) shall be clearly documented in the appropriate transfer/lease documentation and the required environmental covenant as per the Uniform Environmental Covenant Act.

If the Navy, Army Reserve and/or Openlands, as applicable, intend to convey ownership of LF5 or CSA3 or any portion thereof to a non-federal entity, the Navy, Army Reserve and/or Openlands, as applicable, will follow the appropriate laws, regulations and policies as required, including but not limited to CERCLA 120(h) and the Uniform Environmental Covenant Act 765 Illinois Compiled Statutes 122, *et seq*. Each deed will also contain a reservation of access to the property for the IEPA and the Army.

The Army will continue to: (1) conduct all CERCLA 121(c) reviews; (2) notify the appropriate state and/or local government representatives of any known LUC deficiencies or violations; (3) reserve the right to access the property to conduct any necessary response; (4) reserve the authority to change, modify or terminate LUCs, with Illinois EPA and owner approval; and (5) remain responsible for remedy integrity.

9.0 Responsibilities of Subsequent Owner/Lessee

In the event of property transfer or lease, the Navy, Army Reserves and/or Openlands, will consult with the Army and Illinois EPA to determine the requirements of the lease or property transfer with respect to these LUCs. Any responsibilities assumed by transferee(s) and subsequent owner(s) and user(s) shall be clearly documented in the appropriate transfer/lease documentation and the required environmental covenant as per the Uniform Environmental Covenant Act.

The Army will continue to: (1) conduct all CERCLA § 121(c) reviews; (2) notify the appropriate state and/or local government representatives of any known LUC deficiencies or violations; (3) reserve the right to access the property to conduct any necessary response; (4) reserve the authority to change, modify or terminate LUCs, with Illinois EPA in the event that such changes or modifications are significant; and (5) remain responsible for remedy integrity.

10.0 References

DOD (U.S. Department of Defense). 2001. Policy on Land Use Controls Associated with Environmental Restoration Activities. January.

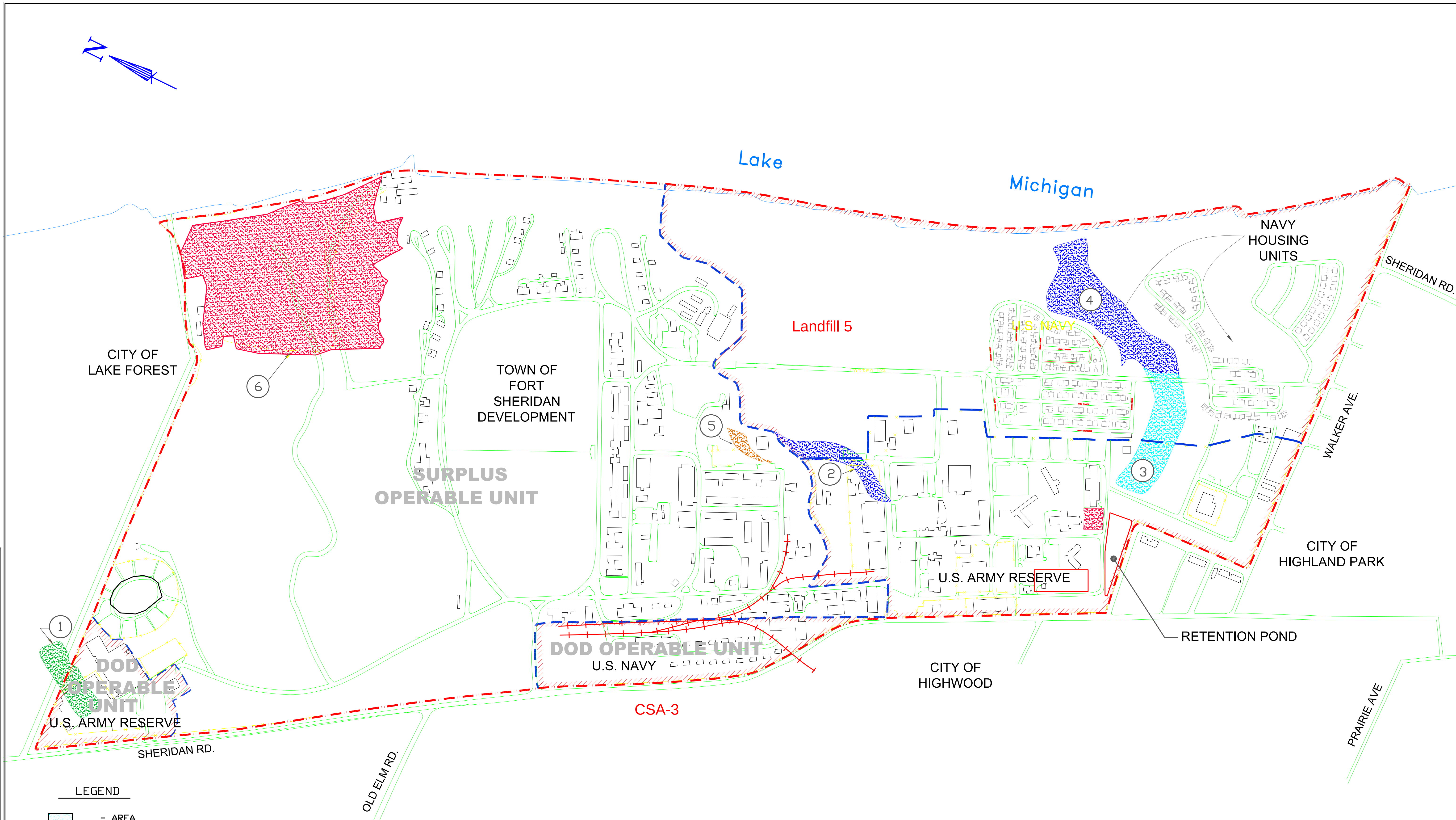
Environmental Science and Engineering, Inc. (ESE). 1992. Draft Final Remedial Investigation (RI)/Risk Assessment (RA) Report -- Remedial Investigation/Feasibility Study Fort Sheridan, Illinois (3 Volumes). June 01.

KEMRON, 2004a. Remedial Design Document Landfill 5 Fort Sheridan Environmental Restoration Project. US Army FORSCOM BRAC OFFICE, July 12

KEMRON, 2004b. Remedial Design Document Coal Storage Area 3 Fort Sheridan Environmental Restoration Project. US Army FORSCOM BRAC OFFICE, July 12

KEMRON, 2004c. Decision Document Coal Storage Area 3 and Landfill 5, Fort Sheridan Environmental Restoration Project. US Army FORSCOM BRAC OFFICE, November 5.

Figures



LEGEND

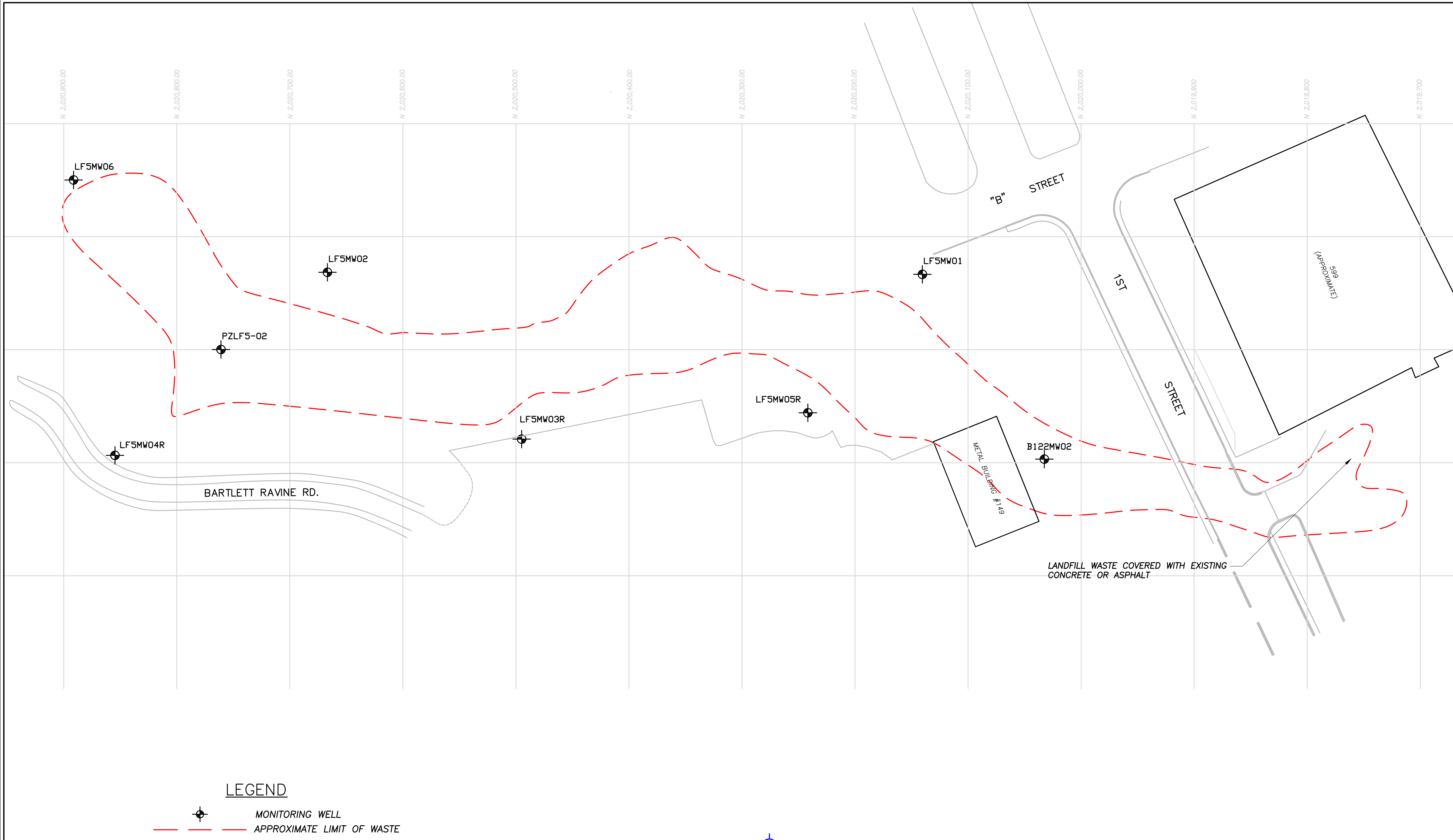
- AREA
- BUILDINGS
- FENCE
- ASPHALT ROADS
- RAILROAD TRACK
- OPERABLE UNIT BOUNDARIES
- PROPERTY BOUNDARY

