ATTACHMENT Q

coterra
ENGINEERING PLLC

321 3rd Avenue South, Suite 406
Seattle, Washington 98104
206.596.7115

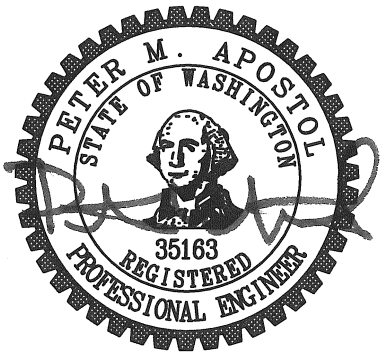
NE 90th STREET OUTFALL BASIN ANALYSIS

Project: Redmond Integrated Service Center
15511 NE 90th Street
Redmond, WA 98052

Prepared For: Third Place Design CO-OP
117 Wester Ave W, Suite 266
Seattle, WA 98119

Prepared By: Max Berde, PE
Reviewed By: Peter Apostol, PE

Date: October 20, 2016



"I hereby certify that this Basin Analysis for the Redmond Integrated Service Center Redevelopment Project has been prepared by me or under my supervision and meets minimum standards of City of Redmond and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

TABLE OF CONTENTS

Section No.	Subject	
SECTION I	PROJECT OVERVIEW	4
SECTION II	EXISTING CONDITIONS	5
SECTION III	DOWNSTREAM ANALYSIS	6
SECTION IV	UNIFORM FLOW ANALYSIS	8
SECTION V	COMPARISION TO EXISTING	9
SECTION VI	COMPARISION TO FULL ONSITE DETENTION	9
SECTION VII	PROPOSED IMPROVEMENTS	9
SECTION VIII	CONCLUSION	10

LIST OF FIGURES

FIGURE 1	VICINITY MAP	5
FIGURE 2	NE 90TH STREET OUTFALL BASIN MAP	7

LIST OF APPENDICES

APPENDIX A	SAMMAMISH RIVER FEMA FLOOD PROFILES
APPENDIX B	SUB-BASIN FLOWS
APPENDIX C	PROPOSED CONDITION BACKWATER ANALYSIS
APPENDIX D	PROPOSED SITE UNIFORM FLOW ANALYSIS
APPENDIX E	EXISTING CONDITION BACKWATER & FLOW ANALYSIS
APPENDIX F	FULL ONSITE DETENTION BACKWATER & FLOW ANALYSIS
APPENDIX G	AS-BUILT PLANS

SECTION I – PROJECT OVERVIEW

General Description:
The Redmond Integrated Service Center project site is located at the existing Sammamish River Business Park Buildings in Redmond, WA. The site address is 15511 NE 90th Street, Redmond, WA 98052. The proposed project site includes the redevelopment of approximately 1.65 acres.

The proposed improvements will consist of the following major items of work:

- Demolition of both existing office buildings (combined footprint of 34,170 SF)
- Construction of two-story Hopelink building (approximate footprint of 14,000 SF)
- Construction of parking lot, utility, landscape, and lighting improvements.

Proposed Site Stormwater Drainage:
Based on the site location adjacent to the Sammamish River, the project proposes to directly discharge treated stormwater to the existing NE 90th Street public stormwater conveyance system directly north of the project site. The stormwater conveyance discharges via 18" outfall to the Sammamish River.

To decrease the volume and peak flows of stormwater runoff from the project site into the public conveyance system, onsite infiltration galleries are proposed to infiltrate clean runoff from the building's roof totaling approximately 15,000 square feet (0.35 acres). Based on the project site's location within Wellhead Protection Zone 2, by code only clean stormwater runoff is allowed to be considered for infiltration.

This basin analysis addresses the existing NE 90th Street conveyance system hydraulic capacity.

See **Figure 1** for the Vicinity Map.

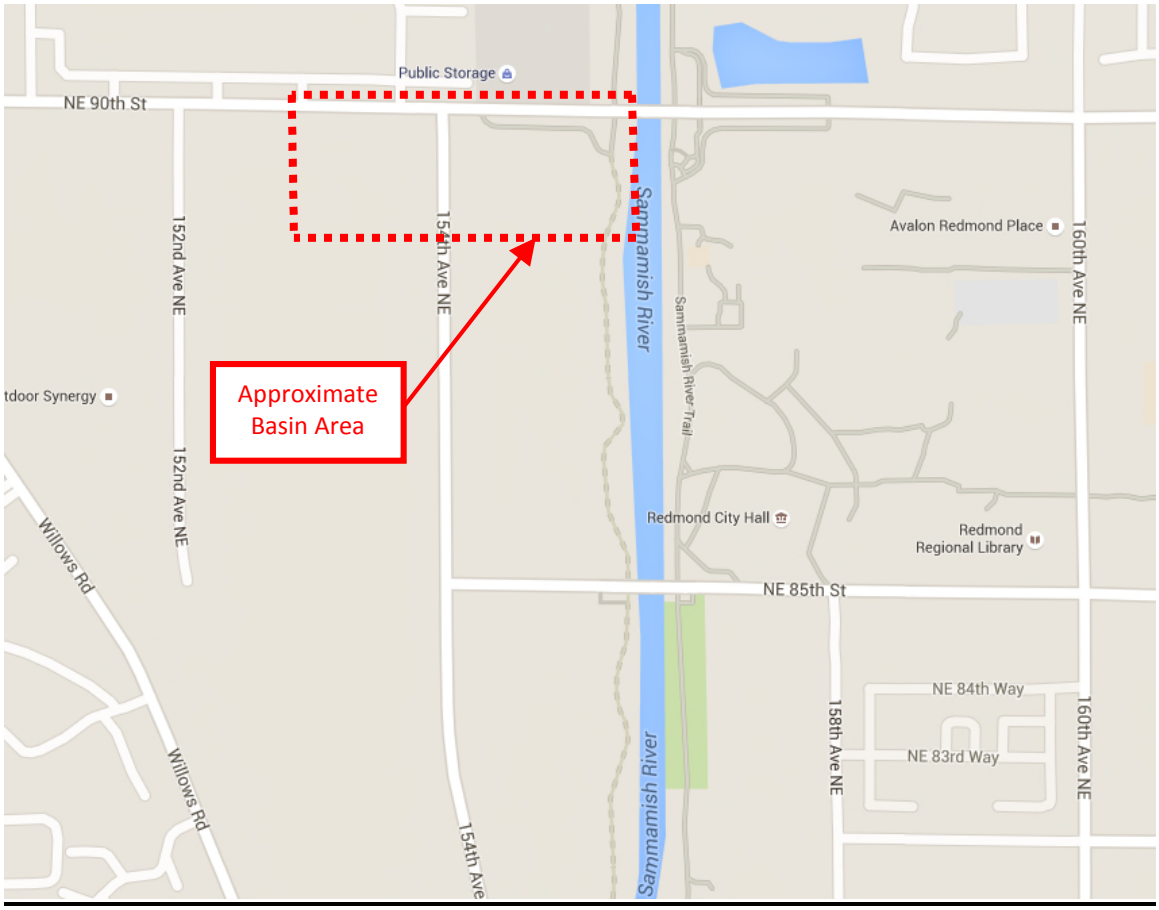


FIGURE 1 – VICINITY MAP

SECTION II – EXISTING CONDITIONS

The basin draining to the existing NE 90th Street conveyance and outfall is approximately 14.0 acres of developed commercial lots (Manufacturing Park zoning) and City of Redmond right-of-way.

The existing storm drainage system is located primarily within NE 90th Street flowing approximately 1000' east to an outfall to the Sammamish River. The conveyance system is comprised of 12" and 18" pipes within the NE 90th Street right-of-way, and an additional contributing branch flowing north on154th Ave NE. The conveyance system receives contributing off-site flows from 3 properties including the proposed project site.

See **Figure 2** for the Basin Map.

The Drainage Report prepared by Entranco, Inc. for construction of the NE 90th Street conveyance and outfall, dated May 1999, noted a history of flooding at the project intersection and options were being evaluated with the City of Redmond to alleviate flooding at the intersection.

SECTION III – DOWNSTREAM ANALYSIS

River Tail Water:
The downstream analysis evaluates the hydraulic capacity of the NE 90th Street conveyance system during a specific flood event in receiving water body, the Sammamish River. The 10, 50, and 100 year flood stages of the river at the outfall were interpolated from the current Sammamish River FEMA Flood Profiles. See **Appendix A.**

For the purposes of this basin analysis, a backwater analysis was performed assuming a tailwater condition at the river outfall equal to the 10-year flood stage of the Sammamish River.

Sammamish River FEMA Flood Profile

Return Period	River Stage (NAVD 88)
10 year	30.2 ft
50 year	32.7 ft
100 year	33.6 ft

Sub-Basin Areas:
The proposed project site and two additional off-site properties were modeled as 80% impervious/20% pervious, the maximum impervious coverage allowed by code for the Manufacturing Park zone. No infiltration of onsite stormwater from the project site was taken in consideration for this basin analysis, but any onsite infiltration proposed in the final site design will benefit the conveyance system and drainage for the whole entire basin.

City of Redmond GIS information as well as as-built plans for the two off-site properties connected to NE 90th Street system indicate perforated pipes through the sites for infiltration of stormwater.

Based on the use of perforated infiltration pipes, the analysis assumes that 50% of runoff from these two properties will remain on the respective properties and not flow to the NE 90th Street conveyance system.

See **Appendix B** for the Sub-Basin area analysis and WWHM 50-year flows.

FIGURE 2 – BASIN MAP

ATTACHMENT Q

SUBBASINS TRIBUTARY TO NE 90TH ST OUTFALL

TOTAL TRIBUTARY BASIN AREA: 14.7 ACRES

coterra
ENGINEERING PLLC
321 3rd Avenue South, Suite 307
Seattle, Washington 98104
206.596.7715 coterraengineering.com

NE 90TH STREET OUTFALL TRIBUTARY AREA

SCALE 1" = 100'

Backwater Analysis:
Hydraulic capacity was analyzed using a 50-year peak backwater analysis of the NE 90th Street system assuming a 10-year flood stage of the Sammamish River at the outfall.

Sub-basin 50-year flows tributary to each catch basin from right-of-way areas and off-site properties was determined using the Western Washington Hydrology Model (WWHM2012).

In the proposed condition, the backwater analysis indicates the hydraulic grade line of the conveyance system above the rim elevations of several drainage structures to the west and south of the NE 90th Street / 154th Avenue NE intersection.

The Washington State Department of Ecology 2005 SWMMWM and City of Redmond 2012 Stormwater Management Technical Notebook note in the direct discharge exemption for a project site, "the conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions of the site, and the existing conditions from non-project areas from which runoff is or will be collected."

The backwater analysis indicates sufficient hydraulic capacity, via the hydraulic grade line, from the project site to the outfall at the Sammamish River.

See **Appendix C** for the proposed condition backwater analysis.

SECTION IV – UNIFORM FLOW ANALYSIS

A uniform flow analysis was performed on the existing NE 90th Street conveyance system assuming the full build-out (80% impervious/20% pervious) of the proposed site and without considering any onsite infiltration. The system was analyzed using a 50-year, 24-hour storm with sub-basin flows calculated using WWHM2012.

See **Appendix D** for the Uniform Flow Analysis.

Based strictly on the uniform flow analysis, without considering the river tail water elevation and backwater effects, the downstream conveyance system has sufficient capacity to convey stormwater discharges from the full built-out project site and the non-project areas which contribute to the NE 90th Street conveyance system. The 50-year, 24-hour flows do not exceed the uniform flow analysis capacity of the conveyance system.

Due to a surveying error, it was originally determined that the conveyance pipe (at incorrectly recorded existing slope) could not convey the 50-year flows.

However, the river elevation at the outfall and its backwater effects must be considered in the overall analysis of the existing conveyance system and contributing flows to the system.

SECTION V – COMPARISON TO EXISTING CONDITIONS

In addition to the proposed project conditions, a 50-year backwater analysis and uniform flow analysis were also completed based on the existing site conditions. An area analysis of the site survey indicates the site impervious coverage currently exceeds the maximum 80% allowed by Code in the MP zone. With the rest of the basin area coverage remaining the same as the earlier analyses in this report, the existing basin in a 50-year storm event and 10-year flood stage on the Sammamish River can expect to be flooded by up to 0.5' of additional stormwater.

The proposed project will decrease the depth of overtopping of drainage structures on the existing NE 90th Street conveyance system.

