Final Design Report

Bethany Home / Grand Canal Flood Control Project

Bethany Home Outfall Channel – Reach D

67th Avenue to Indian School Road

Project No. 2006C027, PCN No. 620 03 32

Prepared for:
Flood Control District of Maricopa County
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Project No. 2006C027

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September 19, 2008

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1.0 INTRODUCTION

The Flood Control District of Maricopa County (FCDMC), in cooperation with the cities of Phoenix and Glendale, began the Bethany Home/Grand Canal Flood Control Project (BH/GC FCP) in June 1999 to mitigate flooding along the Grand Canal between the Loop 101 Freeway at Bethany Home Road and the Sunset Detention Basin south of Indian School Road. The entire project spans approximately 5¼ miles and was divided into 9 segments to better analyze, design, manage, and construct the project. Figure 1 below shows the limits of the BH/GC FCP and the project segments.

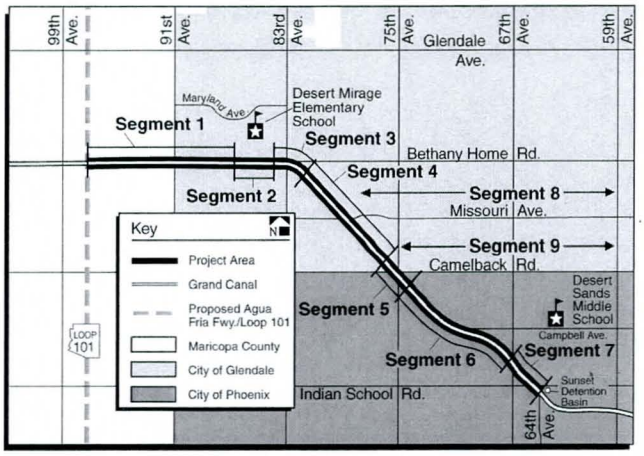

Figure 1: BH/GC Project Area and Segments

Design and construction of Segments 1 through 6 have been completed. The next segment to be designed is Segment 7, also called the Bethany Home Outfall Channel Reach D (BHOC-D). This segment is at the upstream end of the overall project, and extends along the northern bank of the Grand Canal from west of 67th Avenue to south of Indian School Road at the Sunset Detention Basin, within the City of Phoenix.

1.1 Purpose of Project

The purpose of the BH/GC FCP is to minimize flooding adjacent to and north of the Grand Canal between the Loop 101 Freeway at Bethany Home Road and the Sunset Detention Basin south of Indian School Road. The Grand Canal is a large man-made

irrigation channel with elevated banks at various locations along its 22.5-mile reach. During large storm events, water ponds along the north and east banks of the canal and floods adjacent homes and businesses. The Federal Emergency Management Agency (FEMA) has designated a floodplain containing approximately 598 structures along the north side of the Grand Canal between Camelback Road and 67th Avenue (See Figure 2 for the FEMA Flood Insurance Rate Map (FIRM). The BH/GC FCP proposes a drainage system consisting of channels, retention basins, and box culverts along the north and east side of the Grand Canal to capture stormwater along the project limit and convey it to the ultimate outfall at New River. This will mitigate flooding and eliminate the floodplain, allowing owners of affected structures to stop paying flood insurance. Once the BH/GC project is completed and a Letter of Map Revision (LOMR) is submitted and approved by FEMA, the 598 structures along the north side of the Grand Canal between Camelback Road and 67th Avenue will be removed from the floodplain.

The BHOC-D project will construct approximately 2,600 linear feet of storm drain from Sunset Detention Basin just south of Indian School Road to the recently constructed Maryvale Detention Basin just west of 67th Avenue. This will eliminate the 100-year floodplain and local flooding along the reach, as well as upgrade the Sunset Detention Basin to a 100-year level of protection from the current level of protection that is estimated to be approximately the 10-year.

1.2 Location of Project

The BHOC-D Project is located within a portion of Section 24 of Township 2 North, Range 1 East, and Sections 19 and 30 of Township 2 North, Range 2 East, of the Gila and Salt River Meridian, Maricopa County, Arizona. The reach runs from 67th Avenue to Indian School, entirely within the City of Phoenix. Figure 3 provides a Project Vicinity Map, while Figure 4 shows a more detailed location of the site.

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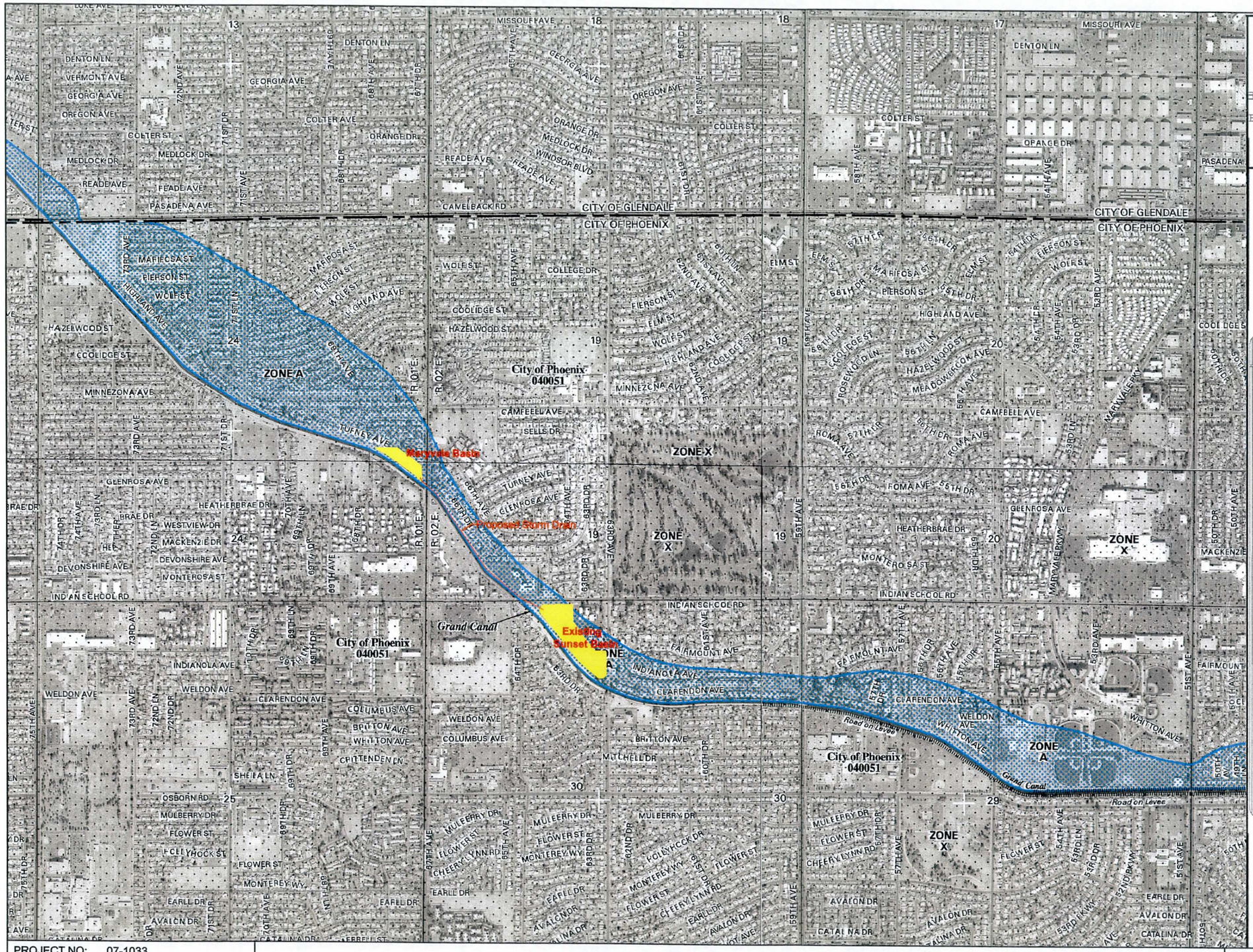
DATE: Apr 22, 2008 1:59pm XREFS:



MAP SCALE 1" = 1000'

0 1000 2000 FEET

0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2110F

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2110 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PHOENIX, CITY OF	040051	2110	F

PANEL 1640 OF 4350
PANEL 1645 OF 4350
PANEL 2105 OF 4350

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C2110F
MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

PROJECT NO:	07-1033
DRAWN BY:	GMS
DATE:	04/22/2008

FLOOD INSURANCE RATE MAP

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FIGURE
2

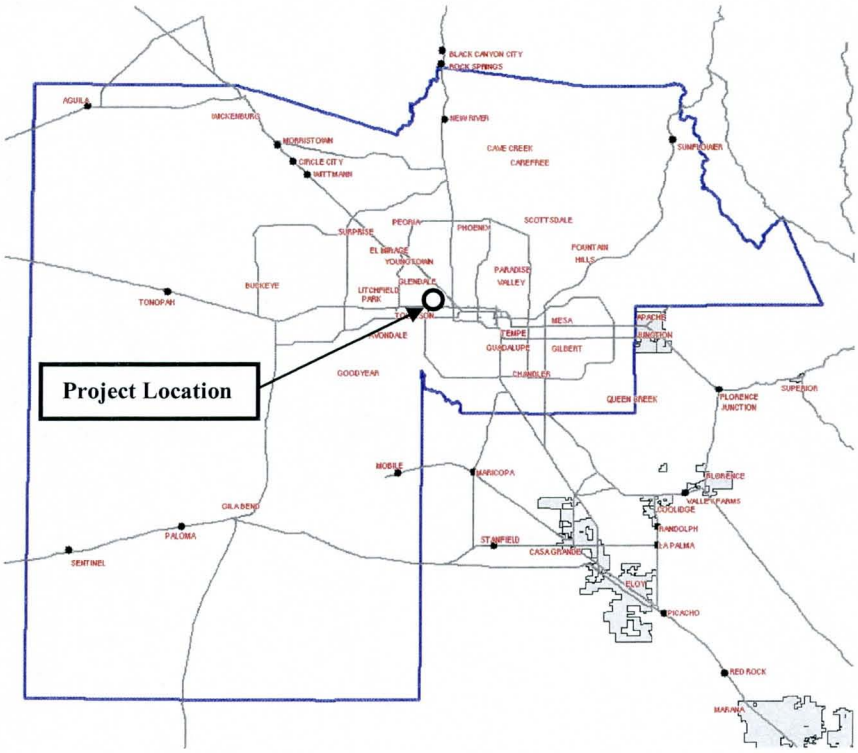


Figure 3: Project Vicinity Map

Figure 4: Site Location Map

1.3 Basis of Design

The basis of design for this project will be the *Bethany Home/Grand Canal Flood Control Project Pre-Design Study* (DMJM, September 2000), along with refinements made during design and construction of Segments 1 through 6 from the Loop 101 Freeway to 67th Avenue. Additionally, the design of this project will comply with the intent set forth in the Conditional Letter of Map Revision (CLOMR) that was completed in October 2003.

1.3.1 Basis of Hydrology

The basis for the hydrology for this project is the HEC-1 model that was received from the District on April 18, 2007. This model, named BHGC00C7.dat, is the most current that was updated for the Reach B design, and is different than the model that was submitted for the CLOMR.

1.3.2 Basis of Hydraulics

The basis for the hydraulics for this project is the HEC-RAS model that was received from the District on April 18, 2007. This model is named BHOC_VE2.prj and is the most current model that was updated for the Reach B design, and is different than the model that was submitted for the CLOMR.

1.4 Design Criteria

The BHOC-D Project is located entirely within the City of Phoenix. Therefore, the intent is for the design of the proposed storm drain to meet the standards and criteria set forth in the City of Phoenix's *Storm Water Policies and Standards*, unless otherwise noted. These criteria are supplemented with design standards and procedures established in the FCDMC's *Drainage Design Manual*, Volume 1 (Hydrology), and Volume 2 (Hydraulics). The following summarizes the design criteria for the project:

- The storm drain will be designed for the 100-year flow.
- The design will maintain the ADOT IGA discharge of 2,200 cfs into the BHOC, Phase I at the Agua Fria Freeway.

- A one-foot freeboard to the finished floor elevations of adjacent structures will be maintained.
- The hydraulic routing through the proposed storm drain system was determined using a constant 100-year water surface elevation downstream at the Maryvale Detention Basin.

2.0 SURVEY

2.1 Scope

The base aerial mapping for the BH/GC FCP was originally flown by Kenney Aerial Mapping in September, 2000. This project will use this mapping as the base for areas adjacent to the project, and will supplement this with ground survey to update the project corridor areas. Specifically, the entire Sunset Detention Basin was surveyed to verify the basin capacity, as well as cross sections along the proposed alignment and a portion of the Maryvale Detention Basin. The survey scope of work also included verifying the right-of-way limits and drainage easements within the project corridor. Finally, a video survey of the backyards along the alleyway was conducted to document existing conditions and ascertain potential constructability issues.

2.2 Datum

The Scope of Work calls for the survey to be tied into the Maricopa County Department of Transportation Geodetic Densification and Cadastral Survey (GDACS) network control. This system is based on the North American Vertical Datum of 1988 (NAVD 88), whereas the Pre-Design Study and CLOMR survey data were based on the National Geodetic Vertical Datum of 1929 (NGVD 29). The elevation difference between the two datum is typically 1.8' to 2.2' within Central Arizona.

To be consistent with the designs from the previous segments, the District requested that the design for the BHOC-D project use the same datum as the previous Reach B segment. The controls from the Reach B design use the City of Phoenix datum, which is based on the NGVD 29 datum. The survey data was converted from NAVD 88 datum to City of Phoenix datum, using the following conversion factor:

NAVG 88 datum = City of Phoenix datum + 1.679'

Survey data is provided in Appendix D.

3.0 HYDROLOGY

3.1 Regional Hydrology

The regional hydrology for the BH/GC FCP is based on the Maryvale Area Drainage Master Study (ADMS) that was completed by Wood/Patel Associates, Inc. and CH_2M Hill for the FCDMC under Contract No. FCD 93-29. Refinements to the hydrologic model from this study were made as design of the various reaches progressed. The latest HEC-1 model, from the Reach B Design (FCD Project No. 2004C021), was obtained from the FCDMC (BHGC00C7.dat) and was used as the basis of the BHOC-D project. The model was renamed BHGC00D7.dat.

3.1.1 Existing Conditions

The HEC-1 model indicates four hydrographs combine at Sunset Detention Basin: one from the north (SIS4S), one from the west (S59HW), one from the southeast (D59), and one from the sub-basin area (30-22). These four hydrographs combine to produce a peak flow of 782 cfs at the basin (C3022N). This flow is routed through the basin, which results in 55 cfs flowing into the existing storm drain along Indian School Road and 344 cfs going into the proposed storm drain.

3.1.2 Revisions to Hydrology Model

The routing through Sunset Detention Basin (SDB) was updated using the survey results and the hydraulic design of the storm drain for this project. A revised stage-storage table was computed using updated volumes determined from the survey data. As a check, the as-built plans for the SDB was obtained and the basin volumes were hand-calculated. The volumes determined from the survey were similar to the volumes hand-calculated from the as-built plans, but substantially higher than the values used in the Reach B model. Table 1 compares the storage volumes from the different sources.

Table 1: Sunset Detention Basin Volume Comparison

HEC-1 STAGE (NGVD 29)	VOLUME FROM SURVEY (AC-FT)	VOLUME FROM AS-BUILT PLAN (AC-FT)	VOLUME FROM REACH B HEC-1 MODEL (AC-FT)
1085.00	0.0	0	0
1086.00	0.8	1.5	0.5
1086.50	1.8	3.0	1.1
1087.30	4.3	5.7	2.9
1089.60	13.8	15.5	10.6
1092.40	28.0	29.6	22.8
1092.50	28.6	30.2	23.3
1094.80	42.3	43.7	35.8
1095.22	45.0	46.4	38.5
1098.00	64.9	--	56.7

The stage-discharge rating table was also revised, based on the proposed inlet hydraulic design. The weir equation was used to compute the discharge for the various weir configurations at each stage. The original stage-discharge rating table diverts a maximum of 55 cfs into the existing storm drain along Indian School Road, even as the stage increased. In order to maintain consistency, the revised stage-discharge rating table also assumed this behavior, even though the storm drain will, in reality, pass more than the 55 cfs at maximum stage. The Reach B HEC-1 model shows 399 cfs routed through Sunset Detention Basin, with 55 cfs diverted into the existing storm drain along Indian School Road and 344 cfs going into the new storm drain. This is based on hydraulics for an 8'x7' concrete box culvert. The project team evaluated different storm drain sections and weir configurations, and updated the rating table based on the hydraulic of each alternative. Table 2 compares the discharge through SDB and at various concentration points downstream for various design alternatives (storm drain size, weir length). Appendix A contains the HEC-1 output of the revised portions of the model. See Section 4.0 for a discussion of the detailed hydraulic analysis.

Table 2: Discharge Summary for Various Storm Drain Configurations

Config. No.	Configuration	Discharge From Sunset Basin [PA63]	Discharge into Exist Storm Drain on Indian School Rd [D63S]	Discharge into Prop Storm Drain from Sunset Basin [D63]	Water Surface Elev at Sunset Basin [ft]	HEC-1 Output for Different Location Down Stream of Sunset Basin		
						New River Confluence [C8-21W]	Agua Fria Freeway [CBHAF]	Maryvale Basin Inflow [C@DC2]
1	Original Reach B Model	399	55	344	1096.43	4,485	4,430	1,598
2	Original Reach B Model with Updated Volume from Survey	370	55	315	1095.96	4,485	4,430	1,563
3	Weir Length = 22' Pipe Dia = 96"	266	55	211	1096.69	4,485	4,430	1,422
4	Weir Length = 20' Pipe Dia = 90"	262	55	207	1097.50	4,485	4,430	1,426
5	Weir Length = 20' Pipe Dia = 96"	270	55	215	1097.08	4,485	4,430	1,439

Based on review comments received from the 40% Submittal, the concrete box alternative was not evaluated due to cost, traffic impact, and construction requirements, and therefore not shown. The preferred configuration is the 96" diameter pipe with weir length of 22 feet. This alternative results in a water surface elevation of 1096.69' at Sunset Basin, which provides the 1' minimum freeboard required (outfall elevation at Sunset Basin is 1097.83'). The flow routed through Sunset Basin in the preferred alternative is 266 cfs, with 55 cfs going through the existing storm drain in Indian School Road and 211 cfs going through the new storm drain.

The flow routed through Sunset Basin is less than the original Reach B Model. However, the flow at the downstream concentration points (New River Confluence & Agua Fria Freeway) is not impacted and remains the same. This is because the actual capacity of Sunset Basin is higher than originally modeled (see Table 1 for a comparison of the surveyed capacity vs. the original model capacity). The basin attenuates more flow, which results in a later time to peak for the preferred alternative than the original model (14.17 hr vs. 13.83).

3.2 Local Hydrology

A hydrologic analysis was performed to determine the local flows that contribute to the Reach D project area. The Project Team agreed that the southwest ¼ of Section 19, T2N, R2E is acceptable for this analysis. This area is bounded by Campbell Avenue to the north, 63rd Avenue to the east, Indian School Road to the south, and the Grand Canal and 67th Avenue. One-foot contour mapping of the surrounding area was received from the District to help delineate the drainage sub-basins. This mapping is from the Maryvale ADMS study that was flown in March 1994. It was supplemented with current mapping and information from the County Assessor, as well as field reconnaissance observations. Please refer to Plate 1 for the Local Area Drainage Map.

The watershed upstream of the Reach D project area is mostly urbanized consisting mostly of residential homes. Water flows in a southwesterly direction with a gradient of approximately 0.35%. Since the contributing drainage area was less than 160 acres, the Rational Method, using the Rational module of the FCDMC's Drainage Design Management System for Windows software (DDMSW), was utilized to compute the peak discharge for the various frequency storms. The 10-, 50-, and 100-year runoff for each sub-basin are tabulated in Table 3 below.

Table 3: Local Hydrology Discharge Summary

Sub-Basin ID	Area [ac]	Discharge [cfs]		
		Q_{10}	Q_{50}	Q_{100}
A-1	4.6	15	26	30
A-2	17.9	29	53	64
A-3	25.2	57	102	123
A-4	1.3	2	4	4
A-5	48.5	98	179	214
A-6	11.2	30	53	63
A-7	5.7	19	33	39
A-8	7	21	37	43
A-9	5.5	13	23	27
A-10	0.7	1	2	2
TOTAL	127.6	285	512	609

Mapping data indicate low spots along Indian School Road just east of the Grand Canal, along 67th Avenue north of the Grand Canal, and along 66th Drive northeast of the Grand Canal. Street capacity calculations were performed for Indian School Road and the local streets, and are included in Appendix B. The capacity of Indian School Road at this location is computed to be approximately 20 cfs, due to the flat grade. The capacity of the local streets ranges from 22 cfs to 38 cfs. At Indian School Road, water will tend to break south into the large spillway at the east side of Sunset Basin, as finished grade at the church property is higher than the low spot elevation. The project team agreed during the December 3, 2007 progress meeting that the area inlet at the southwest corner of the church property should be designed for the local flow from the church property (Area A-9). The agreed design Q for the area inlet is Q_{100}=35 cfs.

During large storm events, the local storm drain system along 66th Drive will be overwhelmed. Water will break out at the low point north of the canal and flow west across 67th Avenue into the Maryvale Basin. Area inlets are proposed along the alleyway to handle any remaining nuisance flows. A discussion on the area drain hydraulics is included in Section 4.3.

4.0 HYDRAULICS

4.1 Storm Drain

4.1.1 Design Constraints

4.1.1.1 Qwest Telephone Ducts

The design of the proposed storm drain was driven in large by the project team's desire to avoid conflict with the existing Qwest telephone ducts along 67th Avenue and Indian School Road. Communication with Qwest early in the design process revealed that there are 4" transite conduits in 12-duct and 14-duct configurations along 67th Avenue and Indian School Road, respectively. Qwest indicated that relocating these duct banks would be an expensive and time-consuming process that could add cost and time delays to the project. The proposed storm drain was revised to meet this additional objective, while still meeting the drainage design criteria of the project.

To avoid conflict with the duct bank at Indian School Road, three 60" dia. pipes are proposed for the segment between Sunset Basin and Indian School Road. The invert at Sunset Basin was dropped 3.9' to the bottom of the basin (from 1088.9' to 1085.0') and the pipe slope was reversed to drain towards Sunset Basin. The justification for this design is that water does not enter the new storm drain until the water surface elevation in Sunset Basin rises above the tailwater elevation of 1092.45. A weir had been proposed at the inlet with a crest elevation of 1092.45 to perform this function. Water below 1092.45 would drain into the existing storm drain in Indian School Road through the existing inlet structure at the bottom of Sunset Basin. Consequently, the concept from the original drainage design is still maintained.

A transition structure is proposed north of Indian School Road to transition the 3-60" dia. pipes to a single 96" dia. pipe, which continues to Maryvale Basin. To avoid conflict with the Qwest duct bank at 67th Avenue, the project team relocated the weir structure from the inlet location at Sunset Basin to the crossing of the new storm drain and duct banks. The ducts would be slurry-encased and protected inside the weir structure. The

weir structure would be within an outer structure, which the project team agreed would be rectangular in shape to facilitate constructability. The project team also agreed that a length of 5 feet before and after the weir would be sufficient to maintain its hydraulic function.