Number	Feature
1	Landfill #1
2	Landfill #5
3	Landfill #6
4	Landfill #7
5	Coal Storage Area #3
6	Landfill #2

KEMRON ENVIRONMENTAL SERVICES

0 350 700
SCALE 1"=700' (APPROXIMATE)

EDITED BY:	DATE: 21 SEPT. 2012	FIGURE 1	SITE MAP
DRAWN BY: JM	PROJECT NO. CH0010.500.004		
REVIEWED:	DWG. NO. STE MAP. FIG. 1		FORT SHERIDAN, ILLINOIS
APPROVED:			

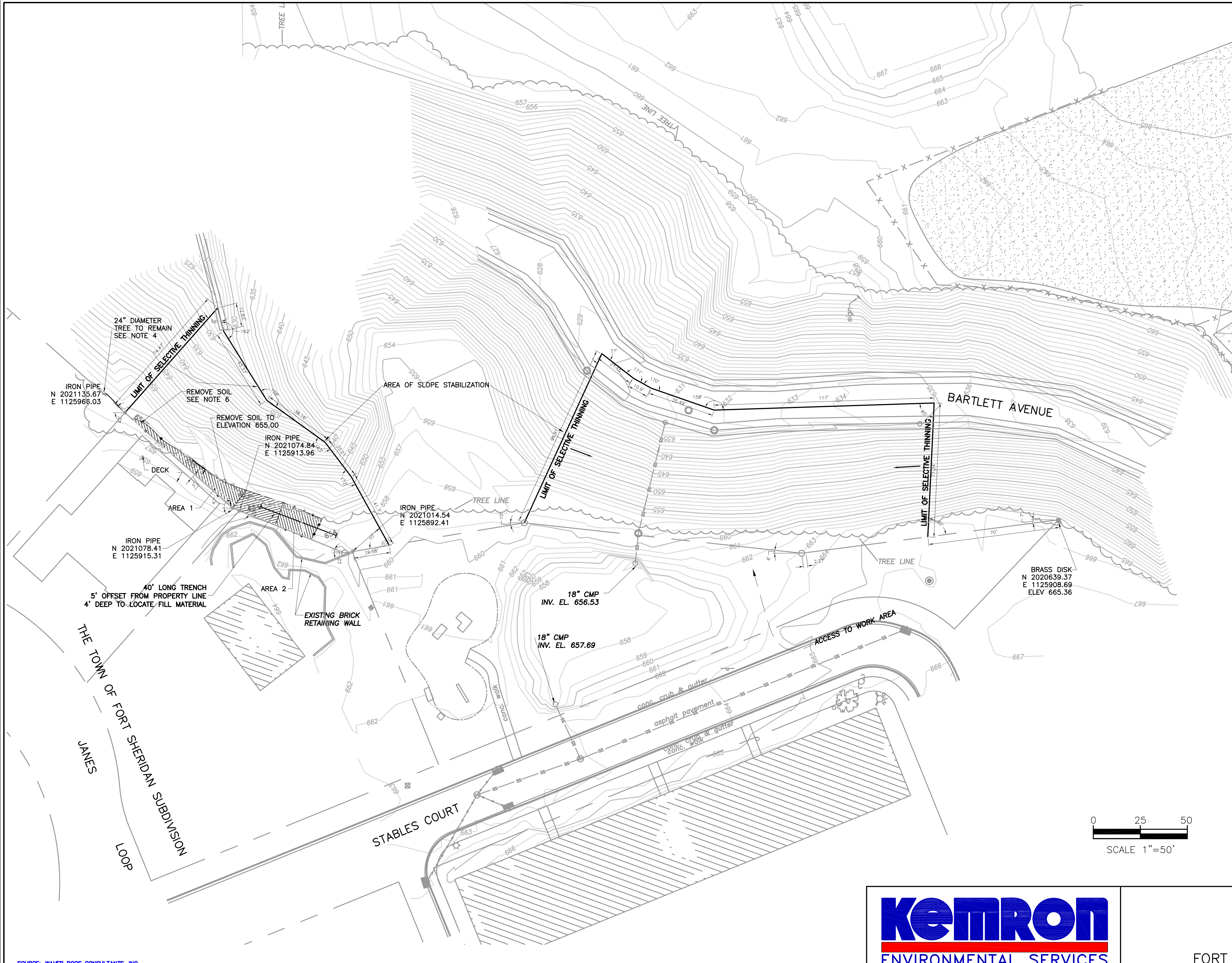


KEMRON ENVIRONMENTAL SERVICES

LANDFILL 5
GROUNDWATER WELL
LOCATION MAP
FORT SHERIDAN, ILLINOIS

FIGURE
2

SOURCE: WAVER BOOS CONSULTANTS, INC.



NOTES:

1. ACCESS TOP OF SLOPE WORK AREAS FROM STABLES COURT. PROTECT CURB & GUTTER FROM DAMAGE. RESTORE SEEDED AREAS DAMAGED DURING CONSTRUCTION.

2. ACCESS BOTTOM OF WORK AREAS FROM RAVINE ROADWAY.

3. CONTRACTOR SHALL VERIFY LOCATION OF PROPERTY LINE ABUTTING WORK AREA, PRIOR TO ANY EXCAVATION WORK. LOCATE ALL PROPERTY CORNERS AND VERIFY LOCATION OF IRON PIPES. NOTIFY ENGINEER OF ANY DISCREPANCY.

4. SAVE AND PROTECT 24" TREE. HAND EXCAVATE SOIL IN AREA 1 UNDER THE TREE OUT TO THE DRIP LINE. EXCAVATE, BY HAND, THE TOP 18 INCHES OF SOIL TO SAVE THE TREE ROOTS. THE EXCAVATED SOIL IS CONSIDERED CONTAMINATED AND SHALL BE DISPOSED OF ACCORDING TO SPECIFICATIONS. ALL PLANTS IN THIS AREA SHALL BE REMOVED AND DISPOSED OF IN THE LANDFILL.

MH-1 RIM EL. 659.21
B/MH EL. 652.83

LEGEND

- EXISTING CONTOURS
- PROPERTY LINE
- STORM SEWER PIPE
- EXCAVATION AREA
- SAMPLING LOCATIONS
- WATER MANHOLE
- STORMWATER MANHOLE
- MANHOLE
- CATCH BASIN
- STORMWATER INLET
- STORMWATER INLET
- SANITARY MANHOLE
- CABLE PEDESTAL
- TRANSFORMER
- SIGN
- POWER POLE
- FIRE HYDRANT
- VALVE BOX
- MONITORY WELL WITH POSTS
- MONITORY WELL
- B-BOX
- IRON PIPE
- ANCHOR
- TREE

KEMRON ENVIRONMENTAL SERVICES

CSA 3
SITE MAP

FORT SHERIDAN, ILLINOIS

FIGURE 3

SOURCE: WAVER BOOS CONSULTANTS, INC.

