2014

Hegewisch Marsh Section 506 Great Lakes Fishery & Ecosystem Restoration Study

Appendix F – Geotechnical Appendix

Chicago District
US Army Corps of Engineers
12/16/2014

APPENDIX F. Geotechnical

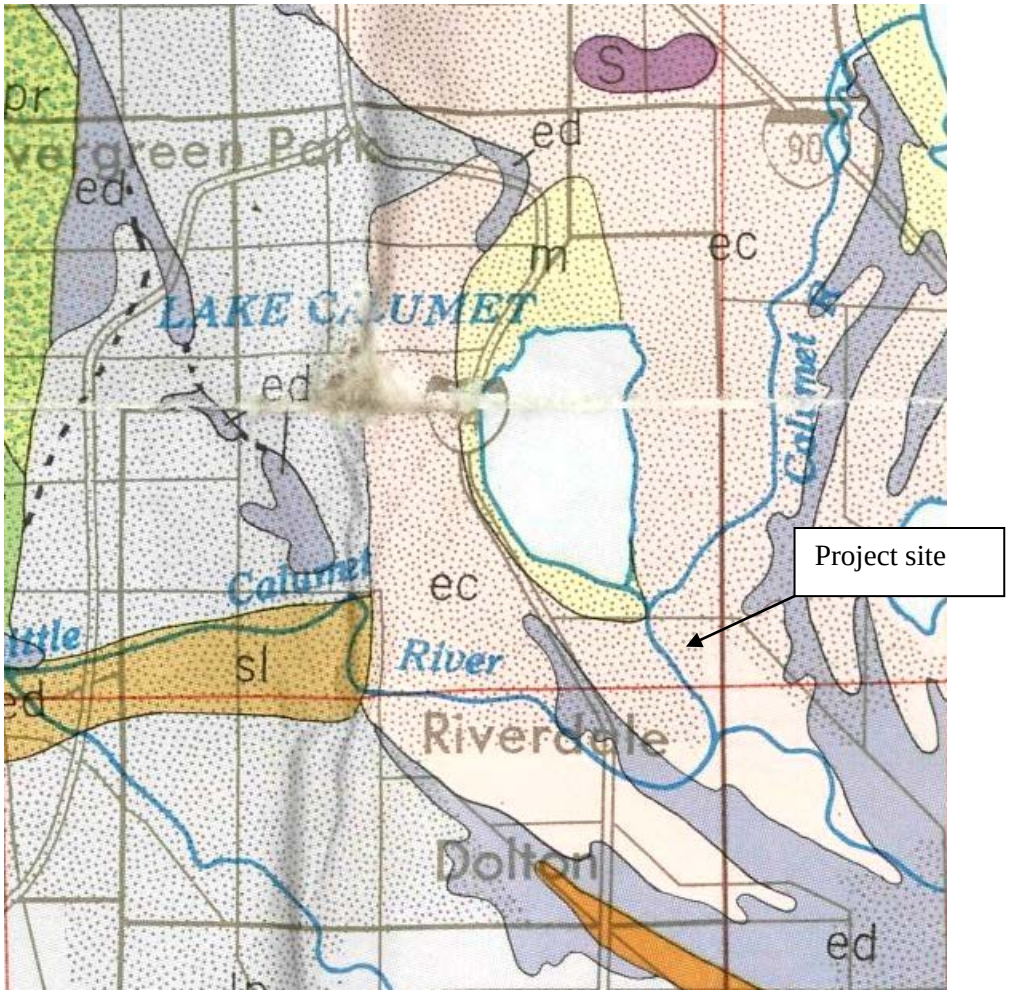
D-1. Project Plan, Site Selection, Foundation Design, Selection of Structures, and Cost Estimates

The project plan and rationale for site selection, which entails site grading and planting, is described in the main text of the Detailed Project Report (DPR). Structures are not anticipated to be included in the final selected plan.

D-1.1. Regional and site geology

The Quaternary geology of the site is shown in Figure D-1 (Lineback, Follmer, Gross, et al., 1975; Illinois State Geological Survey).

Figure D-1. Quaternary site geology (ISGS, 1975)

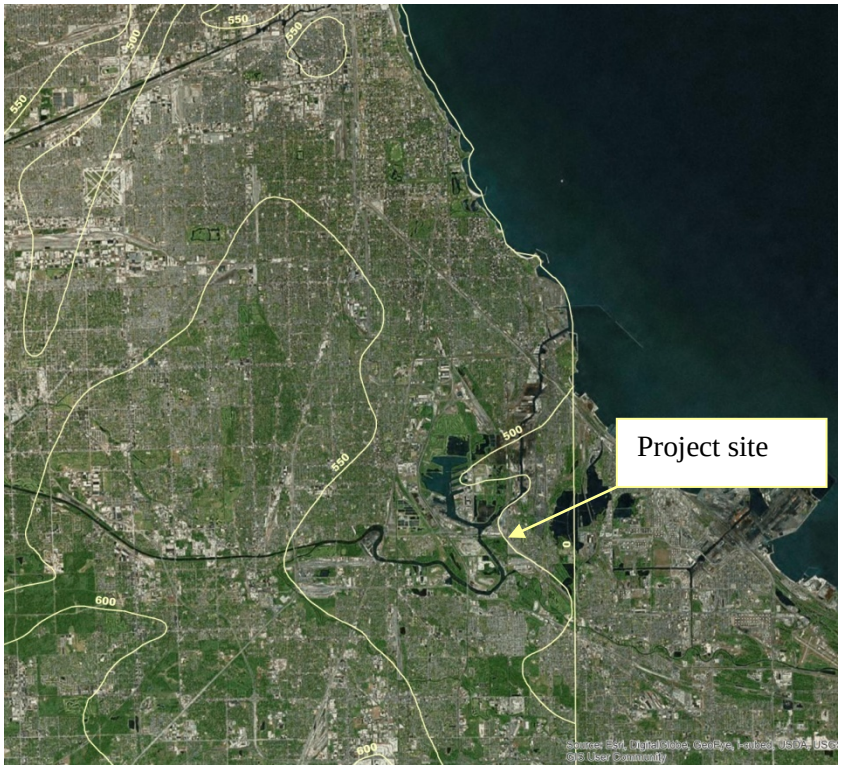


The site is located in the Carmi Member of the Equality Formation, which is described as

Largely quiet-water, lake sediments; dominantly well bedded silt, locally laminated and containing thin beds of clay; local lenses of sand and sandy gravel along beaches.

