CEDAR LAKE AQUATIC ECOSYSTEM RESTORATION FEASIBILITY STUDY

CEDAR LAKE, INDIANA

APPENDIX C

CIVIL ENGINEERING

U.S. Army Corps of Engineers
Chicago District

July 2016

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CHAPTER 1 – INTRODUCTION

1.1 General

The project features consist of rerouting Founders Creek back to Cedar Lake, establish native aquatic vegetation along the shoreline, mechanically dredging the lake at its southern end and pumping the dredge material to the sediment placement site, utilizing a temporary effluent treatment facility, providing any site drainage needed, and adding alum to the water to flocculate the existing and remaining phosphorous.

1.2 Purpose and Scope

The purpose of this appendix is to present the design criteria, engineering methods and procedures used to: (1) establish the locations of the project features on the drawings, preliminary feature designs, typical sections, and; (2) designate the dredging areas, dewatering site and support features; (3) calculate construction quantities; and (4) define the real estate requirements. This scope has been applied to the design analysis of the Locally Preferred Plan (LPP) and the National Ecosystem Restoration (NER) described in this appendix.

CHAPTER 2 – SITE LAYOUT

2.1 General

The design information was developed from site visits, GIS lidar data, and requirements to restore the lake and improve fish habitat as described in the main report. Several environmental restoration alternatives were examined. The selected alternatives (LPP and NER) as discussed in the main report would provide the most benefit and therefore are the only alternatives presented in this section. It shall be noted that the difference between the two alternatives (LPP and NER) is the location and amount of dredging material and the size of the SDF. The quantities provided in the bid schedule (Attachment 1) is for the LPP alternative which is the design plan. Quantities for the NER are

provided in the Quantity Computation (Attachment 2) and are used for cost estimating purposes to determine the cost differences between the LPP and NER plans.

2.2 Surveying and Mapping

The horizontal datum is based on the Indiana State Plane Coordinate System, West Zone, NAD 83 (NSRS2007) and is expressed in US Survey Feet. The vertical datum is based on the North American Vertical Datum 1988 (NAVD88) and expressed in US Survey Feet.

The elevation data used for the SDF and Founders Creek reroute designs are from GIS LiDAR provided by the State of Indiana. The State of Indiana acquired the LiDAR data in 2013 and represents conditions existing at that time. This information is provided for general GIS applications and preliminary engineering designs and not to be used in place of field survey for precise location of features required for any engineering design application or regulatory purpose.

Hydrographic survey was performed by USACE Chicago District personnel in June 2005. All soundings are in feet and are referenced to the lake level at the time of the survey, which had an elevation of 691.97 feet NAVD 88 based.

The mapping for the property owners were provided by Lake County Department of Management Services, GIS/Mapping Division. Files provided are in ESRI Shape File format, Indiana State plane Projection and NAD83 Datum.

2.3 Founders Creek

According to a government survey performed in 1834 on Cedar Lake (previously referred to as Clear Lake in the survey or Lake of the Red Cedars in the source text), Founders Creek originally flowed directly west into Cedar Lake just north of Cedar Creek. Sometime in the early 1900's, Founder's Creek was diverted directly to Cedar Creek downstream of the Cedar Lake. Qualitative water quality sampling performed in August 2005 on Founders Creek near the confluence of Cedar Creek indicated flows were of good water quality indicative of groundwater flow.

The Chicago District is currently evaluating ecosystem restoration measures for Cedar Lake. The addition of clean water flows to Cedar Lake has been demonstrated to provide small improvements to the water quality of Cedar Lake, especially during dry summer periods. It is suggested that if Founders Creek is rerouted to drain back into Cedar Lake an open channel with a small riparian corridor and natural bed materials will be utilized to convey the flows. Founders Creek currently flows through a relatively natural forested area prior to meeting with Cedar Creek. This forested area provides a riparian corridor for plant and animal species while protecting water quality in Founders Creek. It is recommended that any alterations to the channel should not reduce the current habitat quality of the stream. An effort to mimic the current habitat in a new channel should be made.

2.4 Cedar Lake Dredging

Elevated concentrations of available phosphorus within Cedar Lake's lakebed sediments have been found to be the major cause of habitat degradation and eutrophic conditions. Field sampling and analysis of sediments have shown the highest concentrations of phosphorus are located in the south basin of Cedar Lake. All other sediments within the lake are less concentrated than those recommended for removal; therefore additional sediment removal would result in incrementally less water quality and ecosystem restoration benefits. The LPP defines dredging in the south and central basin while the NER only defines dredging in the south basin.