See **Appendix E** for existing basin backwater and uniform flow analyses.

SECTION VI – COMPARISON TO FULL ONSITE DETENTION

Furthermore, a 50-year backwater analysis and uniform flow analysis were also completed to analyze the effects of a full onsite stormwater detention system would release stormwater from the project site to the existing conveyance system meeting the 2005 SWMMWM duration standard to match a historically forested site condition. The 50-year peak release rate from the project site under this scenario is just 0.09 cfs. Yet, the 50-year backwater analysis with full detention still indicates overtopping of drainage structures upstream in the conveyance system.

See **Appendix F** for the full onsite detention scenario backwater and uniform flow analyses.

SECTION VII – PROPOSED IMPROVEMENTS

Based on the modeled results of the full onsite detention scenario, which still indicates a backwater condition in the downstream conveyance system and overtopping of structures upstream of the project site, infiltration of clean runoff from the 0.35 acres of roof area on the project are proposed to decrease overall stormwater discharge to the existing conveyance system. A capture area of 15,000 square feet, approximately 20% of the entire project site, will be routed to onsite infiltration galleries. Based on the project's location in the Wellhead Protection Zone 2, this is the maximum extent of infiltration allowed by code on the project property. The infiltration galleries are sited to be above the yearly average maximum groundwater height, such that roof runoff will infiltrate through imported well-draining material down to existing outwash soils which are strong receptors of infiltration.

This roof infiltration system will retain significant quantities of site runoff within the project site's area and decrease the quantity and peak flows of stormwater off of the project site and into the existing NE 90th Street conveyance system. The proposed onsite stormwater system will not only maintain the existing operating condition of the conveyance system, but provide improvement over existing conditions and full detention scenarios by decreasing contributing runoff from the project to the NE 90th Street conveyance system.

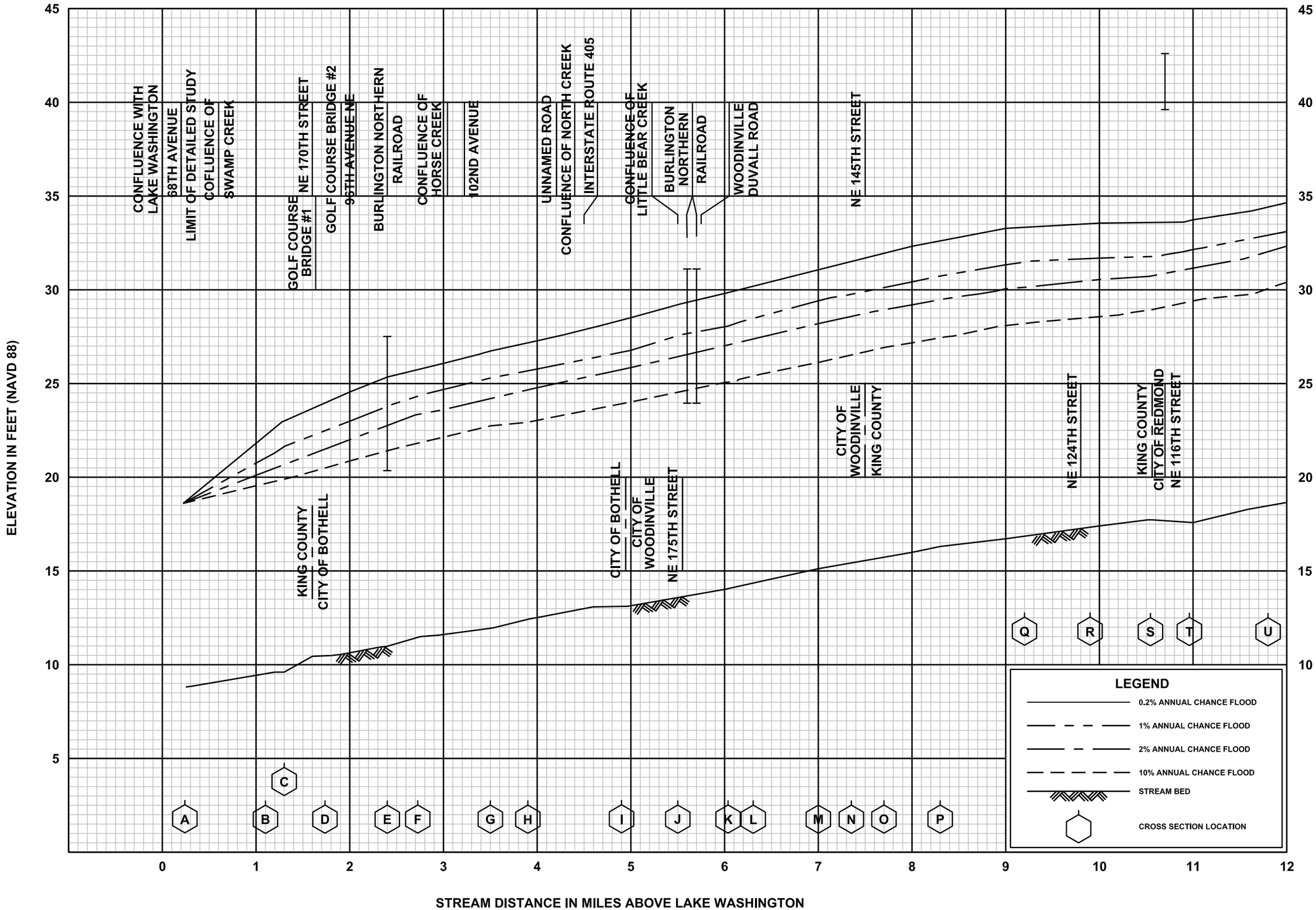
SECTION VIII – CONCLUSION

The basin analysis confirms the City's reports that portions of the existing NE 90th Street conveyance system is overtopped by stormwater runoff during significant storm events which coincide with elevated river levels at the system's outfall in the Sammamish River. The uniform flow analysis shows the existing pipes have the capacity to move the existing and proposed flows of stormwater through the system, but the entire system is inundated by the river elevation and backs up in the conveyance system and upstream catch basins.

The basin analysis also confirms that this backwater condition is not improved or resolved by completely detaining all stormwater runoff onsite, as the entire conveyance system and likely the onsite detention system as well, is fully inundated by stormwater and backed-up river water during large storm events.

This project proposes to mitigate on the project site a portion of the volume and peak rate of stormwater which it discharges to the existing NE 90th Street conveyance system by infiltrating to the extent feasible clean stormwater runoff from the roof directly into the ground on the project site. This will decrease the volume and peak rate of runoff discharged to the existing public conveyance system and the river outfall. This proposal will decrease the magnitude of flooding and overtopping conditions observed in the basin area compared to the existing site and basin conditions.

APPENDIX A –
SAMMAMISH RIVER FEMA FLOOD PROFILES



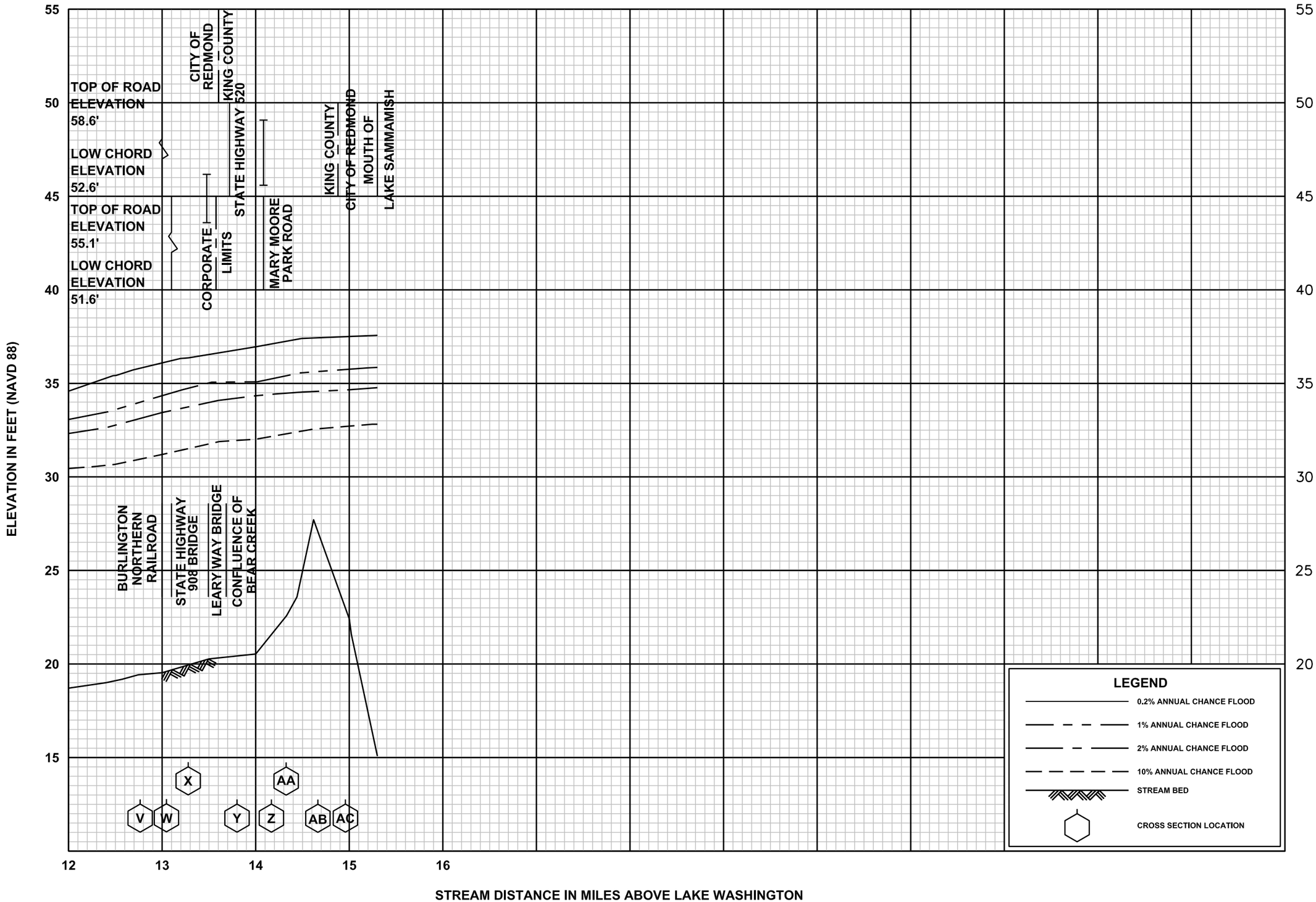
FLOOD PROFILES

SAMMAMISH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KING COUNTY, WA

AND INCORPORATED AREAS



FLOOD PROFILES

SAMMAMISH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

KING COUNTY, WA

AND INCORPORATED AREAS

APPENDIX B – SUB-BASIN FLOWS

ATTACHMENT Q

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

SUB BASIN FLOWS (WWHM)

Project Name: HOPELINK RISC - NE 90th Street ***Designed By: Max Berde Checked By: Peter Apostol***

Job Number: 15011 ***Storm Event: 50-YEAR***

CB # (Figure)	CB # (City GIS ID)	AREA TOTAL (SF)	AREA TOTAL (AC)	IMPERVIOUS (AC)	PERVIOUS (AC)	50 YR FLOW (cfs)	Notes
1	21394	0	0.000	0.000	0.000	0.000	Solid Lid
2	21397	1814	0.042	0.021	0.021	0.020	Approx 50/50 Impervious/Pervious (KC Trail)
3	21370	200201	1.736	1.363	0.373	2.220	Approx 50/50 Impervious/Pervious offsite (trail) [0.086 ac], 80/20 onsite [1.65 ac] and 80/20 adjacent site [3.81 ac]
4	1634	0	0.000	0.000	0.000	0.000	Solid Lid
5	23077	1669	0.038	0.038	0.000	0.027	100% Impervious
6	21580	0	0.000	0.000	0.000	0.000	Solid Lid (Flow Splitter)
7	21237	3654	0.084	0.084	0.000	0.059	100% Impervious
8	21166	5182	0.119	0.119	0.000	0.084	100% Impervious
9	21161	1467	0.034	0.034	0.000	0.024	100% Impervious
10	21379	2040	0.047	0.047	0.000	0.033	100% Impervious
11	21381	1689	0.039	0.039	0.000	0.028	100% Impervious
12	21162	5363	0.123	0.123	0.000	0.087	100% Impervious
13	21383	5085	0.117	0.117	0.000	0.083	100% Impervious
14	21384	14782	0.339	0.339	0.000	0.263	100% Impervious
20	21549	0	0.000	0.000	0.000	0.000	Solid Lid
21	21802	13139	0.302	0.302	0.000	0.104	100% Impervious
22	21753	9657	0.222	0.222	0.000	0.157	100% Impervious
23	21751	5493	0.126	0.126	0.000	0.089	100% Impervious
24	21752	6420	0.147	0.147	0.000	0.104	100% Impervious
30	21378	3970	0.091	0.091	0.000	0.064	100% Impervious
31	21380	2448	0.056	0.056	0.000	0.040	100% Impervious
32	5852	329327	7.560	6.048	1.512	2.2964	80/20% Impervious max./Pervious by zoning