Bedrock topography is presented in Figure D-2, which is taken from The Summary of the Geology of the Chicago Area, Circular 460, H. B. Willman, Illinois State Geological Survey, 1971, 77 pp..

Figure D-2 Bedrock site topography



The top of the bedrock in the vicinity of Hegewisch Marsh is slightly more than 500 ft, which is approximately eighty (80) feet below the ground surface. Therefore the bedrock will not influence the immediate design and implementation of this project.

D-1.2. Summary of Geotechnical Explorations

The geotechnical investigations undertaken were as follows:

- Earth Tech, Inc. 2001. Phase I Environmental Site Assessment, Hegewisch Marsh.
- Earth Tech, Inc. 2002. Phase I Environmental Site Assessment Addendum, Hegewisch Marsh.
- Tetra Tech EM Inc. 2003. Soil Sampling Report, 130th Street and Torrence Avenue.
- Tetra Tech EM Inc., Land and Water Resources Inc., and Terry Guen Design Associates Inc. 2006. Hegewisch Marsh Site Plan. Prepared for Chicago Department of Environment.
- Tetra Tech EM, Inc. 2006. Phase I Environmental Site Assessment, Hegewisch Marsh-Southwest Parcel, 134th Street and Calumet River.
- Tetra Tech EM, Inc. 2006. Hegewisch Marsh Status Report, Additional Soil, Sediment, Vegetation, and Macroinvertebrate Sampling Results for the 100-Acre Parcel.

- Tetra Tech EM, Inc. 2007. Hegewisch Marsh Status Report, Additional Soil Screening and Sampling for the 100-Acre Parcel.
- Tetra Tech EM, Inc. 2007. Phase II Environmental Site Assessment Report, Hegewisch Marsh-17-Acre Parcel, November 2007 Sampling Summary.
- Tetra Tech EM, Inc. 2008. Phase I Environmental Site Assessment, Hegewisch Marsh-17-Acre Parcel, 134th Street and Calumet River. Tetra Tech EM, Inc. 2009. Phase II Environmental and Ecotoxicological Site Assessment Report, Hegewisch Marsh.
- URS Corporation. 2002. Phase II Subsurface Investigation, Hegewisch Marsh.
- V3 Companies, Ltd. 2006. VII Hegewisch Marsh Hydrologic Analysis, Calumet Area Hydrologic Master Plan (HMP). Prepared for Chicago Department of Environment.

D-1.3. Selection of preliminary design parameters.

The permeability of the site was inferred from the site geology. The sand permeability was assumed to be 0.1 cm/s for a preliminary assessment.

D-1.4. Geophysical investigations.

No geophysical investigations were performed as part of this analysis.

D-1.5. Groundwater studies

Groundwater elevation was analyzed in the following (Attachment 1):

- V3 Companies, Ltd. 2006. VII Hegewisch Marsh Hydrologic Analysis, Calumet Area Hydrologic Master Plan (HMP). Prepared for Chicago Department of Environment.

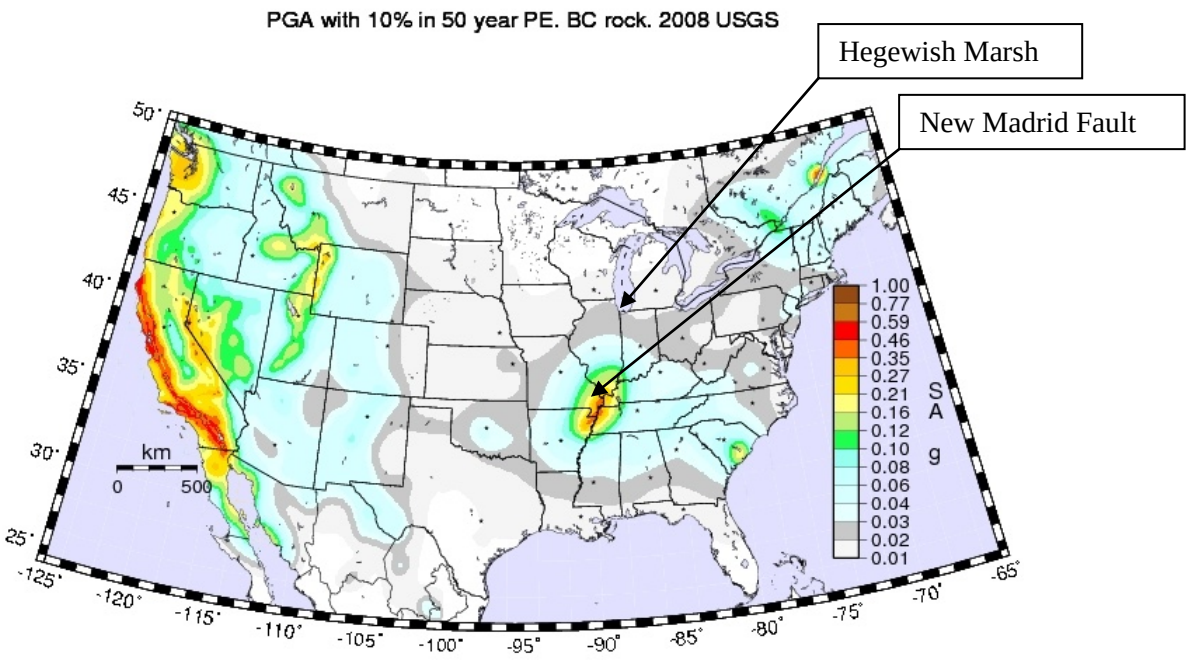
D-1.6. Recommended instrumentation.