4.1.1.2 SRP Irrigation Pipes

SRP irrigation has an existing 48" dia. lateral along the west side of 67th Avenue and an existing 24" dia. drain along the east side of 67th Avenue, both of which are in conflict with the proposed 96" pipe. A pre-design meeting with SRP was held on June 26, 2008, to discuss the relocation design options of the irrigation lateral and drain. SRP proposed a conflict structure at each of the crossings that will pass the irrigation pipe through the BHOC-D storm drain. The 48" lateral would be reduced to 36" with the invert just above the storm drain hydraulic grade line (HGL), while approximately 1/3 of the 24" pipe would be submerged into the storm drain HGL. A detailed hydraulic analysis was performed to evaluate the impact of the conflict structures on the BHOC-D storm drain. This evaluation was submitted to the District in a memorandum on July 15, 2008, a copy of which is included in Appendix B.1.

The evaluation of the SRP conflict structures indicated that the conflict structure for the 48" lateral resulted in minimal impact to the BHOC-D storm drain, as the structure is located downstream of the weir and is mostly above the storm drain HGL. The conflict structure for the 24" drain, however, increased the water surface elevation at Sunset Basin and decreased the freeboard at Sunset Basin to less than the 1-foot requirement. The project team presented to the evaluation results to SRP, who ultimately agreed to go with a siphon for the 24" drain.

4.1.2 Storm Drain Analysis

The BHOC-D storm drain system was analyzed as two systems, one upstream of the weir structure and one downstream of the weir structure. A procedure was set up to analyze the storm drain hydraulics. A detailed discussion of this procedure is provided in Section B.1 of Appendix B. The general procedure consists of determining the flow over the

weir using the broad-crested weir equation, using different weir lengths and the HEC-1 SE elevations to determine the head over the weir. The discharge was also evaluated using the orifice equation, but it was determined that the weir equation was the controlling condition. A storm drain model was set up in StormCAD, using the calculated discharge as the Q in the system and the elevation over the weir as the tailwater elevation for the storm drain model. Losses at the inlet, transition structure, weir structure, and outlet were also included. The StormCAD model provided the hydraulic grade of the storm drain system. This analysis was performed using different weir length and storm drain size combinations until one was found that met the 1-foot minimum freeboard requirement at Sunset Basin. Table 4 summarizes the results of this evaluation.

Table 4: Summary of Storm Drain Hydraulics

Storm Drain Config.	Routed Q through Sunset (cfs)	Q through Exist SD on Indian School (cfs)	Q through New SD (cfs)	WSE at Sunset Basin (ft)	Freeboard at Sunset Basin (ft)
90" Dia. Pipe					
Weir L=20'	262	55	207	1097.50	0.33
96" Dia. Pipe					
Weir L=20'	270	55	215	1097.08	0.75
Weir L=22'	266	55	211	1096.69	1.14

The 96" dia. pipe and 22-foot weir length combination results in a water surface elevation of 1096.69 at Sunset Basin, which provides 1.14' of freeboard. This combination meets the freeboard criterion and therefore is the recommended configuration for the proposed storm drain.

The results of the storm drain hydraulic analysis also indicate that the portion of the storm drain upstream of the weir is under pressure flow, while the portion downstream of

the weir is under open channel flow. An evaluation was performed to determine if the downstream segment can be reduced to an 84" dia. pipe, based on comments received from the 70% submittal. While the evaluation showed that an 84" dia. pipe can be used for the downstream segment, it was decided to keep the pipe at 96" for this segment because of other project considerations (see Appendix B.1 for a copy of the evaluation).

4.2 Structures

Four structures are proposed for this project: the inlet structure at Sunset Basin, the transition structure, the weir structure, and the outlet structure at Maryvale Basin. The weir structure houses the 22' long by 5' wide broad-crested weir, which controls the storm drain hydraulics as well as protects the Qwest 12-duct conduits. An evaluation was performed to determine the head losses through these structures. A detailed discussion of the procedure to calculate the head loss coefficient for each structure is provided in Section B.1 of Appendix B. Table 5 below summarizes the head loss coefficients used in the StormCAD model.

Table 5: Structure Head Loss Coefficients

Structure	Head Loss Coefficient
Inlet	0.2
Transition	1.05
Weir	1.00
Outlet	0.05

4.3 Area Inlets

As discussed earlier in Section 3.2, area inlets are proposed along the alleyway to handle nuisance flows, as well as a double-grate inlet at the southwest corner of the church parking lot for flows from the church property. The capacity of the area drains was calculated, using both weir and orifice flow conditions, for a range of head values. These calculations are included in Appendix B. The capacity was also calculated for the unclogged condition and a 50% clogged condition. Each of the area drain along the

alleyway has a capacity of 8.2 cfs (unclogged) to 6.5 cfs (50% clogged) under an assumed head of 6 inches.

The project team agreed that the design Q for the area inlet at the southwest corner of the church property is Q_{100}=35 cfs. A double-grate MAG 535 inlet is proposed at this location, which has a capacity of 39.4 cfs (unclogged) to 26.7 cfs (50% clogged) under an assumed 12" of head.

5.0 GEOTECHNICAL INVESTIGATION

Five soil borings were performed by Ninyo & Moore to investigate subsurface soil conditions and characteristics. The soil boring locations, as well as boring logs and the Geotechnical Report, are provided in Appendix C.

Preliminary results indicate that that the soil within the project area is mostly sand, with low blow counts. No bedrock was encountered. Based on the boring data, an excavation slope of 1.5 to 1 is recommended. Within the 20-foot right-of-way along the alleyway, this would require removing the existing block walls, replacing impacted hardscapes (pools, gazebos, built-in bbq's, etc.), replacing landscaping, temporary fencing, and security for the existing homes.

Because of the above constructability issues along the alleyway, the geotechnical report recommends a soil retention system during construction of the storm drain. The report recommends three systems, which are summarized below:

- Soil Nail Wall – This method consists of vertically excavating the wall in 4- to 5-foot lifts. The wall is grouted/shotcreted after each lift, then soil nails are drilled at an angle at regular intervals to hold the wall in place. This method is prevalent in Arizona and used by ADOT regularly, and is the most flexible. Temporary Construction Easements from the homeowners will be required if the soil nails extend into their properties. The cost of this method is approximately $30/sf plus easement costs.
- Soldier Pile Wood Lagging System – This method consists of drilling piles at 10 to 15-foot spacing down to approximately two times the wall height. As the excavation in front of the wall proceeds, wood lagging is installed between the soldier piles in lifts. This method costs approximately $75/sf.
- Sheeting – This method consists of driving steel sheets, usually in a "Z" shape, to create a continuous steel wall. The sheets are interlocked and driven with pile hammers or vibratory devices to approximately two times the wall height. This method costs approximately $120/sf.

The District is currently working with SRP on a Joint Trench Use Agreement to allow moving the storm drain inside SRP's right-of-way. This will eliminate the need for a soil retention system as well as the need to relocate the existing 8" sewer line along the

alleyway. SRP has indicated that they may construct a 69kV line along their right-of-way in the future. If this occurs, the construction of the power poles will use a crane that will place a heavy load near the storm drain. Therefore, for the reach along the canal, a Class V pipe is recommended in the event SRP constructs the future 69kV power line.

6.0 UTILITIES

Utilities within the project area were identified using as-built maps, quarter section maps, and facility maps obtained from the utility companies. The utilities identified within the project area include: water, sewer, storm drain, traffic signals, irrigation, cable TV, telephone ducts, fiber optics, gas, and underground and overhead power. Water, sewer, and storm drain relocations will be designed and constructed as part of this project. The SRP irrigation relocation design will be included as an appendix in the special provisions and will be constructed with this project. Other utility relocations will be designed and completed by the respective utility owner prior to construction of this project. A utility coordination meeting was held after the 40% Submittal to begin the utility coordination process. Another meeting was held after the 70% to finalize the relocation design of the impacted utilities.

Potholes were performed by TBE Group, Inc. to locate the existing utilities at the projected crossing with the proposed storm drain. Please see Appendix E for the pothole location maps and the pothole results.

The Qwest telephone ducts along Indian School Road and 67th Avenue will require special consideration. Qwest has indicated that relocation of the duct banks along these streets will be expensive and time consuming. Therefore, the Project Team has revised the storm drain design to avoid conflict with the duct banks. A meeting was held with Qwest personnel on March 14, 2008 to present the revised storm drain design. Qwest was agreeable with the concept of encasing the duct bank in slurry at 67th Avenue. Qwest also indicated they did not have minimum vertical clearance requirements at the crossing.

There is an existing 48" storm drain along 67th Avenue that is in conflict with the proposed storm drain. To resolve this conflict, the portion of the 48" pipe that is in conflict will be replaced with a 15" pipe. This will eliminate the conflict and also allow low flows to continue through the storm drain. A 48" pipe at the junction will also connect to the BHOC-D storm drain to take any overflow from the existing storm drain.

A calculation was performed to determine the flow through the existing 48" storm drain, using survey and as-built information of the storm drain and assuming an HGL of 6" below the curb elevation. This calculation showed a peak flow of 73.68 cfs in the existing storm drain, most of which will be draining into the BHOC-D storm drain during a large storm event. It was determined that this additional flow into the BHOC-D storm drain will not adversely impact the overall storm drain system, because the additional flow is added downstream of the weir, where this portion of the storm drain is under open channel flow. Additionally, the time to peak of this flow is much earlier (13.17 hr) than the time to peak of the flow in the BHOC-D storm drain (14.17 hr). The peak flow from the existing storm drain will have come and gone by the time the peak flow from the BHOC-D storm drain arrives.

7.0 OTHER PROJECT CONSIDERATIONS

Besides the constructability and telephone relocation issues discussed in the previous sections, the Project Team also considered the following issues during the design process.

7.1 Future Pedestrian Underpass

At the beginning of the project, Olsson Associates was informed that the City of Phoenix Parks and Recreation Department (P&RD) was considering constructing a pedestrian underpass along the Grand Canal alignment at 67th Avenue and Indian School Road in the future. Since this would be in the immediate vicinity of the BHOC-D storm drain, the Project Team thought it would be economical to consider these future underpasses in the utility relocations as well. An alignment for the future underpasses was laid out, and a cost estimate was prepared to determine the extra cost that the Parks Department would need to pay to relocate the utilities past the underpass limits.

A meeting with the P&RD was held on August 28, 2007. At this meeting, the Project Team presented the underpass layout and preliminary cost estimate for the underpass project. On September 24, 2007, Jarod Rogers from the P&RD informed the team that they did not have the money to fund the future underpass project. Therefore, the proposed storm drain for this project will be designed to minimize cost without consideration for the future underpass.

7.2 Lighting Around Sunset Detention Basin

On October 8, 2007, Olsson Associates was informed by Mike Bornhoeft from the City of Phoenix Engineering and Architectural Services Department that they were constructing lighting around the perimeter of Sunset Detention Basin. The project is at the 90% design stage, with construction scheduled to begin in mid-2008. OA obtained the 90% Lighting Plans, which showed that a light pole at the northwest corner of the basin will be in conflict with the proposed storm drain. The Project Team is currently under discussion with the Parks Department to coordinate these two projects.

8.0 SUMMARY

- This project will construct a storm drain from the Maryvale Detention Basin west of 67th Avenue to the Sunset Detention Basin at Indian School Road to mitigate flooding along the Grand Canal. The storm drain will be designed for the 100-year flow.
- The design basis for this project is the *Bethany Home/Grand Canal Flood Control Project Pre-Design Study* (DMJM, September 2000), along with refinements made during design and construction of Segments 1 through 6 from the Loop 101 Freeway to 67th Avenue. The design will maintain the ADOT IGA discharge of 2,200 cfs into the BHOC, Phase I at the Agua Fria Freeway.
- The basis of hydrology is the latest HEC-1 model from the BH/GC Reach B project, which is based on the regional hydrology from the Maryvale Area Drainage Master Study (ADMS) that was completed by Wood/Patel Associates, Inc. and CH_2M Hill for the FCDMC under Contract No. FCD 93-29.
- The basis for hydraulics is the latest HEC-RAS model from the Reach B project. The HEC-RAS model was not revised for this project.
- The local hydrology was evaluated using the Rational Method. The area inlet at the southwest corner of the property was designed for a Q_{100}=35 cfs. Area drains are proposed along the alleyway to handle nuisance flows.
- The storm drain hydraulics was analyzed assuming that the beginning tailwater elevation in the storm drain is equal to the water surface elevation (WSE) at the Maryvale Detention Basin (MDB). This elevation is 1092.45 as determined from the HEC-RAS model.
- The proposed storm drain consists of 3-60" dia. pipes from Sunset Basin to a transition structure north of Indian School Road, where it transitions to a single 96" dia. pipe from the transition structure to Maryvale Basin.
- The weir structure at the Qwest duct bank crossing at 67th Avenue contains a 22' long by 5' wide weir that controls the storm drain hydraulics as well as protecting the

Qwest duct bank. The flow over the weir was computed using the broad-crested weir equation for a 5-foot wide weir and a crest elevation of 1092.45'.

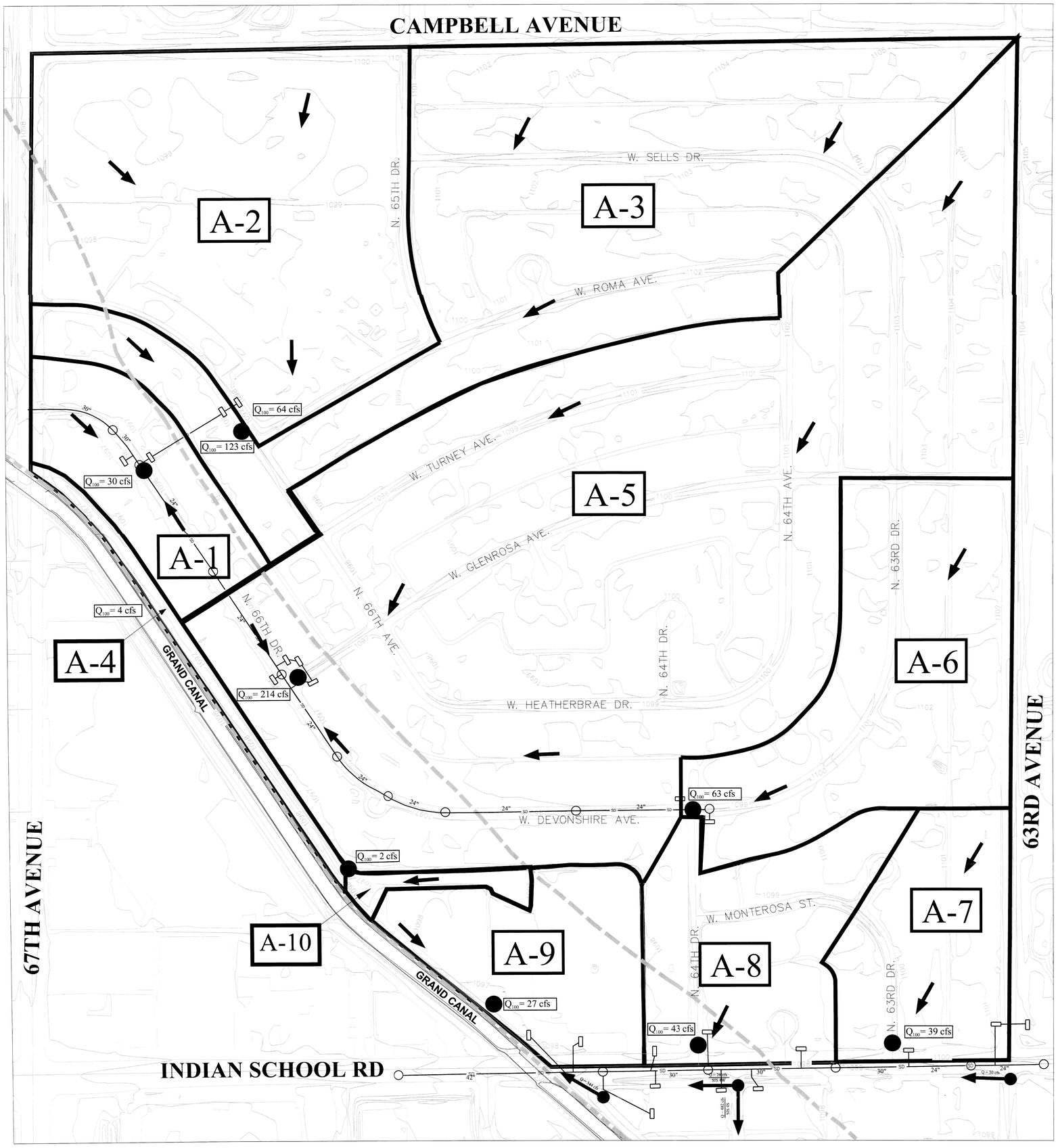
- The storm drain hydraulics was analyzed using StormCAD to determine the hydraulic grade line through the storm drain and the water surface elevation at Sunset Basin. The outfall elevation at the basin is 1097.83, based on survey data.
- The proposed storm drain configuration consists of an inlet structure at Sunset Basin, 3-60" dia. pipes to a transition structure, 96" dia. pipe to a weir structure containing a 22' long by 5' wide weir inside, 96' dia. pipe to an SRP conflict structure, and 96" dia. pipe to an outlet structure at Maryvale Basin. This configuration results in a WSE elevation of 1096.69' at Sunset Basin, which provides a freeboard of 1.14'. The total flow routed through the basin for this design is 266 cfs, with 55 cfs going into the existing storm drain on Indian School Road and 211 cfs going into the new storm drain. The flows downstream at the New River Confluence and Agua Fria concentration points are not affected by this design.

9.0 REFERENCES

1. *Drainage Design Manual for Maricopa County, Arizona, Volume 1 – Hydrology*, Flood Control District of Maricopa County, November 2003 (Draft).
2. *Drainage Design Manual for Maricopa County, Arizona, Volume 2 – Hydraulics*, Flood Control District of Maricopa County, September 2003 (Draft).
3. *Storm Water Policies and Standards*, City of Phoenix, March 2004.
4. *Bethany Home/Grand Canal Flood Control Project, Pre-Design Study, Vol. I*, DMJM for Flood Control District of Maricopa County, FCD No. 98-46, 2000.
5. *Bethany Home Outfall Channel, Technical Data Notebook Conditional Letter of Map Revision (CLOMR) Vol. I (TDN)*, DMJM+HARRIS for Flood Control District of Maricopa County, FCD No. 98-46, 2003.

Plate 1

Local Hydrology Drainage Map



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

BETHANY HOME OUTFALL CHANNEL REACH "D"

F.C.D. CONTRACT NO. 2006C027

LEGEND

- 100-YR FLOODPLAIN BOUNDARY
- SUBBASIN BOUNDARY
- SUBBASIN ID (A-1)
- FLOW DIRECTION
- CONCENTRATION POINT
- FLOW FROM HEC-1 MODEL
- EXISTING STORM DRAIN SYSTEM
- EXISTING STORM DRAIN INLET

BASIN - ID	AREA [ac.]	DISCHARGE [cfs]		
		Q_{10}	Q_{50}	Q_{100}
A-1	4.60	15	26	30
A-2	17.90	29	53	64
A-3	25.20	57	102	123
A-4	1.3	2	4	4
A-5	48.54	98	179	214
A-6	11.20	30	53	63
A-7	5.70	19	33	39
A-8	7.0	21	37	43
A-9	5.5	13	23	27
A-10	0.7	1	2	2

PRELIMINARY
NOT FOR
CONSTRUCTION

N

0' 50' 100' 200'
SCALE IN FEET

OLSSON ASSOCIATES
7250 North 16th Steet
Suite 210
Phoenix, AZ 85020
TEL 602.748.1000
FAX 602.748.1001

LOCAL HYDROLOGY DRAINAGE MAP

	BY	DATE
DESIGN		
DESIGN CHECK		
PLANS		
PLANS CHECK		

SUBMITTED BY:
DUC V. DAO, P.E. DATE : 05/08

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

RECOMMENDED BY:
DATE : /

APPROVED BY:
DATE : /

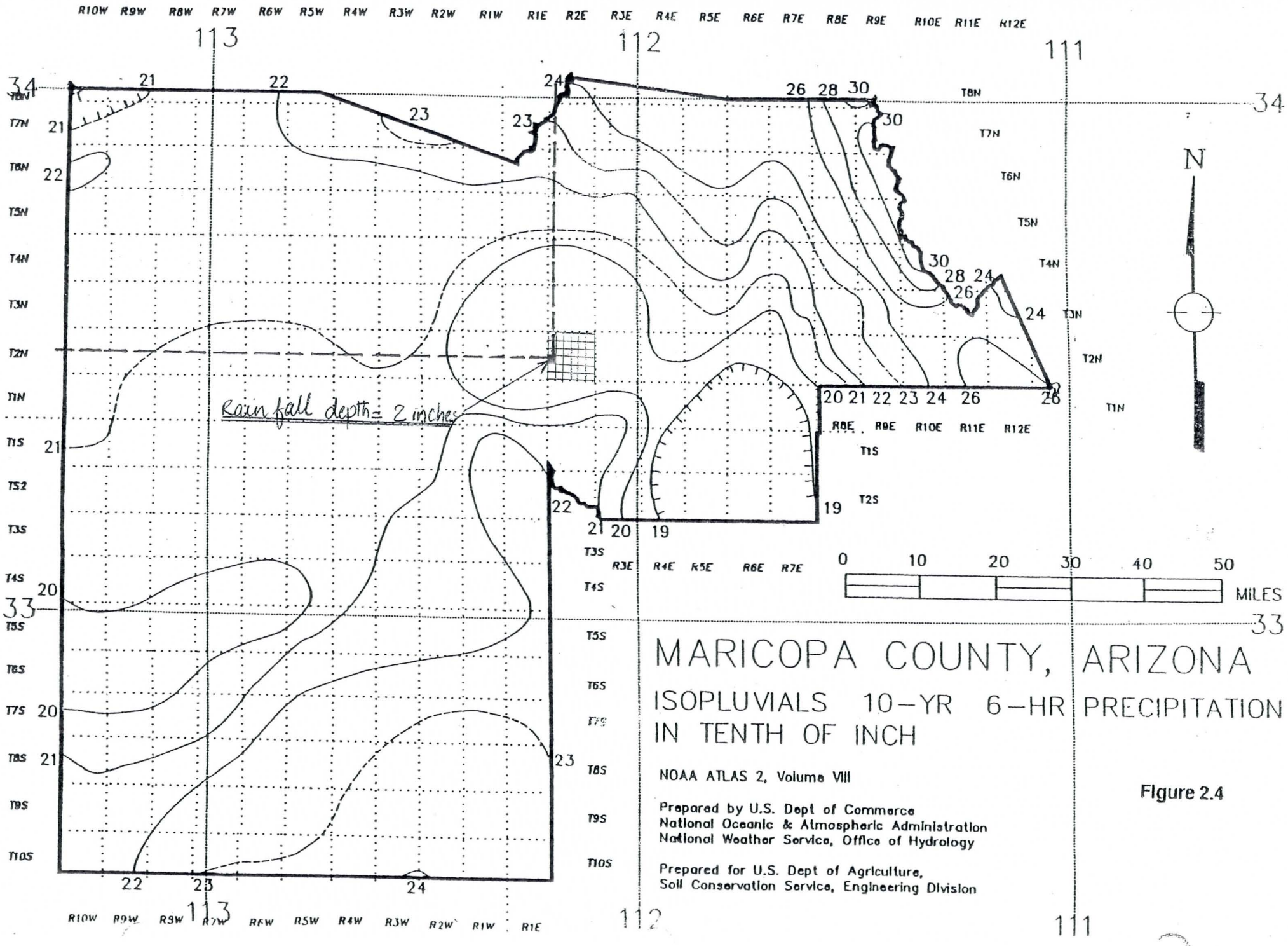
PLATE 1

DWG: F:\Projects\007-1033\CALCS\Hydrology\HYDROLOGY WORK MAP.dwg USER: gshrestha
DATE: Apr 22, 2008 2:19pm XREFS:

Appendix A

Hydrology Supporting Documentation

A.1 Rational Calculations



MARICOPA COUNTY, ARIZONA

ISOPLUVIALS 10-YR 6-HR PRECIPITATION IN TENTH OF INCH

NOAA ATLAS 2, Volume VIII

Prepared by U.S. Dept of Commerce
National Oceanic & Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Dept of Agriculture,
Soil Conservation Service, Engineering Division

Figure 2.4

Titles

BHOC
Maricopa County, AZ

Hydrology

10-Year, 6 Hour Rainfall 2.00

Comments:

Bethany Home Outfall Channel Reach "D"

Flood Control District of Maricopa County
FCD # 2006C027 - Bethany Home Outfall Channel

Sub Basin Data - Rational Method

7/23/2007

Sub Basin	Sub Basin Parameters					Return Period (Years)					
	Area (acres)	Length (ft)	Slope (ft/ft)	Kb		2	5	10	25	50	100
A-1	4.60	500	0.0020	0.036	**Q (cfs)**	9	12	15	21	26	30
A-2	17.90	1,215	0.0008	0.032	**Q (cfs)**	15	23	29	41	53	64
A-3	25.20	2,685	0.0032	0.031	**Q (cfs)**	30	45	57	79	102	123
A-4	1.30	100	0.0100	0.039	**Q (cfs)**	1	2	2	3	4	4
A-5	48.50	3,325	0.0026	0.029	**Q (cfs)**	51	80	98	141	179	214
A-6	11.20	1,240	0.0024	0.033	**Q (cfs)**	16	24	30	42	53	63
A-7	5.70	735	0.0041	0.035	**Q (cfs)**	11	15	19	26	33	39
A-8	7.00	1,060	0.0038	0.035	**Q (cfs)**	12	17	21	29	37	43
A-9	5.50	755	0.0013	0.035	**Q (cfs)**	7	11	13	18	23	27
A-10	0.70	450	0.0022	0.041	**Q (cfs)**	1	1	1	2	2	2

* Non default value

Flood Control District of Maricopa County
FCD # 2006C027 - Bethany Home Outfall Channel

Land Use Data Rational Method

 7/23/2007

Sub Basin ID	Land Use Code	Area	Area Pct (%)	C10 Value	Kb Type	Kb
A-1	M.D.R.	4.630	100.0	0.75 *	Min *	0.04
A-2	PARK	17.960	100.0	0.56 *	Min *	0.03
A-3	M.D.R.	25.150	100.0	0.75 *	Min *	0.03
A-4	OPEN	1.300	100.0	0.30 *	Min	0.04
A-5	M.D.R.	48.540	100.0	0.75 *	Min *	0.03
A-6	M.D.R.	11.230	100.0	0.75 *	Min *	0.03
A-7	M.D.R.	5.700	100.0	0.75 *	Min *	0.04
A-8	M.D.R.	6.960	100.0	0.75 *	Min *	0.04
A-9	COMM	5.470	100.0	0.65 *	Min	0.04
A-10	OPEN	0.700	100.0	0.40 *	Min	0.04

* Custom Value (not default value)

Table 3.2
C Coefficients for Use with the Rational Method

Land Use	Return Period			
	2-10 Year	25 Year	50 Year	100 Year
Streets and Roads				
Paved Roads	0.75 – 0.85	0.83 – 0.94	0.90 – 0.95	0.94 – 0.95
Gravel Roadways & Shoulders	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Industrial Areas				
Heavy	0.70 – 0.80	0.77 – 0.88	0.84 – 0.95	0.88 – 0.95
Light	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Business Areas				
Downtown	0.75 – 0.85	0.83 – 0.94	0.90 – 0.95	0.94 – 0.95
Neighborhood	0.55 – 0.65	0.61 – 0.72	0.66 – 0.78	0.69 – 0.81
Residential Areas				
Lawns – Flat	0.10 – 0.25	0.11 – 0.28	0.12 – 0.30	0.13 – 0.31
– Steep	0.25 – 0.40	0.28 – 0.44	0.30 – 0.48	0.31 – 0.50
Suburban	0.30 – 0.40	0.33 – 0.44	0.36 – 0.48	0.38 – 0.50
Single Family	0.45 – 0.55	0.50 – 0.61	0.54 – 0.66	0.56 – 0.69
Multi-Unit	0.50 – 0.60	0.55 – 0.66	0.60 – 0.72	0.63 – 0.75
Apartments	0.60 – 0.70	0.66 – 0.77	0.72 – 0.84	0.75 – 0.88
Parks/Cemetaries	0.10 – 0.25	0.11 – 0.28	0.12 – 0.30	0.13 – 0.31
Playgrounds	0.40 – 0.50	0.44 – 0.55	0.48 – 0.60	0.50 – 0.63
Agricultural Areas	0.10 – 0.20	0.11 – 0.22	0.12 – 0.24	0.13 – 0.25
Bare Ground	0.20 – 0.30	0.22 – 0.33	0.24 – 0.36	0.25 – 0.38
Undeveloped Desert	0.30 – 0.40	0.33 – 0.44	0.36 – 0.48	0.38 – 0.50
Mountain Terrain (Slopes > 10%)	0.60 – 0.80	0.66 – 0.88	0.72 – 0.95	0.75 – 0.95

Note: Values of C for 25, 50 and 100 Year were derived using frequency adjustment factors of 1.10, 1.20, and 1.25, respectively, with an upper limit of 0.95 for C for the 2-10 Year values.

Table 3.1
Equation for Estimating K_b in the Tc Equation

$K_b = m \log A + b$ Where A is drainage area, in acres				
Type	Description	Typical Applications	Equation Parameters	
			m	b
A	Minimal roughness: Relatively smooth and/or well graded and uniform land surfaces. Surface runoff is sheet flow.	Commercial/ industrial areas Residential area Parks and golf courses	–0.00625	0.04
B	Moderately low roughness: Land surfaces have irregularly spaced roughness elements that protrude from the surface but the overall character of the surface is relatively uniform. Surface runoff is predominately sheet flow around the roughness elements.	Agricultural fields Pastures Desert rangelands Undeveloped urban lands	–0.01375	0.08
C	Moderately high roughness: Land surfaces that have significant large- to medium-sized roughness elements and/or poorly graded land surfaces that cause the flow to be diverted around the roughness elements. Surface runoff is sheet flow for short distances draining into meandering drainage paths.	Hillslopes Brushy alluvial fans Hilly rangeland Disturbed land, mining, etc. Forests with underbrush	–0.025	0.15
D	Maximum roughness: Rough land surfaces with torturous flow paths. Surface runoff is concentrated in numerous short flow paths that are often oblique to the main flow direction.	Mountains Some wetlands	–0.030	0.20

3.3 Assumptions

Application of the Rational Equation requires consideration of the following:

1. The peak discharge rate corresponding to a given intensity would occur only if the rainfall duration is at least equal to the time of concentration.

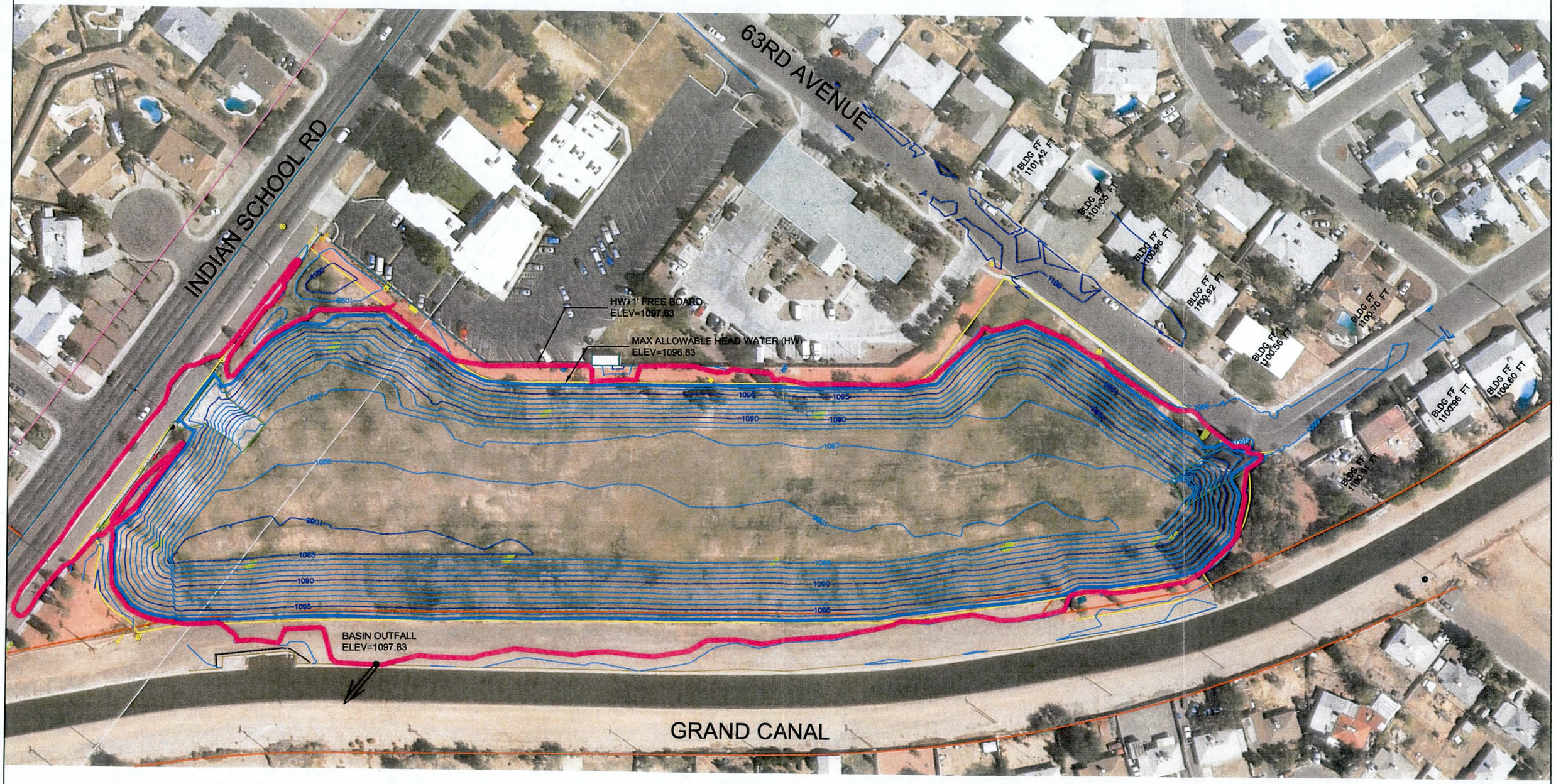
2. The calculated runoff is directly proportional to the rainfall intensity.

3. The frequency of occurrence for the peak discharge is the same as the frequency for the rainfall producing that event.

4. The runoff coefficient increases as storm frequency decreases.

BETHANY HOME OUTFALL CHANNEL, REACH D DESIGN

BASIN OUTFALL LOCATION



Flood Control District of Maricopa County

0' 100' 200'

SCALE IN FEET

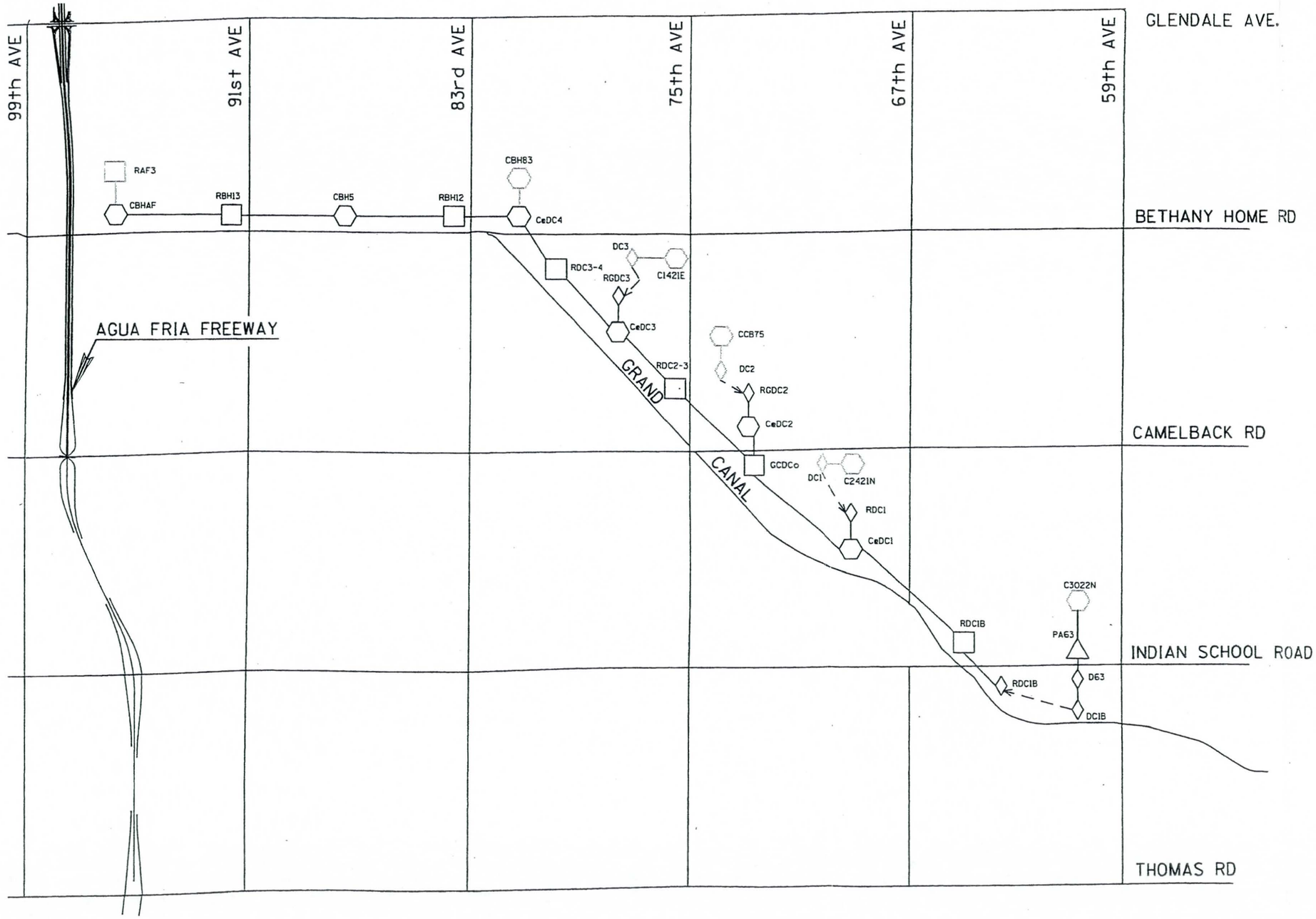
N

OLSSON ASSOCIATES

7250 North 16th Street, Suite 210
Phoenix, AZ 85020-5282

TEL 602.748.1000
FAX 602.748.1001

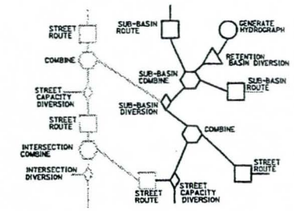
www.oaconsulting.com



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL FLOOD CONTROL PROJECT
FCD CONTRACT # 98-46

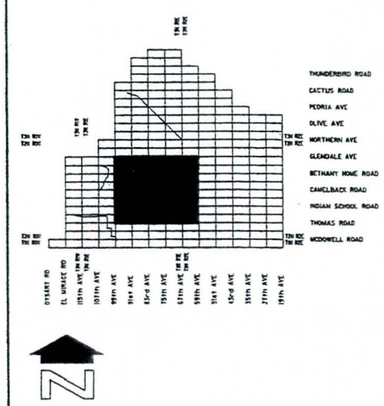
LEGEND



NOTE: BOLD Is Rerun Portion.
GRAY SCALE Is from Original Model.

PROPOSED AGUA FREEWAY ALIGNMENT

INDEX MAP



HEC-1 RERUN-SCHEMATIC

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, ARIZONA 85016
(602)337-2777

	BY	DATE
DESIGN	DBL	10/99
DESIGN CHK.	ABM	10/99
PLANS	DBL	10/99
PLANS CHK.	JRM	10/99

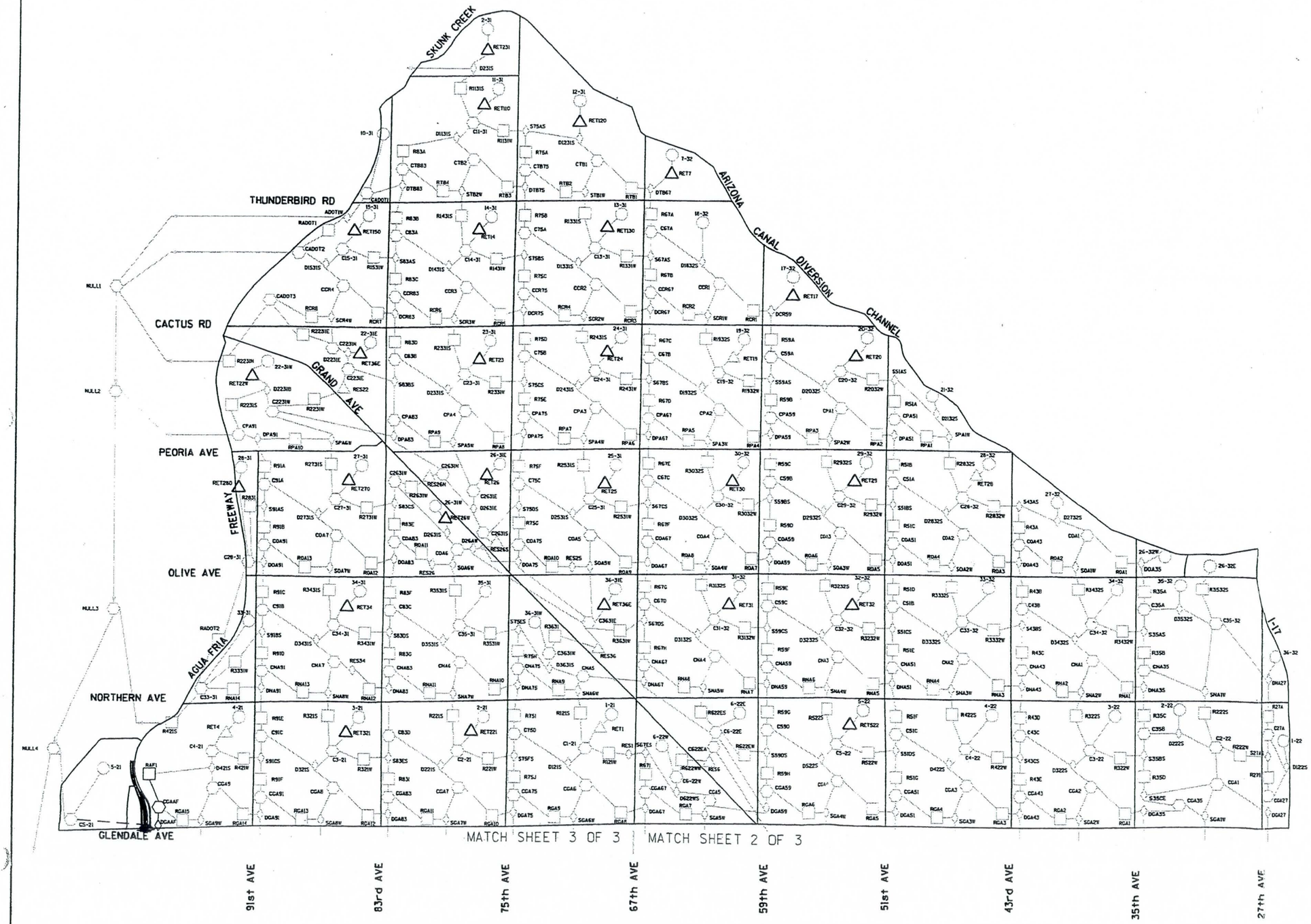
SUBMITTED BY: DATE: 9/00

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE
APPROVED BY: DATE
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 1

09/14/00 n:\2788\Prod\Exhibits\exhbtl-4a.dgn



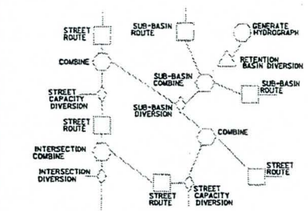
ORIGINAL EXHIBIT DEVELOPED BY CH2M HILL AND WOOD/PATEL (10/96)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL FLOOD CONTROL PROJECT

FCD CONTRACT # 98-46

LEGEND

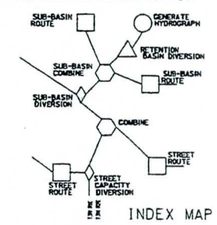


DRAINAGE SUB-BASIN BOUNDARY

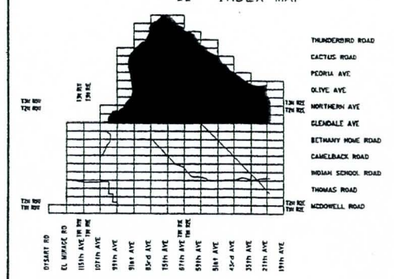
REVISED OR NEW RETENTION ELEMENT

CONNECTION MAINTAINING East-West COMPUTATION STRUCTURE (Diversion to West Coded In HEC-1 = 0?)