APPENDIX C –
PROPOSED CONDITION BACKWATER ANALYSIS

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

BACKWATER ANALYSIS - PROPOSED PROJECT

Project Name: HOPELINK RISC - NE 90th Street
Job Number: 15011

Designed By: Max Berde Checked By: Peter Apostol
Storm Event: 50-YEAR

Conveyance System Information																				Outlet Control						Inlet Control		Headwater Summation										Overtopping Check	
Pipe Segment		Surface Flow	Total Flow	Length	Pipe Size	"n" value	Down-Stream Invert	Down-Stream Rim	Up-Stream Invert	Up-Stream Rim	Pipe Slope	Barrel Velocity	Barrel Velocity Head	Critical Depth Ratio	Critical Depth	TW Elev.	TW Check	Barrel Hyd. Rad.	Friction Loss	Entrance HGL Elev.	Entrance K_e	Entrance Head Loss	Exit Head Loss	Outlet Control Elev.	Inlet Control HW/D	Inlet Control Elev.	Control HW Elev.	Approach Velocity Head	Bend K_b	Bend Head Loss	Q_1	Q_3	V_1	Junction Head Loss	Head Loss Total	HW Elev.	(HW - Rim) Clearance	Over-topping Check
CB/MH # Down	CB/MH # Up	Q	Qtot	L	D																																		
		CFS	CFS	FT	IN		FT	FT	FT	FT	%	FPS	FT		FT	FT	FT	FT	FT	FT		FT	FT	FT	FT	FT	FT	FT		FT	CFS	CFS	FPS	FT	FT	FT	FT	
RIVER OUTFALL	CB #01 (21394)	0.000	5.78	65.0	18	0.012	23.31	24.81	23.59	31.29	0.43%	3.27	0.17	0.78	1.17	30.20	30.20	0.38	0.17	30.37	0.50	0.08	0.17	30.62	1.35	25.62	30.62	0.17	0.02	0.00	5.78		3.27		0.00	30.45	-0.84	Okay
CB #01 (21394)	CB #02 (21397)	0.020	5.78	76.0	18	0.012	23.64	31.29	24.22	34.23	0.76%	3.27	0.17	0.78	1.17	30.45	30.45	0.38	0.20	30.65	0.50	0.08	0.17	30.90	1.35	26.25	30.90	0.16	0.02	0.00	5.76		3.27		0.00	30.74	-3.49	Okay
CB #02 (21397)	CB #03 (21370)	2.220	5.76	155.6	18	0.012	24.22	34.23	24.72	32.77	0.32%	3.26	0.16	0.78	1.17	30.74	30.74	0.38	0.40	31.13	0.50	0.08	0.16	31.38	1.35	26.75	31.38	0.06	0.02	0.00	3.54		3.26		0.00	31.32	-1.45	Okay
CB #03 (21370)	CB #04 (1634)	0.000	3.54	120.5	18	0.012	24.72	32.77	25.29	34.59	0.47%	2.00	0.06	0.62	0.47	31.32	31.32	0.38	0.12	31.44	0.50	0.03	0.06	31.53	0.90	26.64	31.53	0.06	0.02	0.00	3.54		2.00		0.00	31.47	-3.12	Okay
CB #04 (1634)	CB #05 (23077)	0.027	3.54	19.6	18	0.012	25.29	34.59	25.48	33.80	0.97%	2.00	0.06	0.62	0.36	31.47	31.47	0.38	0.02	31.49	0.50	0.03	0.06	31.58	0.90	26.83	31.58	0.06	1.33	0.08	3.51		2.00		0.08	31.60	-2.20	Okay
CB #05 (23077)	CB #06 (21580)	0.000	3.51	25.9	18	0.012	25.50	33.80	25.68	33.33	0.69%	1.99	0.06	0.62	0.15	31.60	31.60	0.38	0.02	31.63	0.50	0.03	0.06	31.72	0.90	27.03	31.72	0.06	0.02	0.00	3.51		1.99		0.00	31.66	-1.67	Okay
CB #06 (21580)	CB #07 (21237)	0.059	3.51	34.5	18	0.012	25.68	33.33	26.02	32.82	0.99%	1.99	0.06	0.62	0.15	31.66	31.66	0.38	0.03	31.69	0.50	0.03	0.06	31.79	0.90	27.37	31.79	0.04	1.33	0.08	3.00	0.45	1.99	0.01	0.09	31.83	-0.99	Okay
CB #07 (21237)	CB #08 (21166)	0.084	3.00	51.0	18	0.012	26.02	32.82	26.48	32.98	0.90%	1.70	0.04	0.59	0.13	31.83	31.83	0.38	0.04	31.87	0.50	0.02	0.04	31.93	0.85	27.76	31.93	0.04	1.33	0.06	2.92		1.70		0.06	31.95	-1.03	Okay
CB #08 (21166)	CB #09 (21161)	0.024	2.92	70.0	18	0.012	26.48	32.98	27.09	32.84	0.87%	1.65	0.04	0.58	0.87	31.95	31.95	0.38	0.05	32.00	0.50	0.02	0.04	32.06	0.85	28.37	32.06	0.04	0.02	0.00	2.89		1.65		0.00	32.02	-0.82	Okay
CB #09 (21161)	CB #10 (21379)	0.033	2.89	65.0	18	0.012	27.19	32.84	27.95	33.25	1.17%	1.64	0.04	0.58	0.87	32.02	32.02	0.38	0.04	32.06	0.50	0.02	0.04	32.12	0.85	29.23	32.12	0.01	0.02	0.00	0.46	2.40	1.64	0.05	0.05	32.17	-1.08	Okay
CB #10 (21379)	CB #11 (21381)	0.028	0.46	78.0	12	0.012	27.95	33.25	*28.60*	31.58	0.83%	0.59	0.01	0.21	0.21	32.17	32.17	0.25	0.01	32.18	0.50	0.00	0.01	32.19	0.10	28.70	32.19	0.00	0.02	0.00	0.43		0.59		0.00	32.18	0.60	Overtopping!!
CB #11 (21381)	CB #12 (21162)	0.087	0.43	190.0	12	0.012	*28.60*	31.58	*30.15*	31.94	0.82%	0.55	0.00	0.16	0.16	32.18	32.18	0.25	0.02	32.20	0.50	0.00	0.00	32.21	0.10	30.25	32.21	0.00	0.02	0.00	0.35		0.55		0.00	32.21	0.27	Overtopping!!
CB #12 (21162)	CB #13 (21383)	0.083	0.35	63.0	12	0.012	30.15	31.94	30.28	32.65	0.21%	0.44	0.00	0.15	0.15	32.21	32.21	0.25	0.01	32.21	0.50	0.00	0.00	32.22	0.10	30.38	32.22	0.00	1.33	0.00	0.26		0.44		0.00	32.22	-0.43	Okay
CB #13 (21383)	CB #14 (21384)	0.263	0.26	41.0	12	0.012	30.28	32.65	30.38	32.63	0.24%	0.33	0.00	0.10	0.10	32.22	32.22	0.25	0.00	32.22	0.50	0.00	0.00	32.22	0.10	30.48	32.22	0.01	0.02	0.00	0.45		0.33		0.00	32.22	-0.41	Okay
CB #7	CB #20 (21549)	0.000	0.45	33.6	12	0.012	26.17	32.82	27.59	33.09	4.23%	0.58	0.01	0.31	0.31	32.22	32.22	0.25	0.00	32.22	0.50	0.00	0.01	32.23	0.50	28.09	32.23	0.01	0.48	0.00	0.45		0.58		0.00	32.23	-0.86	Okay
CB #20 (21549)	CB #21 (21802)	0.104	0.45	39.0	12	0.012	27.79	33.09	29.79	32.49	5.13%	0.58	0.01	0.31	0.31	32.23	32.23	0.25	0.01	32.23	0.50	0.00	0.01	32.24	0.50	30.29	32.24	0.00	0.48	0.00	0.25	0.10	0.58	0.00	0.00	32.24	-0.25	Caution
CB #21 (21802)	CB #22 (21753)	0.157	0.25	204.0	12	0.012	29.79	32.49	31.97	34.72	1.07%	0.31	0.00	0.21	0.21	32.24	32.24	0.25	0.01	32.97	0.50	0.00	0.00	32.97	0.10	32.07	32.97	0.00	1.33	0.00	0.09		0.31		0.00	32.97	-1.75	Okay
CB #22 (21753)	CB #23 (21751)	0.089	0.09	47.0	12	0.012	32.12	34.72	32.81	34.96	1.47%	0.11	0.00	0.12	0.12	32.97	32.97	0.25	0.00	33.81	0.50	0.00	0.00	33.81	0.10	32.91	33.81	0.00	0.02	0.00	0.10		0.11		0.00	33.81	-1.15	Okay
CB #21 (21802)	CB #24 (21752)	0.104	0.10	47.0	12	0.013	30.39	32.49	31.12	32.75	1.55%	0.13	0.00	0.13	0.13	33.81	33.81	0.25	0.00	33.81	0.50	0.00	0.00	33.81	0.10	31.22	33.81	0.03	0.05	0.00	2.40		0.13		0.00	33.78	1.03	Overtopping!!
CB #10 (21379)	CB #30 (21378)	0.064	2.40	42.0	18	0.013	28.38	33.25	28.51	33.46	0.31%	1.36	0.03	0.56	0.84	33.78	33.78	0.38	0.02	33.80	0.50	0.01	0.03	33.85	0.82	29.74	33.85	0.03	1.33	0.04	2.34		1.36		0.04	33.86	0.40	Overtopping!!
CB #30 (21378)	CB #31 (21380)	0.040	2.34	78.0	18	0.013	28.56	33.46	28.60	33.81	0.05%	1.32	0.03	0.56	0.84	33.86	33.86	0.38	0.04	33.90	0.50	0.01	0.03	33.94	0.82	29.83	33.94	0.13	0.48	0.01	2.30		1.32		0.01	33.82	0.01	Overtopping!!
CB #31 (21380)	CB #32 (5852)	2.296	2.30	80.0	12	0.012	29.40	33.81	30.27	*34.00*	1.09%	2.92	0.13	0.89	0.89	33.82	33.82	0.25	0.28	34.10	0.50	0.07	0.13	34.30	2.15	32.42	34.30		0.48	0.06	0.00		2.92		0.06	34.36	0.36	Overtopping!!
																34.36																							

APPENDIX D –
PROPOSED SITE UNIFORM FLOW ANALYSIS

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

UNIFORM FLOW ANALYSIS

Project Name: NE 90th Street Outfall — *Designed By: Max Berde* — *Checked By: Peter Apostol*