Because the site already contains several groundwater wells and surface water monitoring stations, no additional instrumentation is recommended.

D-1.7. Earthquake studies

The Chicago area is not a seismically active area. The closest significant fault is the New Madrid. A map of peak ground accelerations with a 10% recurrence interval is presented in Figure D-3.

Figure D-3 Peak ground accelerations

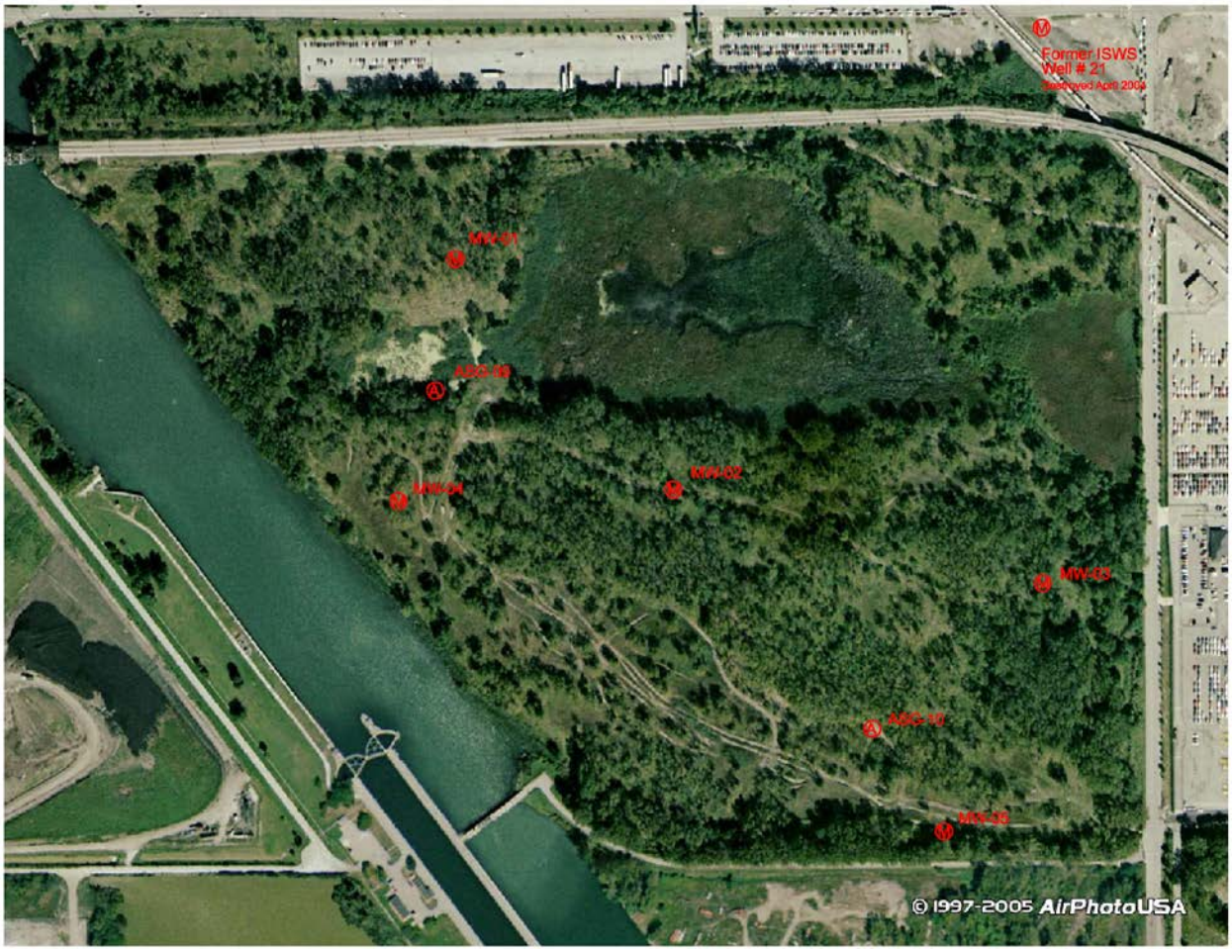


Though there is some chance that the project area may experience some shaking, the 0.02 g peak ground acceleration is not expected to impact this ecosystem restoration project.