PROPOSED AGUA FREEWAY ALIGNMENT



INDEX MAP



0 2000' 4000' 6000'

SCALE: 1" = 2000'

EXHIBIT 1
HEC-1 SCHEMATIC

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, ARIZONA 85016
(602)337-2777

	BY	DATE
DESIGN	ABM	10/99
DESIGN CHK.	JRM	10/99
PLANS	ABM	10/99
PLANS CHK.	JRM	10/99
SUBMITTED BY:		DATE: 10/99

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

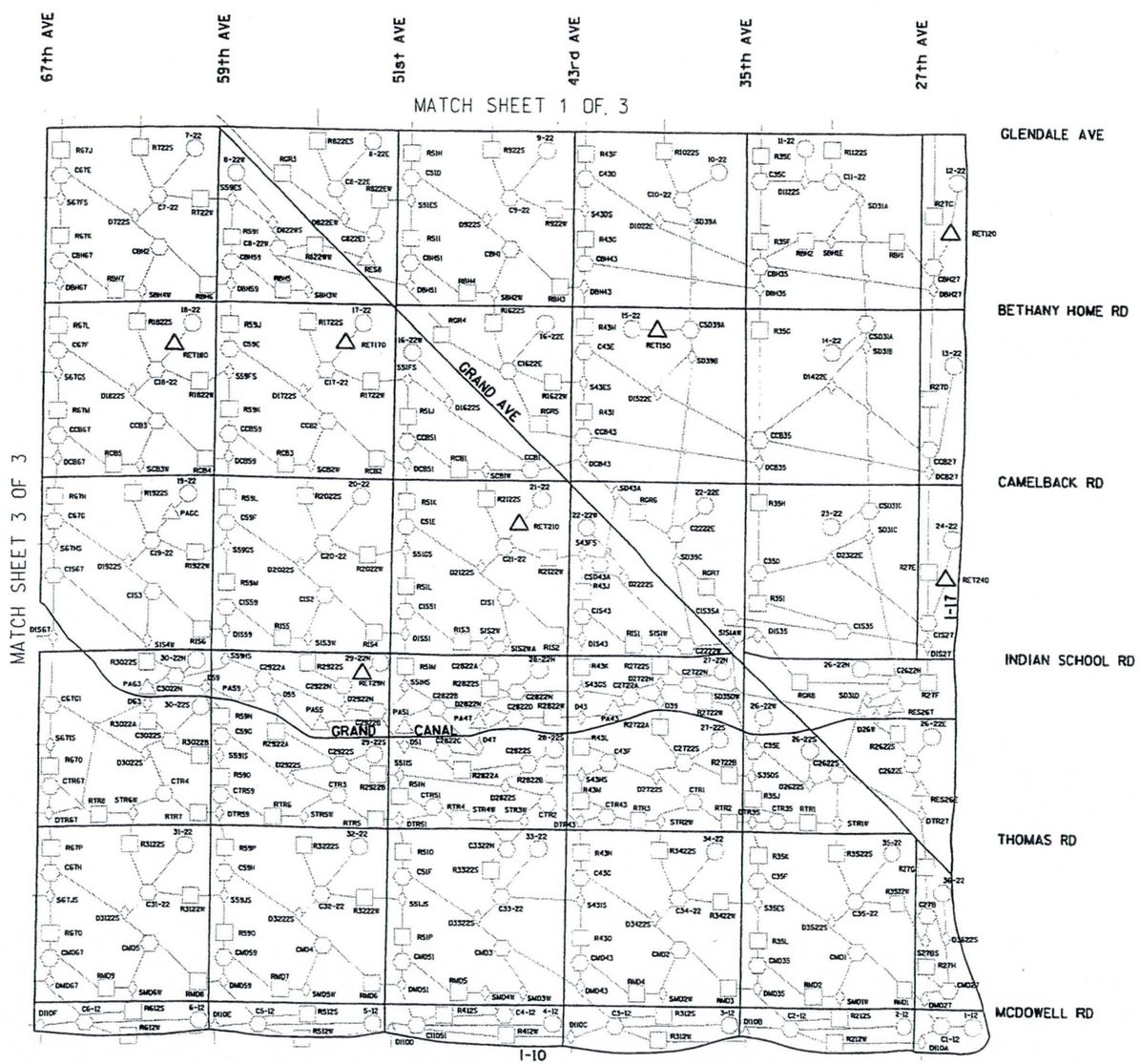
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 3

09/14/00 n:\2788\Prod\Exhibits\exhbt1-1a.dgn

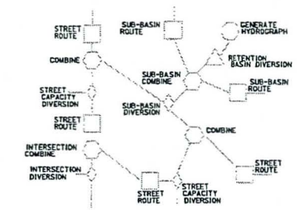


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL FLOOD CONTROL PROJECT

FCD CONTRACT # 98-46

LEGEND



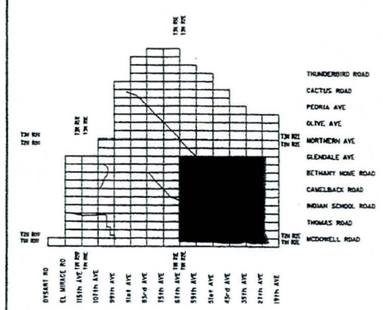
DRAINAGE SUB-BASIN BOUNDARY

REVISED OR NEW RETENTION ELEMENT

CONNECTION MAINTAINING East-West COMPUTATION STRUCTURE (Diversion to West Coded In HEC-1 = 0X)

PROPOSED ACUA FREEWAY ALIGNMENT

INDEX MAP



0 2000' 4000' 6000'

SCALE: 1" = 2000'

EXHIBIT 1

HEC-1 SCHEMATIC

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, ARIZONA 85016
(602)337-2777

	BY	DATE
DESIGN	ABM	10/99
DESIGN CHK.	JRM	10/99
PLANS	ABM	10/99
PLANS CHK.	JRM	10/99
SUBMITTED BY:		DATE:10/99

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

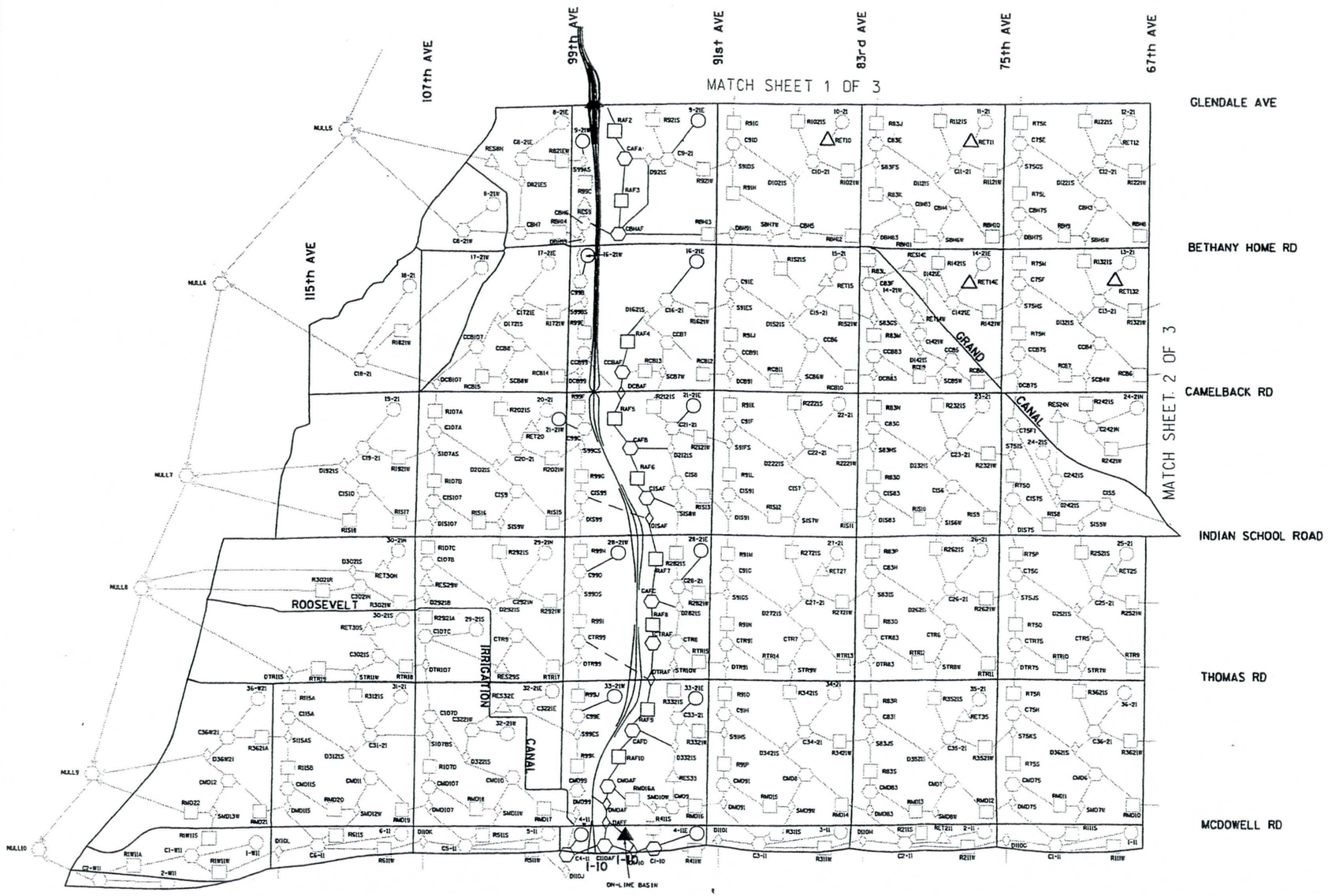
RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 2 OF 3

ORIGINAL EXHIBIT DEVELOPED BY CH2M HILL AND WOOD/PATEL (10/96)

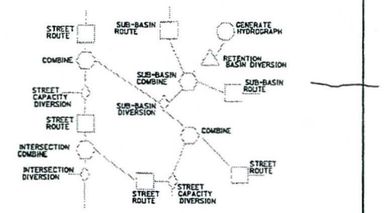


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL FLOOD CONTROL PROJECT

FCD CONTRACT # 98-46

LEGEND

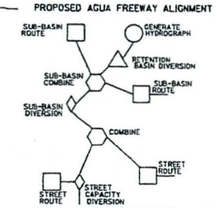


DRAINAGE SUB-BASIN BOUNDARY

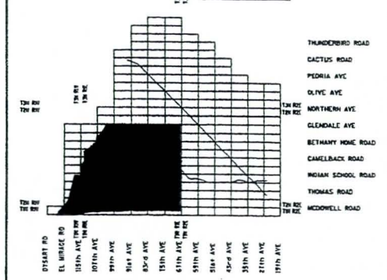
REVISED OR NEW RETENTION ELEMENT

CONNECTION MAINTAINING East-West COMPUTATION STRUCTURE (Diversion to West Coded in HEC-1 = 02)

PROPOSED AGUA FREEWAY ALIGNMENT



INDEX MAP



0 2000' 4000' 6000'

SCALE: 1" = 2000'

EXHIBIT 1
HEC-1 SCHEMATIC

DMJM ARIZONA, INC.
2777 E. CAMELBACK ROAD
SUITE 200
PHOENIX, ARIZONA 85016
(602)337-2777

	BY	DATE
DESIGN	ABM	10/99
DESIGN CHK.	JRM	10/99
PLANS	ABM	10/99
PLANS CHK.	JRM	10/99
SUBMITTED BY:		DATE: 10/99

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

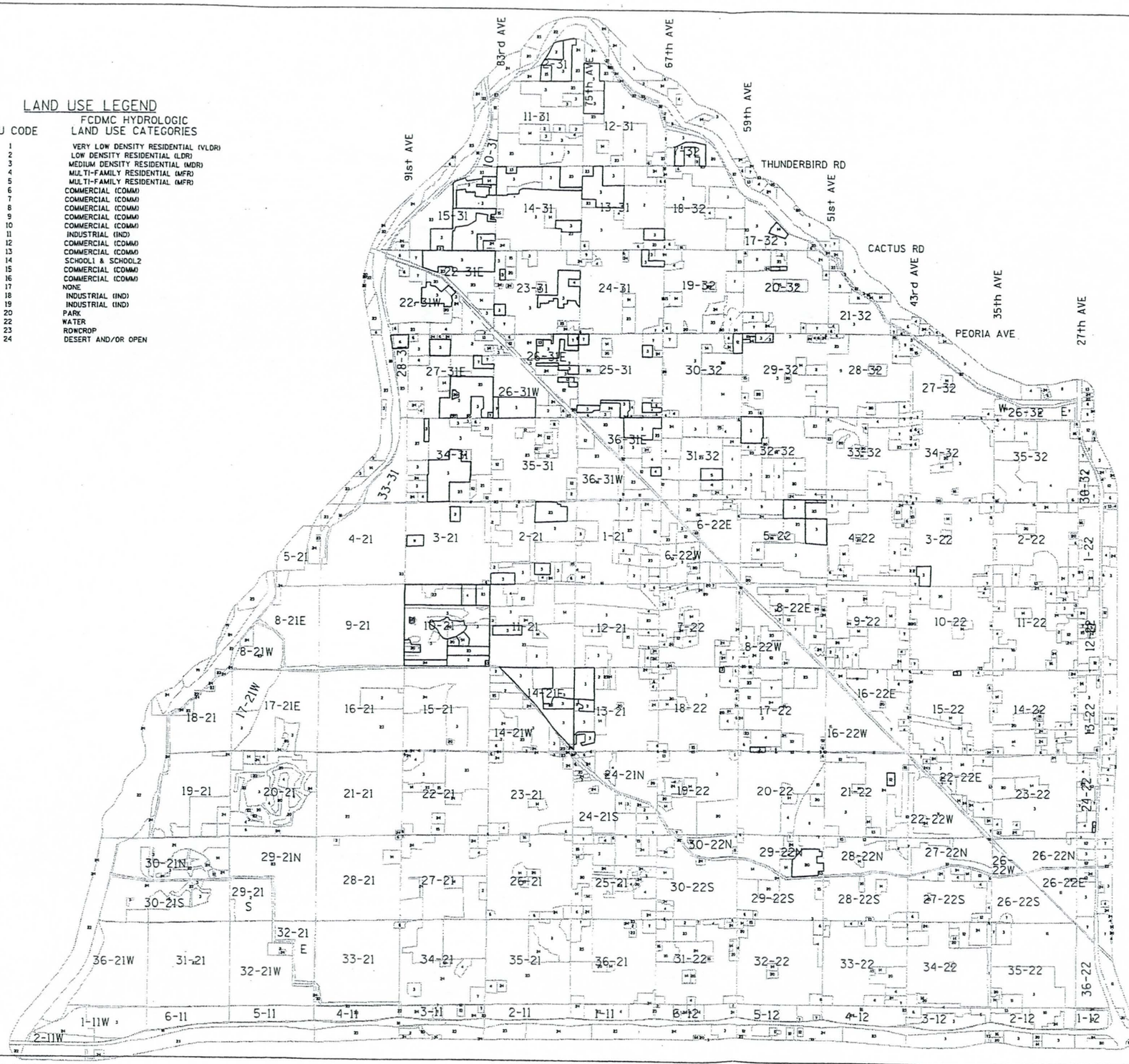
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 3

ORIGINAL EXHIBIT DEVELOPED BY CH2M HILL AND WOOD/PATEL (10/96)

LAND USE LEGEND

LU CODE	FCDMC HYDROLOGIC LAND USE CATEGORIES
1	VERY LOW DENSITY RESIDENTIAL (VLDR)
2	LOW DENSITY RESIDENTIAL (LDR)
3	MEDIUM DENSITY RESIDENTIAL (MDR)
4	MULTI-FAMILY RESIDENTIAL (MFR)
5	MULTI-FAMILY RESIDENTIAL (MFR)
6	COMMERCIAL (COMM)
7	COMMERCIAL (COMM)
8	COMMERCIAL (COMM)
9	COMMERCIAL (COMM)
10	COMMERCIAL (COMM)
11	INDUSTRIAL (IND)
12	COMMERCIAL (COMM)
13	COMMERCIAL (COMM)
14	SCHOOL1 & SCHOOL2
15	COMMERCIAL (COMM)
16	COMMERCIAL (COMM)
17	NONE
18	INDUSTRIAL (IND)
19	INDUSTRIAL (IND)
20	PARK
22	WATER
23	ROWCROP
24	DESERT AND/OR OPEN



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL FLOOD CONTROL PROJECT

FCD CONTRACT # 98-46

LEGEND

16-22E — DRAINAGE SUB-BASIN BOUNDARY

LAND USE AREA

REVISED OR NEW LAND USE AREA

0 3000' 6000' 9000'

SCALE: 1" = 3000'

EXHIBIT 4
LAND USE MAP

DMJM ARIZONA, INC.
2777 E. CAMELBACK RD.
SUITE 200
PHOENIX, AZ. 85016-4320
(602) 337-2777

	BY	DATE
DESIGN	ABM	10/99
DESIGN CHK.	JRM	10/99
PLANS	ABM	10/99
PLANS CHK.	JRM	10/99
SUBMITTED BY:		DATE: 10/99

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 OF 1

N:/2788/.../ex-4a.dgn

ORIGINAL EXHIBIT DEVELOPED BY CH2M HILL AND WOOD/PATEL (10/96)

A.2 HEC-1 Output Excerpts

```
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *              JUN   1998              *
 *            VERSION 4.1               *
 *                                      *
 *  RUN DATE   01JUL08  TIME  11:40:10  *
 *                                      *
 ****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X                X
XXXXXXX  XXXX     X        XXXXX   X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1                                    HEC-1 INPUT                                    PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             1          ID   ==========================================================================
             2          ID  **************************************************************************
             3          ID   Model revised by Olsson Associates for the Bethany Home Outfall Channel Proje
             4          ID   Model revised for Reach D Final Design
             5          ID   Model revised for Sunset Detention Basin refinements
             6          ID   File: BHGC00D7.dat
             7          ID   July  2007
             8          ID  **************************************************************************
             9          ID   ==========================================================================
            10          ID  **************************************************************************
            11          ID   Model revised by Wood Patel for the Bethany Home Outfall Channel Project
            12          ID   Model revised for Reach C Value Engineering
            13          ID   Model revised for Maryvale Detention Basin refinements - Outlet Culvert
            14          ID   File: BHGC00c7.dat
            15          ID   March 2006
            16          ID  **************************************************************************
            17          ID   ==========================================================================
            18          ID  **************************************************************************
            19          ID   Model revised by DMJM for the Bethany Home-Grand Canal Flood Control Project
            20          ID   Model revised for Reach B & C Final Designs
            21          ID   Model revised for Maryvale Detention Basin refinements
            22          ID   File: BHGC00c6.dat
            23          ID   November 2004
            24          ID  **************************************************************************
            25          ID   ==========================================================================
            26          ID   *************************************************************************
            27          ID   Model revised by DMJM+HARRIS to reflect proposed upper hydrologic changes
            28          ID   Model changed to reflect proposed Coyote Arena and TSA/Cardinals Stadium Site
            29          ID   Model Updated for Land Use Changes and Retention in Sub-basin 9-21E
            30          ID   File: BGGCstad.dat - 100 YEAR EVENT
            31          ID   April 2003
            32          ID   *************************************************************************
            33          ID   ==========================================================================
                        *
            34          ID   ==========================================================================
            35          ID  **************************************************************************
            36          ID   Model revised by DMJM for the Bethany Home-Grand Canal Flood Control Project
            37          ID   Model Updated for Land Use - Development Changes - 19 AUG 99
            38          ID   Model Split for Improved Performance - Middle Portion (Glendale - Thomas)
            39          ID   Model includes Camelback Road Storm Drain System (10 Year Interception)
            40          ID   Model revised to incorporate revised Agua Fria Freeway Alignment
            41          ID   Model revised to include connection with the Sunset Detention Basin
            42          ID   Model revised for 60% Design and 91st Ave. Detention Basin refinements
            43          ID   Model revised for 90% Design and 91st Ave. Detention Basin refinements
            44          ID   Model revised for 90% Design, CLOMR and Detention Basin refinements
            45          ID   File: BHGC_100.dat - 100 YEAR  - 24 HOUR EVENT
            46          ID   January 2003
            47          ID  **************************************************************************
            48          ID   ==========================================================================
            49          ID   MARYVALE ADMS - FCD#93-29: CH2M HILL & Wood/Patel & Associates
            50          ID   Model for Entire Study Area (Approximately 100 square miles)
            51          ID   Existing Conditions
            52          ID   100Yr-24Hr Event
            53          ID   Clark Unit Hydrograph
            54          ID   24-Hour SCS TYPE II Rainfall Pattern was used to determine TC & R
1                                    HEC-1 INPUT                                    PAGE  2

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            55          ID   Green-Ampt Precipitation Losses
            56          ID   Model Prepared and Checked by David Dust and Jim Geisbush
            57          ID   MV100-24 (BASE79): SWW\132586\HEC-1
```

```
 58          ID   January 1997
 59          ID
 60          ID   ==========================================================================
 61          ID   File GC002e.ih1          Wood/Patel by David T. Phelps          25-SEP-97
 62          ID   OPTIONS MODELED         100-yr 24-hr storm
 63          ID   GRAND CANAL DIVERSIONS
 64          ID   === GCDC flows (100%) diverted West from 67th AVE to New River
 65          ID       - Flow arriving at Grand Canal west of 67th Avenue diverted northwest
 66          ID         along the Grand Canal.
 67          ID           -  Splits at SBH7W, DBH91, and DBH99 revised
 68          ID           -  RES9 & RES10 Removed
 69          ID       - USE SECOND SET OF RESULTS for GCDC Flows.
 70          ID       - Splits along GCDC provide influance of GCDC on D/S areas
 71          ID       - On-Line Detention Basin (67th - 73rd Ave) modeled at GCDC1
 72          ID           Using 2-6'x3' Box Culverts and 4:1 sides unlined basin (LEVEL II)
 73          ID   PROPOSED AGUA FRIA FREEWAY INTERCEPTOR DIVERSIONS
 74          ID   === Proposed Agua Fria Freeway Alingment modeled (Along 99th AVE)
 75          ID   === Proposed Agua Fria Channel modeled - 1st cut Routing Geometry (RX & RY)
 76          ID   === Proposed Bethany Home Outfall Channel Modeled  (RES9 & RES8S Removed)
 77          ID        - operation S99AS revised (All flow to South)
 78          ID   ADOT DETENTION BASIN MODELING  -- NONE
 79          ID   ADMS multiple use of Diversion ID D2631N fixed
 80          ID   **************************************************************************
 81          ID
 82          ID   Revisions made by DMJM for BH-GC Flood Control Project:
 83          ID
 84          ID       - Inclusion of Bethany Home Road Storm Drain System (from BHSD002b.ih1)
 85          ID       - Revision of Sub-Basins for Updated Land Use Information
 86          ID       - Revision and Addition of Retention for Updated Development Information
 87          ID       - Revision to detention facilities at SDB, MDB, and 91st Avenue
 88          ID       - Revision to include channel routings for "Recommended Alternative"
 89          ID
 90          ID   **************************************************************************
 91          ID
 92          ID   ==========================================================================
 93          ID
 94          ID   Revisions made by DMJM for BH-GC Flood Control Project (Phase 1 - 30% Design)
 95          ID
 96          ID       - Revision to detention facilities at MDB and 91st Avenue
 97          ID       - Revision to include channel routings for preliminary design refinements
 98          ID
 99          ID   ==========================================================================
100          ID
101          ID  **************************************************************************
102          ID   HEC-1 ELEMENT NOMENCLATURE
103          ID   SUB-BASIN HYDROGRAPH:
104          ID      Example: "17-32N": the sub-basin is Section 17, T3N, R2E
105          ID
106          ID   SUB-BASIN DIVERSION:
107          ID      Example: "D1732S": is the southerly component of divert in Section 17
108          ID
109          ID   SUB-BASIN ROUTE:
```



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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

110          ID      Example: "R1732S": is the southerly flow route through Sec. 17, T3N, R2E
111          ID
112          ID   SUB-BASIN RESERVOIR ROUTE OR SURGE BASIN DIVERT:
113          ID      Example: "RES17": corresponds to a reservoir route or surge basin divert
114          ID                        in Sub-basin 17-##
115          ID
116          ID   RETENTION BASIN DIVERT:
117          ID      Example: "RET17": corresponds to retention basin divert in
118          ID                        Sub-Basin 17-##
119          ID
120          ID   SUB-BASIN COMBINE:
121          ID      Example: "C17-32": corresponds to sub-basin combine in Sec. 17, T3N, R2E
122          ID
123          ID   STREET ROUTE:
124          ID      Example: "RPA1": first route for Peoria Avenue
125          ID      Example" "R67C": third route for 67th Avenue
126          ID
127          ID   STREET CAPACITY DIVERSION:
128          ID      Example: "SPA1S": first diversion from Peoria Avenue to the south
129          ID
130          ID   STREET INTERSECTION DIVERSION:
131          ID      Example: "RPA67": flow component along Peoria Avenue from diversion at
132          ID                        Peoria Avenue and 67th Avenue
133          ID      Example: "R67PA": flow component along 67th Avenue from diversion at
134          ID                        Peoria Avenue and 67th Avenue
135          ID
136          ID   STREET INTERSECTION COMBINE:
137          ID      Example: "CPA67": hydrograph combine at the intersection of Peoria Avenue
138          ID                        and 67th Avenue
139          ID
140          ID   STREET COMBINE:
141          ID      Example: "CPA2": second hydrograph combine along Peoria Avenue
142          ID
143          ID   "NULL" COMBINE:
144          ID      Example: "NULL2": dummy hydrograph combine used to free up a HEC-1
145          ID                        computational path.  Hence, hydrograph is meaningless.
146          ID
147          ID   **************************************************************************
148          ID   STREET NAME CODES
149          ID     Thunderbird Road  = TB
150          ID     Cactus Road       = CR
151          ID     Peoria Avenue     = PA
152          ID     Olive Avenue      = OA
153          ID     Northern Avenue   = NA
```