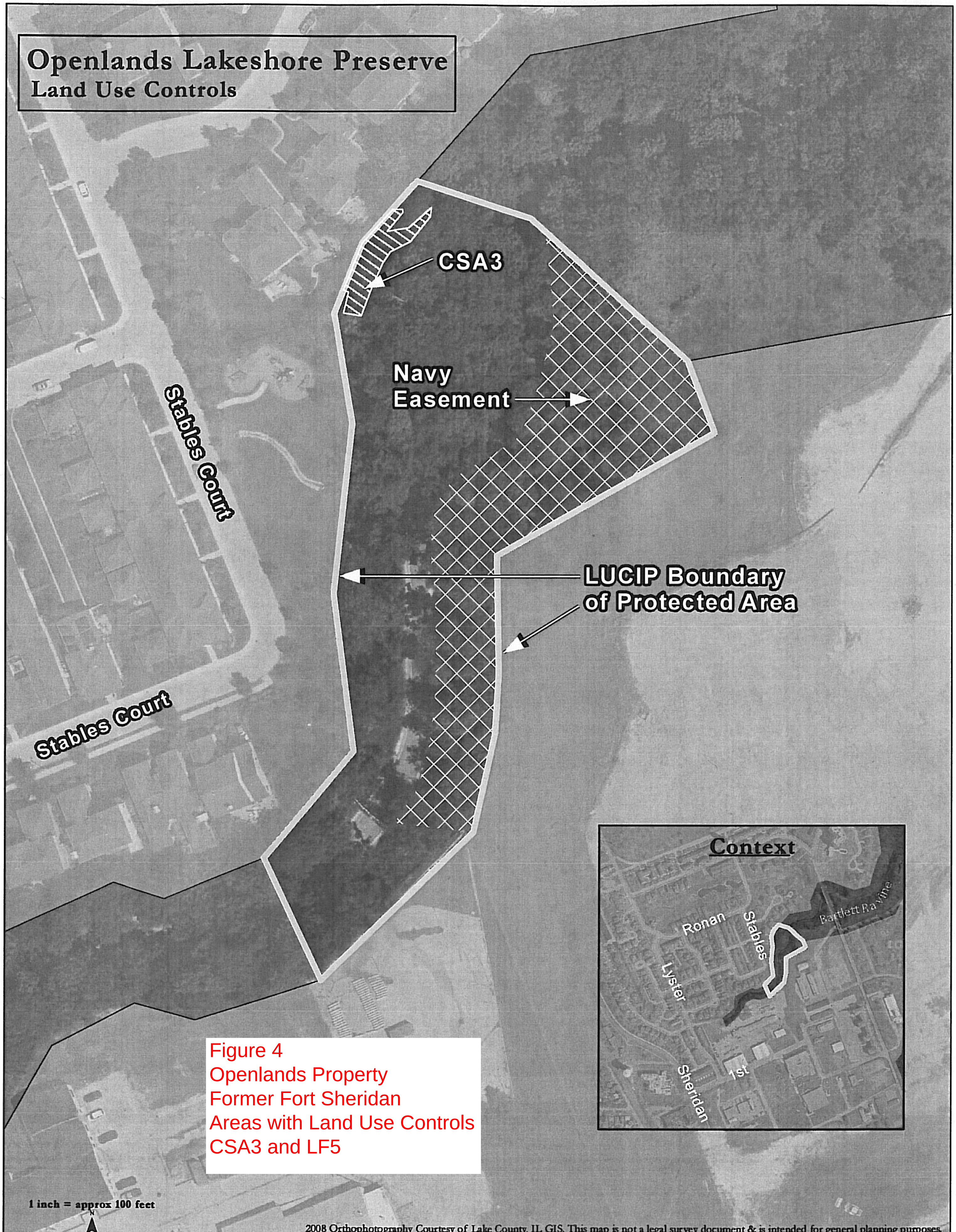
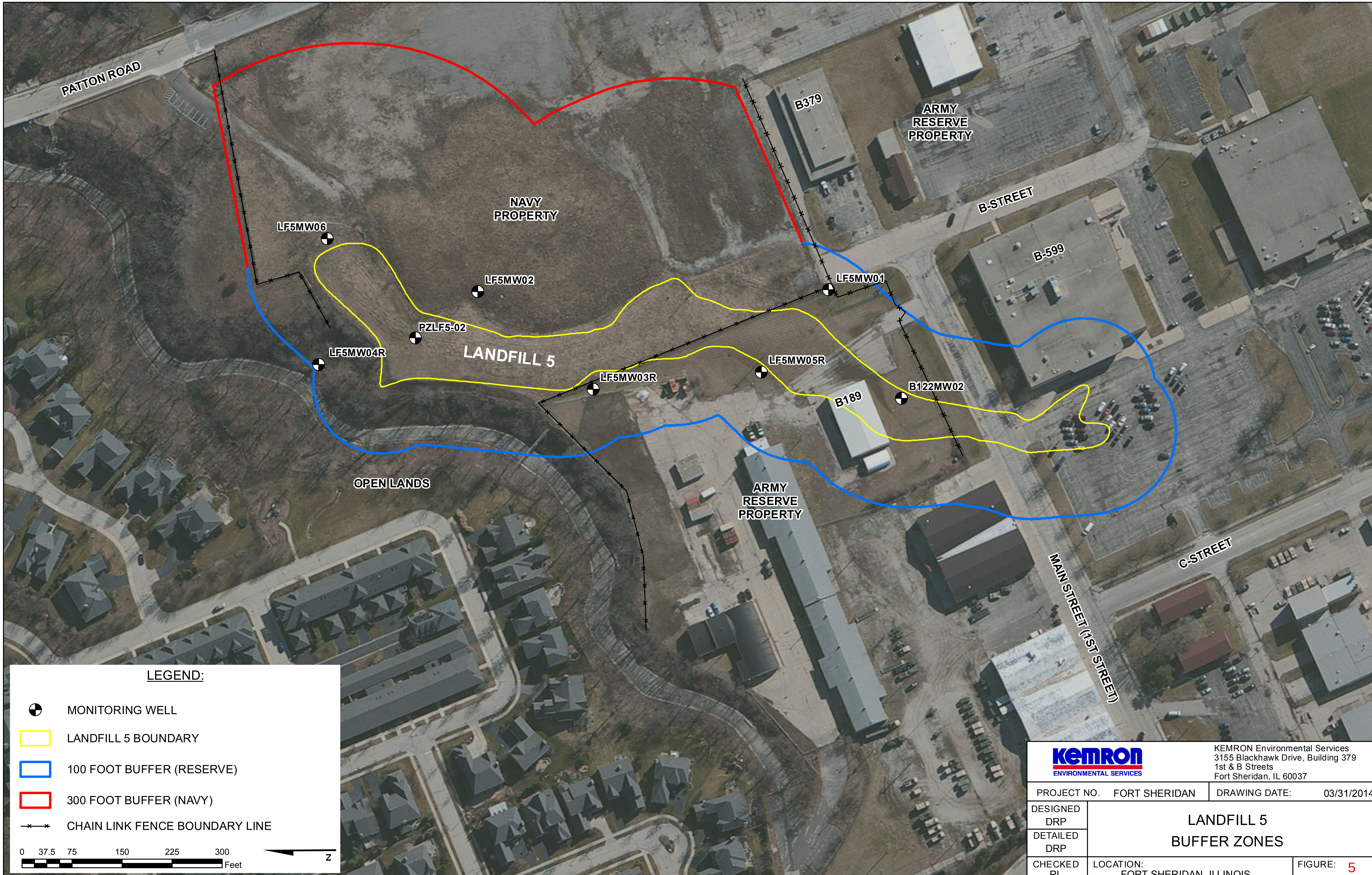


Figure 4
Openlands Property
Former Fort Sheridan
Areas with Land Use Controls
CSA3 and LF5



LEGEND:

MONITORING WELL

LANDFILL 5 BOUNDARY

100 FOOT BUFFER (RESERVE)

300 FOOT BUFFER (NAVY)

CHAIN LINK FENCE BOUNDARY LINE

0 37.5 75 150 225 300 Feet

N

KEMRON ENVIRONMENTAL SERVICES

KEMRON Environmental Services
3155 Blackhawk Drive, Building 379
1st & B Streets
Fort Sheridan, IL 60037

PROJECT NO.	FORT SHERIDAN	DRAWING DATE:	03/31/2014
DESIGNED DRP	LANDFILL 5 BUFFER ZONES		
DETAILED DRP			
CHECKED RL	LOCATION: FORT SHERIDAN, ILLINOIS	FIGURE:	5

APPENDIX F.2

FINAL

FORT SHERIDAN LANDFILLS 6 & 7

LAND USE CONTROL REMEDIAL DESIGN

DEPARTMENT OF DEFENSE OPERABLE UNIT
FORT SHERIDAN, ILLINOIS

July 2011

Prepared for:

HEADQUARTERS, DEPARTMENT OF THE ARMY
ATTN: HQDA-OACSIM-ODB
2530 CRYSTAL DRIVE
ARLINGTON, VA 22202

Prepared by:

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1.0 BACKGROUND

Landfills 6 & 7 consist of 14.5 acres of property located in the south-central portion of Fort Sheridan. The eastern boundary of Landfill 7 fronts Lake Michigan (see Figure 1). Landfills 6 & 7 were used for the disposal of industrial and domestic waste and demolition debris. Landfill 6, located in the southern portion of Fort Sheridan, encompasses 6 acres of the former Wells Ravine area between Patten Road and H Street. Industrial and domestic wastes reportedly were disposed of in the landfill along with debris from the demolition of several World War II barracks in the 1960s. The Enhanced Preliminary Assessment of Fort Sheridan (Argonne, 1989) documents that waste oil, solvents, paint products, carbon cleaning compounds, hospital and veterinary wastes, ammunition boxes, dials, and gauges, sewage treatment plant (STP) sludge, incinerator and heating plant ash, building debris, and general office/domestic refuse were inferred to have been disposed of in the Wells Ravine landfills (Landfills 6 & 7) and in older landfills on the Post. The RI/BRA Report (SAIC, 1999) documents that soil fill with considerable quantities of organic-laden municipal waste, consisting of household trash, processed wood, scrap metal, burnt wood, newspaper, and construction debris (i.e. larger concrete blocks, tires, metal debris, bottles, cans, bricks, cardboard, plastic bags, and trees) were found during the RI activities at Landfill 6. The Sampling and Analysis Report for Interim Remedial Action at Landfills 6 & 7 (Stone & Webster, 2001) documents that stained soil, small pockets of thick oily residues, asphalt, wood, glass, plastic, paper, metal, concrete, and pieces of brick were found during excavation activities. The RI results indicated that risks from the current land use scenarios were within the target risk management range. The U.S. Department of the Navy (Navy) owns the property underlying Landfill 6 with the exception of approximately 2.0 acres located at the western end of the landfill. These 2 acres are owned by the U.S. Army Reserve (Army Reserve).