Job Number: 15011 — *Storm Event: 50-YEAR*

CB Downstream	CB Upstream	Pipe Size in	Q50-yr cfs	Manning's "n" "n" unitless	Pipe Slope %	Qf Pipe Full cfs	Vf Pipe Full ft/s	Uniform Flow Check *	Uniform Velocity Check Check **
RIVER OUTFALL	CB #01 (21394)	18	5.78	0.012	0.43%	7.49	4.24	Ok	Ok
CB #01 (21394)	CB #02 (21397)	18	5.78	0.012	0.76%	9.97	5.64	Ok	Ok
CB #02 (21397)	CB #03 (21370)	18	5.76	0.012	0.32%	6.47	3.66	Warning!	Ok
CB #03 (21370)	CB #04 (1634)	18	3.54	0.012	0.47%	7.85	4.44	Ok	Ok
CB #04 (1634)	CB #05 (23077)	18	3.54	0.012	0.97%	11.23	6.36	Ok	Ok
CB #05 (23077)	CB #06 (21580)	18	3.51	0.012	0.69%	9.51	5.38	Ok	Ok
CB #06 (21580)	CB #07 (21237)	18	3.51	0.012	0.99%	11.33	6.41	Ok	Ok
CB #07 (21237)	CB #08 (21166)	18	3.00	0.012	0.90%	10.84	6.13	Ok	Ok
CB #08 (21166)	CB #09 (21161)	18	2.92	0.012	0.87%	10.65	6.03	Ok	Ok
CB #09 (21161)	CB #10 (21379)	18	2.89	0.012	1.17%	12.34	6.98	Ok	Ok
CB #10 (21379)	CB #11 (21381)	12	0.46	0.012	0.83%	3.53	4.50	Ok	Ok
CB #11 (21381)	CB #12 (21162)	12	0.43	0.012	0.82%	3.50	4.45	Ok	Ok
CB #12 (21162)	CB #13 (21383)	12	0.35	0.012	0.21%	1.76	2.24	Ok	Ok
CB #13 (21383)	CB #14 (21384)	12	0.26	0.012	0.24%	1.91	2.43	Ok	Ok
CB #7	CB #20 (21549)	12	0.45	0.012	4.23%	7.96	10.13	Ok	Ok
CB #20 (21549)	CB #21 (21802)	12	0.45	0.012	5.13%	8.76	11.16	Ok	Ok
CB #21 (21802)	CB #22 (21753)	12	0.25	0.012	1.07%	4.00	5.09	Ok	Ok
CB #22 (21753)	CB #23 (21751)	12	0.09	0.012	1.47%	4.69	5.97	Ok	Ok
CB #21 (21802)	CB #24 (21752)	12	0.10	0.013	1.55%	4.45	5.67	Ok	Ok
CB #10 (21379)	CB #30 (21378)	18	2.40	0.013	0.31%	5.86	3.32	Ok	Ok
CB #30 (21378)	CB #31 (21380)	18	2.34	0.013	0.05%	2.39	1.35	Warning!	Ok
CB #31 (21380)	CB #32 (5852)	12	2.30	0.012	1.09%	4.04	5.14	Ok	Ok

APPENDIX E – EXISTING CONDITION BACKWATER AND FLOW ANALYSES

ATTACHMENT Q

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

EXISTING SUB BASIN FLOWS (WWHM)

Project Name: HOPELINK RISC - NE 90th Street ***Designed By: Max Berde Checked By: Peter Apostol***

Job Number: 15011 ***Storm Event: 50-YEAR***

CB # (Figure)	CB # (City GIS ID)	AREA TOTAL (SF)	AREA TOTAL (AC)	IMPERVIOUS (AC)	PERVIOUS (AC)	50 YR FLOW (cfs)	Notes
1	21394	0	0.000	0.000	0.000	0.000	Solid Lid
2	21397	1814	0.042	0.021	0.021	0.020	Approx 50/50 Impervious/Pervious
3	21370	200201	1.736	1.363	0.373	2.470	Approx 50/50 Impervious/Pervious offsite (trail) [0.086 ac] and 80/20 onsite [1.65 ac] and 80/20 adjacent site [3.81 ac]
4	1634	0	0.000	0.000	0.000	0.000	Solid Lid
5	23077	1669	0.038	0.038	0.000	0.027	100% Impervious
6	21580	0	0.000	0.000	0.000	0.000	Solid Lid (Flow Splitter)
7	21237	3654	0.084	0.084	0.000	0.059	100% Impervious
8	21166	5182	0.119	0.119	0.000	0.084	100% Impervious
9	21161	1467	0.034	0.034	0.000	0.024	100% Impervious
10	21379	2040	0.047	0.047	0.000	0.033	100% Impervious
11	21381	1689	0.039	0.039	0.000	0.028	100% Impervious
12	21162	5363	0.123	0.123	0.000	0.087	100% Impervious
13	21383	5085	0.117	0.117	0.000	0.083	100% Impervious
14	21384	14782	0.339	0.339	0.000	0.263	100% Impervious
20	21549	0	0.000	0.000	0.000	0.000	Solid Lid
21	21802	13139	0.302	0.302	0.000	0.104	100% Impervious
22	21753	9657	0.222	0.222	0.000	0.157	100% Impervious
23	21751	5493	0.126	0.126	0.000	0.089	100% Impervious
24	21752	6420	0.147	0.147	0.000	0.104	100% Impervious
30	21378	3970	0.091	0.091	0.000	0.064	100% Impervious
31	21380	2448	0.056	0.056	0.000	0.040	100% Impervious
32	5852	329327	7.560	6.048	1.512	2.296	80/20% Impervious max./Pervious by zoning

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

BACKWATER ANALYSIS - EXISTING BASIN

Project Name: HOPELINK RISC - NE 90th Street
Job Number: 15011

Designed By: Max Berde Checked By: Peter Apostol
Storm Event: 50-YEAR

Conveyance System Information																				Outlet Control						Inlet Control		Headwater Summation										Overtopping Check	
Pipe Segment		Surface Flow	Total Flow	Length	Pipe Size	"n" value	Down-Stream Invert	Down-Stream Rim	Up-Stream Invert	Up-Stream Rim	Pipe Slope	Barrel Velocity	Barrel Velocity Head	Critical Depth Ratio	Critical Depth	TW Elev.	TW Check	Barrel Hyd. Rad.	Friction Loss	Entrance HGL Elev.	Entrance K_e	Entrance Head Loss	Exit Head Loss	Outlet Control Elev.	Inlet Control HW/D	Inlet Control Elev.	Control HW Elev.	Approach Velocity Head	Bend K_b	Bend Head Loss	Q_1	Q_3	V_1	Junction Head Loss	Head Loss Total	HW Elev.	(HW - Rim) Clearance	Over-topping Check
CB/MH # Down	CB/MH # Up	Q	Qtot	L	D																																		
		CFS	CFS	FT	IN		FT	FT	FT	FT	%	FPS	FT		FT	FT	FT	FT	FT	FT		FT	FT	FT	FT	FT	FT	FT		FT	CFS	CFS	FPS	FT	FT	FT	FT	
RIVER OUTFALL	CB #01 (21394)	0.000	6.03	65.0	18	0.012	23.31	24.81	23.59	31.29	0.43%	3.41	0.18	0.78	1.17	30.20	30.20	0.38	0.18	30.38	0.50	0.09	0.18	30.65	1.35	25.62	30.65	0.18	0.02	0.00	6.03		3.41		0.00	30.48	-0.81	Okay
CB #01 (21394)	CB #02 (21397)	0.020	6.03	76.0	18	0.012	23.64	31.29	24.22	34.23	0.76%	3.41	0.18	0.78	1.17	30.48	30.48	0.38	0.21	30.69	0.50	0.09	0.18	30.96	1.35	26.25	30.96	0.18	0.02	0.00	6.01		3.41		0.00	30.78	-3.45	Okay
CB #02 (21397)	CB #03 (21370)	2.470	6.01	155.6	18	0.012	24.22	34.23	24.72	32.77	0.32%	3.40	0.18	0.78	1.17	30.78	30.78	0.38	0.43	31.22	0.50	0.09	0.18	31.49	1.35	26.75	31.49	0.06	0.02	0.00	3.54		3.40		0.00	31.43	-1.34	Okay
CB #03 (21370)	CB #04 (1634)	0.000	3.54	120.5	18	0.012	24.72	32.77	25.29	34.59	0.47%	2.00	0.06	0.62	0.47	31.43	31.43	0.38	0.12	31.54	0.50	0.03	0.06	31.64	0.90	26.64	31.64	0.06	0.02	0.00	3.54		2.00		0.00	31.57	-3.02	Okay
CB #04 (1634)	CB #05 (23077)	0.027	3.54	19.6	18	0.012	25.29	34.59	25.48	33.80	0.97%	2.00	0.06	0.62	0.36	31.57	31.57	0.38	0.02	31.59	0.50	0.03	0.06	31.69	0.90	26.83	31.69	0.06	1.33	0.08	3.51		2.00		0.08	31.71	-2.09	Okay
CB #05 (23077)	CB #06 (21580)	0.000	3.51	25.9	18	0.012	25.50	33.80	25.68	33.33	0.69%	1.99	0.06	0.62	0.15	31.71	31.71	0.38	0.02	31.73	0.50	0.03	0.06	31.83	0.90	27.03	31.83	0.06	0.02	0.00	3.51		1.99		0.00	31.77	-1.56	Okay
CB #06 (21580)	CB #07 (21237)	0.059	3.51	34.5	18	0.012	25.68	33.33	26.02	32.82	0.99%	1.99	0.06	0.62	0.15	31.77	31.77	0.38	0.03	31.80	0.50	0.03	0.06	31.89	0.90	27.37	31.89	0.04	1.33	0.08	3.00	0.45	1.99	0.01	0.09	31.93	-0.89	Okay
CB #07 (21237)	CB #08 (21166)	0.084	3.00	51.0	18	0.012	26.02	32.82	26.48	32.98	0.90%	1.70	0.04	0.59	0.13	31.93	31.93	0.38	0.04	31.97	0.50	0.02	0.04	32.04	0.85	27.76	32.04	0.04	1.33	0.06	2.92		1.70		0.06	32.05	-0.93	Okay
CB #08 (21166)	CB #09 (21161)	0.024	2.92	70.0	18	0.012	26.48	32.98	27.09	32.84	0.87%	1.65	0.04	0.58	0.87	32.05	32.05	0.38	0.05	32.10	0.50	0.02	0.04	32.16	0.85	28.37	32.16	0.04	0.02	0.00	2.89		1.65		0.00	32.12	-0.72	Okay
CB #09 (21161)	CB #10 (21379)	0.033	2.89	65.0	18	0.012	27.19	32.84	27.95	33.25	1.17%	1.64	0.04	0.58	0.87	32.12	32.12	0.38	0.04	32.16	0.50	0.02	0.04	32.23	0.85	29.23	32.23	0.01	0.02	0.00	0.46	2.40	1.64	0.05	0.05	32.27	-0.98	Okay
CB #10 (21379)	CB #11 (21381)	0.028	0.46	78.0	12	0.012	27.95	33.25	*28.60*	31.58	0.83%	0.59	0.01	0.21	0.21	32.27	32.27	0.25	0.01	32.28	0.50	0.00	0.01	32.29	0.10	28.70	32.29	0.00	0.02	0.00	0.43		0.59		0.00	32.29	0.71	Overtopping!!
CB #11 (21381)	CB #12 (21162)	0.087	0.43	190.0	12	0.012	*28.60*	31.58	*30.15*	31.94	0.82%	0.55	0.00	0.16	0.16	32.29	32.29	0.25	0.02	32.31	0.50	0.00	0.00	32.32	0.10	30.25	32.32	0.00	0.02	0.00	0.35		0.55		0.00	32.31	0.37	Overtopping!!
CB #12 (21162)	CB #13 (21383)	0.083	0.35	63.0	12	0.012	30.15	31.94	30.28	32.65	0.21%	0.44	0.00	0.15	0.15	32.31	32.31	0.25	0.01	32.32	0.50	0.00	0.00	32.32	0.10	30.38	32.32	0.00	1.33	0.00	0.26		0.44		0.00	32.32	-0.33	Okay
CB #13 (21383)	CB #14 (21384)	0.263	0.26	41.0	12	0.012	30.28	32.65	30.38	32.63	0.24%	0.33	0.00	0.10	0.10	32.32	32.32	0.25	0.00	32.33	0.50	0.00	0.00	32.33	0.10	30.48	32.33	0.01	0.02	0.00	0.45		0.33		0.00	32.32	-0.31	Okay
CB #7	CB #20 (21549)	0.000	0.45	33.6	12	0.012	26.17	32.82	27.59	33.09	4.23%	0.58	0.01	0.31	0.31	32.32	32.32	0.25	0.00	32.33	0.50	0.00	0.01	32.34	0.50	28.09	32.34	0.01	0.48	0.00	0.45		0.58		0.00	32.33	-0.76	Okay
CB #20 (21549)	CB #21 (21802)	0.104	0.45	39.0	12	0.012	27.79	33.09	29.79	32.49	5.13%	0.58	0.01	0.31	0.31	32.33	32.33	0.25	0.01	32.34	0.50	0.00	0.01	32.35	0.50	30.29	32.35	0.00	0.48	0.00	0.25	0.10	0.58	0.00	0.00	32.35	-0.14	Caution
CB #21 (21802)	CB #22 (21753)	0.157	0.25	204.0	12	0.012	29.79	32.49	31.97	34.72	1.07%	0.31	0.00	0.21	0.21	32.35	32.35	0.25	0.01	32.97	0.50	0.00	0.00	32.97	0.10	32.07	32.97	0.00	1.33	0.00	0.09		0.31		0.00	32.97	-1.75	Okay
CB #22 (21753)	CB #23 (21751)	0.089	0.09	47.0	12	0.012	32.12	34.72	32.81	34.96	1.47%	0.11	0.00	0.12	0.12	32.97	32.97	0.25	0.00	33.81	0.50	0.00	0.00	33.81	0.10	32.91	33.81	0.00	0.02	0.00	0.10		0.11		0.00	33.81	-1.15	Okay
CB #21 (21802)	CB #24 (21752)	0.104	0.10	47.0	12	0.013	30.39	32.49	31.12	32.75	1.55%	0.13	0.00	0.13	0.13	33.81	33.81	0.25	0.00	33.81	0.50	0.00	0.00	33.81	0.10	31.22	33.81	0.03	0.05	0.00	2.40		0.13		0.00	33.78	1.03	Overtopping!!
CB #10 (21379)	CB #30 (21378)	0.064	2.40	42.0	18	0.013	28.38	33.25	28.51	33.46	0.31%	1.36	0.03	0.56	0.84	33.78	33.78	0.38	0.02	33.80	0.50	0.01	0.03	33.85	0.82	29.74	33.85	0.03	1.33	0.04	2.34		1.36		0.04	33.86	0.40	Overtopping!!
CB #30 (21378)	CB #31 (21380)	0.040	2.34	78.0	18	0.013	28.56	33.46	28.60	33.81	0.05%	1.32	0.03	0.56	0.84	33.86	33.86	0.38	0.04	33.90	0.50	0.01	0.03	33.94	0.82	29.83	33.94	0.13	0.48	0.01	2.30		1.32		0.01	33.82	0.01	Overtopping!!
CB #31 (21380)	CB #32 (5852)	2.296	2.30	80.0	12	0.012	29.40	33.81	30.27	*33.50*	1.09%	2.92	0.13	0.89	0.89	33.82	33.82	0.25	0.28	34.10	0.50	0.07	0.13	34.30	2.15	32.42	34.30		0.48	0.06	0.00		2.92		0.06	34.36	0.86	Overtopping!!
																34.36																							