```
 154          ID     Glendale Avenue   = GA
 155          ID     Bethany Home Road = BH
 156          ID     Camelback Road    = CB
 157          ID     Indian School Road= IS
 158          ID     Thomas Road       = TR
 159          ID     McDowell Road     = MD
 160          ID   ***************************************************************************
 161          ID
 162          ID   DDM MCUHP1 Bethany Home/Grand Canal Flood Control Project - 100-Year, 24-Hour
              *DIAGRAM
 163          IT       5                    1000
1                                           HEC-1 INPUT                                          PAGE  4

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 164          IO       5
 165          IN      15
              *       The following is the FCDMC 100-yr 24-hr Storm
 166          JD    3.69    0.01
 167          PC    .000    .002    .005    .008    .011    .014    .017    .020    .023    .026
 168          PC    .029    .032    .035    .038    .041    .044    .048    .052    .056    .060
 169          PC    .064    .068    .072    .076    .080    .085    .090    .095    .100    .105
 170          PC    .110    .115    .120    .126    .133    .140    .147    .155    .163    .172
 171          PC    .181    .191    .203    .218    .236    .257    .283    .387    .663    .707
 172          PC    .735    .758    .776    .791    .804    .815    .825    .834    .842    .849
 173          PC    .856    .863    .869    .875    .881    .887    .893    .898    .903    .908
 174          PC    .913    .918    .922    .926    .930    .934    .938    .942    .946    .950
 175          PC    .953    .956    .959    .962    .965    .968    .971    .974    .977    .980
 176          PC    .983    .986    .989    .992    .995    .998   1.000
 177          JD    3.47   10.00
 178          JD    3.32   30.00
 179          JD    3.17   60.00
 180          JD    3.12   90.00
 181          JD    3.08  120.00
 182          JD    3.04  150.00
 183          JD    2.95  300.00
 184          JD    2.88  500.00
              *
              *
              * DDM   ***** Preserved *****

 185          KK   NULL4
 186          BI              22
              *
              *
              * BETHANY HOME ROAD COMPUTATION PATH
              *
              *
              * DDM   ***** Updated *****

 187          KK   11-22
 188          KM   SUB-BASIN 11-22
 189          KM   24-HOUR SCS TYPE II RAINFALL WAS USED TO FIND TC & R FOR THIS BASIN
 190          KM   THIS BASIN USED RAINFALL REDUCTION FACTOR OF  .994
 191          KM     L = 1.48  Kb = .064  Adj. Slope =   14.0
 192          BA   1.006
 193          LG    .220    .260   5.200    .290  38.000
 194          UC   1.429    .750
 195          UA       0       5      16      30      65      77      84      90      94      97
 196          UA     100
              * DDM   ***** Preserved *****
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

4564          KK    PA63        STORAGE ROUTING AT SUNSET BASIN
              *  KO     3
              * KM ==========================================================================
              * KM REVISED BY DMJM ---> SUNSET DETENTION BASIN @ INDIAN SCHOOL AND 67TH AVE.
              * KM              Revised also for Tailwater Conditions and 8'x6'RCB(L=2330 ft.)
              * KM ==========================================================================
              * KM  DATA BASED ON HEC-1 BY HOSKINS ENGINEERING CONSULTANTS (8-99) FOR COP
              * KM  Detention basin sized for the 10-year event.
              * KM  BASIN DRAIN INTO AN EXISTING STORM DRAIN SYSTEM IN INDIAN SCHOOL
              * RS     1    STOR      -1
              *
              *  *** Revised to Avoid Error Message - Extrapolated Values Above Elevation 1098
              *
              * SV     0    0.50    1.10    2.90   10.60    22.8    23.3    35.8    38.5    56
              * SV  74.9
              * SQ     0       6      10      20      30      40    40.4     313     371     4
              *
              *   **** Revised by DMJM+HARRIS for 8'x7' (L=2520 lin. ft.) RCB Outlet ****
              *
              * SQ     0       6      10      20      30      40    40.4     289     325     4
              * SQ   665
              * SE  1085  1086.0  1086.5  1087.3  1089.6  1092.4  1092.5  1094.8 1095.22    10
              * SE1100.8
              *
4565          KM   ==========================================================================
4566          KM   REVISED BY Olsson Associates--> SUNSET DETENTION BASIN: Storage volume (SV)
4567          KM   is based on new survey data and Storage Discharge (SQ) based on the Proposed
4568          KM   weir length at the outlet of the Sunset Basin.
4569          KM   ==========================================================================
4570          KM    Proposed weir is broad-crested with L=22' & B=5'
4571          KM    Detention basin sized for the 100-year event.
4572          RS       1    STOR      -1
              *
              * SV     0    0.50    1.10    2.90   10.60    22.8    23.3    35.8    38.5    56
              * SV  74.9
4573          SV       0     0.9     2.1     4.8    15.3    30.4    31.1    62.1    69.2    71.3
4574          SV    86.8
4575          SQ       0       6      10      20      30    40.0    40.4   294.2   333.2   380.6
4576          SQ   630.4
4577          SE    1085  1086.0  1086.5  1087.3  1089.6 1092.40 1092.50 1097.27 1098.14 1098.38
4578          SE  1100.3
              * DDM   ***** Preserved *****
              *
              * KK   D63
              * KM  100% FLOW DIVERTED SOUTH
              * KM  COMPUTATION PATH WEST ALONG NORTH SIDE OF GRAND CANAL IS TERMINATED
              * KM  COMPUTATION PATH TO WEST IS COLLECTED @ THOMAS & 67 INTERSECTION COMBINE
              * DT  D63S
              * DI    0.  10000.
              * DQ    0.  10000.
              *
              * ** Diversion D63 modified from 60 to 55 cfs for 30" drain pipe in Sunset Basin
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

4579          KK     D63
4580          KM   ==========================================================================
4581          KM   REVISED BY DMJM --> PROVIDE 55 CFS DIVERSION FOR THE SUNSET BASIN OUTLET INTO
4582          KM                      THE INDIAN SCHOOL ROAD STORM DRAIN.
4583          KM   ==========================================================================
4584          DT    D63S            55.0
4585          DI      0.  10000.
4586          DQ      0.  10000.
              *

4587          KK    DC1B
4588          KM   ==========================================================================
4589          KM   REVISED BY DMJM --> DIVERT REMAINING FLOWS FROM SUNSET BASIN FOR FUTURE
4590          KM                       RETRIEVAL.
4591          KM   ==========================================================================
4592          DT  GCDC1B
4593          DI       0     100    1000
4594          DQ       0     100    1000
              *
              *  MAIN THOMAS ROAD (SOUTH OF GRAND CANAL) COMPUTATIONAL PATH
              *
              * DDM   ***** Preserved *****
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	NULL4	3714.	13.17	1695.	519.	176.	1.00		
+	HYDROGRAPH AT	11-22	558.	12.58	169.	53.	18.	1.01		
+	DIVERSION TO	D1122W	117.	12.58	35.	11.	4.	1.01		
+	HYDROGRAPH AT	D1122S	441.	12.58	133.	42.	14.	1.01		
+	HYDROGRAPH AT	SGA1S	1140.	12.67	307.	94.	31.	2.54		
+	ROUTED TO	R1122S	1136.	12.83	306.	94.	31.	2.54		
+	2 COMBINED AT	C11-22	1537.	12.83	436.	135.	45.	3.50		
+	DIVERSION TO	SD31AS	147.	12.00	126.	57.	19.	3.50		
+	HYDROGRAPH AT	SD31A	1390.	12.83	310.	78.	26.	3.50		
+	DIVERSION TO	SBH1W	695.	12.83	155.	39.	13.	3.50		
+	HYDROGRAPH AT	SBH1E	695.	12.83	155.	39.	13.	3.50		
+	ROUTED TO	RBH1	693.	12.92	155.	39.	13.	3.50		
+	HYDROGRAPH AT	D27GA	231.	12.58	63.	20.	7.	.36		
+	ROUTED TO	R27C	223.	12.83	63.	20.	7.	.36		
+	HYDROGRAPH AT	12-22	205.	12.33	47.	15.	5.	.25		
+	DIVERSION TO	D1222R	14.	12.33	3.	1.	0.	.25		
+	HYDROGRAPH AT	RET120	191.	12.33	44.	14.	5.	.25		
+	3 COMBINED AT	CBH27	963.	12.92	245.	68.	23.	21.30		
+	DIVERSION TO	D27BH	963.	12.92	245.	68.	23.	21.30		
+	HYDROGRAPH AT	DBH27	0.	.00	0.	0.	0.	21.30		
+	HYDROGRAPH AT	D35GA	79.	12.92	35.	12.	4.	2.10		
+	ROUTED TO	R35E	78.	13.17	35.	12.	4.	2.10		
+	HYDROGRAPH AT	D1122W	117.	12.58	35.	11.	4.	1.01		
+	2 COMBINED AT	C35C	178.	12.92	70.	23.	8.	3.10		
+	ROUTED TO	R35F	175.	13.08	70.	23.	8.	3.10		
+	HYDROGRAPH AT	SBH1W	695.	12.83	155.	39.	13.	3.50		
+	ROUTED TO	RBH2	691.	12.92	155.	39.	13.	3.50		
+	HYDROGRAPH AT	SGA2S	412.	12.67	149.	48.	16.	4.68		
+	ROUTED TO	R1022S	408.	12.83	148.	48.	16.	4.68		
+	HYDROGRAPH AT	10-22	526.	12.58	157.	48.	16.	.99		
+	2 COMBINED AT	C10-22	902.	12.75	302.	95.	32.	5.70		

+	DIVERSION TO	SD39AS	164.	12.00	127.	51.	17.	5.70
+	HYDROGRAPH AT	SD39A	738.	12.75	176.	44.	15.	5.70
+	DIVERSION TO	D1022W	436.	12.75	104.	26.	9.	5.70
+	HYDROGRAPH AT	D1022E	303.	12.75	72.	18.	6.	5.70
+	4 COMBINED AT	CBH35	1143.	12.92	294.	79.	26.	7.10
+	DIVERSION TO	D35BH	1143.	12.92	294.	79.	26.	7.10
+	HYDROGRAPH AT	DBH35	0.	.00	0.	0.	0.	7.10
+	HYDROGRAPH AT	D43GA	328.	12.83	139.	49.	16.	4.68
+	ROUTED TO	R43F	325.	13.00	139.	49.	16.	4.68
+	HYDROGRAPH AT	D1022W	436.	12.75	104.	26.	9.	5.70
+	2 COMBINED AT	C43D	736.	12.92	243.	75.	25.	5.70
+	DIVERSION TO	S43DW	363.	12.92	87.	22.	7.	5.70
+	HYDROGRAPH AT	S43DS	373.	12.92	155.	53.	18.	5.70
+	ROUTED TO	R43G	371.	13.00	155.	53.	18.	5.70
+	2 COMBINED AT	CBH43	371.	13.00	155.	53.	18.	5.70
+	DIVERSION TO	D43BH	233.	13.00	119.	44.	15.	5.70
+	HYDROGRAPH AT	DBH43	138.	13.00	36.	9.	3.	5.70
+	ROUTED TO	RBH3	135.	13.25	36.	9.	3.	5.70
+	HYDROGRAPH AT	SGA3S	545.	13.08	166.	45.	15.	8.07
+	ROUTED TO	R922S	533.	13.33	166.	45.	15.	8.07
+	HYDROGRAPH AT	9-22	609.	12.58	180.	56.	19.	.99
+	HYDROGRAPH AT	S43DW	363.	12.92	87.	22.	7.	5.70
+	ROUTED TO	R922W	351.	13.25	87.	22.	7.	5.70
+	3 COMBINED AT	C9-22	1278.	13.25	425.	121.	40.	10.10
+	DIVERSION TO	D922W	435.	13.25	144.	41.	14.	10.10
+	HYDROGRAPH AT	D922S	844.	13.25	280.	80.	27.	10.10
+	2 COMBINED AT	CBH1	978.	13.25	316.	89.	30.	10.10
+	DIVERSION TO	SBH2S	705.	13.25	227.	63.	21.	10.10
+	HYDROGRAPH AT	SBH2W	273.	13.25	90.	26.	9.	10.10
+	ROUTED TO	RBH4	270.	13.42	90.	26.	9.	10.10
+	HYDROGRAPH AT	D51GA	278.	13.33	102.	33.	11.	8.07
+	ROUTED TO	R51H	275.	13.42	102.	33.	11.	8.07
+	HYDROGRAPH AT	D922W	435.	13.25	144.	41.	14.	10.10

+	2 COMBINED AT	C51D	695.	13.33	246.	73.	25.	10.10
+	DIVERSION TO	S51EW	259.	13.33	45.	11.	4.	10.10
+	HYDROGRAPH AT	S51ES	436.	13.33	200.	62.	21.	10.10
+	ROUTED TO	R51I	433.	13.50	200.	62.	21.	10.10
+	2 COMBINED AT	CBH51	703.	13.42	290.	88.	29.	10.10
+	DIVERSION TO	D51BH	310.	13.42	53.	13.	4.	10.10
+	HYDROGRAPH AT	DBH51	393.	13.25	237.	75.	25.	10.10
+	HYDROGRAPH AT	D822ES	355.	12.67	201.	65.	22.	12.60
+	HYDROGRAPH AT	D822E1	108.	12.25	11.	3.	1.	.52
+	HYDROGRAPH AT	S51EW	259.	13.33	45.	11.	4.	10.10
+	ROUTED TO	R822EW	251.	13.58	45.	11.	4.	10.10
+	3 COMBINED AT	C822E1	579.	13.58	253.	78.	26.	14.60
+	2 COMBINED AT	CBH51b	946.	13.58	477.	148.	50.	24.70
+	DIVERSION TO	SBH51	826.	13.58	358.	90.	30.	24.70
+	HYDROGRAPH AT	SBH51	120.	11.67	119.	59.	20.	24.70
+	ROUTED TO	R822WW	120.	12.25	119.	59.	20.	24.70
+	HYDROGRAPH AT	8-22W	807.	12.08	98.	32.	11.	.49
+	DIVERSION TO	D822WW	169.	12.08	21.	7.	2.	.49
+	HYDROGRAPH AT	D822WS	637.	12.08	78.	26.	9.	.49
+	2 COMBINED AT	C8-22W	725.	12.08	188.	83.	28.	15.10
+	DIVERSION TO	SBH3S	162.	12.08	9.	2.	1.	15.10
+	HYDROGRAPH AT	SBH3W	563.	12.08	180.	81.	27.	15.10
+	ROUTED TO	RBH5	545.	12.25	179.	81.	27.	15.10
+	HYDROGRAPH AT	D822WW	169.	12.08	21.	7.	2.	.49
+	DIVERSION TO	S59EW	78.	12.08	5.	1.	0.	.49
+	HYDROGRAPH AT	S59ES	91.	12.08	15.	5.	2.	.49
+	ROUTED TO	R59I	74.	12.33	15.	5.	2.	.49
+	2 COMBINED AT	CBH59	609.	12.25	193.	86.	29.	15.10
+	DIVERSION TO	D59BH	133.	12.25	8.	2.	1.	15.10
+	HYDROGRAPH AT	DBH59	476.	12.25	186.	84.	29.	15.10
+	ROUTED TO	RBH6	469.	12.33	186.	84.	29.	15.10
+	HYDROGRAPH AT	SGA5S	440.	14.42	111.	28.	9.	17.90
+	ROUTED TO	R722S	420.	14.92	110.	28.	9.	17.90
	HYDROGRAPH AT							

+	7-22	532.	12.58	166.	52.	17.	.97
+ HYDROGRAPH AT	S59EW	78.	12.08	5.	1.	0.	.49
+ ROUTED TO	R722W	37.	12.75	5.	1.	0.	.49
+ 3 COMBINED AT	C7-22	548.	12.67	266.	77.	26.	19.30
+ DIVERSION TO	D722W	197.	12.67	96.	28.	9.	19.30
+ HYDROGRAPH AT	D722S	351.	12.67	171.	50.	17.	19.30
+ 2 COMBINED AT	CBH2	756.	12.50	349.	131.	44.	25.80
+ DIVERSION TO	SBH4S	202.	12.50	22.	6.	2.	25.80
+ HYDROGRAPH AT	SBH4W	553.	12.50	326.	125.	42.	25.80
+ ROUTED TO	RBH7	552.	12.58	326.	125.	42.	25.80
+ HYDROGRAPH AT	D67GA	180.	14.58	52.	13.	4.	17.90
+ ROUTED TO	R67J	175.	14.75	52.	13.	4.	17.90
+ HYDROGRAPH AT	D722W	197.	12.67	96.	28.	9.	19.30
+ 2 COMBINED AT	C67E	347.	14.83	147.	41.	14.	19.30
+ DIVERSION TO	S67FW	164.	14.83	64.	16.	5.	19.30
+ HYDROGRAPH AT	S67FS	183.	14.83	82.	25.	8.	19.30
+ ROUTED TO	R67K	177.	15.08	82.	25.	8.	19.30
+ 2 COMBINED AT	CBH67	654.	12.75	410.	150.	51.	21.30
+ DIVERSION TO	D67BH	90.	12.75	17.	4.	1.	21.30
+ HYDROGRAPH AT	DBH67	564.	12.75	394.	146.	49.	21.30
+ ROUTED TO	RBH8	563.	12.83	393.	146.	49.	21.30
+ HYDROGRAPH AT	SGA6S	182.	14.75	83.	21.	7.	27.66
+ ROUTED TO	R1221S	177.	15.08	81.	21.	7.	27.66
+ HYDROGRAPH AT	12-21	733.	12.50	178.	49.	16.	1.00
+ DIVERSION TO	D1221R	44.	12.50	8.	2.	1.	1.00
+ HYDROGRAPH AT	RET12	689.	12.50	170.	47.	16.	1.00
+ HYDROGRAPH AT	S67FW	164.	14.83	64.	16.	5.	19.30
+ ROUTED TO	R1221W	144.	15.25	64.	16.	5.	19.30
+ 3 COMBINED AT	C12-21	700.	13.00	315.	86.	29.	31.35
+ DIVERSION TO	D1221W	246.	13.00	108.	30.	10.	31.35
+ HYDROGRAPH AT	D1221S	402.	13.00	176.	48.	16.	31.35
+ 2 COMBINED AT	CBH3	959.	13.00	560.	191.	64.	31.35
+ DIVERSION TO	SBH5S	115.	13.00	24.	6.	2.	31.35
+ HYDROGRAPH AT	SBH5W	843.	13.00	536.	185.	62.	31.35

+	ROUTED TO	RBH9	841.	13.08	536.	185.	62.	31.35
+	HYDROGRAPH AT	D75GA	459.	14.83	238.	70.	24.	27.66
+	ROUTED TO	R75K	453.	15.00	237.	70.	24.	27.66
+	HYDROGRAPH AT	D1221W	246.	13.00	108.	30.	10.	31.35
+	2 COMBINED AT	C75E	550.	15.08	333.	97.	34.	31.35
+	DIVERSION TO	S75GW	173.	15.08	102.	27.	9.	31.35
+	HYDROGRAPH AT	S75GS	378.	15.08	231.	71.	25.	31.35
+	ROUTED TO	R75L	375.	15.25	230.	71.	25.	31.35
+	2 COMBINED AT	CBH75	1183.	13.08	763.	253.	87.	31.35
+	DIVERSION TO	D75BH	145.	13.08	43.	11.	4.	31.35
+	HYDROGRAPH AT	DBH75	1038.	13.08	720.	242.	84.	31.35
+	ROUTED TO	RBH10	1036.	13.17	720.	242.	84.	31.35
+	HYDROGRAPH AT	SGA7S	231.	14.08	140.	35.	12.	30.20
+	ROUTED TO	R1121S	227.	14.42	138.	35.	12.	30.20
+	HYDROGRAPH AT	11-21	635.	12.58	150.	41.	14.	.99
+	DIVERSION TO	D1121R	178.	12.58	28.	7.	2.	.99
+	HYDROGRAPH AT	RET11	457.	12.58	123.	34.	11.	.99
+	HYDROGRAPH AT	S75GW	173.	15.08	102.	27.	9.	31.35
+	ROUTED TO	R1121W	170.	15.33	101.	27.	9.	31.35
+	3 COMBINED AT	C11-21	634.	13.33	332.	90.	30.	34.87
+	DIVERSION TO	D1121W	190.	13.33	100.	27.	9.	34.87
+	HYDROGRAPH AT	D1121S	444.	13.33	233.	63.	21.	34.87
+	2 COMBINED AT	CBH4	1467.	13.17	943.	303.	104.	34.87
+	DIVERSION TO	SBH6S	133.	13.17	44.	11.	4.	34.87
+	HYDROGRAPH AT	SBH6W	1334.	13.17	899.	291.	100.	34.87
+	ROUTED TO	RBH11	1334.	13.25	898.	291.	100.	34.87
+	HYDROGRAPH AT	D83GA	91.	13.00	30.	8.	3.	30.20
+	ROUTED TO	R83J	81.	14.50	30.	8.	3.	30.20
+	HYDROGRAPH AT	D1121W	190.	13.33	100.	27.	9.	34.87
+	2 COMBINED AT	C83E	264.	13.25	128.	34.	11.	34.87
+	DIVERSION TO	S83FW	83.	13.25	39.	10.	3.	34.87
+	HYDROGRAPH AT	S83FS	181.	13.25	88.	24.	8.	34.87
+	ROUTED TO	R83K	180.	13.42	88.	24.	8.	34.87

+	2 COMBINED AT	CBH83	1511.	13.33	988.	316.	108.	34.34
+	DIVERSION TO	D83BH	0.	13.25	0.	0.	0.	34.34
+	HYDROGRAPH AT	DBH83	1510.	13.33	988.	316.	108.	34.34
+	ROUTED TO	RBH12	1507.	13.42	986.	316.	108.	34.34
+	HYDROGRAPH AT	SGA8S	126.	13.00	47.	12.	4.	34.46
+	ROUTED TO	R1021S	119.	13.33	47.	12.	4.	34.46
+	HYDROGRAPH AT	10-21	586.	12.58	160.	45.	15.	.98
+	DIVERSION TO	D1021R	410.	12.58	81.	21.	7.	.98
+	HYDROGRAPH AT	RET10	312.	13.50	84.	24.	8.	.98
+	HYDROGRAPH AT	S83FW	83.	13.25	39.	10.	3.	34.87
+	ROUTED TO	R1021W	77.	13.58	39.	10.	3.	34.87
+	3 COMBINED AT	C10-21	309.	13.83	144.	39.	13.	43.32
+	DIVERSION TO	D1021W	133.	13.83	62.	17.	6.	43.32
+	HYDROGRAPH AT	D1021S	176.	13.83	82.	22.	7.	43.32
+	HYDROGRAPH AT	D91GA	327.	13.17	145.	36.	12.	34.46
+	ROUTED TO	R91G	320.	13.33	145.	36.	12.	34.46
+	HYDROGRAPH AT	D1021W	133.	13.83	62.	17.	6.	43.32
+	2 COMBINED AT	C91D	421.	13.33	200.	51.	17.	43.32
+	DIVERSION TO	S91DW	180.	13.33	85.	21.	7.	43.32
+	HYDROGRAPH AT	S91DS	241.	13.33	115.	30.	10.	43.32
+	ROUTED TO	R91H	236.	13.50	114.	30.	10.	43.32
+	3 COMBINED AT	CBH5	1851.	13.42	1152.	360.	123.	43.32
+	DIVERSION TO	SBH7S	0.	13.42	0.	0.	0.	43.32
+	HYDROGRAPH AT	SBH7W	1851.	13.42	1152.	360.	123.	43.32
+	DIVERSION TO	D91BH	0.	.00	0.	0.	0.	43.32
+	HYDROGRAPH AT	DBH91	1851.	13.42	1152.	360.	123.	43.32
+	ROUTED TO	RBH13	1848.	13.58	1150.	360.	123.	43.32
+	HYDROGRAPH AT	SGA9S	0.	.00	0.	0.	0.	35.26
+	ROUTED TO	R921S	0.	.00	0.	0.	0.	35.26
+	HYDROGRAPH AT	9-21E	360.	12.67	106.	27.	9.	.86
+	HYDROGRAPH AT	S91DW	180.	13.33	85.	21.	7.	43.32
+	ROUTED TO	R921W	177.	13.58	85.	21.	7.	43.32
+	3 COMBINED AT	C9-21	372.	13.50	173.	44.	15.	44.97
	DIVERSION TO							

