Appendix K
Water Quality Analysis

Addendum to the Water Quality Analysis of Elgin O'Hare - West Bypass Project

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The Elgin O'Hare – West Bypass (EO-WB) project has been evaluated to determine the potential effects stormwater runoff may have on water quality in area waterways. The water quality analysis was documented in a February 2012 memorandum. This addendum provides an update to the original water quality memorandum based upon the conceptual roadway and stormwater best management practice (BMP) design.

Conceptual Design Water Quality Analysis

Under this revised water quality analysis for the Elgin O'Hare-West Bypass project, specific drainage areas to the various BMPs were delineated to more accurately quantify the stormwater treatment for each sub-area. Delineated drainage areas were bounded by the 2040 Full Build Footprint. The 2040 Full Build Footprint represents the outer limit of construction disturbance and encompasses the 2030 ICP Footprint. Total suspended solids (TSS) and metals reductions were evaluated for flows within the individual drainage areas by accounting for the BMP or sequentially placed BMPs within those areas (BMP treatment train). Each BMP provided an average percent removal of both TSS and metals. For all watersheds except the Salt Creek Watershed, accounting for a two-BMP treatment train demonstrates water quality standards are met and that water quality improves for TSS and metals in each watershed.

The exhibits in Attachments 1 and 2 show the stormwater BMP treatment train by sub-basin. Tables 1 and 2 summarize the BMP treatment train by sub-basin for all watersheds.

BMPs Considered

BMPs considered in the conceptual design analysis include those in the February 2012 memorandum and the following:

- Infiltration Areas, similar to bioswales with engineered soil but provide increased storage capacity using a larger width dimension
- Rock Basins, riprap-lined basins which provide flood storage capacity while also providing some additional water quality benefit
- Basins, designation provided to Rock Basins providing a minimum water capture storage volume

Rock Basins were suggested for areas located within a five mile radius, known as the wildlife hazard separation distance, from the Chicago O'Hare International Airport and within a 10,000-foot radius of the Schaumberg Regional Airport. This wildlife hazard separation distance is applicable across all but a small portion of the project right-of-way. The Rock Basins were characterized according to their time to drawdown of the free water surface to the normal water line (or infiltration surface). The drawdown time was considered either greater than 48 hours or less than or equal to 48 hours. Rock Basins were provided a minimum water quality storage volume of 0.08 acre-ft. This minimum storage volume was selected based upon minimum forebay volume consistent with other recent Tollway projects (CBBEL, 2012). The water quality volume is in addition to any forebay designed for the pond.

Conceptual plan details of the BMPs from the Proposed BMP Plan provided by Christopher B. Burke Engineering, Ltd., can be found in Attachment 3.

TABLE 1
Revised Proposed 2040 Full Build BMP Coverage

	Basin (Dry)	Wet Basin	Rock Basin	Low Treatment Grass Swale	Grass Swale	Bioswale	Grass Swale & Basin (Dry)	Grass Swale & Wet Basin	Grass Swale & Rock Basin	Bioswale & Basin (Dry)	Bioswale & Wet Basin	Bioswale & Rock Basin	Total % BMP Coverage
Addison Creek			40%	5%	2%	1%	15%					14%	77%
Silver Creek			10%			4%			15%	3%		20%	52%
Bensenville Ditch	12%		49%							11%		6%	78%
Willow Creek	7%	2%	5%		17%	19%	13%		8%	4%		5%	80%
Higgins Creek	8%		9%	24%		10%	2%			6%		9%	68%
Salt Creek	4%	3%			13%	7%	6%	1%	2%	2%	14%	7%	59%
Spring Brook Creek					13%	30%		54%					97%
Meacham Creek					11%	7%		43%	7%		22%	6%	96%
West Branch DuPage River		20%			8%	26%		26%			18%		98%

TABLE 2
Additional Proposed 2040 Full Build BMP Coverage for Salt Creek

	Grass Swale & Rock Basin & Wet Basin	Grass Swale & Basin (Dry) & Wet Basin	Grass Swale & Bioswale & Basin (Dry)	Bioswale & Basin (Dry) & Wet Basin	Bioswale & Rock Basin & Wet Basin	Rock Basin & Wet Basin	Total Additional % BMP Coverage
Salt Creek	9%	5%	1%	4%	1%	1%	21%

Drainage Area Delineation

Drainage areas which were tributary to each BMP treatment train were delineated using the Proposed BMP Plan provided by Christopher B. Burke Engineering Ltd. Proposed roadways, BMPs and storm sewer, as well as topography, were observed from the proposed plan set and used to delineate these areas. For all watersheds, except for Salt Creek, the BMP treatment train located within a given area consisted of a single BMP or two BMPs in series, though additional treatment may have been present. In general, multiple BMPs in series provide superior treatment of runoff.