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

EXISTING BASIN UNIFORM FLOW ANALYSIS

Project Name: NE 90th Street Outfall — *Designed By: Max Berde* *Checked By: Peter Apostol*

Job Number: 15011 — *Storm Event: 50-YEAR*

CB Downstream	CB Upstream	Pipe Size	Q50-yr	Manning's "n"	Pipe Slope	Qf Pipe Full	Vf Pipe Full	Uniform Flow Check *	Uniform Velocity Check Check **
		in	cfs	unitless	%	cfs	ft/s		
RIVER OUTFALL	CB #01 (21394)	18	6.03	0.012	0.43%	7.49	4.24	Warning!	Ok
CB #01 (21394)	CB #02 (21397)	18	6.03	0.012	0.76%	9.97	5.64	Ok	Ok
CB #02 (21397)	CB #03 (21370)	18	6.01	0.012	0.32%	6.47	3.66	Warning!	Ok
CB #03 (21370)	CB #04 (1634)	18	3.54	0.012	0.47%	7.85	4.44	Ok	Ok
CB #04 (1634)	CB #05 (23077)	18	3.54	0.012	0.97%	11.23	6.36	Ok	Ok
CB #05 (23077)	CB #06 (21580)	18	3.51	0.012	0.69%	9.51	5.38	Ok	Ok
CB #06 (21580)	CB #07 (21237)	18	3.51	0.012	0.99%	11.33	6.41	Ok	Ok
CB #07 (21237)	CB #08 (21166)	18	3.00	0.012	0.90%	10.84	6.13	Ok	Ok
CB #08 (21166)	CB #09 (21161)	18	2.92	0.012	0.87%	10.65	6.03	Ok	Ok
CB #09 (21161)	CB #10 (21379)	18	2.89	0.012	1.17%	12.34	6.98	Ok	Ok
CB #10 (21379)	CB #11 (21381)	12	0.46	0.012	0.83%	3.53	4.50	Ok	Ok
CB #11 (21381)	CB #12 (21162)	12	0.43	0.012	0.82%	3.50	4.45	Ok	Ok
CB #12 (21162)	CB #13 (21383)	12	0.35	0.012	0.21%	1.76	2.24	Ok	Ok
CB #13 (21383)	CB #14 (21384)	12	0.26	0.012	0.24%	1.91	2.43	Ok	Ok
			0.00						
CB #7	CB #20 (21549)	12	0.45	0.012	4.23%	7.96	10.13	Ok	Ok
CB #20 (21549)	CB #21 (21802)	12	0.45	0.012	5.13%	8.76	11.16	Ok	Ok
CB #21 (21802)	CB #22 (21753)	12	0.25	0.012	1.07%	4.00	5.09	Ok	Ok
CB #22 (21753)	CB #23 (21751)	12	0.09	0.012	1.47%	4.69	5.97	Ok	Ok
			0.00						
CB #21 (21802)	CB #24 (21752)	12	0.10	0.013	1.55%	4.45	5.67	Ok	Ok
			0.00						
CB #10 (21379)	CB #30 (21378)	18	2.40	0.013	0.31%	5.86	3.32	Ok	Ok
CB #30 (21378)	CB #31 (21380)	18	2.34	0.013	0.05%	2.39	1.35	Warning!	Ok
CB #31 (21380)	CB #32 (5852)	12	2.30	0.012	1.09%	4.04	5.14	Ok	Ok

APPENDIX F –
FULL ONSITE DETENTION BACKWATER AND FLOW ANALYSES

ATTACHMENT Q

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

SUB BASIN FLOWS (WWHM) - WITH DETENTION

Project Name: HOPELINK RISC - NE 90th Street ***Designed By: Max Berde Checked By: Peter Apostol***

Job Number: 15011 ***Storm Event: 50-YEAR***

CB # (Figure)	CB # (City GIS ID)	AREA TOTAL (SF)	AREA TOTAL (AC)	IMPERVIOUS (AC)	PERVIOUS (AC)	50 YR FLOW (cfs)	Notes
1	21394	0	0.000	0.000	0.000	0.000	Solid Lid
2	21397	1814	0.042	0.021	0.021	0.020	Approx 50/50 Impervious/Pervious
3	21370	3742	1.736	1.363	0.373	1.150	Approx 50/50 Impervious/Pervious offsite (trail) [0.086 ac] and 80/20 onsite [1.65 ac] and 80/20 adjacent site [3.81 ac]
4	1634	0	0.000	0.000	0.000	0.000	Solid Lid
5	23077	1669	0.038	0.038	0.027	0.027	
6	21580	0	0.000	0.000	0.000	0.000	Solid Lid (Flow Splitter)
7	21237	3654	0.084	0.084	0.000	0.059	100% Impervious
8	21166	5182	0.119	0.119	0.000	0.084	100% Impervious
9	21161	1467	0.034	0.034	0.000	0.024	100% Impervious
10	21379	2040	0.047	0.047	0.000	0.033	100% Impervious
11	21381	1689	0.039	0.039	0.000	0.028	100% Impervious
12	21162	5363	0.123	0.123	0.000	0.087	100% Impervious
13	21383	5085	0.117	0.117	0.000	0.083	100% Impervious
14	21384	14782	0.339	0.339	0.000	0.263	100% Impervious
20	21549	0	0.000	0.000	0.000	0.000	Solid Lid?
21	21802	13139	0.302	0.302	0.000	0.104	100% Impervious
22	21753	9657	0.222	0.222	0.000	0.157	100% Impervious
23	21751	5493	0.126	0.126	0.000	0.089	100% Impervious
24	21752	6420	0.147	0.147	0.000	0.104	100% Impervious
30	21378	3970	0.091	0.091	0.000	0.064	100% Impervious
31	21380	2448	0.056	0.056	0.000	0.040	100% Impervious
32	5852	329327	7.560	6.048	1.512	2.296	80/20% Impervious max./Pervious by zoning