D-1.8. Preliminary foundation design and slope stability analysis

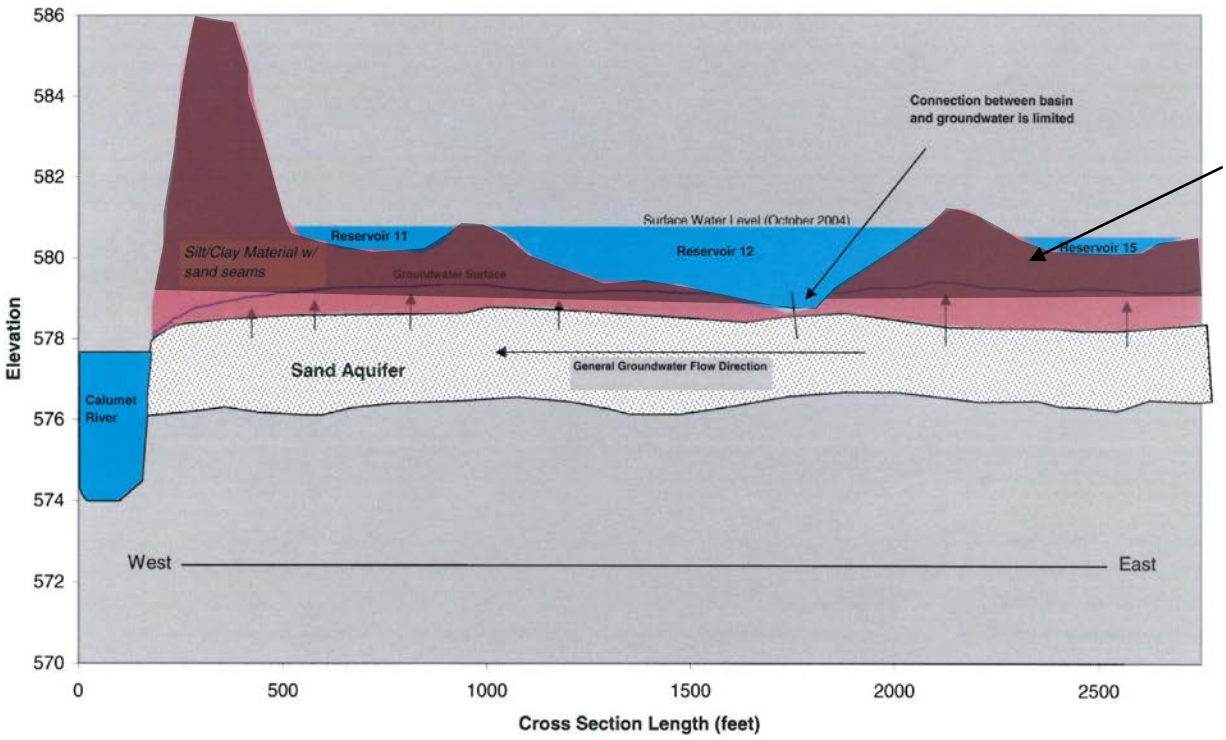
Because this project involves minimal site grading there are no slope issues that warrant slope stability analyses. The primary focus of analysis is toward groundwater flow. Site monitoring wells are shown in Figure D-4. Monitoring wells as designated as “M” and surface water monitoring stations are designated as “A”.

Figure D-4 Groundwater and surface water monitoring locations (V3, 2006)



A generalized cross section as developed by V3 (2006) with location of fill indicated is shown in Figure D-5.

Figure D-5 Cross section of site geology based on V3 (2006) with fill indicated



Fill material, which plays a large role in the site hydrogeology is noted in the boring logs to depths and elevations shown in Table D-1

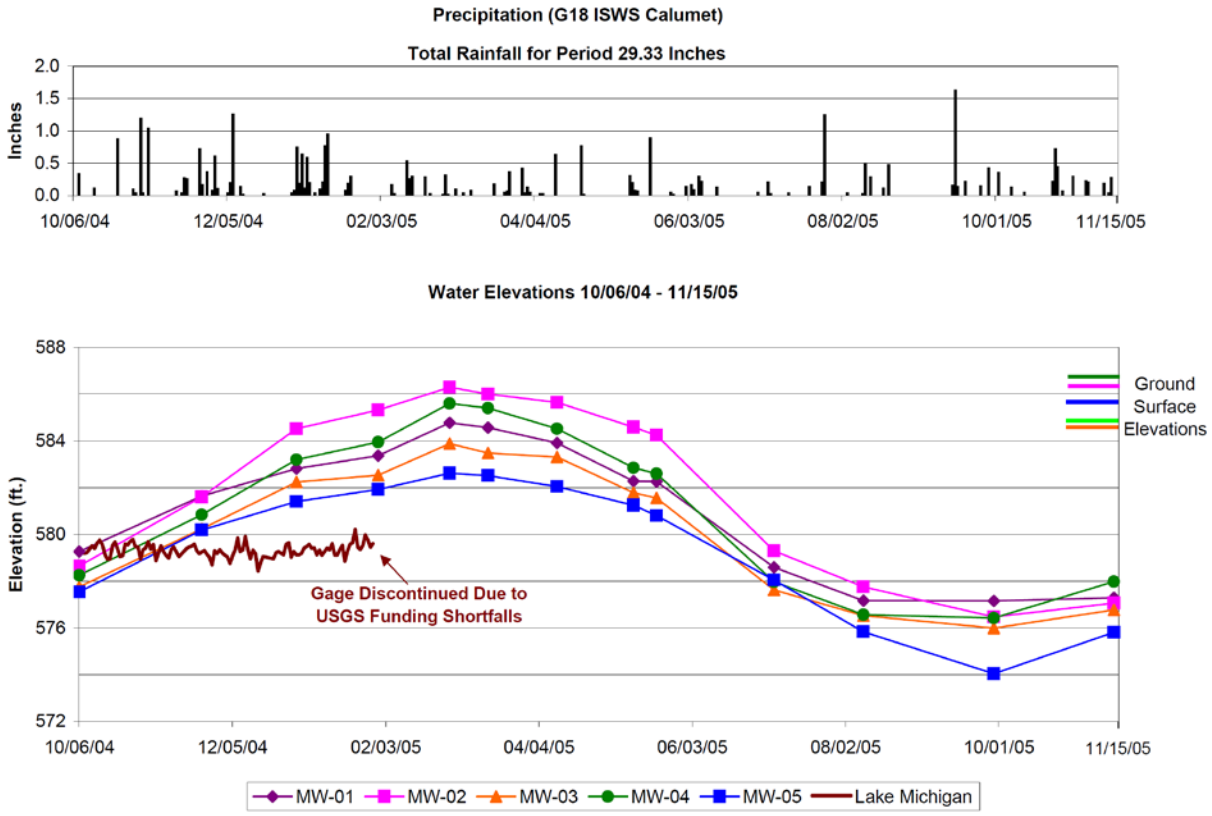
Table D-1 Summary of fill depth and elevation

Boring	Depth of Fill	Elevation of Fill
MW-01	None noted	
MW-02	7.0 ft	579.3
MW-03	5.5 ft	580.4 ft
MW-04	5.5 ft	581.1 ft

The fill is described predominantly as clay (CL, CH) and silt (MH, ML). This low permeability material would inhibit infiltration of groundwater into the underlying sand layer, which is described in 3 of the 4 available logs as SP and is roughly three (3) ft thick.