For Salt Creek, a three BMP treatment train approach was considered where significant downstream wet detention basins already existed. In most cases where this three-BMP treatment train was considered, the final BMP was an existing wet detention basin located immediately adjacent to the 2040 Full Build Footprint. The area of the individual drainage areas were calculated using ArcGIS computer software. These areas were then related to the total area of the watershed by calculating the percent of the total 2040 Full Build Footprint within each watershed. After delineating the drainage areas and their contributing percent to the total watershed, flow arrows were added to indicate the inflows and outflows of runoff for each drainage area. Exhibits which show the BMPs and the delineated drainage areas for the entire project within 2040 Full Build Footprint are provided in Attachments 1 and 2.

Water Quality Capture

Section 15-64 of the *DuPage County Ordinance* (DuPage County 2012) requires that the volume control best management practice be calculated as the product of the new impervious area and the rainfall depth generated from a 1.25-inch rainfall event occurring over a two-hour period (excluding abstractions). As a result, BMPs were designed to capture and store the 1.25-inch of rainfall within a watershed. Actual volume provided within individual sub-watersheds varied depending upon site constraints.

Table 3 shows how the conceptual designs allocated volume control storage by BMP. Variations in volume control for water quality storage are expected to occur during final design; however, the expectation is that the overall volume in Table 3 should be achieved within each watershed.

TABLE 3

BMP Volume Control Contribution by Watershed

Watershed	Rock Pond Volume (>48 Hour Drawdown) (acre-ft)	Rock Pond Volume (≤48 Hour Drawdown) (acre-ft)	Total Rock Pond Volume (acre-ft)	Infiltration Area Storage Volume (acre-ft)	Bioswale Storage Volume (acre-ft)	Total BMP Storage Volume (acre-ft)	New Impervious Area (acre)	Required Storage Volume Based on 1.25-inch rainfall (acre-ft)	Total Impervious Area (acre)	Meets Water Quality Volume Goal? (Yes/No)
West Branch DuPage River	0.24	0.00	0.24	0.31	0.16	0.71	6.05	0.63	37.87	Yes
Spring Brook Creek	0.00	0.08	0.08	0.00	0.46	0.54	4.57	0.48	23.73	Yes
Meacham Creek	0.60	0.00	0.60	2.03	0.57	3.20	28.57	2.98	78.73	Yes
Salt Creek	2.06	0.40	2.46	3.05	1.04	6.55	56.98	5.94	144.31	Yes
Willow Creek	4.95	1.78	6.73	4.23	1.01	11.97	110.20	11.48	165.93	Yes
Higgins Creek	3.02	0.97	3.99	3.13	0.49	7.61	71.14	7.41	183.80	Yes
Bensenville Ditch	0.00	2.68	2.68	0.00	0.16	2.84	24.03	2.50	24.03	Yes
Silver Creek	1.43	1.66	3.09	0.00	0.34	3.43	31.71	3.30	45.49	Yes
Addison Creek	1.89	1.18	3.07	0.00	0.24	3.31	29.73	3.10	77.16	Yes
Total	14.19	8.75	22.94	12.75	4.47	40.16	362.98	37.81	781.05	Yes

Note: The 1.25-inch volume control captures 97 to 99 percent of all rainfall events and treats 77 percent of annual average runoff volume from new impervious area.

For a detailed list of allocated volume control storage by subarea and watershed, see Attachment 4. According to a PCSWMM model for Stormcepter which used a 44-year (1962-2005) record of rainfall data from a rainfall station located at the Chicago O'Hare Airport, this 1.25-inch criterion represents approximately 98 percent of all annual rainfall events. The proposed BMP storage volumes, therefore, would accommodate about 77 percent of all annual rainfall. See Attachment 5.

Water Quality Analysis

Tables 1 and 2 list BMP treatment train coverage by watershed for existing and revised 2040 Full Build conditions. The single or two-BMP treatment trains considered are included in Table 1. In order to account for the additional wet ponds in the Salt Creek Watershed, three-BMP treatment trains had to be considered. The BMP treatment trains used specifically for Salt Creek are listed in Table 2. Total BMP coverage attributed to the Salt Creek watershed is the sum of the total percent BMP coverage present in Tables 1 and 2.

Where possible within the 2040 Full Build Footprint, if stormwater runoff leaves the highway footprint without entering a basin, bioswales were recommended to provide an additional level of treatment prior to discharging from the highway footprint. This was not possible at all locations due to highway footprint constraints, in which a grass swale was used where possible. There are some instances of direct drainage without treatment from the highway footprint, but the analysis considers these situations and concludes that overall water quality improves with the additional BMPs provided.

The water quality analysis compared the existing and proposed TSS and metals concentrations expected from the recommended BMP treatment train configurations for each individual watershed. This comparison is indicated by an expected percent change in TSS or metals concentrations, where a positive percent increase indicates a decline in water quality and a negative percent increase indicates an improvement in water quality. The results of the water quality analysis are shown in Table 4 and confirm that an improvement in water quality is expected in all watersheds.

BMP Assumptions

A number of assumptions were made for the BMPs. These included average TSS and metals removal efficiencies, void ratios of riprap-lined rock basins, and the void ratio and depth of engineered soil in bioswales and infiltration areas. Void ratios and depths affect the potential storage volume of the BMPs.