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

BACKWATER ANALYSIS - WITH DETENTION

Project Name: HOPELINK RISC - NE 90th Street
Job Number: 15011

Designed By: Max Berde Checked By: Peter Apostol
Storm Event: 50-YEAR

Conveyance System Information																				Outlet Control						Inlet Control		Headwater Summation										Overtopping Check	
Pipe Segment		Surface Flow	Total Flow	Length	Pipe Size	"n"	Down-Stream	Down-Stream	Up-Stream	Up-Stream	Pipe	Barrel	Barrel	Critical	Critical	TW	TW	Barrel	Friction	Entrance	Entrance	Entrance	Exit	Outlet	Inlet	Inlet	Control	Approach	Bend	Bend	Q_1	Q_3	V_1	Junction	Head	HW	(HW - Rim)	Over-
CB/MH # Down	CB/MH # Up	Q	Qtot	L	D	value	Invert	Rim	Invert	Rim	Slope	Velocity	Velocity Head	Depth Ratio	Depth	Elev.	Check	Hyd. Rad.	Loss	HGL Elev.	K_e	Head Loss	Head Loss	Control Elev.	HW/D	Control Elev.	HW Elev.	Veloctiy Head	K_b	Head Loss				Head Loss	Loss Total	Elev.	Clearance	topping Check
CFS	CFS	FT	IN		FT	FT	FT	FT	FT	%	FPS	FT		FT	FT	FT	FT	FT	FT		FT	FT	FT	FT	FT	FT	FT		FT	CFS	CFS	FPS	FT	FT	FT	FT	
RIVER OUTFALL	CB #01 (21394)	0.000	4.71	65.0	18	0.012	23.31	24.81	23.59	31.29	0.43%	2.67	0.11	0.78	1.17	30.20	30.20	0.38	0.11	30.31	0.50	0.06	0.11	30.48	1.35	25.62	30.48	0.11	0.02	0.00	4.71		2.67		0.00	30.37	-0.92	Okay
CB #01 (21394)	CB #02 (21397)	0.020	4.71	76.0	18	0.012	23.64	31.29	24.22	34.23	0.76%	2.67	0.11	0.78	1.17	30.37	30.37	0.38	0.13	30.50	0.50	0.06	0.11	30.66	1.35	26.25	30.66	0.11	0.02	0.00	4.69		2.67		0.00	30.56	-3.67	Okay
CB #02 (21397)	CB #03 (21370)	1.150	4.69	155.6	18	0.012	24.22	34.23	24.72	32.77	0.32%	2.65	0.11	0.78	1.17	30.56	30.56	0.38	0.26	30.82	0.50	0.05	0.11	30.98	1.35	26.75	30.98	0.06	0.02	0.00	3.54		2.65		0.00	30.92	-1.85	Okay
CB #03 (21370)	CB #04 (1634)	0.000	3.54	120.5	18	0.012	24.72	32.77	25.29	34.59	0.47%	2.00	0.06	0.62	0.47	30.92	30.92	0.38	0.12	31.04	0.50	0.03	0.06	31.13	0.90	26.64	31.13	0.06	0.02	0.00	3.54		2.00		0.00	31.07	-3.52	Okay
CB #04 (1634)	CB #05 (23077)	0.027	3.54	19.6	18	0.012	25.29	34.59	25.48	33.80	0.97%	2.00	0.06	0.62	0.36	31.07	31.07	0.38	0.02	31.09	0.50	0.03	0.06	31.18	0.90	26.83	31.18	0.06	1.33	0.08	3.51		2.00		0.08	31.21	-2.59	Okay
CB #05 (23077)	CB #06 (21580)	0.000	3.51	25.9	18	0.012	25.50	33.80	25.68	33.33	0.69%	1.99	0.06	0.62	0.15	31.21	31.21	0.38	0.02	31.23	0.50	0.03	0.06	31.32	0.90	27.03	31.32	0.06	0.02	0.00	3.51		1.99		0.00	31.26	-2.07	Okay
CB #06 (21580)	CB #07 (21237)	0.059	3.51	34.5	18	0.012	25.68	33.33	26.02	32.82	0.99%	1.99	0.06	0.62	0.15	31.26	31.26	0.38	0.03	31.29	0.50	0.03	0.06	31.39	0.90	27.37	31.39	0.04	1.33	0.08	3.00	0.45	1.99	0.01	0.09	31.43	-1.39	Okay
CB #07 (21237)	CB #08 (21166)	0.084	3.00	51.0	18	0.012	26.02	32.82	26.48	32.98	0.90%	1.70	0.04	0.59	0.13	31.43	31.43	0.38	0.04	31.47	0.50	0.02	0.04	31.53	0.85	27.76	31.53	0.04	1.33	0.06	2.92		1.70		0.06	31.55	-1.43	Okay
CB #08 (21166)	CB #09 (21161)	0.024	2.92	70.0	18	0.012	26.48	32.98	27.09	32.84	0.87%	1.65	0.04	0.58	0.87	31.55	31.55	0.38	0.05	31.60	0.50	0.02	0.04	31.66	0.85	28.37	31.66	0.04	0.02	0.00	2.89		1.65		0.00	31.62	-1.22	Okay
CB #09 (21161)	CB #10 (21379)	0.033	2.89	65.0	18	0.012	27.19	32.84	27.95	33.25	1.17%	1.64	0.04	0.58	0.87	31.62	31.62	0.38	0.04	31.66	0.50	0.02	0.04	31.72	0.85	29.23	31.72	0.01	0.02	0.00	0.46	2.40	1.64	0.05	0.05	31.77	-1.48	Okay
CB #10 (21379)	CB #11 (21381)	0.028	0.46	78.0	12	0.012	27.95	33.25	*28.60*	31.58	0.83%	0.59	0.01	0.21	0.21	31.77	31.77	0.25	0.01	31.78	0.50	0.00	0.01	31.79	0.10	28.70	31.79	0.00	0.02	0.00	0.43		0.59		0.00	31.78	0.20	Overtopping!!
CB #11 (21381)	CB #12 (21162)	0.087	0.43	190.0	12	0.012	*28.60*	31.58	*30.15*	31.94	0.82%	0.55	0.00	0.16	0.16	31.78	31.78	0.25	0.02	31.81	0.50	0.00	0.00	31.81	0.10	30.25	31.81	0.00	0.02	0.00	0.35		0.55		0.00	31.81	-0.13	Caution
CB #12 (21162)	CB #13 (21383)	0.083	0.35	63.0	12	0.012	30.15	31.94	30.28	32.65	0.21%	0.44	0.00	0.15	0.15	31.81	31.81	0.25	0.01	31.81	0.50	0.00	0.00	31.82	0.10	30.38	31.82	0.00	1.33	0.00	0.26		0.44		0.00	31.82	-0.83	Okay
CB #13 (21383)	CB #14 (21384)	0.263	0.26	41.0	12	0.012	30.28	32.65	30.38	32.63	0.24%	0.33	0.00	0.10	0.10	31.82	31.82	0.25	0.00	31.82	0.50	0.00	0.00	31.83	0.10	30.48	31.83	0.01	0.02	0.00	0.45		0.33		0.00	31.82	-0.81	Okay
CB #7	CB #20 (21549)	0.000	0.45	33.6	12	0.012	26.17	32.82	27.59	33.09	4.23%	0.58	0.01	0.31	0.31	31.82	31.82	0.25	0.00	31.83	0.50	0.00	0.01	31.83	0.50	28.09	31.83	0.01	0.48	0.00	0.45		0.58		0.00	31.83	-1.26	Okay
CB #20 (21549)	CB #21 (21802)	0.104	0.45	39.0	12	0.012	27.79	33.09	29.79	32.49	5.13%	0.58	0.01	0.31	0.31	31.83	31.83	0.25	0.01	31.84	0.50	0.00	0.01	31.84	0.50	30.29	31.84	0.00	0.48	0.00	0.25	0.10	0.58	0.00	0.00	31.85	-0.64	Okay
CB #21 (21802)	CB #22 (21753)	0.157	0.25	204.0	12	0.012	29.79	32.49	31.97	34.72	1.07%	0.31	0.00	0.21	0.21	31.85	31.85	0.25	0.01	32.97	0.50	0.00	0.00	32.97	0.10	32.07	32.97	0.00	1.33	0.00	0.09		0.31		0.00	32.97	-1.75	Okay
CB #22 (21753)	CB #23 (21751)	0.089	0.09	47.0	12	0.012	32.12	34.72	32.81	34.96	1.47%	0.11	0.00	0.12	0.12	32.97	32.97	0.25	0.00	33.81	0.50	0.00	0.00	33.81	0.10	32.91	33.81	0.00	0.02	0.00	0.10		0.11		0.00	33.81	-1.15	Okay
CB #21 (21802)	CB #24 (21752)	0.104	0.10	47.0	12	0.013	30.39	32.49	31.12	32.75	1.55%	0.13	0.00	0.13	0.13	33.81	33.81	0.25	0.00	33.81	0.50	0.00	0.00	33.81	0.10	31.22	33.81	0.03	0.05	0.00	2.40		0.13		0.00	33.78	1.03	Overtopping!!
CB #10 (21379)	CB #30 (21378)	0.064	2.40	42.0	18	0.013	28.38	33.25	28.51	33.46	0.31%	1.36	0.03	0.56	0.84	33.78	33.78	0.38	0.02	33.80	0.50	0.01	0.03	33.85	0.82	29.74	33.85	0.03	1.33	0.04	2.34		1.36		0.04	33.86	0.40	Overtopping!!
CB #30 (21378)	CB #31 (21380)	0.040	2.34	78.0	18	0.013	28.56	33.46	28.60	33.81	0.05%	1.32	0.03	0.56	0.84	33.86	33.86	0.38	0.04	33.90	0.50	0.01	0.03	33.94	0.82	29.83	33.94	0.13	0.48	0.01	2.30		1.32		0.01	33.82	0.01	Overtopping!!
CB #31 (21380)	CB #32 (5852)	2.296	2.30	80.0	12	0.012	29.40	33.81	30.27	*34.00*	1.09%	2.92	0.13	0.89	0.89	33.82	33.82	0.25	0.28	34.10	0.50	0.07	0.13	34.30	2.15	32.42	34.30		0.48	0.06	0.00		2.92		0.06	34.36	0.36	Overtopping!!
																34.36																							

coterra
ENGINEERING PLLC
collaborative civil engineering + site development + infrastructure design

UNIFORM FLOW ANALYSIS-WITH DETENTION

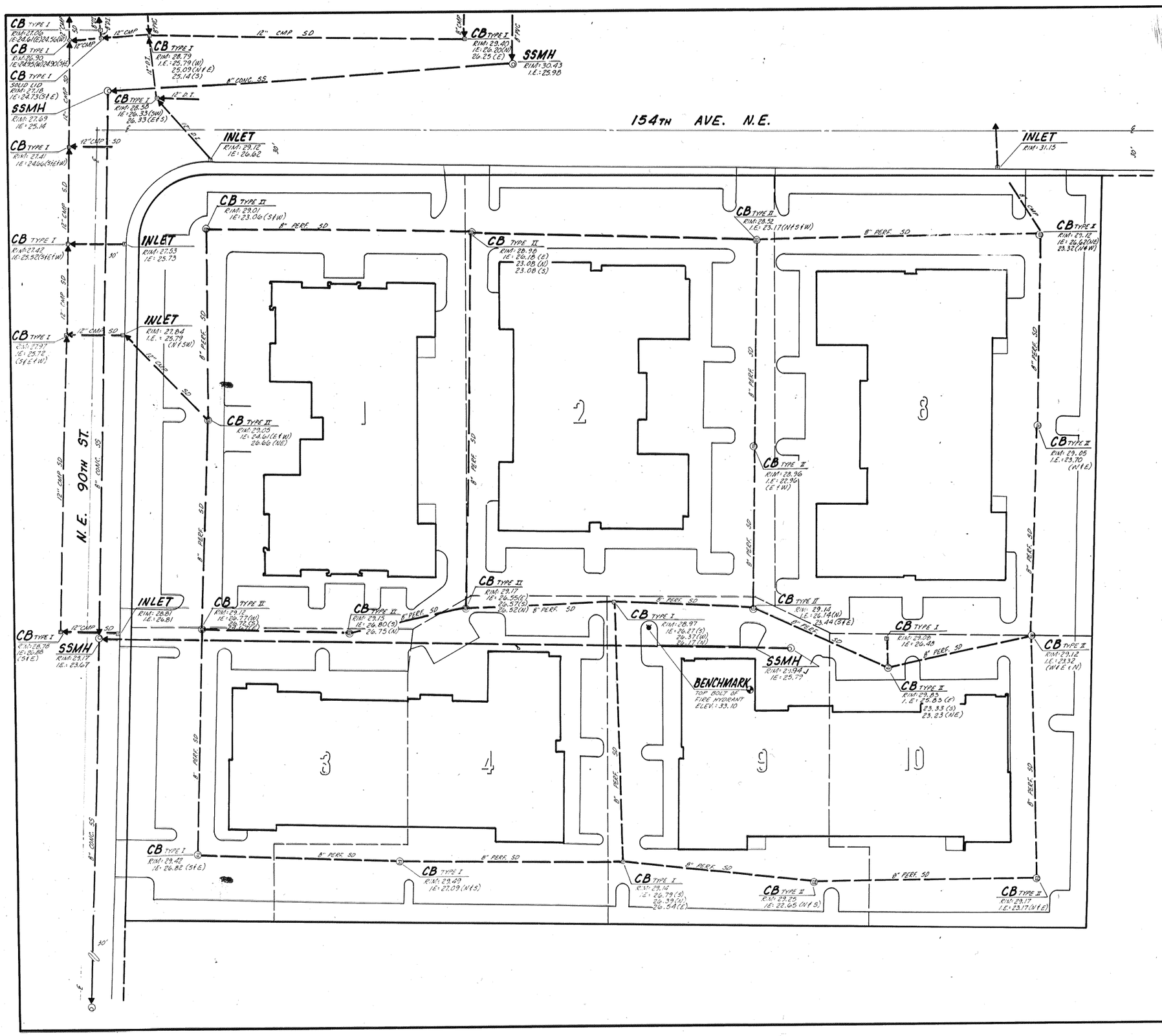
Project Name: NE 90th Street Outfall — *Designed By: Max Berde* — *Checked By: Peter Apostol*

Job Number: 15011 — *Storm Event: 50-YEAR*

CB Downstream	CB Upstream	Pipe Size	Q50-yr	Manning's "n"	Pipe Slope	Qf Pipe Full	Vf Pipe Full	Uniform Flow Check *	Uniform Velocity Check Check **
		in	cfs	unitless	%	cfs	ft/s		
RIVER OUTFALL	CB #01 (21394)	18	4.71	0.012	0.43%	7.49	4.24	Ok	Ok
CB #01 (21394)	CB #02 (21397)	18	4.71	0.012	0.76%	9.97	5.64	Ok	Ok
CB #02 (21397)	CB #03 (21370)	18	4.69	0.012	0.32%	6.47	3.66	Ok	Ok
CB #03 (21370)	CB #04 (1634)	18	3.54	0.012	0.47%	7.85	4.44	Ok	Ok
CB #04 (1634)	CB #05 (23077)	18	3.54	0.012	0.97%	11.23	6.36	Ok	Ok
CB #05 (23077)	CB #06 (21580)	18	3.51	0.012	0.69%	9.51	5.38	Ok	Ok
CB #06 (21580)	CB #07 (21237)	18	3.51	0.012	0.99%	11.33	6.41	Ok	Ok
CB #07 (21237)	CB #08 (21166)	18	3.00	0.012	0.90%	10.84	6.13	Ok	Ok
CB #08 (21166)	CB #09 (21161)	18	2.92	0.012	0.87%	10.65	6.03	Ok	Ok
CB #09 (21161)	CB #10 (21379)	18	2.89	0.012	1.17%	12.34	6.98	Ok	Ok
CB #10 (21379)	CB #11 (21381)	12	0.46	0.012	0.83%	3.53	4.50	Ok	Ok
CB #11 (21381)	CB #12 (21162)	12	0.43	0.012	0.82%	3.50	4.45	Ok	Ok
CB #12 (21162)	CB #13 (21383)	12	0.35	0.012	0.21%	1.76	2.24	Ok	Ok
CB #13 (21383)	CB #14 (21384)	12	0.26	0.012	0.24%	1.91	2.43	Ok	Ok
			0.00						
CB #7	CB #20 (21549)	12	0.45	0.012	4.23%	7.96	10.13	Ok	Ok
CB #20 (21549)	CB #21 (21802)	12	0.45	0.012	5.13%	8.76	11.16	Ok	Ok
CB #21 (21802)	CB #22 (21753)	12	0.25	0.012	1.07%	4.00	5.09	Ok	Ok
CB #22 (21753)	CB #23 (21751)	12	0.09	0.012	1.47%	4.69	5.97	Ok	Ok
			0.00						
CB #21 (21802)	CB #24 (21752)	12	0.10	0.013	1.55%	4.45	5.67	Ok	Ok
			0.00						
CB #10 (21379)	CB #30 (21378)	18	2.40	0.013	0.31%	5.86	3.32	Ok	Ok
CB #30 (21378)	CB #31 (21380)	18	2.34	0.013	0.05%	2.39	1.35	Warning!	Ok
CB #31 (21380)	CB #32 (5852)	12	2.30	0.012	1.09%	4.04	5.14	Ok	Ok