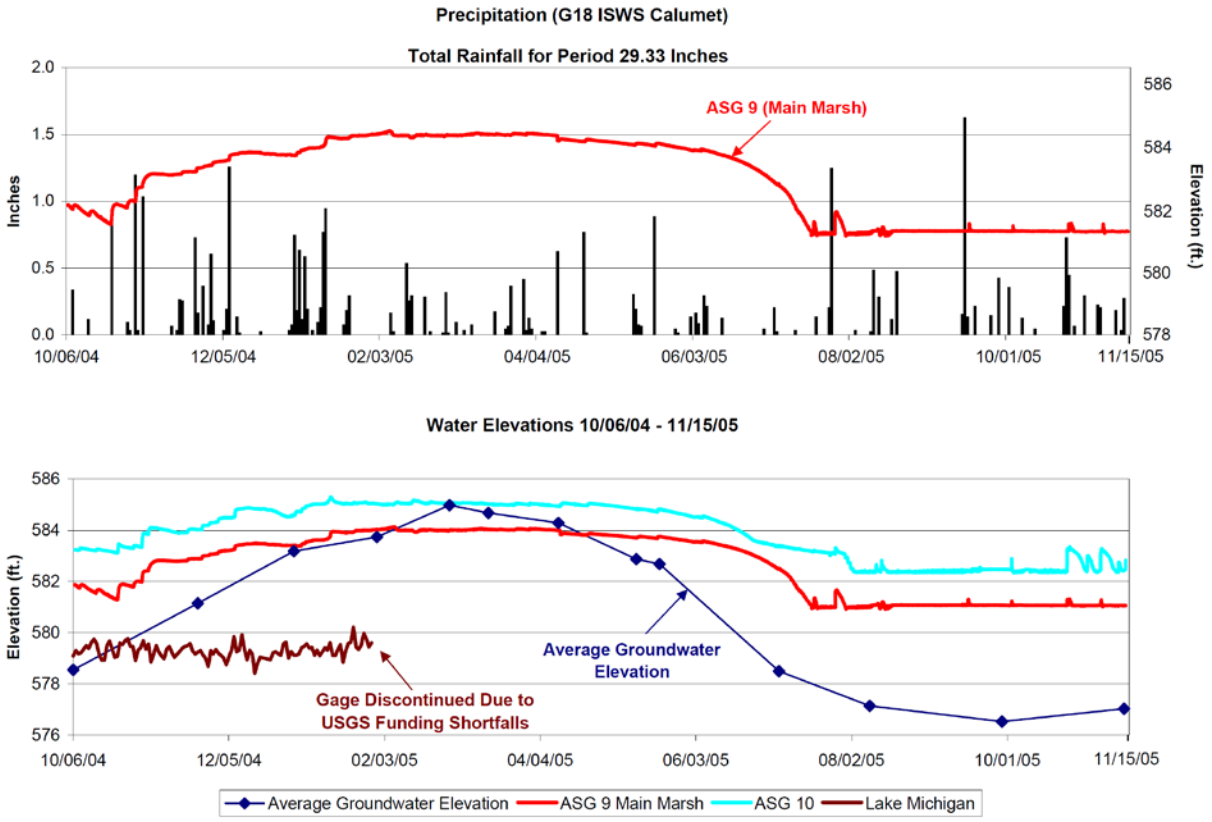
Groundwater elevations were monitored periodically by V3 (2006) as shown in Figure D-6.

Figure D-6 Groundwater elevation monitoring values (V3, 2006)



Surface water readings were monitored as shown in Figure D-7.

Figure D-7 Surface water readings (V3, 2006)



The groundwater elevations were contoured during the wettest time (Feb 2005) and the driest time (Sep 2005) shown in Figure D-8 and Figure D-9.

Figure D-8. Contour of groundwater elevations during wet period (Spring 2005)