A temporary staging area located in a parking lot at the west corner of the lake will receive the mechanically loaded dredged material. Refer to the drawings for the staging/off-loading area location. Dredging will consist of a crane mounted on a barge equipped with an appropriate mechanical, modified environmental type bucket. The mechanical dredging equipment will be designed and operated to minimize turbidity from the re-suspension of sediment to the water column, to minimize the spillage of dredged material and to minimize the quantity of water removed with the dredged material. The sediment will be placed in a hopper barge for transportation adjacent to the staging area. The material will then be pumped in slurry pipes through an afforested area and discharge into the Sediment Dewatering Facility (SDF) site located southwest of the lake. Floating booms or other environmental controls will be positioned around the crane barge and hopper barge to contain any floating material and minimize sediment migration in the water column resulting from dredging operations. Once a hopper barge is filled, it will be replaced with an empty barge so that dredging can continue. After the sediment within the reach of the crane has been removed, the crane barge will be moved to a new location and the process continued.

2.5 Sediment Dewatering Facility (SDF)

The dredged material placement site is comprised of approximately 114-ac of farmland encompassed by Parrish Avenue to the west, West 155th Avenue to the south and the CSX Railroad Spur at the northeast corner of the site. Approximately 96.1-ac will be used to construct the Sediment Dewatering Facility (SDF) for the project. The dewatering site is shown on attached drawings.

CHAPTER 3 – PROJECT FEATURES

3.1 General

The project features for the LPP and the NER consists of rerouting Founders Creek, mechanically dredging the lake and disposing of the dredge materials at an existing farm

area. The dewatering site of the dredged material may require drainage swales around the exterior of the dikes to facilitate positive drainage and avoid ponding to adjacent properties. Other restoration features such as establishing native aquatic vegetation and introducing fish community will enhance the aquatic ecosystem of Cedar Lake.

3.2 Founders Creek Relocation

In order to improve the water quality of Cedar Lake, it is recommended that Founders Creek be relocated to drain into the lake again. This relocation shall not reduce the current habitat quality of the stream. Preliminary flow calculations of 400-cfs indicate the reroute will involve the excavation of approximately 950-ft of material to create a new 7-ft wide channel bottom with 3:1 side slopes and a minimum depth of 4-ft. Refer to the channel typical cross-section provided in drawings Roadway improvements from the installation of box culverts under Lake Shore to accommodate the channel relocation are also necessary. Lastly the channel will be restored along the embankment for erosion control and the riparian corridor with native establishment.

3.3 Aquatic Vegetation and Fish Community Restoration

Aquatic restoration will consist of planting 35-ac of emergent and 95-ac of submerged vegetation along the shoreline of the lake within the littoral zone. Once the aquatic vegetation has been established and has taken hold, the lake will be restocked with native a fish community.

3.4 Dredging

Dredging operations for the NER will consist of mechanically dredging approximately 87-ac in the south basin to depth of 1-ft for a total of 140,000 cy. Dredging operations for the LPP will consist of mechanically dredging approximately 163 acres in the south and central basins to a depth of one foot for a total of 263,000 cy. The dredged material will be hydraulically off-loaded and pumped through approximately 6000-LF of dredging pipeline routed south and southwest through partially forested areas to the SDF. For cost estimating purposes, a 12” High Density Polyethylene Pipe (HDPE) is assumed for the slurry pipe. Once in the SDF, the solids will settle out and the effluent will be returned to the dredge site by pumping the water back to the off-loader for use in the slurry to transport additional dredged material. Excess water remaining in the SDF that does not flow naturally over the weir structures and into the water clarifying cells, will be pumped to Water Clarification Cell #1 and eventually flow over the weir and into Water Clarification Cell #2. Treated water from the SDF will be transported back to the Cedar Lake using a return pipe, approximately 1700 LF (assumed 12” HDPE pipe). The return pipe from Cell #2 will connect to the slurry pipe for gravity flow of water to the lake. The water may also be released into an existing drainage ditch, adjacent to the Clarification Cell #2. From aerial observation, the drainage ditch flows through a wetland and

discharges to Cedar Lake. This option will be further evaluated during the PED phase. Refer to the drawings for SDF and cell locations.