Landfill 7 is located over the eastern portion of the former Wells Ravine between Patten Road and Lake Michigan and encompasses 8.5 acres. Waste disposal activities at Landfill 7 occurred in the 1940s, 1960s, and 1970s, with all disposal operations ceasing in 1979. The depth of fill at the deepest point directly beneath the top of the east slope is estimated to be approximately 55 to 60 feet below the land surface (BLS) based on a comparison of current topography with historical (1963) topographic maps (ESE, 1996). Fill materials reportedly disposed of in Wells Ravine included but were not limited to, waste oils, solvents, hospital and veterinary wastes, pentachlorphenol (PCP)-treated ammunition boxes, STP sludge, incinerator and heating plant ash, building debris, and domestic and office refuse (Argonne, 1989). Open burning reportedly was implemented at the landfill prior to 1970 using a dug trench near the lake shore (Argonne 1989). Sludge from the STP and coal ash from the incinerator were mixed with soil and used as cover materials (Argonne, 1989). Observation of the eastern landfill slope in 1978 indicated that the bulk of the landfill slope consisted of construction debris; large , broken concrete blocks; wire mesh; steel; old water tanks; cinders; and clay fill. Household refuse was not observed within the open slope face. Waste materials excavated from the landfill during a 1979 investigation unearthed paper, shoes, cans, glass, asphalt, rags, bricks, plastic bags and wrap, wood boards, bed springs, and sheet metal fragments. The RI/BRA Report (SAIC, 1999) documents that soil fill with considerable quantities of organic-laden material waste consisting of household trash, processed wood, newspaper, and construction debris (i.e., concrete metal debris, bottles cans, bricks, cardboard, plastic bags, and wood) were found during the RI activities at Landfill 7. The property underlying Landfill 7 is owned by the Navy.

The U.S. Department of the Army's (Army) presence at Landfills 6 & 7 is solely for the purpose of implementation, operation and maintenance of the remedial actions for Landfills 6 & 7. During the period of 2002 through 2004, the Army implemented the remedy including the construction of a cap, a gas collection system, and a leachate collection system in accordance with the Decision Document for Interim Source Control Action for Landfills 6 & 7 (ESE, 1997), and two subsequent Explanation of Significant Differences (ESD's) (Reilly, C., 1999 and 2001). The construction was done in accordance with the Final (100%) Design Submittal, Interim Remedial Design (Parsons Engineering Science, Inc., 2002), that was approved by the Illinois EPA and EPA-5.

The key elements of the Final Record of Decision (ROD) for Landfills 6 & 7 included:

- Installation and maintenance of erosion control measures and storm water conveyance facilities.
- Installation and operation and maintenance (O&M) of an active leachate collection, storage and disposal system.
- Installation and O&M of an active landfill gas collection and enclosed flare treatment systems.
- Construction of a RCRA-equivalent cap on Landfills 6 & 7
- Long-term maintenance of the landfill's cover system as specific in the O&M plan (KEMRON, 2010).
- Implementation of land use controls that allow for the future use of the open land space on the landfill surfaces for passive recreational activities, while preventing potentially adverse/damaging activities to the cap and ancillary remedial system components
- Placement of large armor stones at the ends of two steel sheet pile groins that flank the north and south limits of Landfill 7 along the toe of the east slope. These stones and sheet pile groins protect the east slope from large waves that are induced by winds from the northeast, east and southeast directions. Stone was also placed under water between the two piles to act as wave breakers and below the beach. These stones extend up to elevation 591 and are located just east of the Leachate Interception Trench.
- Installation and maintenance, of the 72-inch concrete outfall structure and the landfills 6 and 7 perimeter storm water collection pipe network, that delivers storm water runoff captured in a 130-acre drainage basin that includes Landfills 6 & 7, and other areas encompassing much of the Navy Public/Private Venture (PPV) housing units, Patten Road, Army Reserve property west of Landfill 6 and portions of the City of Highwood along Sheridan Road.
- There is a 10-foot wide grouted riprap channel located along the south flank of Landfill 7 east slope. This channel conveys surface water runoff from the east slope and a portion of the southeast corner of Landfill 7 cap.
- A leachate Land Application System was approved and installed during the 2007-2008 season. This includes underground piping and 22 lawn sprinklers that apply the leachate to a 2-acre parcel of grassy land adjacent to the Army maintenance building. It also includes the existing and newly installed fences that encompass the land application area and maintenance building (Building 100). The application system and Building 100 are surrounded by fencing.

Construction of the RCRA-equivalent caps at Landfills 6 & 7 included the following components, which will be maintained as part of the land use controls and remedy O&M (KEMRON, 2010).

- Prairie and turf grass;
- 6-inches of topsoil;
- 3 feet of vegetative/protective cover soil layer;
- Geocomposite (synthetic) drainage layer, consisting of a geonet with a geotextile fastened on both sides of the geonet;
- 40-mil thick linear low-density polyethylene (LLDPE), water tight, geomembrane to serve as the impermeable barrier portion of the cover;
- A geocomposite clay liner layer;
- An extra 12 inches of compacted clay soil layer on the east slope of Landfill 7.
- Geocomposite vent layer to transfer landfill gases from the underlying waste to the landfill gas collection system.

The Buffer Zone (Figure 2) surrounding Landfills 6 & 7 was established in 2005. The Buffer Zone is regulatory required component for a landfill system and must be maintained under the LUCs. It is basically a setback. The buffer zone consists of five primary components, namely: a 100 foot setback from the edge of constructed liner; 150-foot radii from several gas monitoring probes; The surface water drainage system: Building 100 and the 2-acre adjacent parcel used for the land application system; and the location of two groundwater monitoring wells that are part of the long-term monitoring plan at this site.

Recycled telephone poles and boulders have been placed on the ground, within the buffer zone and in landfills' perimeter drainage swale to serve as a deterrent for unauthorized vehicular access onto the landfills

1.1 PURPOSE

The purpose of this LUC RD is to define the implementation, maintenance, and enforcement of LUCs as part of the final remedy for Landfills 6 & 7. This LUC RD provides LUC performance objectives, the LUCs to be used, and the LUC implementation actions relevant to Landfills 6 & 7. This LUC RD describes how the LUCs presented in the Decision Document for the Final Remedy at Landfills 6 & 7 will be implemented and enforced. The intent of the land use restrictions implemented by this RD is to protect the remedy, but also ensure the protection of human health and the environment.

2.0 LAND USE CONTROL OBJECTIVES

The Army will implement LUCs to achieve the performance objectives listed below for Landfills 6 & 7. Figure 2 depicts the LUC boundaries (e.g. Buffer Zone) for Landfills 6 & 7.

The LUC objectives at Landfills 6 & 7 are as follows:

1. Prevent unauthorized intrusive activity or excavation at Landfills 6 & 7.
2. Prevent alteration, damage, or removal of any portion of the final remedy.

3. Maintain the facilities in accordance with the O&M Plan.
4. Prevent access to or use of the groundwater.
5. Prevent all but passive recreational use at Landfills 6 & 7.

3.0 LAND USE CONTROLS

This section provides a description of the LUCs, the logic for their selection, and implementation actions. As previously noted, the parcels of land underlying Landfills 6 & 7 are owned by the Navy, with the exception of approximately 2 acres on the western end of Landfill 6, which is owned by the Army Reserve. The Army is obligated, by the ROD and this LUC RD, to operate and maintain the final remedy identified in the ROD and to implement, inspect, report, maintain and enforce the LUCs for Landfills 6 & 7 pursuant to the Illinois EPA Uniform Environment Covenants Act, 765 ILCS 122. The Army shall remain responsible for the O&M of the remedy as identified in the ROD and for land use control integrity in the event of any future transfer of the property to a third party. The Army or it's representative will constantly monitor the LUCs. Should any LUC be violated, the Army will ensure that appropriate actions are taken to terminate the offending land use, and remedy the situation.

The Navy and the Army Reserve will be responsible for notifying the Army and Illinois EPA if either party decides to transfer their respective property out of federal ownership.