Each BMP is capable of providing water quality benefits. Average percent removals of both TSS and metals for each BMP were documented in the original memorandum. BMPs included in the conceptual design, but not in the original memorandum, were modeled as follows:

Bioswales:

- Void Ratio: 0.20
- Width: 6 ft (variations on the assumed bioswale for water quality analysis are shown in Attachment 3)
- Depth of Engineered Soil: 2 ft

Infiltration Areas:

- Void Ratio: 0.20
- Depth of Engineered Soil: 2 ft

Rock Basin:

- Because the rock basins have some water quality volume contained in them, they were modeled to have performance between a dry pond and a wet pond for water quality purposes.
- Void Ratio: 0.30
- TSS reduction: 70 percent
- Metals reduction: 43 percent

Basin:

- These basins may have rock in them, but only minimal water quality volume. Because the rock basins have some water quality volume contained in them, they were modeled as a dry pond for water quality purposes.

Results

The water quality analysis calculated existing and proposed 2040 Build water quality in the project area watersheds. The findings were compared to background sample data and water quality criteria to determine the effect of the EO-WB on water quality. The results for TSS and metals analysis are shown in Table 3.

TSS

With BMPs in place, the TSS concentration decreases in all watersheds by 16 to 52 percent for the once in 3 year concentration. The decrease in TSS concentration is due to the limited amount of BMPs currently in place in these watersheds under existing conditions combined with the amount of BMPs implemented with the 2040 Build condition. The TSS concentrations in Spring Brook Creek, Meacham Creek, and West Branch DuPage River watersheds are generally better than the other watersheds because they already have water quality BMPs present. There is no numeric water quality standard in Illinois for TSS.

TABLE 4

Revised Water Quality Analysis Results with Best Management Practices (BMPs)

		Addison Creek	Silver Creek	Bensenville Ditch	Willow Creek	Higgins Creek	Salt Creek	Spring Brook Creek	Meacham Creek	West Branch DuPage River
TSS[b]	Criteria (mg/L)[a]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	227	292	261	326	302	74	88	68	70
	Revised 2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	144	171	152	155	246	63	60	54	47
	Percent increase[c] in concentration	37%	42%	42%	52%	18%	16%	32%	21%	33%
Copper[b]	Criteria (mg/L)[a]	0.046	0.037	0.037	0.037	0.045	0.040	0.050	0.049	0.037
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	0.030	0.038	0.034	0.043	0.041	0.013	0.019	0.017	0.015
	Revised 2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	0.026	0.026	0.019	0.028	0.036	0.011	0.016	0.015	0.013
	Percent increase[c] in concentration	16%	33%	43%	36%	11%	10%	19%	8%	12%
Lead[b]	Criteria (mg/L)[a]	0.236	0.184	0.184	0.185	0.226	0.200	0.258	0.251	0.184
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	0.005	0.006	0.005	0.007	0.006	0.002	0.003	0.003	0.002
	Revised 2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	0.004	0.004	0.003	0.004	0.006	0.002	0.002	0.002	0.002
	Percent increase[c] in concentration	16%	33%	43%	36%	11%	10%	19%	8%	12%
Zinc[b]	Criteria (mg/L)[a]	0.295	0.241	0.241	0.242	0.284	0.258	0.317	0.310	0.241
	Existing condition with BMPs—once in 3 year stream concentration (mg/L)	0.138	0.174	0.155	0.196	0.187	0.058	0.087	0.076	0.066
	Revised 2040 Build condition with BMPs—once in 3 year stream concentration (mg/L)	0.116	0.116	0.089	0.125	0.166	0.052	0.071	0.070	0.059
	Percent increase[c] in concentration	16%	33%	43%	36%	11%	10%	19%	8%	12%

[a] No Numeric General Use Water Quality Standard is provided in the Illinois Administrative Code for total suspended solids.

[b] Calculated using the FHWA Pollutant Loadings and Impacts from *Highway Stormwater Runoff Volume I: Design Procedure*.

[c] Percent increase values were rounded. Percentages were calculated prior to rounding.

Metals (Copper, Lead, Zinc)

With BMPs in place, the once in 3 year metals concentration improves by decreasing between 8 and 43 percent for all watersheds. All of the watersheds have concentrations that are less than the acute metals criteria under 2040 Build conditions. The Willow Creek and Silver Creek copper concentrations under existing conditions were found to exceed the acute copper criteria; however under 2040 Build conditions, the copper concentrations were determined to improve and be less than the acute copper criteria due to the additional BMPs in place under 2040 Build conditions.

Chloride

A detailed analysis of the chlorides pollutant concentrations from the project watersheds is included in the memorandum *Chloride Concentration Analysis*, which is included in the original memorandum.

References

CBBEL, BCP Tollway Partners JV BMP Coordination Meeting #1 Meeting Notes, June 6, 2012.

DuPage County, DuPage County Countywide Stormwater and Floodplain Ordinance, Version 4.1, 2012.