3.5 Sediment Dewatering Facility

The dewatering site is comprised of one storage cell and two water clarification cells. Storage cells constructed with a perimeter dike containing a 10 foot wide crest, 3:1 side slopes and heights as indicated below will store the required amount of dredge material.. Below is a list of SDF assumptions:

- SDF site possesses uniform and relatively level elevation.
- SDF site is suitable as a containment facility.
- There are no leaching issues, i.e.: into groundwater supply.
- Clearing and grubbing will be minimal.
- On-site excavated material is suitable for constructing the containment dike.
- Stripped 12 inches of topsoil is not suitable for dike construction, but can be applied to the cap.
- Dredge volume includes one-half foot of over-dredge.
- Height of dike for the NER plan is 3.2 feet.
- Height of dike for the LPP is 4.2 feet.
- Sediment bulking factor = 1.12.

Due to Indiana RISC regulations, a protective cap/cover will be established over the dredged material for final site closure consisting of replacement of a 12-in topsoil layer stripped from the site to create the SDF. The SDF will be stabilized with vegetation to control erosion of the dredged material and protective cover.

3.6 Utility Coordination

Utility survey was not completed at this phase of the project. Utility survey and coordination will be completed during the design phase, and impacts to utilities will be investigated and addressed during the design phase. It is assumed that there will be little impact to existing utilities and costs for utility relocation, where necessary, is assumed under the contingency for the Real Estate Land and Damages. The design assumptions made for utilities are discussed below.

1) Slurry Pipe: A slurry pipe will be used to transport dredge material from the off-loading area to the SDF. The pipe will also be used to pump water back into Cedar Lake from the Water Clarification Cell #2. Refer to drawings for the proposed layout of the pipes. The slurry pipe will cross a 2-lane road (Lauerman St.), follow the west edge of the road, and intercepts a wetland and railroad to the SDF. With the exception of the road and railroad crossings, the pipe will be placed on-grade and adjusted as necessary to avoid utilities above grade. The pipe will be placed underneath Lauerman St. and location of the pipe crossing will be finalized upon investigation of the utility survey to be completed in the PED

phase. The road trench and pipe will be located where there is little or no impact to underground utilities. The trench will be filled under a temporary road plate or asphalt road surface. At the end of construction, the pipe will be removed and all areas will be restored to pre-existing condition or better. To limit impacts to the wetlands, most of the pipe will be placed along an existing ditch that transverses the wetland and follows a drainage path that leads to an existing culvert located underneath a railroad. The slurry pipe will be placed through the culvert. The culvert may need to be adjusted to accommodate the pipe. The railroad is owned by CXS Transportation and the pipe will be designed and placed to meet the requirements of CXS Transportation, *Design & Construction Standard Specification for Pipelines Occupancies*.

2) Existing Ditch and SDF: The SDF is primarily located on a previously farm land. It is assumed that drain tiles may be present at the site and will need to be disabled in-place or removed. The layout of the SDF and cells will be refined and optimized to avoid impacts to the existing ditch located on the south side of the SDF. The entire real estate area is assumed for the SDF and treatment cells layout. The SDF and treatment cells will be optimized during the design phase. The footprint of the SDF and cells can be reduced for the dredge volume capacity needed at the SDF.

3.7 Project Boundary and Real Estate Map

Cedar Lake: The project boundary at Cedar Lake was developed from the parcel limits outside of private properties along the lake shoreline. The boundary is within the Indiana DNR legal and average normal water levels of elevation 692.90 msl (mean sea level).

Founders Creek: Within the property limits, the riparian corridor, approximately 50 FT upland of both sides of the rerouted channel, will be restored. A temporary staging area is also proposed at Founders Creek.

Dredging Operations and SDF: A staging area is proposed west of Cedar Lake for dredging operations and a 20-foot utility easement is proposed along the slurry pipeline from the staging area to the SDF. The SDF property boundary was developed from the parcel limits.

ATTACHMENT 1

BID SCHEDULE

Title: Bid Schedule for Cedar Lake Feasibility Study (LPP)
Project Name: Cedar Lake Aquatic Ecosystem Restoration
Phase: Feasibility
Date: Jul-16
Lead Engineer:
Estimator:

ITEM	DESCRIPTION	Quantity	U/M	Unit Price	Amount
	MOBILIZATION/DEMOBILIZATION	1	LS		
SEDIMENT DISPOSAL FACILITY					
	TOPSOIL STRIPPING	138,000	CY		
	SDF EXCAVATION AND GRADING	1	LS		
	BERM PLACEMENT	160,675	CY		
	BERM TOPSOIL PLACEMENT AND SEEDING	732000	SF		
	DRAINAGE DITCH	10,000	LF		
	WEIRS	4	EA		
	AERATOR	2	EA		
DREDGING					
	ROAD CONSTRUCTION	350	SF		
	DREDGING	263,000	CY		
	ADDITIONAL DREDGING	3,000	CY		
	HYDRAULIC OFFLOADING	263,000	CY		
SDF CLOSURE					
	12" TOPSOIL CAP PLACEMENT	138,101	CY		
	SEEDING	86	AC		
CEDAR LAKE					
	ALUM TREATMENT	400	AC		
	EMERGENT PLUGS	30,000	EA		
	EMERGENT SEEDING	35	AC		
	SUBMERGENT PLUGS	TBD	EA		
	SUBMERGENT SEEDING	95	AC		
	5-YR MAINTENANCE AND MONITORING	1	JOB		
	FISH RESTOCKING	1	JOB		
FOUNDERS CREEK					
	NEW CREEK EXCAVATION AND GRADING	3,790	CY		
	EXISTING CREEK FILL AND GRADING	641	CY		
	CULVERT INSTALLATION	1	LS		
	ROAD CONSTRUCTION	1,150	SF		
	PLUGS	TBD	EA		
	SEEDING	3	AC		
	Total Estimate				

Project Name: Cedar Lake Aquatic Ecosystem Restoration
Phase: Feasibility
Date: Jul-16
Lead Engineer:
Estimator:

ITEM	DESCRIPTION	Quantity	U/M	Unit Price	Amount

ATTACHMENT 2

QUANTITY COMPUTATIONS

US Army Corps of Engineers, Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:
	CEDAR LAKE FEASIBILITY STUDY	FAYE LEFFLER	7/6/2016
	COMPUTATION TITLE:	CHECKED BY:	DATE:
	EARTHWORK QUANTITY	STEVEN GOODPASTOR	7/13/2016

With the exception of Founders Creek, the earthwork quantities below are used to check the MII quantities from the legendary computations for the project. Where the calculations are close, the legendary MII quantities will be used for the bid schedule. Otherwise, the values computed below will be used for the bid schedule.
All quantities computed below for Founders Creek will be used for the bid schedule.
A C-SP_Quanity Comp.dgn file was created as a 2D file and used to measure and document lengths and areas measurements referenced below.

SDF VOLUME CAPACITY FOR NER AND LPP

The recommended plan is Alternative 5, which includes a an NER dredge volume of 140,000 CY and LPP dredge volume of 263,000 CY. Volume capacity of the SDF includes the required dredge volume for the NER or LPP, an assumed over-dredge volume of 0.5' depth of the SDF, volume of the 12" topsoil cap, and an application of a bulk or swelling factor of 1.12 to the dredge material.
Additional 3000 CY of material will be dredged to allow for equipment access in and out of the marina for staging.

SDF Volume Capacity (NER)

NER Volume	140,000.00	CY
0.5' over-dredge, bottom of SDF =	3,132,826.22	SF
Over-dredge volume =	58,015.30	CY
Total Dredge Volume =	198,015.30	
Apply Bulking factor of 1.12	221,777.14	CY
Topsoil Cap of 12" =	116,030.60	CY
Total Capacity of SDF (NER) =	337,807.74	CY

SDF Volume Capacity (LPP, Design Volume)

LPP Volume	263,000.00	CY
0.5' over-dredge, top of berm area =	3,132,826.22	SF
Over-dredge volume =	58,015.30	CY
Total Dredge Volume =	321,015.30	
Apply Bulking factor of 1.12	359,537.14	CY
Topsoil Cap of 12" =	116,030.60	CY
Total Capacity of SDF (LPP) =	**475,567.74**	**CY**

The SDF should have a minimum of 475570 CY of volume.

SDF BERM AND VOLUME CALCULATIONS FOR NER

The quantities provided in the bid schedule for the SDF construction and dredge volume references the LPP dredge volume of 263,000 CY. The SDF construction for the NER dredge volume of 140,000 CY is provided below.
The cells lengths are based on the CL alignment of the cell berm. Cell #1 alignment follows the east and south alignment of the cells. And cell #2 follows the east-west alignment of the cells. Refer to the quantity.dgn file

SDF (NER)

SDF Berm Top EL =	739	
SDF Berm Toe at SDF EL =	735.8	
SDF Depth =	3.2	FT
SDF Berm Top Width =	10	FT
Side Slopes =	3(H):1(V)	
SDF Berm Length =	9,663	LF
Cell #1 Length =	1,466	LF
Cell #2 Length =	1,294	LF

SDF Volume
The terrrain to plane volume provided below was from a PowerInroads report. The terrain to plane volume emcompasses the volume between the SDF terrain and a plane (EL 739), which is the top elevation of the SDF berm.