3.1 LAND USE RESTRICTIONS

Landfills 6 & 7 pose no unacceptable threat to human health and the environment provided the following Land Use Restrictions are employed:

(1) Operation and Maintenance of the remedy identified in the ROD

(2) Recreational Use Restrictions

> Landfills 6 & 7 shall be used solely for passive, non-intrusive recreational purposes such as walking, picnicking, sledding, and bicycle riding. Motorized vehicles of any kind are not to be used on the landfills. Camping shall not be permitted. No commercial/industrial or residential uses shall be permitted. No structures will be constructed within the buffer zone unless approved by the Illinois EPA.

(2) Groundwater Restriction

> Other than for the installation of and obtaining samples from groundwater monitoring wells, there shall be no access to or use of the groundwater on Landfills 6 & 7 or within the buffer zone for any purpose without the prior written approval of the Army, the Illinois EPA and the Army Reserve or Navy, as appropriate.

(3) Buffer Zone Restrictions

> Activities that are restricted within the buffer zone shall include:

- No vehicular access, except authorized maintenance vehicles.
- No buildings, foundations or structures of any kind.

- No intrusive activities of any kind without permission from the Army, Illinois EPA and the Army Reserve or the Navy, as appropriate.

(4) Remedy Restrictions

- No digging or excavation shall be permitted on Landfills 6 & 7 without prior written approval of the Army and the Illinois EPA, except:
  - Required O&M activities.
  - Other activities as approved by the Illinois EPA, Army, the Army Reserve, or Navy as appropriate (note - if the Reserve or Navy needs to perform some activity that may encroach on the landfills, such as utility work, permission must be obtained and the party performing the action would be expected to return the remedy to its original condition).
  - No unauthorized changes to the remedy will be permitted without Illinois EPA approval.

(5) Physical Land Use Controls

The Army has implemented and will maintain the following measures to prevent or minimize damages to the remedy:

- Used telephone poles and boulders placed in the buffer zone surrounding the landfill caps to prevent unauthorized vehicular access.
- Warning signs placed along the boundary to limit intrusive activities within the landfill boundaries. The signs are placed within a line of sight distance from each other, approximately every 250 feet along the boundaries. An example of the sign is included as Attachment A. A telephone number is posted to encourage people to call if any damage has been noticed. Also, the area around Building 100 is bounded by split rail fencing or natural areas. Additional signs have been placed on the fencing stating it is the property of US Government with warnings regarding the land application site.
- Army's contractor who is onsite to perform operation and maintenance activities will intervene with any potential violator of a LUC and/or report immediately to the BRAC Environmental Coordinator (BEC) and appropriate authorities (e.g. Highland Park Police, Navy or Army Reserve points of contacts (POCs)).

4.0 MODIFICATION OR TERMINATION OF LUCs

All remedy components, including LUCs for Landfills 6 & 7 are expected to remain in place indefinitely. The land use restrictions are expected to remain in place indefinitely, unless further action is taken to remove the waste and reduce the concentrations of hazardous substances in soil to levels that allow for unlimited use and unrestricted exposure.

No one shall, without Illinois EPA approval, make any modifications to the remedy. No one shall, without Illinois EPA approval, make any land use changes inconsistent with Landfills 6 & 7 or this LUC RD. The Army shall provide at least 14 days notice to the Illinois EPA and seek approval prior to commencing actions that may impact remedy integrity.

No one shall, without Illinois EPA approval, terminate or modify any LUC or remedy component. The decision to terminate, or modify, LUCs will be documented consistent with the National Oil and Hazardous Substances Pollution Contingency Plan process for post-ROD changes.

5.0 MONITORING AND REPORTING

Monitoring of LUCs in the form of site inspections will be conducted by the Army to confirm whether the LUCs remain effective and meet LUC objectives for continued remedy protectiveness. Visual inspections will be conducted on a weekly basis and formal inspections will be performed quarterly. Monitoring frequency will be coordinated with and approved by Illinois EPA and the land owner The State and landowners will be notified of any remedy breach, LUCs included, within 24 to 72 hours of discovery. Additionally, the Army has prepared and is following the Illinois EPA-approved Operations and Maintenance Plan and the Groundwater and Leachate Monitoring Plan for Landfills 6 & 7. The Army is required to follow these plans as written and approved.

The Army will prepare an annual report that will evaluate the status and effectiveness of LUCs with a description of how any LUC deficiencies or inconsistent uses were addressed. As part of the annual report, a written certification will be submitted stating the LUCs remain in place and are effective. Inspection reports and monitoring results will be submitted in the annual report.

6.0 CERCLA 121(C) FIVE-YEAR REVIEWS

As required under CERCLA Section 121(c) five-year remedy review process, the Army shall prepare a report evaluating the continued effectiveness of the remedy, including effectiveness of the LUCs. Also addressed will be an assessment of whether there is a need to modify the LUCs. Each remedy review will evaluate whether conditions have changed due to contaminant attenuation, migration or other factors such as land use. If risk levels have changed since initial LUC implementation, LUC modification will be considered. The five-year review will include the CERCLA required components: 1) community involvement and notification, 2) document review, 3) data review and analysis, 4) site inspection, 5) interviews, and 6) protectiveness determination.

7.0 IMPLEMENTATION ACTIONS

The Army shall work with the Navy and Army Reserve to ensure that the following LUC objectives are met.

A. The Navy or Army Reserve will consult the Illinois EPA and Army prior to any leasing or transfer of property. However, it is noted that the Navy has no current or future plans to release the said property. LUCs shall remain in place until the Army, Illinois EPA and land owner(s) agree, in writing, that the restrictions are no longer required to protect human health and the environment.

B. Army Enforcement - If the Army becomes aware of an action that interferes with or violates any portion of the selected remedy, including the LUCs, it will take immediate action to resolve the matter. The Army will notify Illinois EPA and the Navy within one day of becoming aware of the violation. If the matter is not resolved, the Army will notify Illinois EPA and the Navy of the results of its resolution efforts (e.g., any corrective action) or proposal to resolve the matter within ten (10) days of discovery of the violation.

C. Annual Certification - The Army shall annually, or within such time as may be allowed (with the consent of Illinois EPA), perform a physical inspection confirming that no changes or damages have been made to the remedy and submit a written statement certifying that the land use controls employed at Landfills 6 & 7 are still effective and unchanged from the previous certification, or that any changes to the controls were approved by Illinois EPA and that nothing has occurred that would impair the ability of such controls to protect human health and the environment.

8.0 LEASES AND PROPERTY TRANSFERS

If the property is ever transferred out of Federal ownership, the Navy or the Army Reserve, as applicable, shall notify the Army and Illinois EPA prior to leasing or transferring its property. Such notification shall be given no later than sixty (60) days prior, as appropriate, to the lease or transfer execution. The notice shall identify the proposed lessee or transferee and describe any additional mechanism(s) to be used for future LUC responsibilities after lease or transfer

If the Navy or Army Reserve, as applicable, intends to convey ownership of Landfills 6 & 7 or any portion thereof to a non-federal entity, the Navy, or Army Reserve, as applicable, will follow the appropriate laws, regulations and policies as required, including but not limited to CERCLA 120(h). Each deed will also contain a reservation of access to the property for the, as applicable, Army, Navy, and/or Illinois EPA.

9.0 RESPONSIBILITIES OF SUBSEQUENT OWNERS/LESSEES

In the event of property transfer or lease, outside Federal ownership, the Navy and/or Army Reserve will consult with the Army and Illinois EPA to determine the requirements of the lease or property transfer. Army concerns will be taken into consideration to the extent practicable. This may include requiring the transferee or lessee and subsequent property owner(s) to assume certain responsibilities for LUC implementation actions. Any responsibilities assumed by transferee(s) and subsequent owner(s) and user(s) shall be clearly documented in the appropriate transfer/lease documentation and the required environmental covenant as per the Uniform Environmental Covenant Act.

The Army will continue to: (1) conduct all CERCLA 121(c) reviews; (2) notify the appropriate state and/or local government representatives of any known LUC deficiencies or violations; (3) reserve the right to access the property to conduct any necessary response; (4) reserve the authority to change, modify or terminate LUCs, with Illinois EPA and land owner approval; and, (5) remain responsible for remedy integrity.

10.0 REFERENCES

Argonne, 1989. Enhanced Preliminary Assessment Report, Fort Sheridan, Illinois. USATHAMA, October.

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Reilly, C., 1999. Explanation of Significant Differences to the Decision Document for Interim Source Control Action, Landfills 6 and 7, Fort Sheridan, Illinois. Environmental Restoration Program Fact Sheet, Fort Sheridan BRAC Office, May.

Reilly, C., 2001. Explanation of Significant Differences to the Decision Document for Interim Source Control Action, Landfills 6 and 7, Fort Sheridan, Illinois. Environmental Restoration Program Fact Sheet, Fort Sheridan BRAC Office, August.

SAIC, 1999. Remedial Investigation/Baseline Risk Assessment Report, DoD Operable Unit, Fort Sheridan, Illinois. USACE, July 28.