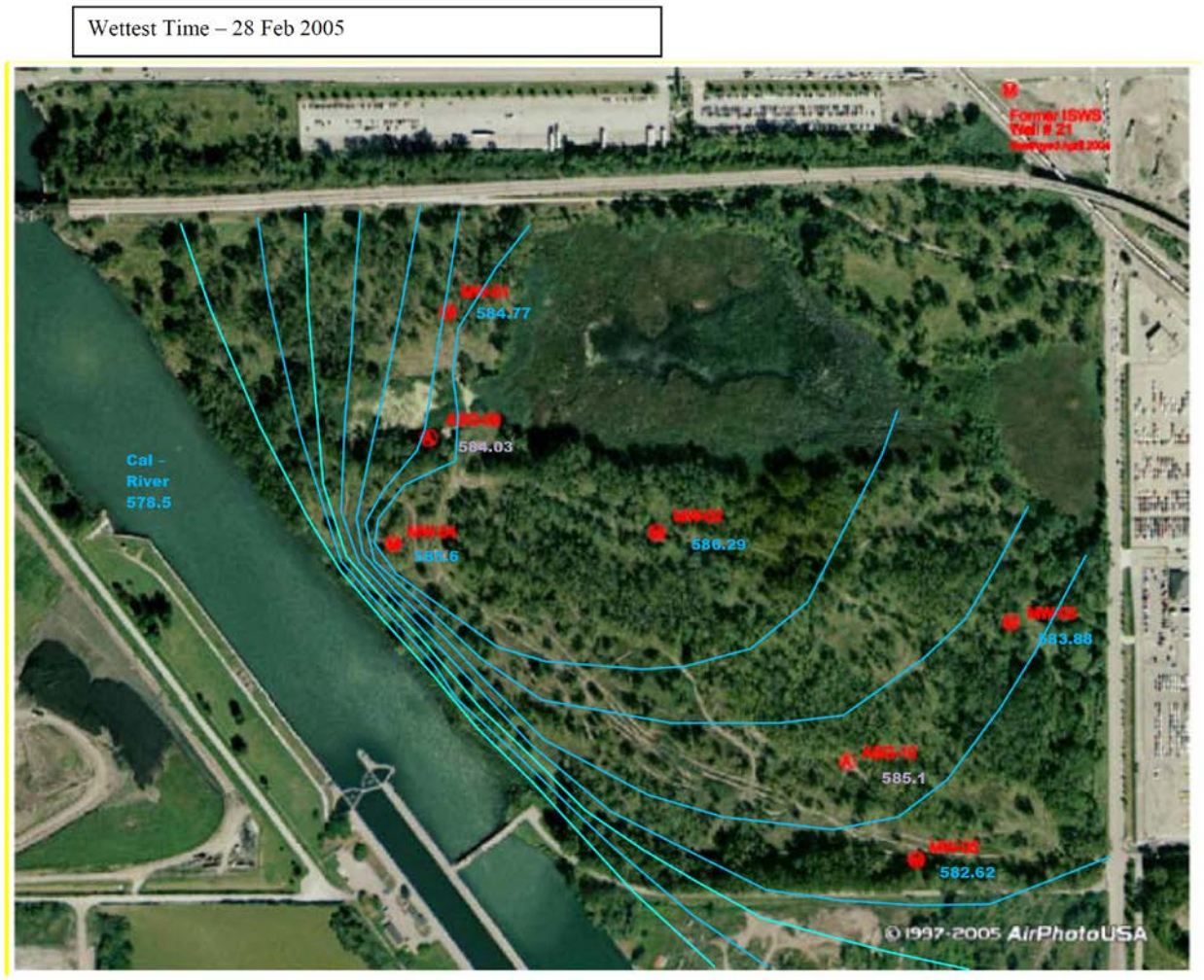
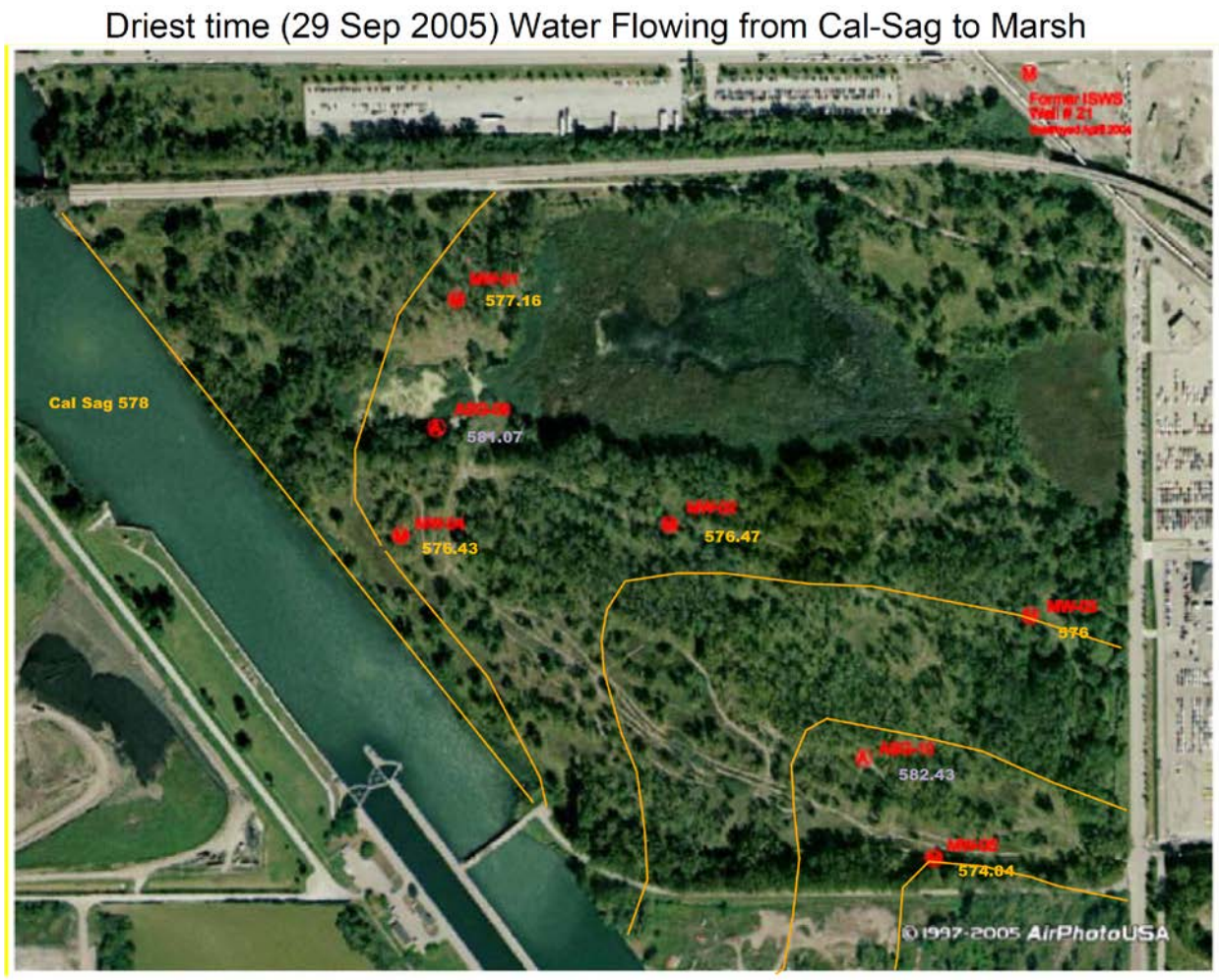


Figure D-9 Contour of groundwater elevations during dry period (Fall 2005)



Groundwater elevation readings are summarized in Table D-2.