Terrain to Plane Volume
Terrain To Plane 739.000
Cut Factor = 1.000
Fill Factor = 1.000
Cut = 0.000 sf3

Fill = sf3	10,794,911.97	CF	399,811.55	CY
Balance = sf3	10,794,911.97	CF	399,811.55	CY

SDF Berm Volume
The terrain to terrain volume is a PowerInroads report derived by comparing two terrains (SDF berm and existing ground terrrains) to compute the volume between the terrains.

Terrain to Terrain Volume
_____
Cut Factor = 1.000
Fill Factor = 1.000

*Cut = 46441.200 sf	0	CF		
Fill = sf3	1,392,305.45	CF	51,566.87	CY

Balance = 1345864.251 sf3
*In areas where the existing grade is larger than EL 739, the top of berm will be the existing grade. Therefore, there will be no cut.

SDF Excavation for Berm Fill
The terrain to terrain volume is a PowerInroads report derived by comparing two terrains (SDF and existing ground terrrains) to compute the volume between the terrains.
Terrain to Terrain Volume
_____

Cut Factor = 1.000
Fill Factor = 1.000
Cut = sf3 1,566,833.80 CF 58,030.88 CY
*Fill = 6150105.290 : 0 CF
Balance = 4583271.489 sf3
*There will be no fill in the SDF, the depressed areas within the SDF will be used as additional storage as needed.
The SDF can generate enough material needed to construct the berms. The layout of the SDF can be optimized during design phase to reduce the footprint of the SDF.

MOB/DEMOB

Refer to the cost engineering appendix for the mob and demob cost assumptions. Mod and Demob will include the placement and removal of the slurry pipes. It is assumed the slurry pipe will also be used for transporting treated water back to the SDF. A return pipe from the treatment cells will connect with the slurry pipe for gravity flow of water to the lake. A 12" pipe is assumed for the slurry and return pipes. A Hign Density Polyethylene Pipe (HDPE) is assumed for the type of pipe.

Refer to the quantiy.dgn file for the pipe lengths.

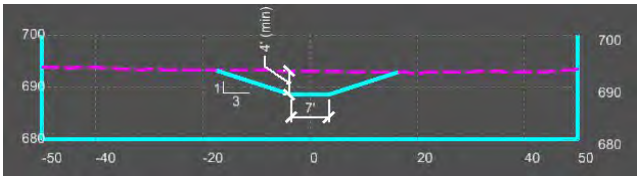
Slurry Pipe
Length of Slurry Pipe = 5,967.3 LF
Length of Return Pipe = 1,713.8 LF
Total 12" HDPE Pipe = 7,681.1 LF

FOUNDERS CREEK

Earthwork

Founders Creek will be rerouted to Cedar Lake. A new channel will be created to intercept Founders creek for a direct flow to Cedar Lake. The section of the exisiting creek from the new creek connection to Cedar Creek will be filled with the excavated material from the new channel connection. A culvert will be needed at Lakeshore DR. to convey flow to Cedar Lake. Further H&H is needed to determine the size and inverts of the culverts.

Assumptions:
Channel Width: 7 FT
Channel Slope: 0.40%
Channel Depth: 4 FT (min)
Channel Length: 948 LF
Culvert: Two 36" box culverts



Founders Creek Typical Section

New Founders Creek Channel Excavation

The terrain to terrain volume is a PowerInroads report derived by comparing two terrains (Founders Creek Reroute Channel and existing ground terrains) to compute the volume between the terrains.
Terrain to Terrain Volume
_____
Terrain DitchArea To Terrain Founders Creek
Cut Factor = 1.000
Fill Factor = 1.000
Cut = sf3 102,222.89 CF
Fill = sf3 44.628 CF
Balance = -102178.260 sf3 (102,178.26) CF
Total Excavation for Founders Creek = 3,784.38 CY
The cut material will be used to fill-in the old founders creek channel and excess will be transported to the SDF for disposal or for use to build berm.

Fill for Existing Founders Creek

The terrain to terrain volume is a PowerInroads report derived by comparing two terrains (Fill and existing ground terrains) to compute the volume between the terrains.
Terrain to Terrain Volume
_____
Terrain DitchArea To Terrain Founders Creek_Fill
Cut Factor = 1.000
Fill Factor = 1.000
Cut = sf3 50.867 CF
Fill = sf3 17,357.87 CF
Balance = sf3 17,307.00 CF
Total Fill for Founders Creek = 641.000037 CY
Length of Creek Fill = 268.611 LF

Culvert Construction

Culverts will placed under E Lakeshore Dr.; Assume two 36 box culverts
The culvert will be open trench and road construction will be completed after installation of the culvert
Length of Culvert = 25 FT
Total length (2 culverts) = 50 FT

Road Trench for Culvert Construction

Assumptions: Open trench construction

Road Repair Length =	46	FT
Length of culvert =	25	FT
Road Repair Construction Area =	1,150	SF
	127.7777778	SY

Proposed Creek Surface Area

Elements Component Quantities Report from PowerInroads report. The area is the top mesh area of the new Founders Creek channel model.
Report Created: 6/30/2016
Time: 5:04pm
Input Grid Factor: Note: All units in this report are in feet, square feet and cubic feet unless specified otherwise.