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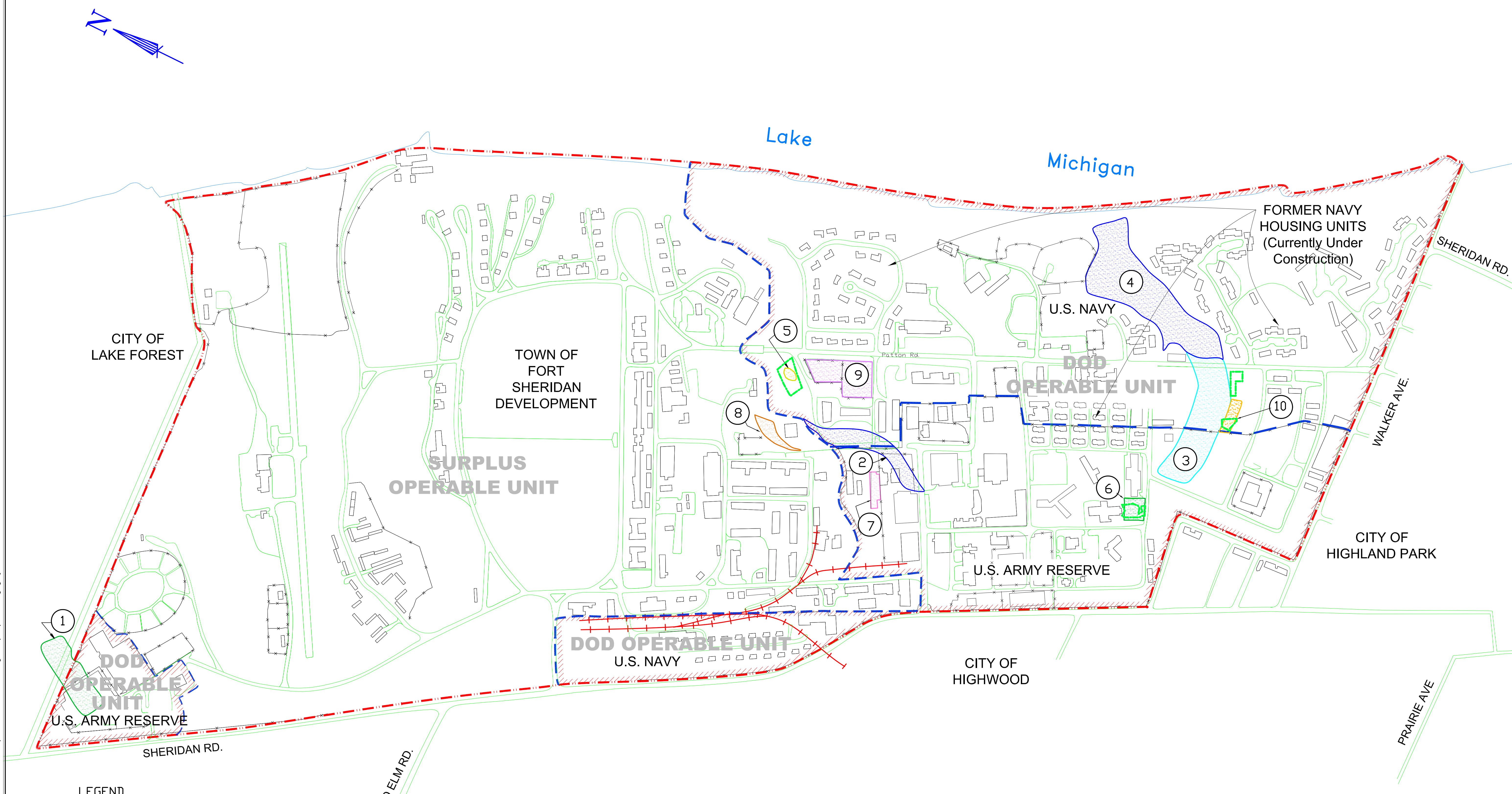
FIGURES



LEGEND

- TASK AREA
- BUILDINGS
- FENCE
- ASPHALT ROADS
- RAILROAD TRACK
- OPERABLE UNIT BOUNDARIES
- PROPERTY BOUNDARY

Number	Task Area
1	Landfill #1
2	Landfill #5
3	Landfill #6
4	Landfill #7
5	Former Coal Storage Area #4
6	Former Water Tower
7	Building 70
8	Coal Storage Area #3
9	Building #208
10	Vehicle & Equipment Storage Area #8

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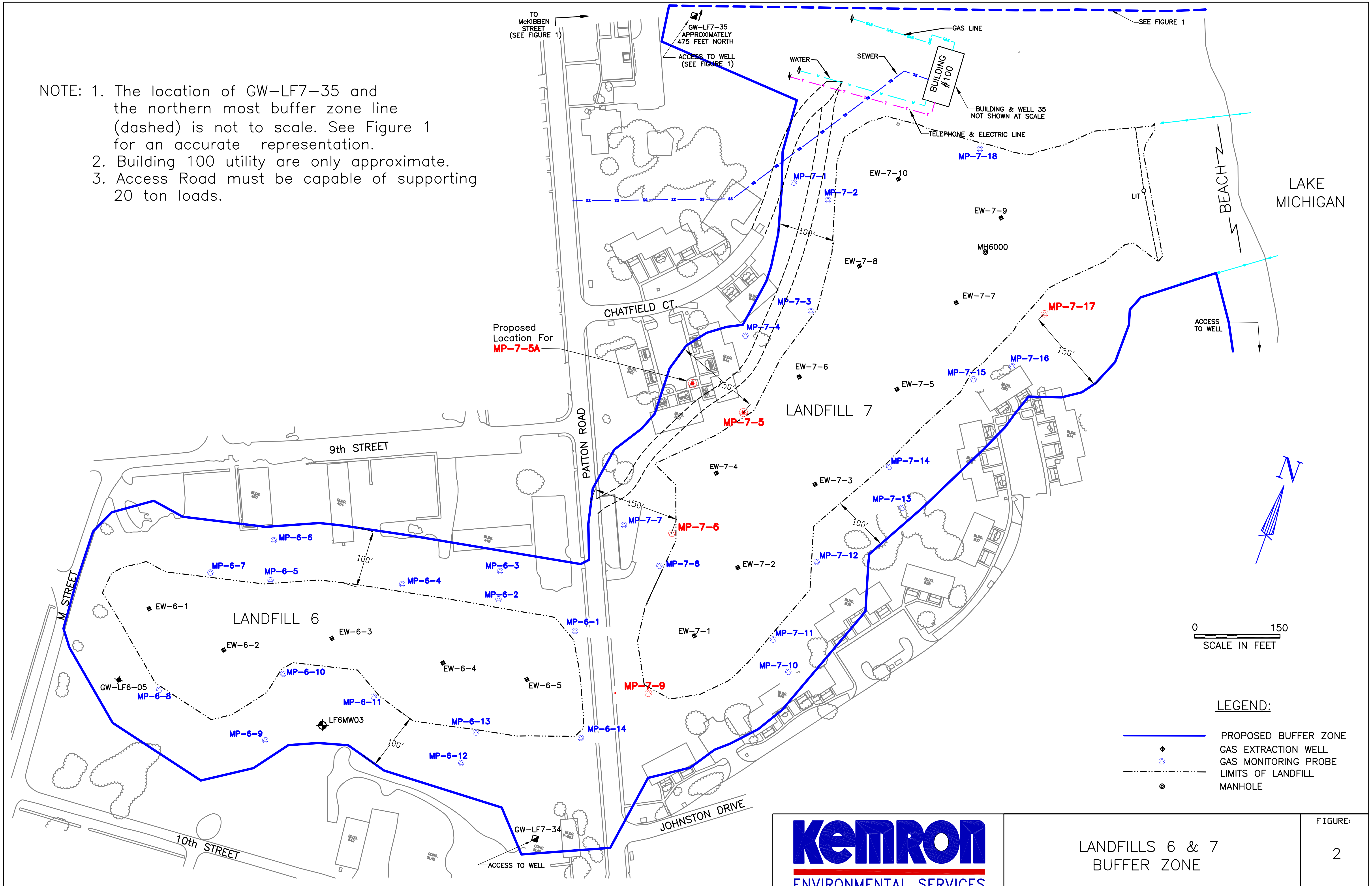
0 350 700
SCALE 1"=700'
(APPROXIMATE)

EDITED BY:	DATE: 14 JULY 2008	FIGURE 1	SITE MAP
DRAWN BY: KG	PROJECT NO. CH0001-106-005		
REVIEWED:	DWG. NO.		
APPROVED:	STE MAP. FIG. 1		FORT SHERIDAN, ILLINOIS

M:\CHICAGO\FORT SHERIDAN (2008)\CH0001 106 005\ FIG. 1. SITE MAP.dwg 07/22/2008 kgrigoryan CH

NOTE: 1. The location of GW–LF7–35 and the northern most buffer zone line (dashed) is not to scale. See Figure 1 for an accurate representation.
2. Building 100 utility are only approximate.
3. Access Road must be capable of supporting 20 ton loads.



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LANDFILLS 6 & 7 BUFFER ZONE

FIGURE 2

APPENDIX G

WEB SOIL SURVEY REPORT

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

Lake County, Illinois

December 11, 2019

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

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: 1:6,070 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 250, 500, 1000, 1500

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N 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 1:12,000.

