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Memorandum

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To: Raymunda Van Hoven, PDE, NMSHTD Drainage

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From: Peter Brakenhoff, Parsons Brinckerhoff
Darryl Gregg, Parsons Brinckerhoff

Date: December 30, 2002

RE: I-40 / Pennsylvania Avenue Overpass in Albuquerque
NM Project No. IM-040-3(120)163, CN 3117
Storm Drainage Design

PB recently submitted the Final Design Inspection plans (90% complete design) and preliminary engineer's estimate for the Pennsylvania Street / I-40 Overpass Reconstruction project for your review and comment. The plans include the design elements necessary to accommodate the drainage improvements at the intersection of Pennsylvania Street and Constitution Avenue as well as the new storm drain system at the intersections of Constitution Avenue, Rhode Island Street and Bellamah Avenue.

This memo serves as a record of the assumptions, decisions and conclusions relating to the design of the storm drainage system.

STORM DRAINAGE ANALYSIS

The storm runoff reaching the intersection of Pennsylvania Street and Constitution Avenue is roughly bounded on the west by Pennsylvania Street, on the north by the Embudo Arroyo, on the east by Wyoming Boulevard, and on the south by Constitution Avenue and Constitution Place. The properties south of Constitution Avenue and Constitution Place were determined to drain toward Interstate 40, and do not impact the subject intersection. A drainage basin map is attached with this memo.

Drainage sub-basins were defined for each of the four intersections where it was anticipated collection inlets would be placed. An additional sub-basin was added to isolate the runoff reaching the retention / detention basin located at the northwest corner of the Presbyterian Hospital property. It is assumed that the runoff from this sub-basin will not reach the Pennsylvania / Constitution intersection until the flow from all other basins have already passes through. Peak discharges were determined for both the 100-year and 10-year, 6-hour storms.

The majority of the storm drainage runoff is generated within sub-basin P2, which contains slightly less than 60 acres and conveys the peak discharge to Bellamah Avenue east of Rhode Island Street, just north of the park.

COLLECTION SYSTEM DESIGN CONSTRAINTS

Because no other means of capturing the runoff reaching this intersection currently exists or is planned for the foreseeable future, a significant amount of discharge has been concentrated into a small area for collection. The existing collection system inlets are inadequate and the current point of discharge into the small, overgrown earth channel paralleling the interstate cannot accommodate the expected peak flows.

The proposed storm drainage system will convey along the west side of Pennsylvania Street and under the interstate to the existing channel located in the center of the highway. This requires boring and jacking a large conduit under the westbound interstate driving lanes and penetration of the existing concrete-lined channel. There are two major obstacles that constrain the design options:

- The depth of the interstate channel combined with the cover available under the existing driving lanes limit the slope and diameter of the discharge pipe, and reduces the capacity of the system.
- The proposed storm drainage pipe will need to pass under the existing 42-inch Water Transmission Line that crosses Pennsylvania Street and parallels the north side of the interstate.

As a result of these constraints, the proposed storm drainage outfall pipes are limited to conveying only the 10-year design flows. The additional flow generated by the 100-year storm will need to be directed to a different point of discharge.

INLET ANALYSIS & DESIGN

Collection inlets were placed to capture as much runoff as possible before reaching the Pennsylvania / Constitution intersection, with the knowledge that the most-upstream inlets would not be capable of intercepting the entire flow without a large amount of bypass flow.

The inlets were sized to intercept the entire 100-year runoff, but due to the large discharge concentrating on this area, the storm drainage outfall pipes could only be designed for the 10-year peak discharges.

DRAINAGE OUTFALL PIPE DESIGN

As noted above, the collection system has been limited to conveying the 10-year storm event only. The backbone of the collection system consists of pipes ranging in diameter from 36 to 72 inches. The inlets are connected to the main system by means of 18 to 24 inches pipes.

Relocation of portions of the existing utility systems has been avoided by strategic placement of the proposed storm drainage system. Along Constitution Avenue, one reach of 38" by 60" horizontal elliptical pipe was recommended to convey the flow under an existing 8-inch sanitary sewer line.

DESIGN CONCERNS & OPTIONS FOR CONSIDERATION

The concerns with the current design of the storm drainage collection system are as follows:

- Cost and constructability of boring and jacking the 72-inch pipe under WB I-40;
- Inability to convey the 100-year flows; and
- Construction phasing at intersections of Constitution Avenue & Pennsylvania Street and Constitution Avenue & Rhode Island Street.

The current design of the boring and jacking under WB I-40 can only provide 24 inches of cover from the top of the proposed 72-inch pipe to the surface of the interstate highway driving lanes, whereas a cover of 5 to 6 feet would be more desirable. Two smaller diameter pipes (in parallel) could attain an equivalent capacity, which would slightly increase the amount of cover, but essentially double the cost of boring and jacking to approximately $220,000. The parallel pipes would need approximately 5 feet of separation, which would require a specially-design splitter box and would likely create a less than desirable hydraulic condition.