Surface	Material	Area	Volume	Unit Cost	Material Cost
Corridor:			Founders Creek Reroute		
	Top Mesh:	34,608.00		1	34,607.65
Proposed Creek Surface Area =			**3,845.33 SY**		

Founders Creek Riparian Corridor Planting

A riparian corridor of 50 feet on each side of the rerouted Founders Creek and within the project limits will be restored along with the creek.
Refer to the quantity.dgn file for the area calculations.

Total Area =	123,010.10	SF
	2.823923324	AC

SDF

SDF Data (LPP)

SDF and Cells Footprint Area =	4,187,881.21	SF	96.1405236 AC
This is the area occupied by all the proposed features - SDF and clarification cells.			
SDF Complete Area (including Berms) =	3,514,482.89	SF	80.6814255 AC
This is the area of the SDF features and does not include the clarification cells.			
SDF Bottom Area =	3,104,151.22	SF	71.2615064 AC
SDF Top Area =	3,273,242.02	SF	75.1432971 AC
Depth of SDF (min) =	4.2	FT	
SDF Property Limits area =	4981416.174	SF	114.35758 AC

SDF Volume Requirements (LPP)

NER Volume	263,000.00	CY
0.5' over-dredge, bottom of SDF =	3,104,151.22	SF
Over-dredge volume =	57,484.28	CY
Total Dredge Volume =	320,484.28	
Apply Bulking factor of 1.12	358,942.40	CY
Topsoil Cap of 12' =	121,231.19	CY
Total Capacity of SDF (LPP) =	**480,173.58**	**CY**

SDF Volume Report (LPP)

The terrrain to plane volume provided below was from a PowerInroads report. The terrain to plane volume emcompasses the volume between the SDF terrain and a plane (EL 740), which is the top elevation of the SDF berm.

Terrain to Plane Volume Report

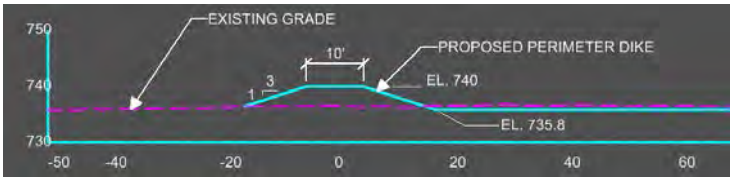
Terrain SDF To Plane 740.000
Cut Factor = 1.000
Fill Factor = 1.000
Cut = 0.000 sf3

Fill = 14073553.811 sf3	14,073,553.81	CF
Balance = 14073553.811 sf3	14,073,553.81	CF
Total SDF Volume Capacity =	**521,242.73**	**CY**

SDF Volume capacity is greated than volume requirements of 480173.6 CY (OK)

US Army Corps of Engineers, Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:
	CEDAR LAKE FEASIBILITY STUDY	FAYE LEFFLER	7/6/2016
	COMPUTATION TITLE:	CHECKED BY:	DATE:
	EARTHWORK QUANTITY	STEVEN GOODPASTOR	7/13/2016

SDF Berm (LPP)



SDF Perimeter Dike or Berm Typical Section

SDF Berm Top EL =	740	
SDF Berm Toe at SDF EL =	735.8	
SDF Berm Top Width =	10	FT
Side Slopes =	3(H):1(V)	
SDF Berm Length =	9663	LF
Cell #1 Length =	1466	LF
Cell #2 Length =	1294	LF

The cells lengths are based on the CL alignment of the cell berm. Cell #1 alignment follows the east and south alignment of the cells. And cell #2 follows the east-west alignment of the cells. Refer to the quantity.dgn file

SDF and Cells Berm Volume Report

The terrain to terrain volume is a PowerInroads report derived by comparing two terrains (SDF annd Cell Berms and existing ground terrains) to compute the volume between the terrains.