APPENDIX G – AS-BUILT PLANS

ATTACHMENT Q



SCALE: 1": 30'

VERTICAL DATUM:
CITY OF REDMOND VERTICAL DATUM

BENCHMARK:
TOP BOLT OF FIRE HYDRANT NEAR NORTHEAST CORNER OF LOT 9:
ELEVATION: 33.10

REV	DATE	DESCRIPTION	BY

CONTINENTAL PACIFIC, INC.
1380 112TH AVE. N.E., SUITE 305
BELLEVUE, WASHINGTON 98004

PACIFIC BUSINESS & TECHNICAL CTR.
STORM DRAINAGE & SANITARY AS-BUILT

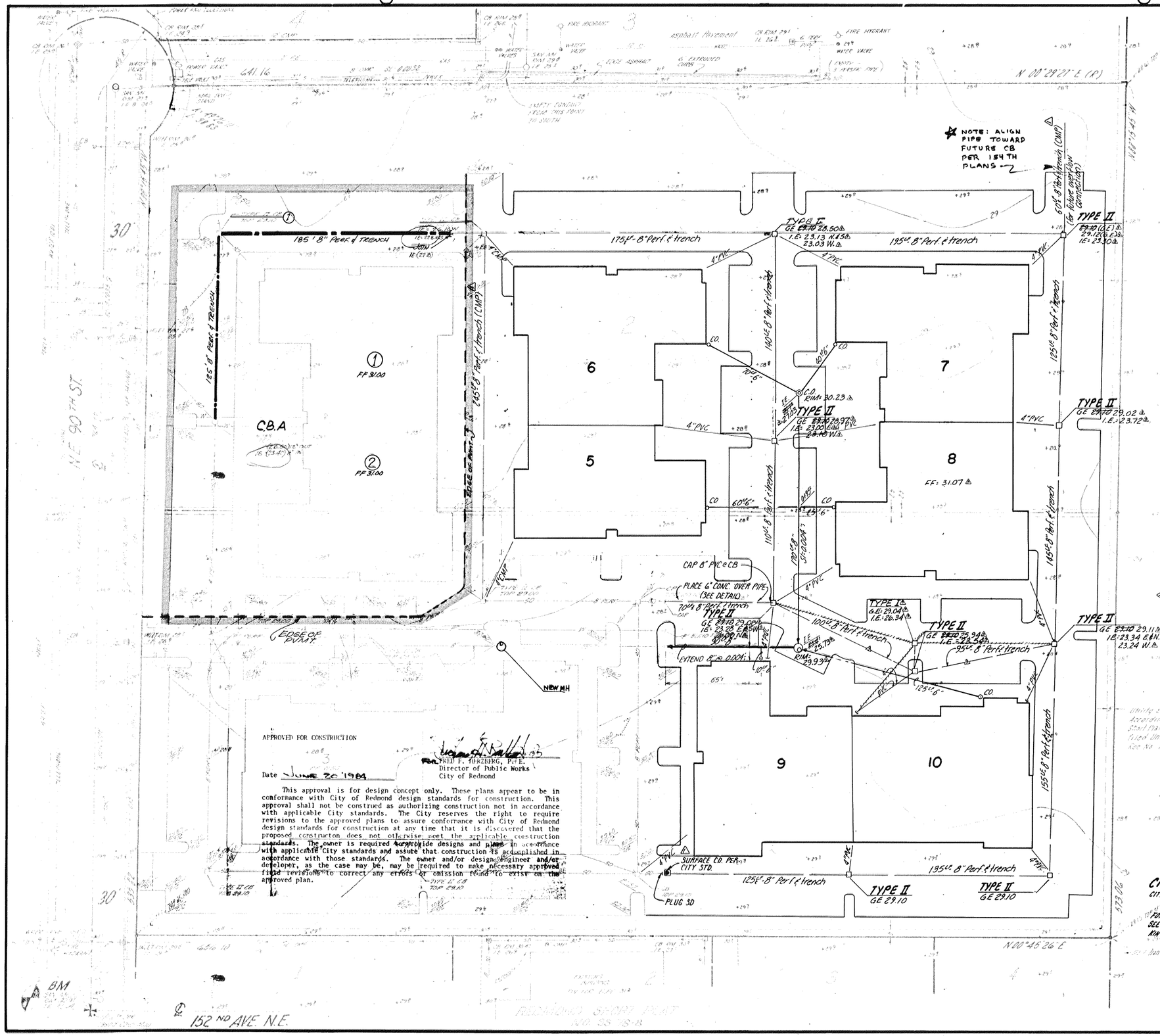
(206) 454-3743 OR 885-7877
DODDS ENGINEERS, INC.
4205-148th AVENUE NORTHEAST
BELLEVUE, WASHINGTON 98007

DWN J.S. STEADMAN BOOK 2-25-5
SVD L. BECHER DATE MAR, 1988
APP'D S.A. MERRYMAN

PROJ. NO. 82112
SHT 1 OF 1

8612050012

ATTACHMENT Q



APPROVED FOR CONSTRUCTION

Date June 20 1984

FOR FRED F. HIRZBERG, P.E.
Director of Public Works
City of Redmond

This approval is for design concept only. These plans appear to be in conformance with City of Redmond design standards for construction. This approval shall not be construed as authorizing construction not in accordance with applicable City standards. The City reserves the right to require revisions to the approved plans to assure conformance with City of Redmond design standards for construction at any time that it is discovered that the proposed construction does not otherwise meet the applicable construction standards. The owner is required to provide designs and plans in accordance with applicable City standards and assure that construction is accomplished in accordance with those standards. The owner and/or design engineer and/or developer, as the case may be, may be required to make necessary approved field revisions to correct any errors or omission found to exist on the approved plan.

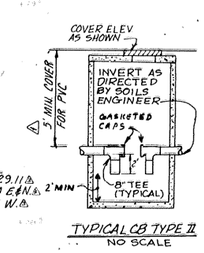
STORM DRAINAGE NOTES

1. All work shall conform to the City of Redmond Standards and Specifications.
2. A copy of this plan must be on-site whenever construction is in progress.
3. It shall be the sole responsibility of the contractor to obtain street use and other related or required permits prior to any construction activity in County or State right(s)-of-way.
4. All locations of existing utilities shown hereon have been established by field survey or obtained from available records and should therefore be considered approximate only and not necessarily complete. It is the sole responsibility of the contractor to independently verify the accuracy of all utility locations shown, and to further discover and avoid any other utilities not shown hereon which may be effected by the implementation of this plan.
5. Locations of the drainage structures shown on these plans are approximate only. Exact locations shall be established by the engineer in the field.
6. Catch Basins:
   A. All Type I C.B.'s shall be Associated Sand and Gravel CB 15 (APWA Std. Plan 52) or equal.
   B. All Type II C.B.'s Shall be Associated Sand and Gravel CB-19 (48" I.D. or 54" I.D. as shown) or equal.
   C. Unit covers as designated are APWA standard.
   D. Other C.B.'s shall be as designated.
7. Pipe Specifications - All pipe shall conform to one of the following:
   PIPE SHALL BE PVC EXCEPT AS INDICATED ON THE PLAN.
   A. 16 ga. (min.) aluminum C.M.P., 2-2/3" rds. X 1/2" corrugations.
   ~~B. 16 ga. (min.) galv. steel C.M.P., asphalt treatment I or better, 2-2/3" rds. X 1/2" corrugations.~~
   C. P.V.C. per A.S.T.M. D-3035 SDR 35. (PVC TO HAVE 5' MIN. COVER TO FINISHED GRADE)

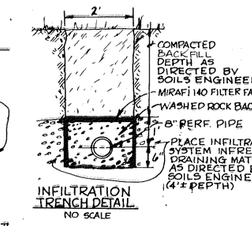
   Note: Pipe may be any of the above provided:
   1. Pipe joints must be of the same materials, and
   2. Where a pipe material is specifically shown on the plan, that material must be used.
8. All pipe bedding shall be APWA Class 'C' or better. All trench backfill shall be compacted to 90% minimum dry density per ASTM D-1557-70.
9. All building roof drain downspouts and footing drains shall be directly connected to the main storm drainage conveyance system through an underground pipe system. Roof drains and footing drains shall be separate systems and shall be constructed of 4" (or 6" diam. where shown) PVC (rigid, non-perforated for roof drains, and perforated for footing drains). Sufficient cleanouts and bends shall be installed so that the system can be easily maintained. The contractor shall keep a dimensioned record of the location of all pipes and cleanouts and submit the same to the owner and engineer upon completion of the work.

SANITARY SEWER GENERAL NOTES

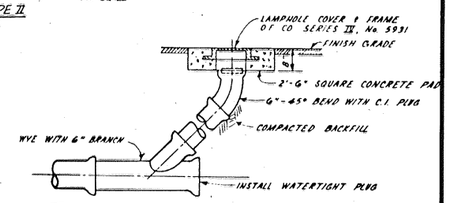
1. The new sanitary sewer line shall be plugged and not put into service until all lines have been cleaned, flushed and tested by the City of Redmond. Contractor to field verify location and invert prior to construction.
2. Construction of this project shall be in accordance with "standard specs for municipal public works construction" as approved by the Washington State Department of Social and Health Services on June 10, 1970.
3. Construction of this project shall be in accordance with Section 2.4 of the "Criteria for Sewage Works Design" as prepared by the State of Washington Department of Ecology and revised as of March, 1980.



TYPICAL CB TYPE II
NO SCALE



INFILTRATION TRENCH DETAIL
NO SCALE



CLEANOUT DETAIL
NO SCALE
SYMBOL = O

SCALE: 1" = 30'

K.C.A.S.

CITY OF REDMOND DATUM
CITY OF REDMOND ENGINEERING DEPARTMENT

REV	DATE	DESCRIPTION	BY
4	10/9/85	REV. PLAN TO SHOW BLDG. No. 1 & 2 AS LIMITS OF CONST.	FJW
3	5-16-85	AS-BUILT STORM - LOTS 1 & 8 & F.F. BLDG. B	JSG
2	2/14/85	REV. PLAN TO SHOW CB DETAIL & AS LIMITS OF CONST.	FJW
1	5-3-84	ADDED 30 LF 8" PVC CMP & PVC CONC. IN TRENCH CB	FJW