+		D921W	145.	13.50	68.	17.	6.	44.97
	HYDROGRAPH AT							
+		D921S	227.	13.50	106.	27.	9.	44.97
	HYDROGRAPH AT							
+		DGAAFS	1316.	13.33	824.	317.	127.	35.26
	ROUTED TO							
+		RAF2	1312.	13.42	823.	317.	127.	35.26
	2 COMBINED AT							
+		CAFA	1504.	13.42	903.	337.	134.	44.97
	ROUTED TO							
+		RAF3	1501.	13.50	902.	337.	134.	44.97
	HYDROGRAPH AT							
+		D921W	145.	13.50	68.	17.	6.	44.97
	3 COMBINED AT							
+		CBHAF	3465.	13.50	2108.	698.	262.	44.97
	HYDROGRAPH AT							
+		9-21W	31.	12.83	13.	4.	1.	.11
	DIVERSION TO							
+		S99AW	31.	12.83	13.	4.	1.	.11
	HYDROGRAPH AT							
+		S99AS	0.	12.42	0.	0.	0.	.11
	ROUTED TO							
+		R99C	0.	12.92	0.	0.	0.	.11
	2 COMBINED AT							
+		CBH6	3465.	13.50	2108.	698.	262.	45.16
	DIVERSION TO							
+		D99BH	0.	.00	0.	0.	0.	45.16
	HYDROGRAPH AT							
+		DBH99	3463.	13.50	2107.	698.	262.	45.16
	ROUTED TO							
+		RBH14	3468.	13.58	2106.	698.	262.	45.16
	HYDROGRAPH AT							
+		8-21E	216.	12.58	55.	14.	5.	.51
	HYDROGRAPH AT							
+		S99AW	31.	12.83	13.	4.	1.	.11
	ROUTED TO							
+		R821EW	30.	13.25	13.	4.	1.	.11
	2 COMBINED AT							
+		C8-21E	216.	12.58	66.	17.	6.	46.01
	DIVERSION TO							
+		D821EW	105.	12.67	32.	8.	3.	46.01
	HYDROGRAPH AT							
+		D821ES	82.	12.67	25.	6.	2.	46.01
	2 COMBINED AT							
+		CBH7	3509.	13.58	2120.	703.	264.	46.01
	HYDROGRAPH AT							
+		8-21W	173.	12.42	34.	9.	3.	.27
	2 COMBINED AT							
+		C8-21W	3537.	13.58	2135.	710.	266.	46.29
	HYDROGRAPH AT							
+		D821EW	105.	12.67	32.	8.	3.	46.01
	ROUTED TO							
+		RES8N	0.	19.08	0.	0.	0.	46.01
	3 COMBINED AT							
+		NULL5	7803.	13.50	4191.	1331.	480.	1.00
	HYDROGRAPH AT							
+		D27BH	963.	12.92	245.	68.	23.	21.30
	ROUTED TO							
+		R27D	952.	13.08	244.	68.	23.	21.30
	HYDROGRAPH AT							
+		13-22	172.	12.42	49.	16.	5.	.25
	HYDROGRAPH AT							
+		14-22	535.	12.58	161.	50.	17.	1.00
	HYDROGRAPH AT							
+		SD31AS	147.	12.00	126.	57.	19.	3.50
	2 COMBINED AT							
+		CSD31B	682.	12.58	287.	107.	36.	1.00

+	DIVERSION TO	SD31BS	150.	11.75	140.	71.	24.	1.00
+	HYDROGRAPH AT	SD31B	532.	12.58	147.	37.	12.	1.00
+	DIVERSION TO	D1422W	255.	12.58	71.	18.	6.	1.00
+	HYDROGRAPH AT	D1422E	277.	12.58	76.	19.	6.	1.00
+	3 COMBINED AT	CCB27	1340.	13.00	379.	106.	35.	5.04
+	DIVERSION TO	D27CB	1340.	13.00	379.	106.	35.	5.04
+	HYDROGRAPH AT	DCB27	0.	.00	0.	0.	0.	5.04
+	HYDROGRAPH AT	D35BH	1143.	12.92	294.	79.	26.	7.10
+	ROUTED TO	R35G	1134.	13.08	294.	79.	26.	7.10
+	HYDROGRAPH AT	D1422W	255.	12.58	71.	18.	6.	1.00
+	HYDROGRAPH AT	15-22	492.	12.67	157.	49.	16.	1.00
+	DIVERSION TO	D1522R	5.	12.58	1.	0.	0.	1.00
+	HYDROGRAPH AT	RET150	488.	12.67	156.	48.	16.	1.00
+	HYDROGRAPH AT	SD39AS	164.	12.00	127.	51.	17.	5.70
+	2 COMBINED AT	CSD39B	652.	12.67	284.	100.	34.	1.00
+	DIVERSION TO	SD39BS	268.	12.00	200.	79.	27.	1.00
+	HYDROGRAPH AT	SD39B	384.	12.67	83.	21.	7.	1.00
+	DIVERSION TO	D1522W	188.	12.67	41.	10.	3.	1.00
+	HYDROGRAPH AT	D1522E	196.	12.67	43.	11.	4.	1.00
+	4 COMBINED AT	CCB35	1500.	13.00	402.	106.	35.	9.14
+	DIVERSION TO	D35CB	1500.	13.00	402.	106.	35.	9.14
+	HYDROGRAPH AT	DCB35	0.	.00	0.	0.	0.	9.14
+	HYDROGRAPH AT	D43BH	233.	13.00	119.	44.	15.	5.70
+	ROUTED TO	R43H	231.	13.17	119.	44.	15.	5.70
+	HYDROGRAPH AT	D1522W	188.	12.67	41.	10.	3.	1.00
+	2 COMBINED AT	C43E	384.	13.00	158.	54.	18.	6.67
+	DIVERSION TO	S43EW	100.	13.00	18.	4.	1.	6.67
+	HYDROGRAPH AT	S43ES	284.	13.00	141.	49.	17.	6.67
+	ROUTED TO	R43I	283.	13.08	141.	49.	17.	6.67
+	HYDROGRAPH AT	D51BH	310.	13.42	53.	13.	4.	10.10
+	ROUTED TO	RGR4	305.	13.67	53.	13.	4.	10.10
+	HYDROGRAPH AT	SBH2S	705.	13.25	227.	63.	21.	10.10
+	ROUTED TO	R1622S	703.	13.33	227.	63.	21.	10.10

+	HYDROGRAPH AT	16-22E	287.	12.58	89.	28.	9.	.51
+	HYDROGRAPH AT	S43EW	100.	13.00	18.	4.	1.	6.67
+	ROUTED TO	R1622W	96.	13.25	18.	4.	1.	6.67
+	4 COMBINED AT	C1622E	1157.	13.50	378.	107.	36.	11.60
+	ROUTED TO	RGR5	1149.	13.67	377.	107.	36.	11.60
+	3 COMBINED AT	CCB43	1391.	13.67	516.	155.	52.	11.60
+	DIVERSION TO	D43CB	1391.	13.67	516.	155.	52.	11.60
+	HYDROGRAPH AT	DCB43	0.	.00	0.	0.	0.	11.60
+	HYDROGRAPH AT	16-22W	697.	12.17	94.	31.	10.	.48
+	DIVERSION TO	D1622W	495.	12.17	66.	22.	7.	.48
+	HYDROGRAPH AT	D1622S	202.	12.17	27.	9.	3.	.48
+	2 COMBINED AT	CCB1	194.	12.17	26.	9.	3.	12.00
+	DIVERSION TO	SCB1S	104.	12.17	10.	2.	1.	12.00
+	HYDROGRAPH AT	SCB1W	90.	12.17	17.	6.	2.	12.00
+	ROUTED TO	RCB1	73.	12.58	17.	6.	2.	12.00
+	HYDROGRAPH AT	D1622W	495.	12.17	66.	22.	7.	.48
+	DIVERSION TO	S51FW	229.	12.17	22.	5.	2.	.48
+	HYDROGRAPH AT	S51FS	266.	12.17	45.	16.	5.	.48
+	ROUTED TO	R51J	248.	12.25	45.	16.	5.	.48
+	2 COMBINED AT	CCB51	275.	12.33	60.	22.	7.	12.00
+	DIVERSION TO	D51CB	135.	12.33	29.	11.	4.	12.00
+	HYDROGRAPH AT	DCB51	140.	12.33	30.	11.	4.	12.00
+	ROUTED TO	RCB2	132.	12.50	30.	11.	4.	12.00
+	HYDROGRAPH AT	SBH3S	162.	12.08	9.	2.	1.	15.10
+	ROUTED TO	R1722S	84.	12.58	9.	2.	1.	15.10
+	HYDROGRAPH AT	17-22	1010.	12.25	182.	58.	19.	1.02
+	DIVERSION TO	D1722R	10.	12.25	1.	0.	0.	1.02
+	HYDROGRAPH AT	RET170	999.	12.25	181.	58.	19.	1.02
+	HYDROGRAPH AT	S51FW	229.	12.17	22.	5.	2.	.48
+	ROUTED TO	R1722W	186.	12.50	22.	5.	2.	.48
+	3 COMBINED AT	C17-22	1028.	12.42	201.	63.	21.	16.10
+	DIVERSION TO	D1722W	298.	12.42	58.	18.	6.	16.10
+	HYDROGRAPH AT	D1722S	730.	12.42	143.	45.	15.	16.10
	2 COMBINED AT							

+	CCB2	846.	12.50	172.	55.	18.	18.10
+ DIVERSION TO	SCB2S	545.	12.50	99.	25.	8.	18.10
+ HYDROGRAPH AT	SCB2W	301.	12.50	73.	30.	10.	18.10
+ ROUTED TO	RCB3	295.	12.58	73.	30.	10.	18.10
+ HYDROGRAPH AT	D59BH	133.	12.25	8.	2.	1.	15.10
+ ROUTED TO	R59J	98.	12.50	8.	2.	1.	15.10
+ HYDROGRAPH AT	D1722W	298.	12.42	58.	18.	6.	16.10
+ 2 COMBINED AT	C59E	394.	12.42	66.	20.	7.	16.10
+ DIVERSION TO	S59FW	223.	12.42	28.	7.	2.	16.10
+ HYDROGRAPH AT	S59FS	171.	12.42	38.	13.	4.	16.10
+ ROUTED TO	R59K	162.	12.58	38.	13.	4.	16.10
+ 2 COMBINED AT	CCB59	455.	12.58	110.	43.	15.	18.10
+ DIVERSION TO	D59CB	161.	12.58	29.	18.	6.	18.10
+ HYDROGRAPH AT	DCB59	294.	12.58	81.	26.	9.	18.10
+ ROUTED TO	RCB4	290.	12.75	81.	26.	9.	18.10
+ HYDROGRAPH AT	SBH4S	202.	12.50	22.	6.	2.	25.80
+ ROUTED TO	R1822S	173.	12.92	22.	6.	2.	25.80
+ HYDROGRAPH AT	18-22	626.	12.58	181.	54.	18.	.97
+ DIVERSION TO	D1822R	3.	12.58	1.	0.	0.	.97
+ HYDROGRAPH AT	RET180	623.	12.58	181.	54.	18.	.97
+ HYDROGRAPH AT	S59FW	223.	12.42	28.	7.	2.	16.10
+ ROUTED TO	R1822W	199.	12.75	28.	7.	2.	16.10
+ 3 COMBINED AT	C18-22	901.	12.83	218.	63.	21.	23.80
+ DIVERSION TO	D1822W	397.	12.83	96.	28.	9.	23.80
+ HYDROGRAPH AT	D1822S	505.	12.83	122.	35.	12.	23.80
+ 2 COMBINED AT	CCB3	781.	12.83	202.	61.	20.	25.30
+ DIVERSION TO	SCB3S	262.	12.83	33.	8.	3.	25.30
+ HYDROGRAPH AT	SCB3W	519.	12.83	169.	52.	17.	25.30
+ ROUTED TO	RCB5	515.	12.92	169.	52.	17.	25.30
+ HYDROGRAPH AT	D67BH	90.	12.75	17.	4.	1.	21.30
+ ROUTED TO	R67L	82.	13.00	17.	4.	1.	21.30
+ HYDROGRAPH AT	D1822W	397.	12.83	96.	28.	9.	23.80
+ 2 COMBINED AT	C67F	439.	12.92	105.	30.	10.	37.08
+ DIVERSION TO	S67GW	258.	12.92	50.	13.	4.	37.08

+	HYDROGRAPH AT	S67GS	181.	12.92	54.	17.	6.	37.08
+	ROUTED TO	R67M	176.	13.08	54.	17.	6.	37.08
+	2 COMBINED AT	CCB67	687.	13.00	226.	70.	24.	25.30
+	DIVERSION TO	D67CB	144.	13.00	19.	5.	2.	25.30
+	HYDROGRAPH AT	DCB67	543.	13.00	206.	65.	22.	25.30
+	ROUTED TO	RCB6	542.	13.08	206.	65.	22.	25.30
+	HYDROGRAPH AT	SBH5S	115.	13.00	24.	6.	2.	31.35
+	ROUTED TO	R1321S	102.	13.50	24.	6.	2.	31.35
+	HYDROGRAPH AT	13-21	698.	12.50	180.	53.	18.	1.00
+	DIVERSION TO	D1321R	91.	12.50	18.	5.	2.	1.00
+	HYDROGRAPH AT	RET132	607.	12.50	163.	48.	16.	1.00
+	HYDROGRAPH AT	S67GW	258.	12.92	50.	13.	4.	37.08
+	ROUTED TO	R1321W	232.	13.33	50.	13.	4.	37.08
+	3 COMBINED AT	C13-21	614.	13.17	217.	62.	21.	37.08
+	DIVERSION TO	D1321W	215.	13.17	76.	22.	7.	37.08
+	HYDROGRAPH AT	D1321S	399.	13.17	141.	40.	13.	37.08
+	2 COMBINED AT	CCB4	926.	13.08	343.	104.	35.	37.08
+	DIVERSION TO	SCB4S	239.	13.08	44.	11.	4.	37.08
+	HYDROGRAPH AT	SCB4W	688.	13.08	299.	93.	31.	37.08
+	ROUTED TO	RCB7	687.	13.25	299.	93.	31.	37.08
+	HYDROGRAPH AT	D75BH	145.	13.08	43.	11.	4.	31.35
+	ROUTED TO	R75M	139.	13.33	43.	11.	4.	31.35
+	HYDROGRAPH AT	D1321W	215.	13.17	76.	22.	7.	37.08
+	2 COMBINED AT	C75F	339.	13.33	112.	31.	10.	40.90
+	DIVERSION TO	S75HW	339.	13.33	112.	31.	10.	40.90
+	HYDROGRAPH AT	S75HS	0.	.00	0.	0.	0.	40.90
+	ROUTED TO	R75N	0.	.00	0.	0.	0.	40.90
+	2 COMBINED AT	CCB75	687.	13.25	299.	93.	31.	37.08
+	DIVERSION TO	GCDC2	687.	13.25	299.	93.	31.	37.08
+	HYDROGRAPH AT	DC2	0.	.00	0.	0.	0.	37.08
+	DIVERSION TO	D75CB	0.	.00	0.	0.	0.	37.08
+	HYDROGRAPH AT	DCB75	0.	.00	0.	0.	0.	37.08
+	ROUTED TO	RCB8	0.	.00	0.	0.	0.	37.08

+	HYDROGRAPH AT	SBH6S	133.	13.17	44.	11.	4.	34.87
+	ROUTED TO	R1421S	131.	13.33	44.	11.	4.	34.87
+	HYDROGRAPH AT	S75HW	339.	13.33	112.	31.	10.	40.90
+	ROUTED TO	R1421W	336.	13.50	112.	31.	10.	40.90
+	HYDROGRAPH AT	14-21E	318.	12.50	83.	24.	8.	.43
+	DIVERSION TO	D1421R	7.	9.25	5.	2.	1.	.43
+	HYDROGRAPH AT	RET14E	318.	12.50	83.	23.	8.	.43
+	HYDROGRAPH AT	S75HW	339.	13.33	112.	31.	10.	40.90
+	ROUTED TO	R1421W	336.	13.50	112.	31.	10.	40.90
+	2 COMBINED AT	C1421A	470.	13.33	183.	50.	17.	41.03
+	DIVERSION TO	GCDC3A	470.	13.33	183.	50.	17.	41.03
+	HYDROGRAPH AT	DC3A	0.	.00	0.	0.	0.	41.03
+	HYDROGRAPH AT	SBH6S	133.	13.17	44.	11.	4.	34.87
+	ROUTED TO	R1421S	131.	13.33	44.	11.	4.	34.87
+	2 COMBINED AT	C1421E	127.	13.33	40.	10.	3.	41.03
+	DIVERSION TO	GCDC3B	127.	13.33	40.	10.	3.	41.03
+	HYDROGRAPH AT	DC3B	0.	.00	0.	0.	0.	41.03
+	DIVERSION TO	D1421X	0.	.00	0.	0.	0.	41.03
+	HYDROGRAPH AT	D1421E	0.	.00	0.	0.	0.	41.03
+	HYDROGRAPH AT	14-21W	611.	12.33	97.	27.	9.	.56
+	DIVERSION TO	D1421P	101.	12.00	6.	2.	1.	.56
+	HYDROGRAPH AT	RET14W	611.	12.33	91.	25.	8.	.56
+	2 COMBINED AT	C1421W	547.	12.33	79.	22.	7.	41.59
+	DIVERSION TO	D1421W	273.	12.33	40.	11.	4.	41.59
+	HYDROGRAPH AT	D1421S	273.	12.33	40.	11.	4.	41.59
+	2 COMBINED AT	CCB5	364.	12.58	150.	41.	14.	41.59
+	DIVERSION TO	SCB5S	189.	12.58	70.	17.	6.	41.59
+	HYDROGRAPH AT	SCB5W	175.	12.58	81.	24.	8.	41.59
+	ROUTED TO	RCB9	173.	13.58	80.	24.	8.	41.59
+	HYDROGRAPH AT	D1421X	0.	.00	0.	0.	0.	41.03
+	ROUTED TO	RES14E	0.	.00	0.	0.	0.	41.03
+	HYDROGRAPH AT	D83BH	0.	13.25	0.	0.	0.	34.34
+	ROUTED TO	R83L	0.	13.83	0.	0.	0.	34.34
	HYDROGRAPH AT							

+	D1421W	273.	12.33	40.	11.	4.	41.59
3 COMBINED AT +	C83F	273.	12.33	40.	11.	4.	41.59
DIVERSION TO +	S83GW	93.	12.33	12.	3.	1.	41.59
HYDROGRAPH AT +	S83GS	181.	12.33	28.	8.	3.	41.59
ROUTED TO +	R83M	168.	12.58	28.	8.	3.	41.59
2 COMBINED AT +	CCB83	329.	12.58	108.	32.	11.	41.59
DIVERSION TO +	D83CB	118.	12.58	39.	11.	4.	41.59
HYDROGRAPH AT +	DCB83	210.	12.58	69.	20.	7.	41.59
ROUTED TO +	RCB10	203.	12.75	69.	20.	7.	41.59
HYDROGRAPH AT +	SBH7S	0.	13.42	0.	0.	0.	43.32
ROUTED TO +	R1521S	0.	14.50	0.	0.	0.	43.32
HYDROGRAPH AT +	15-21	605.	12.58	164.	43.	14.	1.01
DIVERSION TO +	D15	73.	12.58	12.	3.	1.	1.01
HYDROGRAPH AT +	RET15	533.	12.58	152.	40.	13.	1.01
HYDROGRAPH AT +	S83GW	93.	12.33	12.	3.	1.	41.59
ROUTED TO +	R1521W	77.	12.75	12.	3.	1.	41.59
3 COMBINED AT +	C15-21	572.	12.67	152.	40.	13.	48.80
DIVERSION TO +	D1521W	188.	12.67	49.	13.	4.	48.80
HYDROGRAPH AT +	D1521S	348.	12.67	92.	24.	8.	48.80
2 COMBINED AT +	CCB6	547.	12.75	158.	44.	15.	48.80
DIVERSION TO +	SCB6S	208.	12.75	53.	13.	4.	48.80
HYDROGRAPH AT +	SCB6W	338.	12.75	105.	30.	10.	48.80
ROUTED TO +	RCB11	333.	12.92	105.	30.	10.	48.80
HYDROGRAPH AT +	D91BH	0.	.00	0.	0.	0.	43.32
HYDROGRAPH AT +	D1521W	188.	12.67	49.	13.	4.	48.80
2 COMBINED AT +	C91E	188.	12.67	49.	13.	4.	48.80
DIVERSION TO +	S91EW	68.	12.67	13.	3.	1.	48.80
HYDROGRAPH AT +	S91ES	120.	12.67	36.	10.	3.	48.80
ROUTED TO +	R91J	116.	13.00	36.	10.	3.	48.80
2 COMBINED AT +	CCB91	448.	12.92	141.	40.	13.	48.80
DIVERSION TO +	D91CB	255.	12.92	80.	23.	8.	48.80
HYDROGRAPH AT +	DCB91	193.	12.92	61.	17.	6.	48.80
ROUTED TO +	RCB12	189.	13.08	60.	17.	6.	48.80
HYDROGRAPH AT +	16-21E	425.	12.67	127.	33.	11.	.84

+	HYDROGRAPH AT	S91EW	68.	12.67	13.	3.	1.	48.80
+	ROUTED TO	R1621W	57.	13.33	13.	3.	1.	48.80
+	2 COMBINED AT	C16-21	425.	12.75	140.	36.	12.	50.27
+	DIVERSION TO	D1621W	151.	12.75	49.	13.	4.	50.27
+	HYDROGRAPH AT	D1621S	226.	12.75	73.	19.	6.	50.27
+	2 COMBINED AT	CCB7	405.	13.08	133.	36.	12.	50.27
+	DIVERSION TO	SCB7S	99.	13.08	29.	7.	2.	50.27
+	HYDROGRAPH AT	SCB7W	306.	13.08	104.	29.	10.	50.27
+	ROUTED TO	RCB13	305.	13.08	104.	29.	10.	50.27
+	HYDROGRAPH AT	D1621W	151.	12.75	49.	13.	4.	50.27
+	ROUTED TO	RAF4	150.	12.83	49.	13.	4.	50.27
+	2 COMBINED AT	CCBAF	453.	13.08	152.	41.	14.	50.27
+	DIVERSION TO	DCBAFS	453.	13.08	152.	41.	14.	50.27
+	HYDROGRAPH AT	DCBAF	0.	13.00	0.	0.	0.	50.27
+	HYDROGRAPH AT	16-21W	92.	12.58	28.	7.	2.	.18
+	HYDROGRAPH AT	D99BH	0.	.00	0.	0.	0.	45.16
+	2 COMBINED AT	C99B	92.	12.58	28.	7.	2.	50.64
+	DIVERSION TO	S99BW	21.	12.58	4.	1.	0.	50.64
+	HYDROGRAPH AT	S99BS	58.	12.58	20.	5.	2.	50.64
+	ROUTED TO	R99E	56.	12.83	20.	5.	2.	50.64
+	2 COMBINED AT	CCB99	56.	12.83	20.	5.	2.	50.64
+	DIVERSION TO	D99CB	19.	12.83	7.	2.	1.	50.64
+	HYDROGRAPH AT	DCB99	37.	12.83	13.	3.	1.	50.64
+	ROUTED TO	RCB14	35.	13.25	13.	3.	1.	50.64
+	HYDROGRAPH AT	17-21E	287.	12.75	92.	24.	8.	.70
+	HYDROGRAPH AT	S99BW	21.	12.58	4.	1.	0.	50.64
+	ROUTED TO	R1721W	15.	13.75	4.	1.	0.	50.64
+	2 COMBINED AT	C1721E	288.	12.75	96.	25.	8.	51.34
+	DIVERSION TO	D1721W	52.	12.67	17.	4.	1.	51.34
+	HYDROGRAPH AT	D1721S	195.	12.67	65.	17.	6.	51.34
+	2 COMBINED AT	CCB8	214.	13.00	78.	20.	7.	51.34
+	DIVERSION TO	SCB8S	76.	13.00	26.	6.	2.	51.34
+	HYDROGRAPH AT	SCB8W	137.	13.00	52.	14.	5.	51.34