The portion of the 100-year flow that cannot be conveyed directly to the I-40 Channel will need to be removed from the intersection by overland or surface flow. The existing concrete rundown pad west of the intersection could be re-designed / modified to accommodate this flow. The outfall channel parallel along the multi-use trail north of I-40 would be designed to ensure it has sufficient capacity. With a slope of 1.5% and roughness coefficient of n=0.015, a bottom width of 5 feet and 2:1 side slopes, a capacity of 615 cfs can be provided.

As an option to both concerns, the existing channel should be analyzed to determine if a combination box culvert and earth channel or concrete lined channel can be used to convey all flow to the west for eventual discharge to the Embudo Arroyo.

The cost of removing the 100-year flow from this intersection may outweigh the option of capturing a significant portion of the runoff at a strategic upstream location. By constructing a small collection system along Hendola Drive to convey the runoff north to the Embudo Channel, 40% to 50% of the Basin P2 flow could be diverted.

We recommend scheduling a separate coordination meeting to discuss the drainage design issues on this project. We'll discuss this in further detail during the Final Design Inspection review meeting on January 8, 2002.

Attachments:

1. Drainage Basin Layout Map
2. Calculations of Runoff
3. Capacity Calculations for Concrete Lined Channel

Cc: file


INTERSTATE 40
PARKING
P3A
P3B
MONTGOMERY BLVD
EMBUDO ARROYO
WYOMING BLVD

PENNSYLVANIA STREET ~ INTERSTATE 40
~ STORM DRAINAGE ANALYSIS ~

TABLE 1 ~ DRAINAGE BASIN CHARACTERISTICS ~ EXISTING CONDITIONS

BASIN IDENTIFIER	PROPOSED INLET LOCATION	AREA (sq. ft.)	AREA (acres)	AREA (sq. mi.)	Land Treatment Type (%) * A**	B	C	D	Land Treatment Type (Acres) * A**	B	C	D
P-1	Rhode Island St	571,803	13.13	0.0205	16	-	55	29	2.07	-	7.22	3.84
P-2	Bellamah Ave	2,602,054	59.73	0.0933	28	2	46	24	16.73	1.19	27.48	14.34
P-3A	Constitution Ave	1,036,460	23.79	0.0372	-	5	23	72	-	1.19	5.47	17.13
P-3B	Constitution Ave	374,249	8.59	0.0134	30	-	0	70	2.58	-	-	6.01
P-4	Pennsylvania St	213,788	4.91	0.0077	-	-	21	79	-	-	1.03	3.88
Entire Basin		4,798,354	110.16	0.1721	19	2	37	41	21.37	2.38	41.20	45.20

* Land Treatment Types based on City of Albuquerque Development Process Manual ~ Chapter 22, Table A-4 (June 1997)

** 35% of the Land Treatment Type "D" within the Single Family Residential areas of Basins P-1 and P-2 have been considered Type "A" to account for backyard ponding.

** 30% of the Land Treatment Type "D" with the Light Industrial (Hospital) area (All of Basin P-3B) has been considered Type "A" to account for on-site detention. It is assumed that the runoff from this sub-basin will not reach the Pennsylvania / Constitution intersection until the flow from all other basins have already passed through.

BASIN ID	Single Family Resid.				Multiple Unit Resid.		Light Indust.		Parks		Streets		Weighted % Impervious
	Units (Houses)	Acres	Units / Acre	%Imp.	Acres	%Imp.	Acres	%Imp.	Acres	%Imp.	Acres	%Imp.	
P-1	58	13.13	4.4	45.2							-	90	45
P-2	227	48.24	4.7	47.3	3.16	70	6.19	70	1.17	7	0.97	90	52
P-3A					3.65	70	16.74	70	1.30	7	2.11	90	72
P-3B							8.59	70					70
P-4					1.99	70	0.61	70			2.30	90	79
Entire Basin		61.37			8.80		32.13		2.47		5.37		

PENNSYLVANNIA STREET ~ INTERSTATE 40
~ STORM DRAINAGE ANALYSIS ~ EXISTING CONDITIONS ~ 100-YEAR EVENT

TABLE 2 ~ RUNOFF VOLUMES and PEAK DISCHARGES ~ CATCH BASIN DESIGN FLOWS (Q's)

BASIN IDENTIFIER	PROPOSED INLET LOCATION	AREA (A) (acres)	City of Albuquerque Development Process Manual Method			Rational Method
			* WEIGHTED EXCESS PRECIPITATION	RUNOFF VOLUME (ACRE-FEET)	* PEAK DISCHARGE / DESIGN FLOW (Q_{DES}) in CFS	* PEAK DISCHARGE / DESIGN FLOW (Q_{DES}) in CFS
P-1	Rhode Island St	13.13	1.50	1.64	48.05	47.96
P-2	Bellamah Ave	59.73	1.36	6.78	201.15	200.92
P-3A	Constitution Ave	23.79	2.04	4.05	107.97	107.63
P-3B	Constitution Ave	8.59	1.85	1.32	35.01	34.94
P-4	Pennsylvania St	4.91	2.14	0.87	23.02	22.95
Entire Basin		110.16	1.60	14.68	415.20	414.41

* Weighted Excess Precipitation and Peak Discharge based on Precipitation Zone 3, 100 Year, 6-Hour Storm

$Q_{DES} = (Q_P / A_T) \times A$

Where A = Area in acres tributary to catch basin.