Table D-2 Summary of groundwater elevation readings

permeability	10	ft/day													driest time
		ground	top of casing	6-Oct-04	23-Nov-04	30-Dec-04	31-Jan-05	28-Feb-05	15-Mar-05	11-Apr-05	11-May-05	20-May-05	5-Jul-05	9-Aug-05	29-Sep-05
MW-01	Northwest site	585.77	587.17	579.27	581.64	582.81	583.37	584.77	584.57	583.91	582.28	582.26	578.59	577.17	577.16
MW-02	South of Marsh	586.27	587.9	578.65	581.6	584.52	585.32	586.29	586	585.65	584.59	584.24	579.3	577.76	576.47
MW-03	South of Marsh (east)	585.67	587.68	577.76	580.23	582.24	582.53	583.88	583.48	583.31	581.78	581.56	577.63	576.53	576
MW-04	South of Marsh (west)	586.6	587.9	578.26	580.84	583.2	583.95	585.6	585.4	584.52	582.85	582.6	577.97	576.57	576.43
MW-05	Southernmost well	585.91	588.41	577.54	580.19	581.41	581.92	582.62	582.51	582.04	581.25	580.81	578.05	575.84	574.04
	Lake elevation (nominally 578.5)			578.5	578.5	578.5	578.5	578.5	578.5	578.5	578.5	578.5	578.5	578.5	578.5

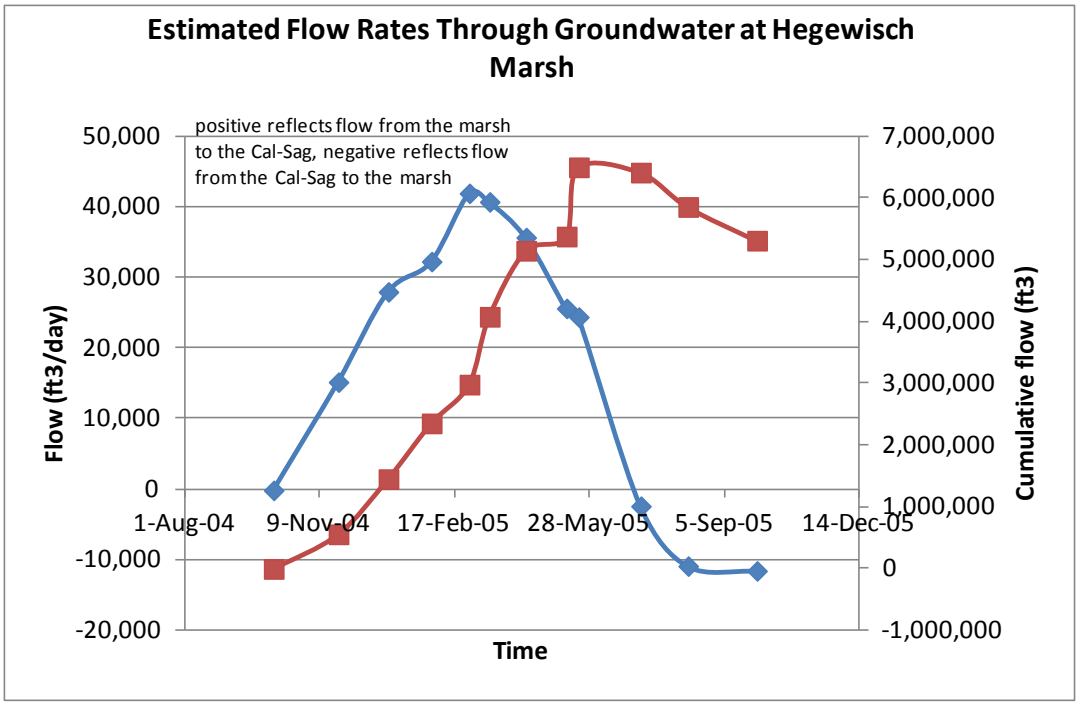
Flow velocity and flow rate are then calculated as shown in Table D-4 based a sand permeability of 0.1 cm/s and an aquifer thickness of three (3) ft.

Table D-4 Calculation of groundwater flow velocity and flow rate

Velocity calculations (ft/day)	Length of seepage path (ft)													
north half (based on MW 1)	830		0.26	1.07	1.47	1.66	2.14	2.07	1.85	1.29	1.28	0.03	-0.45	-0.46
south half (based on MW 4)	215		-0.32	3.09	6.20	7.19	9.36	9.10	7.94	5.74	5.41	-0.70	-2.54	-2.73
positive is toward Cal-Sag/negative is toward marsh														
Flow calculations (ft^3/day)														
north half (based on MW 1)			958.5	3908.8	5365.3	6062.4	7805.2	7556.3	6734.7	4705.5	4680.6	112.0	-1655.7	-1668.1
south half (based on MW 4)			-1153.4	11245.4	22586.9	26191.1	34120.6	33159.4	28930.4	20904.9	19703.4	-2547.0	-9275.0	-9947.8
flow (ft^3/day)			-195	15,154	27,952	32,254	41,926	40,716	35,665	25,610	24,384	-2,435	-10,931	-11,616
cumulative			-9,352	551,354	1,445,823	2,348,923	2,977,810	4,077,134	5,147,085	5,377,579	6,499,246	6,414,021	5,856,557	5,310,608

The flow calculations are summarized in Figure D-10

Figure D-10. Summary of groundwater flow calculations



From the calculations summarized in Figure D-10 it is estimated that the site loses far more water towards the Calumet River than it gains. This estimation is based on the calculated the gradient from high groundwater to the river, which is much higher and over a longer period of time than from the river to the marsh. A rough water budget is shown in Table D-5.