Terrain to Terrain Volume of SDF Berm

Terrain Exst Terrain To Terrain SDF Berm LPP
Cut Factor = 1.000
Fill Factor = 1.000

*Cut = 42189.026 sf3	0	CF
Fill = 1797576.741 sf3	1,797,576.74	CF
Balance = 1755387.715 sf3		

Terrain to Terrain Volume Cell 1

Terrain Exst Terrain To Terrain Berm_Cell 1
Cut Factor = 1.000
Fill Factor = 1.000

*Cut = 25.250 sf3		
Fill = 1695628.285 sf3	1,695,628.29	CF
Balance = 1695603.034 sf3		

Terrain to Terrain Volume Cell 2

Terrain Exst Terrain To Terrain Berm_Cell 2
Cut Factor = 1.000
Fill Factor = 1.000

*Cut = 21.275 sf3		
Fill = 749911.934 sf3	749,911.93	CF
Balance = 749890.658 sf3		

Total Berm Fill = 157,152.48 CY

*In areas where the existing grade is larger than EL 740, the top of berm will be the existing grade. Therefore, there will be no cut.

SDF Excavation Volume for Berm Fill

The terrain to terrain volume is a PowerInroads report derived by comparing two terrains (SDF and existing ground terrains) to compute the volume between the terrains.

Terrain to Terrain Volume

Terrain Exst Terrain To Terrain SDF No Berm
Cut Factor = 1.000
Fill Factor = 1.000

Cut = 1544003.279 sf3	1,544,003.28	CF
*Fill = 6084323.677 sf3	0	CF
Balance = 4540320.398 sf3		

Total Excavation Vol = 57,185.31 CY

The additional 100,000 CY of material needed for the berm fill can be excavated from the SDF site.
*There will be no fill in the SDF, the depressed areas within the SDF will be used as additional storage as necessary.

SDF and Cell Berm Surface Areas

Elements Component Quantities Report from PowerInroads report. The area is the top mesh area of the SDF and Cell berm models.

Elements Component Quantities Report for SDF Berm
Report Created: 6/24/2016
Time: 1:47pm
Input Grid Factor: Note: All units in this report are in feet, square feet and cubic feet unless specified otherwise.

Surface	Material	Area	Volume	Unit Cost	Material Cost
Corridor:			SDF Berm		
	Top Mesh:	410332		1	410331.67

Surface	Material	Area	Volume	Unit Cost	Material Cost
Corridor:			Berm Cell Alignment 2		
	Top Mesh:	104814		1	104813.62

US Army Corps of Engineers, Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:
	CEDAR LAKE FEASIBILITY STUDY	FAYE LEFFLER	7/6/2016
	COMPUTATION TITLE:	CHECKED BY:	DATE:
	EARTHWORK QUANTITY	STEVEN GOODPASTOR	7/13/2016

Surface	Material	Area	Volume	Unit Cost	Material Cost
Corridor:			Cell Berm Alignment 1		
	Top Mesh:	170514		1	170514.03

Total Berm Surface Areas = 685,660.00 SF
76,184.44 SY

SDF Weirs
Four concrete weirs are being assumed for the SDF to allow for flow from the SDF to the cells for water treatment. Refer to the cost appendix MII report for the weir size assumptions.

SDF Aerators
Two aerators are being assumed for the SDF. Refer to the environemental appendix and cost appendix MII report for the aerators details.

TOPSOIL STRIPPING AND SDF TOP SOIL CAP

SDF Footprint Area =	3,514,482.89	SF
Topsoil Stripping Area =	3,514,482.89	SF
Volume of Topsoil (Assuming 12" topsoil to be stripped)	**130,166.03**	**CY**

ROAD CONSTRUCTION FOR SLURRY PIPE

Road Trench for Culvert Construction
The length of the slurry pipe at the road assumes the width of the road, which is approximately 35 FT.

Assumptions: Open trench construction

Road Repair Length =	10	FT
Length of 12" Slurry Pipe =	35	FT
Road Repair Construction Area =	350	SF
	38.88888889	SY

US Army Corps of Engineers® Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:
	CEDAR LAKE FEASIBILITY STUDY	FAYE LEFFLER	7/6/2016
	COMPUTATION TITLE:	CHECKED BY:	DATE:
	FOUNDERS CREEK AVG END-AREA REPORT	STEVEN GOODPASTOR	7/13/2016

Founders Creek Average End-Area PowerInroad Report

Quantities are in square-feet and cubic feet.