	ROUTED TO						
+		RCB15	136.	13.17	52.	14.	5.	51.34
	HYDROGRAPH AT						
+		D1721W	52.	12.67	17.	4.	1.	51.34
	2 COMBINED AT						
+		CCB107	182.	13.08	69.	18.	6.	51.65
	DIVERSION TO						
+		D107CB	82.	13.08	31.	8.	3.	51.65
	HYDROGRAPH AT						
+		DCB107	100.	13.08	38.	10.	3.	51.65
	HYDROGRAPH AT						
+		17-21W	95.	12.67	33.	9.	3.	.31
	ROUTED TO						
+		R1821W	88.	13.58	33.	9.	3.	.31
	HYDROGRAPH AT						
+		18-21	183.	12.67	53.	13.	4.	.54
	3 COMBINED AT						
+		C18-21	251.	13.50	106.	28.	9.	52.19
	2 COMBINED AT						
+		NULL6	478.	13.33	194.	50.	17.	1.00
	HYDROGRAPH AT						
+		23-22	597.	12.67	182.	54.	18.	.99
	HYDROGRAPH AT						
+		SD31BS	150.	11.75	140.	71.	24.	1.00
	2 COMBINED AT						
+		CSD31C	747.	12.67	322.	125.	42.	.99
	DIVERSION TO						
+		SD31CS	251.	12.00	211.	97.	33.	.99
	HYDROGRAPH AT						
+		SD31C	496.	12.67	111.	28.	9.	.99
	DIVERSION TO						
+		D2322W	293.	12.67	65.	16.	5.	.99
	HYDROGRAPH AT						
+		D2322E	203.	12.67	45.	11.	4.	.99
	HYDROGRAPH AT						
+		D27CB	1340.	13.00	379.	106.	35.	5.04
	ROUTED TO						
+		R27E	1331.	13.17	379.	106.	35.	5.04
	HYDROGRAPH AT						
+		24-22	212.	12.33	52.	17.	6.	.22
	DIVERSION TO						
+		D2422R	6.	12.33	1.	0.	0.	.22
	HYDROGRAPH AT						
+		RET240	205.	12.33	51.	17.	6.	.22
	3 COMBINED AT						
+		CIS27	1565.	13.08	470.	133.	44.	6.25
	DIVERSION TO						
+		D27IS	1565.	13.08	470.	133.	44.	6.25
	HYDROGRAPH AT						
+		DIS27	0.	.00	0.	0.	0.	6.25
	HYDROGRAPH AT						
+		D35CB	1500.	13.00	402.	106.	35.	9.14
	ROUTED TO						
+		R35H	1497.	13.08	402.	106.	35.	9.14
	HYDROGRAPH AT						
+		D2322W	293.	12.67	65.	16.	5.	.99
	2 COMBINED AT						
+		C35D	1727.	13.08	464.	122.	41.	10.13
	ROUTED TO						
+		R35I	1719.	13.08	464.	122.	41.	10.13
	2 COMBINED AT						
+		CIS35	1720.	13.08	464.	122.	41.	10.10
	HYDROGRAPH AT						
+		D43CB	1391.	13.67	516.	155.	52.	11.60
	DIVERSION TO						
+		SD43AS	165.	12.33	150.	64.	22.	11.60
	HYDROGRAPH AT						

+		SD43A	1226.	13.67	366.	92.	31.	11.60
+	ROUTED TO	RGR6	1219.	13.75	366.	92.	31.	11.60
+	HYDROGRAPH AT	22-22E	403.	12.42	92.	29.	10.	.53
+	HYDROGRAPH AT	SD39BS	268.	12.00	200.	79.	27.	1.00
+	3 COMBINED AT	C2222E	1557.	13.75	650.	197.	66.	12.10
+	DIVERSION TO	SD39CS	268.	11.92	232.	93.	31.	12.10
+	HYDROGRAPH AT	SD39C	1289.	13.75	418.	105.	35.	12.10
+	ROUTED TO	RGR7	1283.	13.83	418.	105.	35.	12.10
+	2 COMBINED AT	CIS35A	2604.	13.17	861.	221.	74.	15.60
+	DIVERSION TO	D35IS	1313.	13.17	479.	120.	40.	15.60
+	HYDROGRAPH AT	DIS35	1290.	13.17	382.	101.	34.	15.60
+	DIVERSION TO	SIS1AS	1290.	13.17	382.	101.	34.	15.60
+	HYDROGRAPH AT	SIS1AW	0.	.00	0.	0.	0.	15.60
+	HYDROGRAPH AT	22-22W	710.	12.08	93.	31.	10.	.47
+	DIVERSION TO	D2222W	99.	12.08	13.	4.	1.	.47
+	HYDROGRAPH AT	D2222S	610.	12.08	80.	26.	9.	.47
+	HYDROGRAPH AT	SD39CS	268.	11.92	232.	93.	31.	12.10
+	3 COMBINED AT	C2222W	846.	12.08	305.	117.	39.	16.00
+	DIVERSION TO	SIS1S	625.	12.08	287.	113.	38.	16.00
+	HYDROGRAPH AT	SIS1W	221.	12.08	17.	4.	1.	16.00
+	ROUTED TO	RIS1	208.	12.25	17.	4.	1.	16.00
+	HYDROGRAPH AT	D2222W	99.	12.08	13.	4.	1.	.47
+	HYDROGRAPH AT	SD43AS	165.	12.33	150.	64.	22.	11.60
+	2 COMBINED AT	CSD43A	234.	12.25	161.	67.	23.	16.00
+	DIVERSION TO	S43FW	25.	12.25	11.	3.	1.	16.00
+	HYDROGRAPH AT	S43FS	209.	12.25	150.	65.	22.	16.00
+	ROUTED TO	R43J	193.	12.50	150.	65.	22.	16.00
+	2 COMBINED AT	CIS43	370.	12.25	167.	69.	23.	16.00
+	DIVERSION TO	D43IS	266.	12.25	138.	62.	21.	16.00
+	HYDROGRAPH AT	DIS43	104.	12.25	29.	7.	2.	16.00
+	ROUTED TO	RIS2	84.	12.67	29.	7.	2.	16.00
+	HYDROGRAPH AT	SCB1S	104.	12.17	10.	2.	1.	12.00
+	ROUTED TO	R2122S	58.	12.67	10.	2.	1.	12.00
+	HYDROGRAPH AT	21-22	719.	12.42	157.	48.	16.	1.00

+	DIVERSION TO	D2122R	14.	12.42	3.	1.	0.	1.00
+	HYDROGRAPH AT	RET210	704.	12.42	154.	47.	16.	1.00
+	HYDROGRAPH AT	S43FW	25.	12.25	11.	3.	1.	16.00
+	ROUTED TO	R2122W	16.	13.17	10.	3.	1.	16.00
+	3 COMBINED AT	C21-22	708.	12.42	165.	50.	17.	13.50
+	DIVERSION TO	D2122W	198.	12.42	46.	14.	5.	13.50
+	HYDROGRAPH AT	D2122S	510.	12.42	119.	36.	12.	13.50
+	2 COMBINED AT	CIS1	546.	12.58	143.	43.	14.	17.50
+	DIVERSION TO	SIS2SA	273.	12.58	72.	21.	7.	17.50
+	HYDROGRAPH AT	SIS2WA	273.	12.58	72.	21.	7.	17.50
+	DIVERSION TO	SIS2S	167.	12.58	27.	7.	2.	17.50
+	HYDROGRAPH AT	SIS2W	106.	12.58	45.	15.	5.	17.50
+	ROUTED TO	RIS3	104.	12.83	44.	15.	5.	17.50
+	HYDROGRAPH AT	D51CB	135.	12.33	29.	11.	4.	12.00
+	ROUTED TO	R51K	122.	12.50	29.	11.	4.	12.00
+	HYDROGRAPH AT	D2122W	198.	12.42	46.	14.	5.	13.50
+	2 COMBINED AT	C51E	316.	12.50	75.	25.	8.	13.50
+	DIVERSION TO	S51GW	129.	12.50	19.	5.	2.	13.50
+	HYDROGRAPH AT	S51GS	187.	12.50	56.	20.	7.	13.50
+	ROUTED TO	R51L	183.	12.67	56.	20.	7.	13.50
+	2 COMBINED AT	CIS51	281.	12.67	99.	34.	12.	17.50
+	DIVERSION TO	D51IS	265.	12.67	98.	34.	11.	17.50
+	HYDROGRAPH AT	DIS51	16.	12.67	1.	0.	0.	17.50
+	ROUTED TO	RIS4	11.	13.25	1.	0.	0.	17.50
+	HYDROGRAPH AT	SCB2S	545.	12.50	99.	25.	8.	18.10
+	ROUTED TO	R2022S	523.	12.67	99.	25.	8.	18.10
+	HYDROGRAPH AT	20-22	552.	12.67	173.	54.	18.	1.01
+	HYDROGRAPH AT	S51GW	129.	12.50	19.	5.	2.	13.50
+	ROUTED TO	R2022W	109.	13.08	19.	5.	2.	13.50
+	3 COMBINED AT	C20-22	1043.	12.67	279.	81.	27.	20.50
+	DIVERSION TO	D2022W	407.	12.67	109.	31.	10.	20.50
+	HYDROGRAPH AT	D2022S	636.	12.67	170.	49.	16.	20.50
+	2 COMBINED AT	CIS2	629.	12.67	170.	49.	16.	24.50

	DIVERSION TO							
+		SIS3S	424.	12.67	95.	26.	9.	24.50
	HYDROGRAPH AT							
+		SIS3W	205.	12.67	75.	23.	8.	24.50
	ROUTED TO							
+		RIS5	204.	12.92	75.	23.	8.	24.50
	HYDROGRAPH AT							
+		D59CB	161.	12.58	29.	18.	6.	18.10
	ROUTED TO							
+		R59L	152.	12.75	29.	18.	6.	18.10
	HYDROGRAPH AT							
+		D2022W	407.	12.67	109.	31.	10.	20.50
	2 COMBINED AT							
+		C59F	555.	12.75	138.	49.	16.	20.50
	DIVERSION TO							
+		S59GW	300.	12.75	50.	13.	4.	20.50
	HYDROGRAPH AT							
+		S59GS	255.	12.75	87.	36.	12.	20.50
	ROUTED TO							
+		R59M	252.	12.92	87.	36.	12.	20.50
	2 COMBINED AT							
+		CIS59	453.	12.92	161.	59.	20.	24.50
	DIVERSION TO							
+		D59IS	416.	12.92	159.	59.	20.	24.50
	HYDROGRAPH AT							
+		DIS59	37.	12.92	3.	1.	0.	24.50
	ROUTED TO							
+		RIS6	30.	13.08	3.	1.	0.	24.50
	HYDROGRAPH AT							
+		SCB3S	262.	12.83	33.	8.	3.	25.30
	ROUTED TO							
+		R1922S	212.	13.33	33.	8.	3.	25.30
	HYDROGRAPH AT							
+		19-22	631.	12.50	163.	48.	16.	.94
	ROUTED TO							
+		PAGC	626.	12.58	160.	46.	15.	.94
	HYDROGRAPH AT							
+		S59GW	300.	12.75	50.	13.	4.	20.50
	ROUTED TO							
+		R1922W	276.	13.17	50.	13.	4.	20.50
	3 COMBINED AT							
+		C19-22	879.	13.17	231.	64.	22.	28.70
	DIVERSION TO							
+		D1922W	387.	13.17	102.	28.	9.	28.70
	HYDROGRAPH AT							
+		D1922S	492.	13.17	130.	36.	12.	28.70
	2 COMBINED AT							
+		CIS3	507.	13.17	130.	36.	12.	32.70
	DIVERSION TO							
+		SIS4S	482.	13.17	109.	27.	9.	32.70
	HYDROGRAPH AT							
+		SIS4W	26.	13.17	21.	9.	3.	32.70
	HYDROGRAPH AT							
+		D67CB	144.	13.00	19.	5.	2.	25.30
	ROUTED TO							
+		R67N	138.	13.08	19.	5.	2.	25.30
	HYDROGRAPH AT							
+		D1922W	387.	13.17	102.	28.	9.	28.70
	2 COMBINED AT							
+		C67G	523.	13.17	121.	33.	11.	28.70
	DIVERSION TO							
+		S67HW	523.	13.17	121.	33.	11.	28.70
	HYDROGRAPH AT							
+		S67HS	0.	.00	0.	0.	0.	28.70
	2 COMBINED AT							
+		CIS67	26.	13.17	21.	9.	3.	28.70
	DIVERSION TO							

+	D67IS	26.	13.17	21.	9.	3.	28.70
+ HYDROGRAPH AT	DIS67	0.	.00	0.	0.	0.	28.70
+ HYDROGRAPH AT	S67HW	523.	13.17	121.	33.	11.	28.70
+ ROUTED TO	R2421W	481.	13.75	121.	33.	11.	28.70
+ HYDROGRAPH AT	24-21N	421.	12.33	79.	23.	8.	.41
+ HYDROGRAPH AT	SCB4S	239.	13.08	44.	11.	4.	37.08
+ ROUTED TO	R2421S	234.	13.33	44.	11.	4.	37.08
+ 3 COMBINED AT	C2421N	667.	13.67	226.	63.	21.	40.90
+ DIVERSION TO	GCDC1	667.	13.67	226.	63.	21.	40.90
+ HYDROGRAPH AT	DC1	0.	.00	0.	0.	0.	40.90
+ ROUTED TO	RES24N	0.	.00	0.	0.	0.	40.90
+ HYDROGRAPH AT	24-21S	855.	12.25	120.	37.	12.	.61
+ 2 COMBINED AT	C2421S	772.	12.25	108.	33.	11.	41.52
+ DIVERSION TO	D2421W	162.	12.25	23.	7.	2.	41.52
+ HYDROGRAPH AT	D2421S	610.	12.25	85.	26.	9.	41.52
+ 2 COMBINED AT	CIS5	610.	12.25	85.	26.	9.	41.52
+ DIVERSION TO	SIS5S	318.	12.25	36.	9.	3.	41.52
+ HYDROGRAPH AT	SIS5W	292.	12.25	49.	17.	6.	41.52
+ ROUTED TO	RIS8	275.	12.33	49.	17.	6.	41.52
+ HYDROGRAPH AT	D75CB	0.	.00	0.	0.	0.	37.08
+ HYDROGRAPH AT	D2421W	162.	12.25	23.	7.	2.	41.52
+ 2 COMBINED AT	C75F1	162.	12.25	23.	7.	2.	41.52
+ DIVERSION TO	S75IW	89.	12.25	8.	2.	1.	41.52
+ HYDROGRAPH AT	S75IS	73.	12.25	14.	5.	2.	41.52
+ ROUTED TO	R75O	67.	12.42	14.	5.	2.	41.52
+ 2 COMBINED AT	CIS75	338.	12.33	63.	22.	7.	41.52
+ DIVERSION TO	D75IS	282.	12.33	57.	20.	7.	41.52
+ HYDROGRAPH AT	DIS75	56.	12.33	6.	2.	1.	41.52
+ ROUTED TO	RIS9	44.	12.67	6.	2.	1.	41.52
+ HYDROGRAPH AT	SCB5S	189.	12.58	70.	17.	6.	41.59
+ ROUTED TO	R2321S	183.	13.75	70.	17.	6.	41.59
+ HYDROGRAPH AT	23-21	737.	12.50	175.	53.	18.	.99
+ HYDROGRAPH AT	S75IW	89.	12.25	8.	2.	1.	41.52
+ ROUTED TO	R2321W	49.	13.00	8.	2.	1.	41.52

+	3 COMBINED AT	C23-21	737.	12.83	236.	68.	23.	47.02
+	DIVERSION TO	D2321W	309.	12.83	98.	28.	9.	47.02
+	HYDROGRAPH AT	D2321S	409.	12.83	130.	37.	12.	47.02
+	2 COMBINED AT	CIS6	443.	12.75	136.	39.	13.	47.02
+	DIVERSION TO	SIS6S	283.	12.75	67.	17.	6.	47.02
+	HYDROGRAPH AT	SIS6W	159.	12.75	69.	23.	8.	47.02
+	ROUTED TO	RIS10	159.	12.92	69.	23.	8.	47.02
+	HYDROGRAPH AT	D83CB	118.	12.58	39.	11.	4.	41.59
+	ROUTED TO	R83N	112.	12.83	39.	11.	4.	41.59
+	HYDROGRAPH AT	D2321W	309.	12.83	98.	28.	9.	47.02
+	2 COMBINED AT	C83G	420.	12.83	135.	39.	13.	47.02
+	DIVERSION TO	S83HW	6.	12.83	2.	0.	0.	47.02
+	HYDROGRAPH AT	S83HS	414.	12.83	133.	39.	13.	47.02
+	ROUTED TO	R83O	407.	13.00	133.	39.	13.	47.02
+	2 COMBINED AT	CIS83	565.	12.92	202.	62.	21.	47.02
+	DIVERSION TO	D83IS	323.	12.92	155.	50.	17.	47.02
+	HYDROGRAPH AT	DIS83	241.	12.92	47.	12.	4.	47.02
+	ROUTED TO	RIS11	239.	13.08	47.	12.	4.	47.02
+	HYDROGRAPH AT	SCB6S	208.	12.75	53.	13.	4.	48.80
+	ROUTED TO	R2221S	198.	13.17	53.	13.	4.	48.80
+	HYDROGRAPH AT	22-21	696.	12.58	191.	54.	18.	1.00
+	HYDROGRAPH AT	S83HW	6.	12.83	2.	0.	0.	47.02
+	ROUTED TO	R2221W	5.	13.67	2.	0.	0.	47.02
+	3 COMBINED AT	C22-21	696.	13.00	224.	62.	21.	55.24
+	DIVERSION TO	D2221W	386.	13.00	124.	35.	12.	55.24
+	HYDROGRAPH AT	D2221S	291.	13.00	94.	26.	9.	55.24
+	2 COMBINED AT	CIS7	519.	13.08	139.	37.	13.	55.24
+	DIVERSION TO	SIS7S	270.	13.08	59.	15.	5.	55.24
+	HYDROGRAPH AT	SIS7W	249.	13.08	80.	23.	8.	55.24
+	ROUTED TO	RIS12	246.	13.17	80.	23.	8.	55.24
+	HYDROGRAPH AT	D91CB	255.	12.92	80.	23.	8.	48.80
+	ROUTED TO	R91K	251.	13.08	80.	23.	8.	48.80
+	HYDROGRAPH AT	D2221W	386.	13.00	124.	35.	12.	55.24

	2 COMBINED AT						
+		C91F	630.	13.00	202.	57.	19.	55.24
	DIVERSION TO						
+		S91FW	348.	13.00	105.	26.	9.	55.24
	HYDROGRAPH AT						
+		S91FS	283.	13.00	97.	31.	10.	55.24
	ROUTED TO						
+		R91L	278.	13.25	97.	31.	10.	55.24
	2 COMBINED AT						
+		CIS91	523.	13.17	176.	53.	18.	55.24
	DIVERSION TO						
+		D91IS	234.	13.17	120.	39.	13.	55.24
	HYDROGRAPH AT						
+		DIS91	289.	13.17	56.	14.	5.	55.24
	ROUTED TO						
+		RIS13	286.	13.33	56.	14.	5.	55.24
	HYDROGRAPH AT						
+		SCB7S	99.	13.08	29.	7.	2.	50.27
	ROUTED TO						
+		R2121S	96.	13.50	29.	7.	2.	50.27
	HYDROGRAPH AT						
+		21-21E	322.	12.75	110.	28.	9.	.72
	HYDROGRAPH AT						
+		S91FW	348.	13.00	105.	26.	9.	55.24
	ROUTED TO						
+		R2121W	344.	13.25	105.	26.	9.	55.24
	3 COMBINED AT						
+		C21-21	654.	13.25	224.	56.	19.	58.45
	DIVERSION TO						
+		D2121W	347.	13.25	119.	30.	10.	58.45
	HYDROGRAPH AT						
+		D2121S	308.	13.25	105.	26.	9.	58.45
	2 COMBINED AT						
+		CIS8	585.	13.33	161.	40.	13.	58.45
	DIVERSION TO						
+		SIS8S	225.	13.33	57.	14.	5.	58.45
	HYDROGRAPH AT						
+		SIS8W	360.	13.33	104.	26.	9.	58.45
	HYDROGRAPH AT						
+		RCBAF	453.	13.08	152.	41.	14.	50.27
	ROUTED TO						
+		RAF5	453.	13.17	152.	41.	14.	50.27
	HYDROGRAPH AT						
+		D2121W	347.	13.25	119.	30.	10.	58.45
	2 COMBINED AT						
+		CAFB	788.	13.17	268.	70.	23.	58.45
	ROUTED TO						
+		RAF6	787.	13.25	268.	70.	23.	58.45
	2 COMBINED AT						
+		CISAF	1147.	13.25	372.	96.	32.	58.45
	DIVERSION TO						
+		DISAFS	1146.	13.25	372.	96.	32.	58.45
	HYDROGRAPH AT						
+		DISAF	0.	13.25	0.	0.	0.	58.45
	HYDROGRAPH AT						
+		R99CB	19.	12.83	7.	2.	1.	50.64
	ROUTED TO						
+		R99F	17.	13.42	7.	2.	1.	50.64
	HYDROGRAPH AT						
+		21-21W	128.	12.75	45.	11.	4.	.29
	2 COMBINED AT						
+		C99C	116.	12.92	43.	11.	4.	59.10
	DIVERSION TO						
+		S99CW	46.	12.92	13.	3.	1.	59.10
	HYDROGRAPH AT						
+		S99CS	70.	12.92	30.	8.	3.	59.10
	ROUTED TO						