A_T = Total area in acres of the appropriate subarea. 110.16 acres

Q_P = Peak Q from appropriate subarea, in c.f.s. 415.20 c.f.s.

QP / AT = 3.77 c.f.s. /acre

PENNSYLVANNIA STREET ~ INTERSTATE 40
~ STORM DRAINAGE ANALYSIS ~ EXISTING CONDITIONS ~ 10-YEAR EVENT

TABLE 3 ~ RUNOFF VOLUMES and PEAK DISCHARGES ~ CATCH BASIN DESIGN FLOWS (Q's)

BASIN IDENTIFIER	PROPOSED INLET LOCATION	AREA (A) (acres)	City of Albuquerque Development Process Manual Method			Rational Method
			* WEIGHTED EXCESS PRECIPITATION	RUNOFF VOLUME (ACRE-FEET)	* PEAK DISCHARGE / DESIGN FLOW (Q_{DES}) in CFS	* PEAK DISCHARGE / DESIGN FLOW (Q_{DES}) in CFS
P-1	Rhode Island St	13.13	0.81	0.89	28.65	28.73
P-2	Bellamah Ave	59.73	0.71	3.51	114.68	115.03
P-3A	Constitution Ave	23.79	1.24	2.46	70.44	70.57
P-3B	Constitution Ave	8.59	1.11	0.79	21.88	21.92
P-4	Pennsylvania St	4.91	1.32	0.54	15.21	15.23
Entire Basin		110.16	0.89	8.19	250.86	251.49

* Weighted Excess Precipitation and Peak Discharge based on Precipitation Zone 3, 10 Year, 6-Hour Storm

$Q_{DES} = (Q_P / A_T) \times A$

Where A = Area in acres tributary to catch basin.

A_T = Total area in acres of the appropriate subarea. 110.16 acres

Q_P = Peak Q from appropriate subarea, in c.f.s. 250.86 c.f.s.

QP / AT = 2.28 c.f.s. /acre

Trapezoidal Channel between Multi-use Trail and Apartment Complex
Slope = 0.015 ft/ft

Side Slope H:V	Mannings n	Bottom Width (ft)	Discharge Q (cfs)	Depth (ft)	Velocity (ft/s)	Freeboard (ft)	Overall Depth (ft)	Top Width (ft)
2	0.035	5	50	1.32	4.94	1.1	2.5	14.8
2		6		1.22	4.85	1.1	2.3	15.4
2		7		1.14	4.75	1.1	2.3	16.1
2	0.035	5	75	1.64	5.54	1.2	2.8	16.2
2		6		1.52	5.45	1.2	2.7	16.7
2		7		1.42	5.36	1.2	2.6	17.3
2	0.035	5	100	1.9	5.99	1.2	3.1	17.3
2		6		1.77	5.92	1.2	2.9	17.8
2		7		1.66	5.83	1.2	2.8	18.3
2	0.035	5	125	2.12	6.37	1.5	3.7	19.7
2		6		1.99	6.3	1.5	3.5	20.1
2		7		1.87	6.22	1.5	3.4	20.6
3	0.035	5	50	1.2	4.7	1.1	2.3	18.9
3		6		1.1	4.6	1.1	2.2	19.3
3		7		1	4.5	1.1	2.1	19.7
3	0.035	5	75	1.5	5.4	1.2	2.7	20.9
3		6		1.4	5.3	1.1	2.5	21.3
3		7		1.3	5.2	1.1	2.4	21.7
3	0.035	5	100	1.8	5.8	1.2	3.0	22.9
3		6		1.7	5.7	1.2	2.9	23.2
3		7		1.6	5.6	1.2	2.8	23.6
3	0.035	5	125	2	6.2	1.5	3.5	26.2
3		6		1.9	6.1	1.5	3.4	26.6
3		7		1.8	6	1.5	3.3	27.0
2	0.015	5	50	0.83	8.98	1.2	2.0	13.2
2		6		0.76	8.72	1.2	2.0	13.8
2		7		0.7	8.46	1.2	1.9	14.6
2	0.015	5	75	1.04	10.15	1.3	2.3	14.2
2		6		0.96	9.91	1.2	2.2	14.8
2		7		0.89	9.65	1.2	2.1	15.5
2	0.015	5	125	1.37	11.75	1.6	3.0	17.0
2		6		1.27	11.55	1.6	2.9	17.6
2		7		1.18	11.31	1.6	2.8	18.2
2	0.015	5	615	3.5	14.61	1.8	5.3	26.2
2	0.015	5	443	3	13.42	1.7	4.7	24.0