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: Lake County, Illinois
Survey Area Data: Version 14, Sep 16, 2019

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

Date(s) aerial images were photographed: Mar 13, 2012—Mar 28, 2012

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
530B	Ozaukee silt loam, 2 to 4 percent slopes	73.5	79.3%
530C	Ozaukee silt loam, 4 to 6 percent slopes	15.2	16.4%
530F	Ozaukee silt loam, 20 to 30 percent slopes	1.1	1.2%
805B	Orthents, clayey, undulating	2.9	3.1%
Totals for Area of Interest		**92.6**	**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.

Lake County, Illinois

530B—Ozaukee silt loam, 2 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2sn06
Elevation: 550 to 980 feet
Mean annual precipitation: 35 to 41 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 140 to 185 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ozaukee and similar soils: 94 percent
Minor components: 6 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ozaukee

Setting

Landform: End moraines, ground moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Thin mantle of loess over silty clay loam till

Typical profile

Ap - 0 to 4 inches: silt loam
BE - 4 to 10 inches: silt loam
2Bt1 - 10 to 21 inches: silty clay
2Bt2 - 21 to 39 inches: silty clay loam
2Cd - 39 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 4 percent
Depth to restrictive feature: 23 to 45 inches to densic material
Natural 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
Calcium carbonate, maximum in profile: 35 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Ashkum, drained

Percent of map unit: 4 percent
Landform: Ground moraines, end moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Urban land

Percent of map unit: 1 percent
Landform: Ground moraines
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Orthents, clayey

Percent of map unit: 1 percent
Landform: Ground moraines
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

530C—Ozaukee silt loam, 4 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2yrql
Elevation: 610 to 890 feet
Mean annual precipitation: 36 to 39 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 152 to 185 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Ozaukee

Setting

Landform: End moraines, ground moraines
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Thin mantle of loess over silty and clayey till

Typical profile

Ap - 0 to 5 inches: silt loam
E - 5 to 10 inches: silt loam
Bt1 - 10 to 14 inches: silty clay loam
2Bt2 - 14 to 27 inches: silty clay
2Bt3 - 27 to 38 inches: silty clay loam
2Cd - 38 to 60 inches: silty clay loam

Properties and qualities

Slope: 4 to 6 percent
Depth to restrictive feature: 22 to 45 inches to densic material
Natural 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
Calcium carbonate, maximum in profile: 35 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Urban land

Percent of map unit: 5 percent
Landform: Ground moraines
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Orthents, clayey

Percent of map unit: 3 percent
Landform: Ground moraines
Landform position (two-dimensional): Summit, backslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Ashkum, drained

Percent of map unit: 2 percent
Landform: Ground moraines, end moraines
Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

530F—Ozaukee silt loam, 20 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2sn0p
Elevation: 480 to 920 feet
Mean annual precipitation: 32 to 42 inches
Mean annual air temperature: 46 to 53 degrees F
Frost-free period: 135 to 195 days
Farmland classification: Not prime farmland

Map Unit Composition

Ozaukee and similar soils: 96 percent
Minor components: 4 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ozaukee

Setting

Landform: End moraines, ground moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loess over wisconsinan age silty and clayey till

Typical profile

A - 0 to 5 inches: silt loam
E - 5 to 9 inches: silt loam
Bt1 - 9 to 14 inches: silty clay loam
2Bt2 - 14 to 29 inches: silty clay loam
2Bt3 - 29 to 36 inches: silty clay loam
2Cd - 36 to 60 inches: silty clay loam

Properties and qualities

Slope: 20 to 30 percent
Depth to restrictive feature: 22 to 42 inches to densic material
Natural drainage class: Moderately well drained
Runoff class: Very 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
Calcium carbonate, maximum in profile: 35 percent

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Blount, lake mighican lobe

Percent of map unit: 4 percent
Landform: End moraines, ground moraines
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

805B—Orthents, clayey, undulating

Map Unit Setting

National map unit symbol: v39j
Elevation: 510 to 980 feet
Mean annual precipitation: 28 to 40 inches
Mean annual air temperature: 45 to 54 degrees F
Frost-free period: 140 to 190 days
Farmland classification: Not prime farmland

Map Unit Composition

Orthents, clayey, undulating, and similar soils: 91 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Orthents, Clayey, Undulating

Setting

Landform: Lake plains, ground moraines
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Earthy fill

Typical profile

H1 - 0 to 7 inches: silty clay
H2 - 7 to 60 inches: silty clay

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: 4 to 10 inches to densic material
Natural drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low (0.02 to 0.06 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 25 percent
Available water storage in profile: Very low (about 0.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Urban land

Percent of map unit: 3 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ashkum

Percent of map unit: 3 percent
Landform: Ground moraines, end moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Bryce

Percent of map unit: 2 percent
Landform: Glacial lakes (relict), ground moraines
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Aquents, clayey

Percent of map unit: 1 percent
Landform: Lake plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Erosion

This folder contains a collection of tabular reports that present soil erosion factors and groupings. The reports (tables) include all selected map units and components for each map unit. Soil erosion factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

RUSLE2 Related Attributes (Fort Sheridan - RUSLE2 Attributes)

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factor Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the mineral surface horizon. Missing surface data may indicate the presence of an organic layer.

Report—RUSLE2 Related Attributes (Fort Sheridan - RUSLE2 Attributes)

Soil properties and interpretations for erosion runoff calculations. The surface mineral horizon properties are displayed or the first mineral horizon below an organic surface horizon. Organic horizons are not displayed.

RUSLE2 Related Attributes–Lake County, Illinois								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
530B—Ozaukee silt loam, 2 to 4 percent slopes								
Ozaukee	94	151	C	.43	3	14.0	67.0	19.0
530C—Ozaukee silt loam, 4 to 6 percent slopes								
Ozaukee	90	151	C	.43	3	12.0	66.0	22.0
530F—Ozaukee silt loam, 20 to 30 percent slopes								
Ozaukee	96	75	C	.43	3	14.0	67.0	19.0
805B—Orthents, clayey, undulating								
Orthents, clayey, undulating	91	151	D	.32	2	8.0	48.0	44.0

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties (Fort Sheridan - Engineering Properties)

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Lake County, Illinois

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
530B—Ozaukee silt loam, 2 to 4 percent slopes														
Ozaukee	94	C	0-4	Silt loam	CL, ML	A-4, A-7-6, A-6	0- 0- 0	0- 0- 1	98-98-100	96-98-100	89-95-100	81-87-96	28-33-43	9-12-18
			4-10	Silt loam	CL	A-6	0- 0- 0	0- 0- 1	98-98-100	96-98-100	90-96-100	85-90-98	27-32-38	11-15-19
			10-21	Clay, silty clay loam, silty clay	CL	A-7-6, A-6	0- 0- 1	0- 1- 4	95-98-100	85-93-98	78-91-98	72-85-98	31-38-48	15-19-25
			21-39	Silty clay loam, silty clay	CL	A-6	0- 1- 2	0- 1- 5	93-97-98	82-92-98	74-89-98	68-83-95	24-31-37	11-15-19
			39-60	Silty clay loam, clay loam	CL	A-4, A-6	0- 1- 2	0- 2- 7	93-95-98	80-91-97	74-88-97	67-80-90	21-26-30	9-12-14

Engineering Properties–Lake County, Illinois														
Map unit symbol and soil name	**Pct. of map unit**	**Hydrologic group**	**Depth**	**USDA texture**	**Classification**		**Pct Fragments**		**Percentage passing sieve number—**				**Liquid limit**	**Plasticity index**
					Unified	**AASHTO**	**>10 inches**	**3-10 inches**	**4**	**10**	**40**	**200**		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
530C—Ozaukee silt loam, 4 to 6 percent slopes														
Ozaukee	90	C	0-5	Silt loam	CL	A-6, A-7-6	0- 0- 0	0- 0- 1	98-98-100	96-98-100	89-95-100	81-88-96	30-35-42	12-15-19
			5-10	Silt loam	CL	A-6	0- 0- 0	0- 0- 1	98-98-100	96-98-100	90-96-100	82-90-98	27-32-39	11-14-19
			10-14	Silty clay loam	CL	A-6, A-7-6	0- 0- 0	0- 0- 1	98-98-100	96-98-100	90-96-100	83-90-97	37-41-46	19-22-25
			14-27	Silty clay loam, clay, silty clay	CL, CH	A-7-6	0- 0- 1	0- 1- 4	95-98-100	85-93-98	78-91-98	71-85-97	43-50-60	25-30-36
			27-38	Silty clay loam	CL	A-7-6, A-6	0- 1- 2	0- 1- 5	93-97-98	82-92-98	76-89-98	69-83-94	37-41-45	19-22-25
			38-60	Silty clay loam, clay loam	CL	A-6, A-7-6	0- 1- 2	0- 2- 7	93-95-98	80-91-97	74-88-97	65-80-91	34-39-44	17-21-25
530F—Ozaukee silt loam, 20 to 30 percent slopes														
Ozaukee	96	C	0-5	Silt loam	CL, ML	A-4, A-6, A-7-6	0- 0- 0	0- 0- 1	98-100-100	96-100-100	89-97-100	81-88-96	28-33-43	9-12-18
			5-9	Silt loam	CL	A-6, A-4	0- 0- 0	0- 0- 1	98-100-100	96-100-100	89-98-100	84-92-98	27-32-39	10-14-19
			9-14	Silty clay loam, silt loam	CL	A-6, A-7-6	0- 0- 0	0- 0- 1	98-98-100	97-98-100	88-96-100	82-90-95	34-41-45	16-21-24
			14-29	Silty clay loam, clay, silty clay	CL, CH	A-7-6, A-6	0- 0- 1	0- 1- 4	95-98-100	85-93-98	80-91-98	74-85-98	30-36-52	15-18-26
			29-36	Silty clay loam, silty clay	CL	A-6	0- 1- 2	0- 1- 5	93-97-98	82-92-98	74-89-98	68-83-95	24-31-37	11-15-19
			36-60	Silty clay loam, clay loam	CL	A-6, A-4	0- 1- 2	0- 2- 7	93-95-99	80-91-97	75-88-97	68-80-90	21-26-31	9-12-15