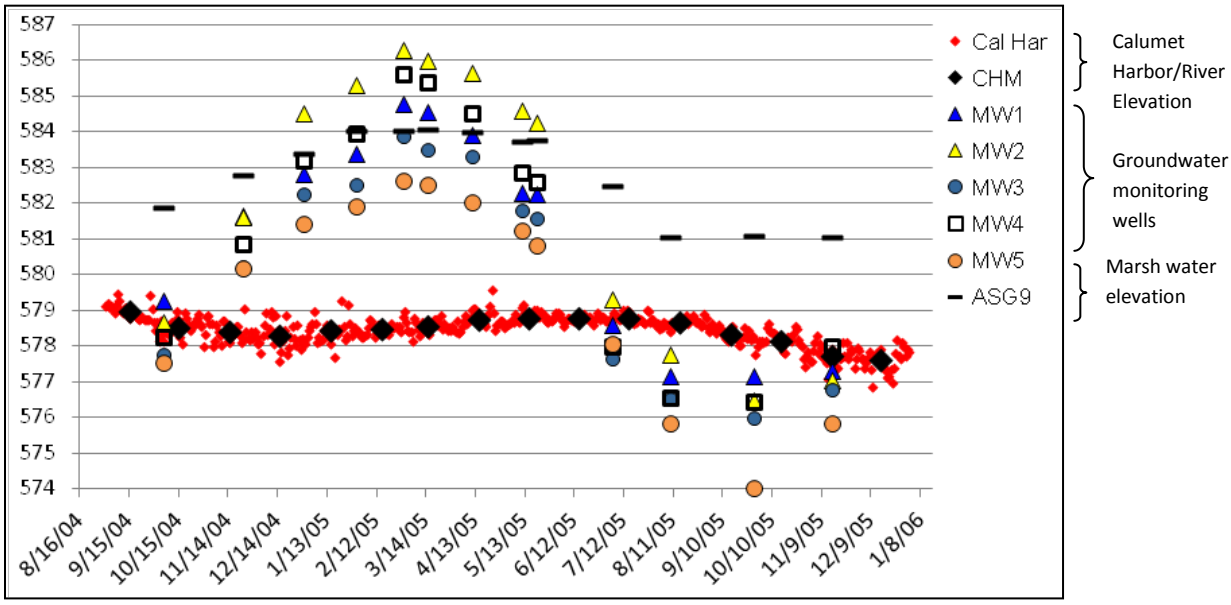
Table D-5. Rough water budget for Hegewisch Marsh

water to site in a year			
2	in	through clay	
12.4	in	through ponding	
14.4	in	total infiltration	
1.2	ft		
5.00E+06	ft2	Site Area	
6,000,000	ft3	Volume to site/year	

The water budget in Table D-5 indicates that roughly 12 inches of water infiltrates annually through the pond and 2 inches through the clay. During the dry period when the pond dries, this infiltration no longer feeds the groundwater.

Water levels in the monitoring wells are shown in Figure D-11.

Figure D-11. Water levels in monitoring wells



A reasonable explanation for lower water levels in the monitoring wells during drier times of the year is that the groundwater may be depressed due to evapotranspiration. The water that feeds the aquifer likely is driven mainly by the surface water ponding. Any vegetation that would serve to reduce this ponding would serve to reduce the water recharging the aquifer and increase water leaving the site. By reducing the amount of evapotranspiration the water level in the aquifer would increase and more net water would be left on site.

D-1.9. Excavatability analysis with possible blasting constraints and controls.

The site soils consist of fill, sand, clay, silt and gravel. Site grading which would be expected as part of this ecosystem restoration should not be adversely affected by these soils.

D-1.10. Anticipated construction techniques, limitations, and problems.

Because the selected plan includes site grading of surface soils and planting, there are no anticipated issues with construction techniques.

D-1.11. Potential borrow sites and disposal sites

Borrow material is not anticipated as part of this project. Any excavation on site will be kept on site. Therefore no issues with disposal site are anticipated.

D-1.12. Potential sources of concrete materials and results of materials investigations.

Concrete materials are not anticipated to be needed for this project.

D-1.13. Suitability of concrete materials and plant, earth and rock borrow material, and stone slope protection

Concrete materials are not anticipated to be needed for this project. Stone and slope protection are not anticipated as part of this project.

D-2. Physical property testing and discuss selected design values.

There was no testing for the physical properties of the materials. The permeable layer is described as poorly graded sand and is assigned a nominal value of 0.1 cm/s for a qualitative assessment of the amount of water flowing away from and to the site via groundwater.

D-3. Summary of any additional exploration, testing, and analysis required for preparation of the DDR

No additional geotechnical exploration, testing, and analysis are anticipated as part of development of the design documentation report (DDR).

D-4. Summary of Laboratory Testing Program

Laboratory testing was not performed as part of the investigation.

Attachments

Attachment 1 Hegewisch Marsh Hydrologic Analysis, Calumet Area Hydrologic Master Plan VII (HMP). Prepared for Chicago Department of Environment. V3 Companies, Ltd. 2006. (*upon request*)