Baseline	Station Quantities								Added Quantities						
Station	Cut				Fill				Cut			Fill			Mass
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted	Factor	Volume	Adjusted	Factor	Volume	Adjusted	Ordinate
0+00.0000	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
0+25.0000	1	188	2353.5	2353.5	1	0	0	0	1	0	0	1	0	0	2353.5
0+50.0000	1	190	4724.8	4724.8	1	0	1.2	1.2	1	0	0	1	0	0	7077.2
0+75.0000	1	193	4787.8	4787.8	1	0	1.2	1.2	1	0	0	1	0	0	11863.7
1+00.0000	1	192	4810.6	4810.6	1	0	0	0	1	0	0	1	0	0	16674.3
1+25.0000	1	23	2680.4	2680.4	1	0	0	0	1	0	0	1	0	0	19354.7
1+50.0000	1	206	2860.3	2860.3	1	0	0	0	1	0	0	1	0	0	22214.9
1+75.0000	1	193	4981.4	4981.4	1	0	0	0	1	0	0	1	0	0	27196.3
2+00.0000	1	189	4772.4	4772.4	1	0	0.2	0.2	1	0	0	1	0	0	31968.5
2+25.0000	1	170	4485.3	4485.3	1	0	0.3	0.3	1	0	0	1	0	0	36453.5
2+50.0000	1	138	3845.1	3845.1	1	0	2	2	1	0	0	1	0	0	40296.7
2+75.0000	1	128	3321.2	3321.2	1	0	2.3	2.3	1	0	0	1	0	0	43615.6
3+00.0000	1	92	2751.6	2751.6	1	0	1.7	1.7	1	0	0	1	0	0	46365.4
3+25.0000	1	87	2245.5	2245.5	1	0	1.2	1.2	1	0	0	1	0	0	48609.7
3+50.0000	1	86	2170.1	2170.1	1	0	0.6	0.6	1	0	0	1	0	0	50779.3
3+75.0000	1	77	2041.2	2041.2	1	0	0.6	0.6	1	0	0	1	0	0	52819.9
4+00.0000	1	75	1902.4	1902.4	1	0	0	0	1	0	0	1	0	0	54722.3
4+25.0000	1	67	1777.4	1777.4	1	0	0.2	0.2	1	0	0	1	0	0	56499.5
4+50.0000	1	66	1656	1656	1	0	0.2	0.2	1	0	0	1	0	0	58155.4
4+75.0000	1	76	1766.6	1766.6	1	0	0	0	1	0	0	1	0	0	59921.9
5+00.0000	1	73	1859	1859	1	0	0	0	1	0	0	1	0	0	61780.9
5+25.0000	1	71	1794	1794	1	0	0	0	1	0	0	1	0	0	63574.9
5+50.0000	1	66	1712.3	1712.3	1	0	1.2	1.2	1	0	0	1	0	0	65286
5+75.0000	1	102	2099.9	2099.9	1	0	5.6	5.6	1	0	0	1	0	0	67380.3
6+00.0000	1	185	3576.2	3576.2	1	0	4.6	4.6	1	0	0	1	0	0	70952
6+25.0000	1	179	4543	4543	1	0	1	1	1	0	0	1	0	0	75493.9
6+50.0000	1	127	3823	3823	1	0	0.9	0.9	1	0	0	1	0	0	79316
6+75.0000	1	82	2615.5	2615.5	1	0	0.2	0.2	1	0	0	1	0	0	81931.3
7+00.0000	1	78	1999.6	1999.6	1	0	0.2	0.2	1	0	0	1	0	0	83930.7

7+25.0000	1	87	2059.6	2059.6	1	0	0.2	0.2	1	0	0	1	0	0	85990.1
7+50.0000	1	90	2208.9	2208.9	1	0	0.4	0.4	1	0	0	1	0	0	88198.6
7+75.0000	1	92	2265.9	2265.9	1	0	0.3	0.3	1	0	0	1	0	0	90464.2
8+00.0000	1	84	2198.6	2198.6	1	0	1.1	1.1	1	0	0	1	0	0	92661.8
8+25.0000	1	80	2052.8	2052.8	1	0	7.2	7.2	1	0	0	1	0	0	94707.4
8+50.0000	1	106	2323.5	2323.5	1	0	6.3	6.3	1	0	0	1	0	0	97024.6
8+75.0000	1	86	2394.4	2394.4	1	0	0	0	1	0	0	1	0	0	99419
9+00.0000	1	27	1410.7	1410.7	1	0	1.1	1.1	1	0	0	1	0	0	100828.5
9+25.0000	1	0	339.5	339.5	1	0	1.1	1.1	1	0	0	1	0	0	101166.9
9+47.8246	1	0	0	0	1	0	0	0	1	0	0	1	0	0	101166.9
Grand Total:			101209.9	101209.9			43	43		0	0		0	0	