Engineering Properties–Lake County, Illinois														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
805B—Orthents, clayey, undulating														
Orthents, clayey, undulating	91	D	0-7	Silty clay	CH, MH	A-7-6	0- 0- 0	0- 1- 3	98-98-100	87-95-100	83-94-100	78-89-100	50-56-68	29-32-40
			7-60	Silty clay, clay, silty clay loam	CH, CL	A-7-6	0- 0- 0	0- 1- 2	99-99-100	84-93-100	74-91-100	64-85-100	46-58-70	25-35-44

Physical Soil Properties (Fort Sheridan - Physical Properties)

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates in the table are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity

(Ksat) is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil.

Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Physical Soil Properties–Lake County, Illinois														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
530B—Ozaukee silt loam, 2 to 4 percent slopes														
Ozaukee	0-4	7-14- 23	52-67- 76	15-19- 27	1.30-1.40-1.50	4.23-9.17-14.11	0.19-0.21-0.23	1.1- 1.5- 2.8	1.2- 2.0-3.0	.43	.43	3	5	56
	4-10	5-10- 18	57-69- 76	17-21- 27	1.35-1.45-1.55	4.23-9.17-14.11	0.20-0.21-0.22	1.1- 1.6- 2.5	0.3- 0.6-1.0	.55	.55			
	10-21	5-11- 18	34-48- 58	35-41- 50	1.45-1.55-1.65	0.42-2.33-4.23	0.09-0.12-0.14	2.3- 3.4- 5.9	0.2- 0.5-0.9	.32	.32			
	21-39	5-12- 20	40-52- 64	29-36- 42	1.55-1.65-1.70	0.42-0.92-1.41	0.08-0.11-0.13	1.3- 2.3- 3.3	0.1- 0.3-0.6	.37	.37			
	39-60	7-14- 23	50-55- 64	27-31- 35	1.60-1.70-1.85	0.42-0.75-1.41	0.06-0.09-0.11	0.9- 1.7- 2.2	0.0- 0.2-0.5	.43	.43			

Physical Soil Properties–Lake County, Illinois														
Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
530C—Ozaukee silt loam, 4 to 6 percent slopes														
Ozaukee	0-5	5-12- 22	53-66- 75	18-22- 27	1.30-1.43-1.55	4.23-9.17-14.11	0.19-0.21-0.22	1.2- 2.2- 3.4	1.0- 1.7-2.5	.43	.43	3	6	48
	5-10	5-10- 18	55-69- 78	17-21- 27	1.35-1.45-1.55	4.23-9.17-14.11	0.20-0.21-0.22	1.1- 1.6- 3.0	0.3- 0.6-1.0	.55	.55			
	10-14	5-10- 18	47-59- 68	27-31- 35	1.35-1.45-1.55	4.23-9.17-14.11	0.17-0.19-0.20	2.0- 3.2- 3.8	0.3- 0.6-1.0	.43	.43			
	14-27	5-11- 18	32-48- 60	35-41- 50	1.45-1.55-1.65	0.42-2.33-4.23	0.09-0.12-0.14	2.3- 3.4- 5.9	0.2- 0.5-0.9	.32	.32			
	27-38	5-12- 20	45-55- 66	29-33- 35	1.55-1.65-1.70	0.42-0.92-1.41	0.08-0.11-0.13	1.3- 2.1- 3.2	0.1- 0.3-0.6	.43	.43			
	38-60	7-14- 23	42-55- 66	27-31- 35	1.60-1.70-1.85	0.42-0.75-1.41	0.06-0.09-0.11	0.7- 1.6- 2.3	0.0- 0.2-0.5	.43	.43			

Physical Soil Properties–Lake County, Illinois														
Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
530F—Ozaukee silt loam, 20 to 30 percent slopes														
Ozaukee	0-5	7-14- 23	52-67- 76	15-19- 27	1.30-1.40-1.50	4.23-9.17-14.11	0.19-0.21-0.23	1.3- 1.8- 3.3	1.2- 2.0-3.0	.43	.43	3	5	56
	5-9	5-10- 18	57-69- 77	16-21- 27	1.35-1.45-1.55	4.23-9.17-14.11	0.19-0.21-0.23	1.3- 2.0- 3.0	0.3- 0.8-1.2	.55	.55			
	9-14	5-10- 18	50-59- 69	24-31- 34	1.40-1.50-1.60	4.23-9.17-14.11	0.18-0.20-0.21	2.1- 3.3- 3.9	0.3- 0.6-1.0	.43	.43			
	14-29	5-11- 18	34-50- 58	35-39- 50	1.45-1.55-1.65	0.42-2.33-4.23	0.09-0.12-0.14	2.2- 3.1- 6.1	0.2- 0.5-0.9	.37	.37			
	29-36	5-12- 20	40-52- 64	29-36- 42	1.55-1.65-1.70	0.42-0.92-1.41	0.08-0.11-0.13	1.3- 2.2- 3.1	0.1- 0.3-0.6	.37	.37			
	36-60	7-14- 23	50-55- 64	27-31- 35	1.65-1.75-1.85	0.42-0.75-1.41	0.06-0.09-0.11	1.0- 1.7- 2.4	0.0- 0.2-0.5	.43	.43			
805B—Orthents, clayey, undulating														
Orthents, clayey, undulating	0-7	2- 8- 20	40-48- 58	40-44- 55	1.50-1.58-1.65	0.42-0.92-1.41	0.08-0.11-0.14	6.0- 7.5- 8.9	0.5- 1.3-2.0	.32	.32	2	4	86
	7-60	2-11- 30	10-41- 60	35-48- 60	1.60-1.75-1.90	0.14-0.28-0.42	0.03-0.07-0.10	6.0- 7.5- 8.9	0.2- 0.6-1.0	.32	.32			

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Hydrologic Soil Group and Surface Runoff (Fort Sheridan - Soils Water Feature)

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

Report—Hydrologic Soil Group and Surface Runoff (Fort Sheridan - Soils Water Feature)

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Hydrologic Soil Group and Surface Runoff–Lake County, Illinois			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
530B—Ozaukee silt loam, 2 to 4 percent slopes			
Ozaukee	94	Medium	C
530C—Ozaukee silt loam, 4 to 6 percent slopes			
Ozaukee	90	High	C
530F—Ozaukee silt loam, 20 to 30 percent slopes			
Ozaukee	96	Very high	C
805B—Orthents, clayey, undulating			
Orthents, clayey, undulating	91	Very high	D

Water Features (Fort Sheridan - Soils Water Feature)

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table. The kind of water table, apparent or perched, is given if a seasonal high water table exists in the soil. A water table is perched if free water is restricted from moving downward in the soil by a restrictive feature, in most cases a hardpan; there is a dry layer of soil underneath a wet layer. A water table is apparent if free water is present in all horizons from its upper boundary to below 2 meters or to the depth of observation. The water table kind listed is for the first major component in the map unit.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Map unit symbol and soil name	Hydrologic group	Surface runoff	Most likely months	Water table			Ponding			Flooding	
				Upper limit	Lower limit	Kind	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*		*Ft*				
530B—Ozaukee silt loam, 2 to 4 percent slopes											
Ozaukee	C	Medium	Jan	—	—	—	—	—	None	—	None
			Feb-Apr	2.0-3.5	2.2-4.3	Perched	—	—	None	—	None
			May-Dec	—	—	—	—	—	None	—	None
530C—Ozaukee silt loam, 4 to 6 percent slopes											
Ozaukee	C	High	Jan	—	—	—	—	—	None	—	None
			Feb-Apr	2.0-3.5	2.2-4.3	Perched	—	—	None	—	None
			May-Dec	—	—	—	—	—	None	—	None
530F—Ozaukee silt loam, 20 to 30 percent slopes											
Ozaukee	C	Very high	Jan	—	—	—	—	—	None	—	None
			Feb-Apr	2.0-3.5	2.2-4.0	Perched	—	—	None	—	None
			May-Dec	—	—	—	—	—	None	—	None
805B—Orthents, clayey, undulating											
Orthents, clayey, undulating	D	Very high	Jan	—	—	—	—	—	None	—	None
			Feb-Apr	2.0-3.5	2.2-4.0	Perched	—	—	None	—	None
			May-Dec	—	—	—	—	—	None	—	None

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