CONTINENTAL PACIFIC, INC.
2105 - 112th AVENUE N.E.
BELLEVUE, WASHINGTON 98004

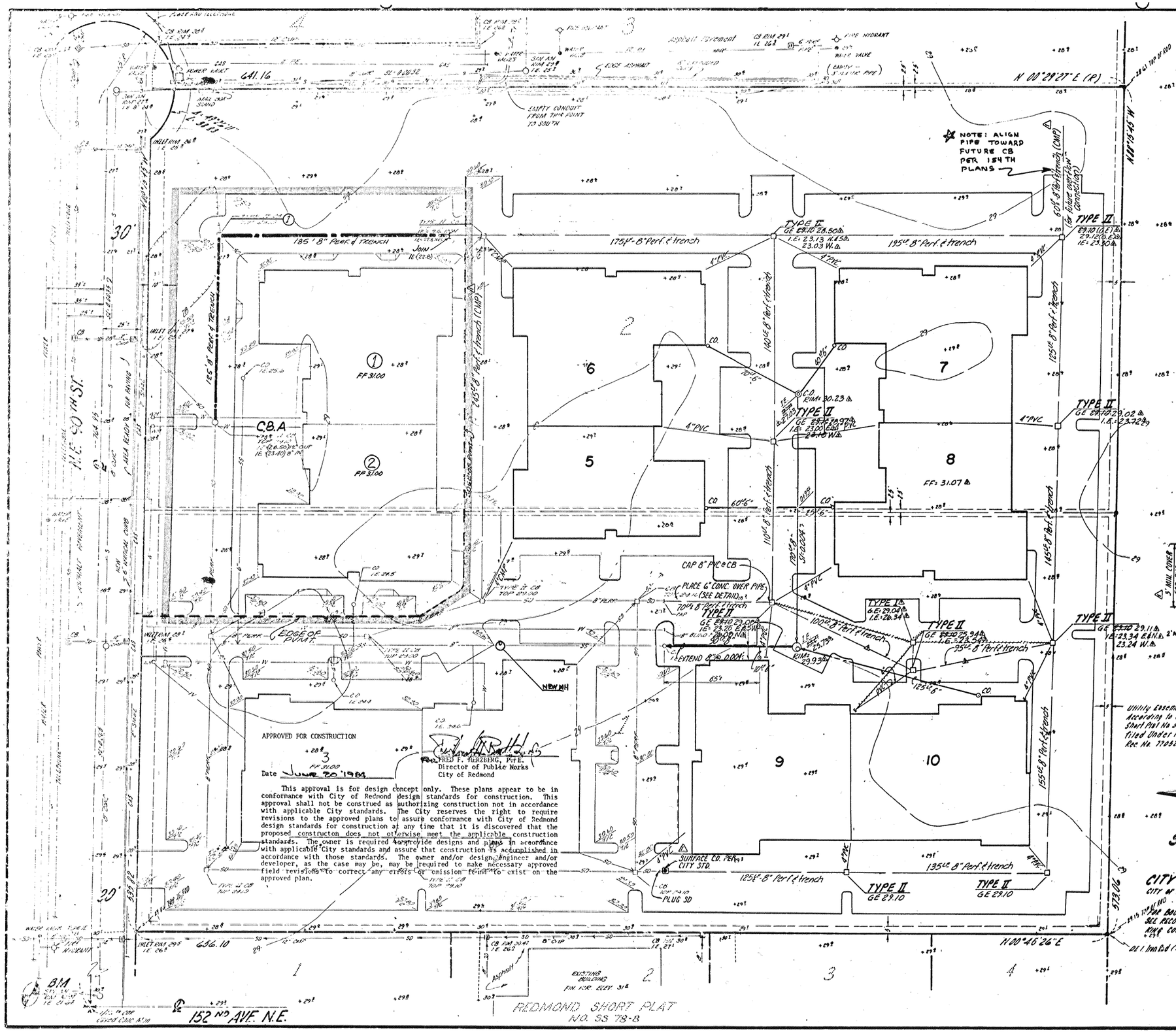
PACIFIC BUSINESS & TECH CENTER
STORM & SANITARY SEWER

(206) 454-3743 OR 885-7877
DOODS ENGINEERS, INC.
4205-148th AVENUE NORTHEAST
BELLEVUE, WASHINGTON 98007

DWN BJD	BOOK	PROJ. NO. 82112
SVD	DATE	
APP'D BJD 4-26-84		SHT 2 OF

8612050013

ATTACHMENT Q



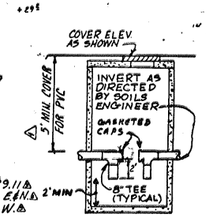
STORM DRAINAGE NOTES

1. All work shall conform to the City of Redmond Standards and Specifications.
2. A copy of this plan must be on-site whenever construction is in progress.
3. It shall be the sole responsibility of the contractor to obtain street use and other related or required permits prior to any construction activity in County or State right(s)-of-way.
4. All locations of existing utilities shown hereon have been established by field survey or obtained from available records and should therefore be considered approximate only and not necessarily complete. It is the sole responsibility of the contractor to independently verify the accuracy of all utility locations shown, and to further discover and avoid any other utilities not shown hereon which may be effected by the implementation of this plan.
5. Locations of the drainage structures shown on these plans are approximate only. Exact locations shall be established by the engineer in the field.
6. Catch Basins:
   A. All Type I C.B.'s shall be Associated Sand and Gravel CB 15 (APWA Std. Plan 52) or equal.
   B. All Type II C.B.'s Shall be Associated Sand and Gravel CB-19 (48" I.D. or 54" I.D. as shown) or equal.
   C. Unit covers as designated are APWA standard.
   D. Other C.B.'s shall be as designated.
7. Pipe Specifications - All pipe shall conform to one of the following:
   PIPE SHALL BE PVC EXCEPT AS INDICATED ON THE PLAN
   A. 16 ga. (min.) aluminum C.M.P., 2-2/3" rds. X 1/2" corrugations.
   ~~B. 16 ga. (min.) galv. steel C.M.P., asphalt treatment 1 or better, 2-2/3" rds. X 1/2" corrugations.~~
   C. P.V.C. per A.S.T.M. D-3035 SDR 35. *(PVC TO HAVE 5' MIN. COVER TO FINISHED GRADE)*

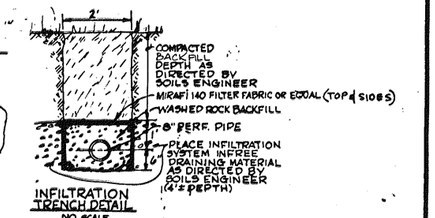
   Note: Pipe may be any of the above provided:
   1. Pipe joints must be of the same materials, and
   2. Where a pipe material is specifically shown on the plan, that material must be used.
8. All pipe bedding shall be APWA Class 'C' or better. All trench backfill shall be compacted to 90% minimum dry density per ASTM D-1557-70.
9. All building roof drain downspouts and footing drains shall be directly connected to the main storm drainage conveyance system through an underground pipe system. Roof drains and footing drains shall be separate systems and shall be constructed of 4" (or 6" diam. where shown) PVC (rigid, non-perforated for roof drains, and perforated for footing drains). Sufficient cleanouts and bends shall be installed so that the system can be easily maintained. The contractor shall keep a dimensioned record of the location of all pipes and cleanouts and submit the same to the owner and engineer upon completion of the work.

SANITARY SEWER GENERAL NOTES

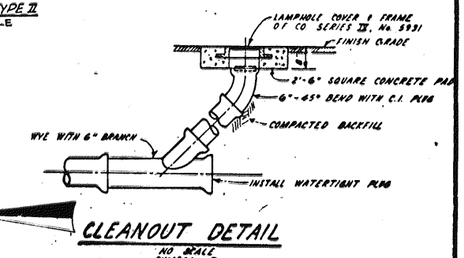
1. The new sanitary sewer line shall be plugged and not put into service until all lines have been cleaned, flushed and tested by the City of Redmond. Contractor to field verify location and invert prior to construction.
2. Construction of this project shall be in accordance with "standard specs for municipal public works construction" as approved by the Washington State Department of Social and Health Services on June 10, 1970.
3. Construction of this project shall be in accordance with Section 2.4 of the "Criteria for Sewage Works Design" as prepared by the State of Washington Department of Ecology and revised as of March, 1980.



TYPICAL CB TYPE II
NO SCALE



INFILTRATION TRENCH DETAIL
NO SCALE



CLEANOUT DETAIL
NO SCALE
SYMBOL = O

SCALE: 1" = 30'

K.C.A.S.

CITY OF REDMOND DATUM
CITY OF REDMOND ENGINEERING DEPARTMENT

FOR BOUNDARY AND CONTROL INFORMATION SEE RECORD OF SURVEY, VOL. 16, PAGE 68 KING COUNTY REC. NO. 7801190900

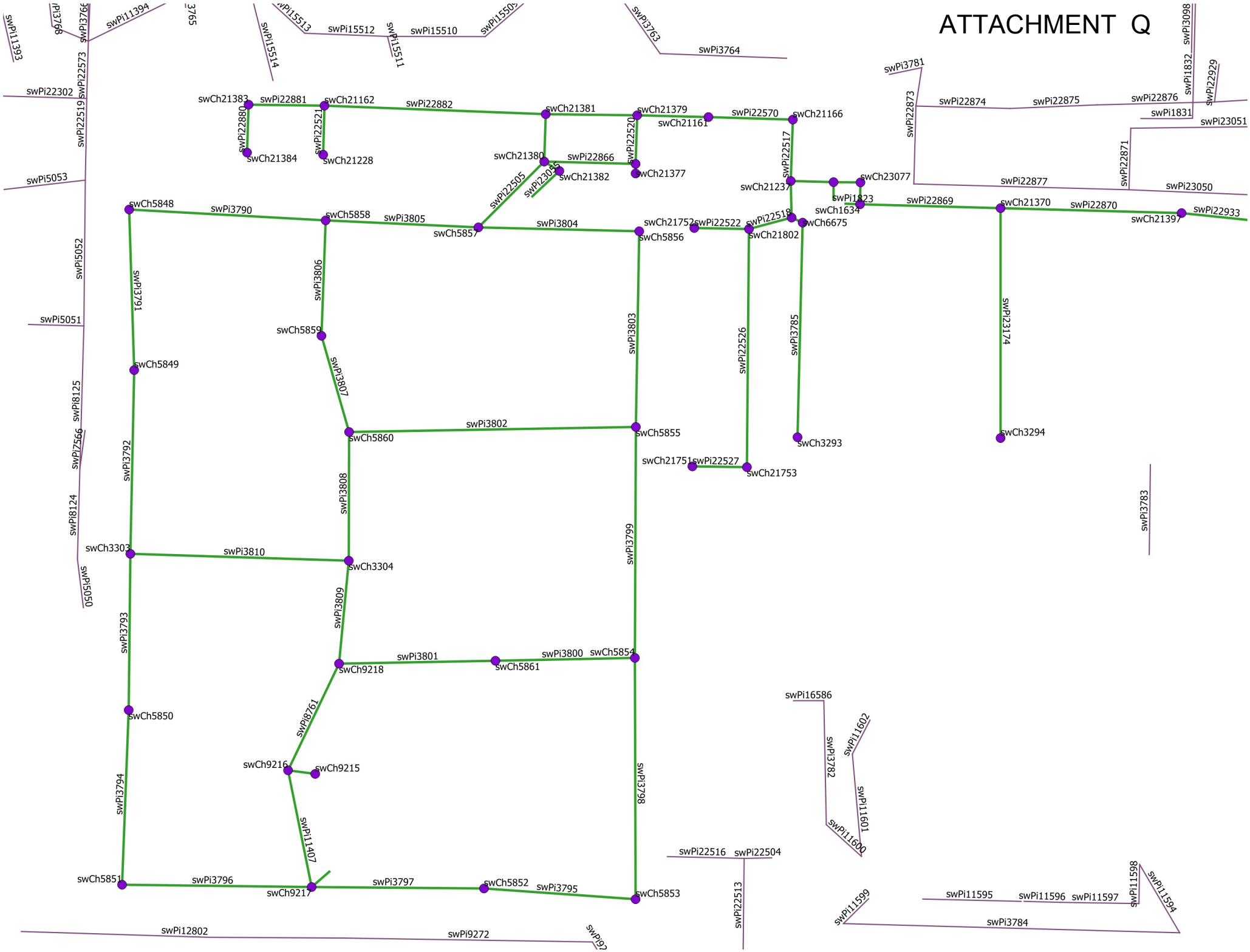
REV	DATE	DESCRIPTION	BY
4	10/4/86	REV. PLAN TO SHOW BLDG. # 1 & 2 AS LIMITS OF CONST.	FJW
3	5-16-86	AS-BUILT STORM - LOTS 7 & 8 & F.F. BLDG. 8.	JSS
2	9/14/84	REVISE PLAN TO SHOW BLDGS 5,7,8 AS LIMITS OF CONST.	FJW
1	4-26-84	ADDED BLDG. 10 & ADJ. WEST CUP STRM. CONF. IN FRONT OF BLDG. 10	FJW

CONTINENTAL PACIFIC, INC.
2105 - 112th AVENUE N.E.
BELLEVUE, WASHINGTON 98004

PACIFIC BUSINESS & TECH CENTER
STORM & SANITARY SEWER

(206) 454-3743 OR 885-7877
DODDS ENGINEERS, INC.
4205-148th AVENUE NORTHEAST
BELLEVUE, WASHINGTON 98007

DWN BJD	BOOK	PROJ. NO. 82112
SVD	DATE	
APP'D BJD 4-26-84		SHT 2 OF

8612050014

ATTACHMENT Q