+	R99G	69.	13.25	30.	8.	3.	59.10
+ 2 COMBINED AT	CIS99	69.	13.25	30.	8.	3.	59.10
+ DIVERSION TO	D99IS	15.	13.25	7.	2.	1.	59.10
+ HYDROGRAPH AT	DIS99	54.	13.25	23.	6.	2.	59.10
+ ROUTED TO	RIS15	53.	13.50	23.	6.	2.	59.10
+ HYDROGRAPH AT	SCB8S	76.	13.00	26.	6.	2.	51.34
+ ROUTED TO	R2021S	74.	13.58	26.	6.	2.	51.34
+ HYDROGRAPH AT	20-21	574.	12.67	177.	51.	17.	1.02
+ DIVERSION TO	D2021R	379.	12.67	57.	15.	5.	1.02
+ HYDROGRAPH AT	RET20	501.	13.08	127.	36.	12.	1.02
+ HYDROGRAPH AT	S99CW	46.	12.92	13.	3.	1.	59.10
+ ROUTED TO	R2021W	40.	13.83	13.	3.	1.	59.10
+ 3 COMBINED AT	C20-21	729.	13.17	155.	43.	14.	60.83
+ DIVERSION TO	D2021W	124.	13.25	38.	10.	3.	60.83
+ HYDROGRAPH AT	D2021S	336.	13.25	102.	28.	9.	60.83
+ 2 COMBINED AT	CIS9	387.	13.25	125.	34.	11.	60.83
+ DIVERSION TO	SIS9S	105.	13.25	31.	8.	3.	60.83
+ HYDROGRAPH AT	SIS9W	282.	13.25	94.	26.	9.	60.83
+ ROUTED TO	RIS16	273.	13.50	94.	26.	9.	60.83
+ HYDROGRAPH AT	D107CB	82.	13.08	31.	8.	3.	51.65
+ ROUTED TO	R107A	81.	13.33	31.	8.	3.	51.65
+ HYDROGRAPH AT	D2021W	124.	13.25	38.	10.	3.	60.83
+ 2 COMBINED AT	C107A	203.	13.25	68.	18.	6.	60.83
+ DIVERSION TO	S107AW	80.	13.25	22.	5.	2.	60.83
+ HYDROGRAPH AT	S107AS	123.	13.25	46.	13.	4.	60.83
+ ROUTED TO	R107B	117.	13.58	46.	13.	4.	60.83
+ 2 COMBINED AT	CIS107	389.	13.50	140.	39.	13.	60.83
+ DIVERSION TO	D107IS	261.	13.50	94.	26.	9.	60.83
+ HYDROGRAPH AT	DIS107	129.	13.50	46.	13.	4.	60.83
+ ROUTED TO	RIS17	123.	13.83	46.	13.	4.	60.83
+ HYDROGRAPH AT	19-21	443.	12.50	98.	27.	9.	.87
+ HYDROGRAPH AT	S107AW	80.	13.25	22.	5.	2.	60.83
+ ROUTED TO	R1921W	74.	13.58	22.	5.	2.	60.83
+ 2 COMBINED AT	C19-21	443.	12.50	124.	33.	11.	61.70

+	DIVERSION TO	D1921W	262.	12.50	73.	20.	7.	61.70
+	HYDROGRAPH AT	D1921S	102.	12.50	28.	8.	3.	61.70
+	2 COMBINED AT	CIS10	167.	13.75	73.	21.	7.	61.70
+	ROUTED TO	RIS18	163.	13.92	72.	21.	7.	61.70
+	HYDROGRAPH AT	D1921W	262.	12.50	73.	20.	7.	61.70
+	3 COMBINED AT	NULL7	827.	13.33	371.	99.	33.	1.00
+	HYDROGRAPH AT	D35IS	1313.	13.17	479.	120.	40.	15.60
+	ROUTED TO	RGR8	1313.	13.33	479.	120.	40.	15.60
+	HYDROGRAPH AT	D27IS	1565.	13.08	470.	133.	44.	6.25
+	ROUTED TO	R27F	1570.	13.17	470.	133.	44.	6.25
+	HYDROGRAPH AT	26-22N	652.	12.08	77.	25.	8.	.38
+	HYDROGRAPH AT	SD31CS	251.	12.00	211.	97.	33.	.99
+	4 COMBINED AT	C2622N	3080.	13.17	1207.	366.	123.	16.65
+	DIVERSION TO	SD31DS	251.	11.58	245.	125.	42.	16.65
+	HYDROGRAPH AT	SD31D	2829.	13.17	962.	240.	80.	16.65
+	ROUTED TO	RES26T	2832.	13.25	996.	369.	230.	16.65
+	DIVERSION TO	D26S	2832.	13.25	996.	369.	230.	16.65
+	HYDROGRAPH AT	D26W	0.	.00	0.	0.	0.	16.65
+	HYDROGRAPH AT	SIS1AS	1290.	13.17	382.	101.	34.	15.60
+	DIVERSION TO	SD35DS	75.	12.25	64.	21.	7.	15.60
+	HYDROGRAPH AT	SD35DW	1215.	13.17	318.	80.	27.	15.60
+	ROUTED TO	R2722W	1216.	13.33	318.	80.	27.	15.60
+	HYDROGRAPH AT	SIS1S	625.	12.08	287.	113.	38.	16.00
+	ROUTED TO	R2722S	603.	12.25	287.	113.	38.	16.00
+	HYDROGRAPH AT	27-22N	399.	12.25	84.	28.	9.	.37
+	4 COMBINED AT	C2722N	1615.	13.25	682.	218.	73.	16.40
+	DIVERSION TO	D2722A	244.	13.25	74.	18.	6.	16.40
+	HYDROGRAPH AT	D2722N	1371.	13.25	608.	200.	67.	16.40
+	DIVERSION TO	D39S	771.	13.25	338.	133.	45.	16.40
+	HYDROGRAPH AT	D39	600.	12.92	270.	68.	23.	16.40
+	HYDROGRAPH AT	D43IS	266.	12.25	138.	62.	21.	16.00
+	ROUTED TO	R43K	258.	12.42	138.	62.	21.	16.00
+	DIVERSION TO	S43GW	84.	12.42	25.	6.	2.	16.00

	HYDROGRAPH AT						
+		S43GS	173.	12.42	113.	55.	19.	16.00
	HYDROGRAPH AT						
+		D2722A	244.	13.25	74.	18.	6.	16.40
	3 COMBINED AT						
+		C2722A	959.	13.25	456.	141.	48.	16.40
	ROUTED TO						
+		PA43	960.	13.25	457.	142.	48.	16.40
	DIVERSION TO						
+		D43S	760.	13.25	328.	109.	37.	16.40
	HYDROGRAPH AT						
+		D43	200.	12.00	129.	32.	11.	16.40
	ROUTED TO						
+		R2822W	200.	12.67	128.	32.	11.	16.40
	HYDROGRAPH AT						
+		SIS2S	167.	12.58	27.	7.	2.	17.50
	HYDROGRAPH AT						
+		SIS2SA	273.	12.58	72.	21.	7.	17.50
	2 COMBINED AT						
+		C2822A	439.	12.58	99.	28.	9.	18.30
	ROUTED TO						
+		R2822S	432.	12.67	98.	28.	9.	18.30
	HYDROGRAPH AT						
+		28-22N	386.	12.33	79.	25.	8.	.45
	HYDROGRAPH AT						
+		S43GW	84.	12.42	25.	6.	2.	16.00
	3 COMBINED AT						
+		C2822N	798.	12.58	194.	58.	19.	18.30
	DIVERSION TO						
+		D2822A	590.	12.58	144.	43.	14.	18.30
	HYDROGRAPH AT						
+		D2822N	207.	12.58	50.	15.	5.	18.30
	2 COMBINED AT						
+		C2822D	407.	12.58	177.	47.	16.	18.30
	ROUTED TO						
+		PA47	364.	12.92	177.	47.	16.	18.30
	DIVERSION TO						
+		D47S	0.	12.83	0.	0.	0.	18.30
	HYDROGRAPH AT						
+		D47	364.	12.92	177.	47.	16.	18.30
	HYDROGRAPH AT						
+		D51IS	265.	12.67	98.	34.	11.	17.50
	ROUTED TO						
+		R51M	263.	12.83	98.	34.	11.	17.50
	DIVERSION TO						
+		S51HW	28.	12.83	2.	1.	0.	17.50
	HYDROGRAPH AT						
+		S51HS	235.	12.83	96.	34.	11.	17.50
	HYDROGRAPH AT						
+		D2822A	590.	12.58	144.	43.	14.	18.30
	3 COMBINED AT						
+		C2822B	1148.	12.67	416.	123.	41.	18.30
	ROUTED TO						
+		PA51	886.	13.17	408.	123.	41.	18.30
	DIVERSION TO						
+		D51S	871.	13.17	405.	122.	41.	18.30
	HYDROGRAPH AT						
+		D51	16.	13.17	3.	1.	0.	18.30
	HYDROGRAPH AT						
+		SIS3S	424.	12.67	95.	26.	9.	24.50
	ROUTED TO						
+		R2922S	421.	12.83	95.	26.	9.	24.50
	HYDROGRAPH AT						
+		29-22N	435.	12.25	71.	22.	7.	.41
	DIVERSION TO						
+		D2922R	33.	12.00	3.	1.	0.	.41
	HYDROGRAPH AT						

+		RET29N	435.	12.25	69.	21.	7.	.41
	2 COMBINED AT							
+		C2922N	604.	12.75	158.	45.	15.	24.90
	DIVERSION TO							
+		D2922A	326.	12.75	85.	24.	8.	24.90
	HYDROGRAPH AT							
+		D2922N	278.	12.75	73.	21.	7.	24.90
	HYDROGRAPH AT							
+		S51HW	28.	12.83	2.	1.	0.	17.50
	3 COMBINED AT							
+		C2922B	303.	12.75	78.	22.	7.	25.80
	ROUTED TO							
+		PA55	124.	13.25	78.	22.	7.	25.80
	DIVERSION TO							
+		D55S	124.	13.25	73.	18.	6.	25.80
	HYDROGRAPH AT							
+		D55	54.	11.92	7.	4.	1.	25.80
	HYDROGRAPH AT							
+		D59IS	416.	12.92	159.	59.	20.	24.50
	DIVERSION TO							
+		S59HW	29.	12.92	2.	1.	0.	24.50
	HYDROGRAPH AT							
+		S59HS	388.	12.92	156.	58.	19.	24.50
	HYDROGRAPH AT							
+		D2922A	326.	12.75	85.	24.	8.	24.90
	3 COMBINED AT							
+		C2922A	704.	12.75	246.	86.	29.	25.80
	ROUTED TO							
+		PA59	606.	13.17	246.	86.	29.	25.80
	DIVERSION TO							
+		D59S	347.	13.17	201.	74.	25.	25.80
	HYDROGRAPH AT							
+		D59	259.	13.17	45.	11.	4.	25.80
	HYDROGRAPH AT							
+		SIS4S	482.	13.17	109.	27.	9.	32.70
	ROUTED TO							
+		R3022S	474.	13.25	109.	27.	9.	32.70
	HYDROGRAPH AT							
+		30-22N	88.	12.58	30.	9.	3.	.16
	HYDROGRAPH AT							
+		S59HW	29.	12.92	2.	1.	0.	24.50
	4 COMBINED AT							
+		C3022N	782.	13.25	180.	46.	15.	34.80
	ROUTED TO							
+		PA63	266.	14.17	123.	46.	15.	34.80	ROUTE THROUGH SUNSET BASIN
	DIVERSION TO							
+		D63S	55.	13.33	50.	28.	9.	34.80	FLOW INTO EXIST SD
	HYDROGRAPH AT							
+		D63	211.	14.17	73.	18.	6.	34.80	FLOW INTO NEW SD
	DIVERSION TO							
+		GCDC1B	211.	14.17	73.	18.	6.	34.80
	HYDROGRAPH AT							
+		DC1B	0.	.00	0.	0.	0.	34.80
	HYDROGRAPH AT							
+		D26S	2832.	13.25	996.	369.	230.	16.65
	ROUTED TO							
+		R2622S	2824.	13.33	996.	369.	230.	16.65
	HYDROGRAPH AT							
+		26-22E	533.	12.17	84.	27.	9.	.38
	2 COMBINED AT							
+		C2622E	2926.	13.33	1093.	399.	240.	12.14
	ROUTED TO							
+		RES26E	2402.	13.83	1087.	399.	240.	12.14
	DIVERSION TO							
+		D27TR	2369.	13.83	1054.	369.	212.	12.14
	HYDROGRAPH AT							
+		DTR27	33.	.08	33.	30.	28.	12.14

+	HYDROGRAPH AT 26-22S	833.	12.00	86.	28.	9.	.39
+	DIVERSION TO D2622W	200.	12.00	21.	7.	2.	.39
+	HYDROGRAPH AT D2622S	633.	12.00	66.	21.	7.	.39
+	HYDROGRAPH AT SD31DS	251.	11.58	245.	125.	42.	16.65
+	3 COMBINED AT C2622S	917.	12.00	343.	180.	79.	.39
+	DIVERSION TO STR1S	745.	12.00	306.	162.	72.	.39
+	HYDROGRAPH AT STR1W	173.	12.00	38.	17.	7.	.39
+	ROUTED TO RTR1	146.	12.33	38.	17.	7.	.39
+	HYDROGRAPH AT SD35DS	75.	12.25	64.	21.	7.	15.60
+	HYDROGRAPH AT 26-22W	111.	12.08	16.	5.	2.	.08
+	HYDROGRAPH AT D2622W	200.	12.00	21.	7.	2.	.39
+	3 COMBINED AT C35E	332.	12.08	97.	33.	11.	.47
+	DIVERSION TO S35DW	114.	12.08	9.	2.	1.	.47
+	HYDROGRAPH AT S35DS	218.	12.08	88.	31.	11.	.47
+	ROUTED TO R35J	201.	12.25	88.	31.	11.	.47
+	2 COMBINED AT CTR35	342.	12.25	126.	48.	18.	.47
+	DIVERSION TO D35TR	265.	12.25	96.	37.	14.	.47
+	HYDROGRAPH AT DTR35	77.	12.25	29.	11.	4.	.47
+	ROUTED TO RTR2	66.	12.67	29.	11.	4.	.47
+	HYDROGRAPH AT D39S	771.	13.25	338.	133.	45.	16.40
+	ROUTED TO R2722A	763.	13.42	338.	132.	45.	16.40
+	HYDROGRAPH AT 27-22S	585.	12.42	131.	40.	13.	.63
+	HYDROGRAPH AT S35DW	114.	12.08	9.	2.	1.	.47
+	ROUTED TO R2722B	54.	12.92	9.	2.	1.	.47
+	3 COMBINED AT C2722S	1006.	13.33	478.	175.	59.	12.14
+	DIVERSION TO D2722W	58.	13.33	17.	4.	1.	12.14
+	HYDROGRAPH AT D2722S	948.	13.33	461.	171.	57.	12.14
+	2 COMBINED AT CTR1	986.	13.33	488.	182.	62.	12.14
+	DIVERSION TO STR2S	840.	13.33	441.	170.	58.	12.14
+	HYDROGRAPH AT STR2W	146.	13.33	47.	12.	4.	12.14
+	ROUTED TO RTR3	141.	13.83	47.	12.	4.	12.14
+	HYDROGRAPH AT D43S	760.	13.25	328.	109.	37.	16.40
+	HYDROGRAPH AT D2722W	58.	13.33	17.	4.	1.	12.14

+	2 COMBINED AT	C43F	822.	13.25	350.	115.	39.	12.14
+	DIVERSION TO	S43HW	498.	13.25	174.	43.	14.	12.14
+	HYDROGRAPH AT	S43HS	324.	13.25	176.	72.	24.	12.14
+	ROUTED TO	R43M	323.	13.42	176.	72.	24.	12.14
+	2 COMBINED AT	CTR43	452.	13.83	222.	83.	28.	12.14
+	DIVERSION TO	D43TR	416.	13.83	214.	81.	28.	12.14
+	HYDROGRAPH AT	DTR43	36.	13.83	8.	2.	1.	12.14
+	HYDROGRAPH AT	D51S	871.	13.17	405.	122.	41.	18.30
+	HYDROGRAPH AT	D47S	0.	12.83	0.	0.	0.	18.30
+	2 COMBINED AT	C2822C	871.	13.17	405.	122.	41.	18.32
+	ROUTED TO	R2822A	857.	13.33	404.	122.	41.	18.32
+	HYDROGRAPH AT	28-22S	533.	12.33	95.	29.	10.	.54
+	2 COMBINED AT	C2822S	955.	13.25	480.	149.	50.	18.86
+	DIVERSION TO	D2822W	19.	13.25	10.	3.	1.	18.86
+	HYDROGRAPH AT	D2822S	936.	13.25	471.	146.	49.	18.86
+	HYDROGRAPH AT	S43HW	498.	13.25	174.	43.	14.	12.14
+	ROUTED TO	R2822B	493.	13.75	174.	43.	14.	12.14
+	3 COMBINED AT	CTR2	1294.	13.50	644.	190.	63.	19.96
+	DIVERSION TO	STR3S	647.	13.50	322.	95.	32.	19.96
+	HYDROGRAPH AT	STR3W	647.	13.50	322.	95.	32.	19.96
+	DIVERSION TO	STR4S	506.	13.50	249.	68.	23.	19.96
+	HYDROGRAPH AT	STR4W	141.	13.50	73.	27.	9.	19.96
+	ROUTED TO	RTR4	139.	13.75	73.	27.	9.	19.96
+	HYDROGRAPH AT	D2822W	19.	13.25	10.	3.	1.	18.86
+	DIVERSION TO	S51IW	0.	13.17	0.	0.	0.	18.86
+	HYDROGRAPH AT	S51IS	19.	13.25	10.	3.	1.	18.86
+	ROUTED TO	R51N	17.	13.58	10.	3.	1.	18.86
+	2 COMBINED AT	CTR51	156.	13.75	82.	30.	10.	19.96
+	DIVERSION TO	D51TR	156.	13.75	82.	30.	10.	19.96
+	HYDROGRAPH AT	DTR51	0.	.00	0.	0.	0.	19.96
+	ROUTED TO	RTR5	0.	.00	0.	0.	0.	19.96
+	HYDROGRAPH AT	D55S	124.	13.25	73.	18.	6.	25.80
+	ROUTED TO	R2922A	124.	14.08	73.	18.	6.	25.80
	HYDROGRAPH AT							

+	29-22S	553.	12.33	106.	32.	11.	.59
HYDROGRAPH AT +	S51IW	0.	13.17	0.	0.	0.	18.86
ROUTED TO +	R2922B	0.	14.33	0.	0.	0.	18.86
3 COMBINED AT +	C2922S	571.	12.42	170.	48.	16.	26.90
DIVERSION TO +	D2922W	154.	12.42	46.	13.	4.	26.90
HYDROGRAPH AT +	D2922S	417.	12.42	124.	35.	12.	26.90
2 COMBINED AT +	CTR3	416.	12.42	124.	35.	12.	28.00
DIVERSION TO +	STR5S	230.	12.42	54.	14.	5.	28.00
HYDROGRAPH AT +	STR5W	186.	12.42	69.	21.	7.	28.00
ROUTED TO +	RTR6	181.	12.58	69.	21.	7.	28.00
HYDROGRAPH AT +	D59S	347.	13.17	201.	74.	25.	25.80
ROUTED TO +	R59N	346.	13.25	201.	74.	25.	25.80
HYDROGRAPH AT +	D2922W	154.	12.42	46.	13.	4.	26.90
2 COMBINED AT +	C59G	418.	13.17	246.	87.	29.	26.90
DIVERSION TO +	S59IW	1.	13.08	0.	0.	0.	26.90
HYDROGRAPH AT +	S59IS	418.	13.17	246.	87.	29.	26.90
ROUTED TO +	R59O	416.	13.25	246.	87.	29.	26.90
2 COMBINED AT +	CTR59	562.	12.67	315.	109.	36.	28.00
DIVERSION TO +	D59TR	493.	12.67	302.	105.	35.	28.00
HYDROGRAPH AT +	DTR59	69.	12.67	13.	3.	1.	28.00
ROUTED TO +	RTR7	63.	13.08	13.	3.	1.	28.00
HYDROGRAPH AT +	D63S	55.	13.33	50.	28.	9.	34.80
ROUTED TO +	R3022A	55.	15.58	50.	28.	9.	34.80
HYDROGRAPH AT +	30-22S	630.	12.50	157.	47.	16.	.81
HYDROGRAPH AT +	S59IW	1.	13.08	0.	0.	0.	26.90
ROUTED TO +	R3022B	0.	14.00	0.	0.	0.	26.90
3 COMBINED AT +	C3022S	630.	12.50	194.	72.	25.	36.03
DIVERSION TO +	D3022W	139.	12.50	43.	16.	6.	36.03
HYDROGRAPH AT +	D3022S	440.	12.50	137.	51.	18.	36.03
2 COMBINED AT +	CTR4	442.	12.50	149.	54.	19.	37.13
DIVERSION TO +	STR6S	286.	12.50	90.	25.	8.	37.13
HYDROGRAPH AT +	STR6W	156.	12.50	59.	29.	11.	37.13
ROUTED TO +	RTR8	154.	12.75	59.	29.	11.	37.13
HYDROGRAPH AT +	D3022W	139.	12.50	43.	16.	6.	36.03

+	HYDROGRAPH AT	D67IS	26.	13.17	21.	9.	3.	28.70
+	2 COMBINED AT	C67G1	165.	12.50	63.	25.	9.	36.03
+	DIVERSION TO	S67IW	0.	12.50	0.	0.	0.	36.03
+	HYDROGRAPH AT	S67IS	165.	12.50	63.	25.	9.	36.03
+	ROUTED TO	R67O	161.	12.67	63.	25.	9.	36.03
+	3 COMBINED AT	CTR67	314.	12.75	122.	53.	19.	37.13
+	DIVERSION TO	D67TR	284.	12.75	119.	53.	19.	37.13
+	HYDROGRAPH AT	DTR67	30.	12.75	3.	1.	0.	37.13
+	ROUTED TO	RTR9	20.	13.17	3.	1.	0.	37.13
+	HYDROGRAPH AT	SIS5S	318.	12.25	36.	9.	3.	41.52
+	ROUTED TO	R2521S	284.	12.50	36.	9.	3.	41.52
+	HYDROGRAPH AT	25-21	754.	12.50	200.	59.	20.	1.00
+	DIVERSION TO	D2521R	15.	12.50	4.	1.	0.	1.00
+	HYDROGRAPH AT	RET25	739.	12.50	196.	58.	19.	1.00
+	HYDROGRAPH AT	S67IW	0.	12.50	0.	0.	0.	36.03
+	ROUTED TO	R2521W	0.	13.42	0.	0.	0.	36.03
+	3 COMBINED AT	C25-21	960.	12.50	213.	61.	20.	37.64
+	DIVERSION TO	D2521W	230.	12.50	51.	15.	5.	37.64
+	HYDROGRAPH AT	D2521S	730.	12.50	162.	47.	16.	37.64
+	2 COMBINED AT	CTR5	728.	12.50	164.	47.	16.	38.75
+	DIVERSION TO	STR7S	336.	12.50	55.	14.	5.	38.75
+	HYDROGRAPH AT	STR7W	392.	12.50	109.	33.	11.	38.75
+	ROUTED TO	RTR10	385.	12.67	109.	33.	11.	38.75
+	HYDROGRAPH AT	D75IS	282.	12.33	57.	20.	7.	41.52
+	ROUTED TO	R75P	276.	12.50	57.	20.	7.	41.52
+	HYDROGRAPH AT	D2521W	230.	12.50	51.	15.	5.	37.64
+	2 COMBINED AT	C75G	508.	12.50	109.	35.	12.	37.64
+	DIVERSION TO	S75JW	97.	12.50	6.	1.	0.	37.64
+	HYDROGRAPH AT	S75JS	411.	12.50	103.	33.	11.	37.64
+	ROUTED TO	R75Q	405.	12.67	103.	33.	11.	37.64
+	2 COMBINED AT	CTR75	790.	12.67	212.	67.	22.	38.75
+	DIVERSION TO	D75TR	628.	12.67	191.	61.	21.	38.75
+	HYDROGRAPH AT	DTR75	162.	12.67	21.	5.	2.	38.75

+	ROUTED TO	RTR11	151.	12.83	21.	5.	2.	38.75
+	HYDROGRAPH AT	SIS6S	283.	12.75	67.	17.	6.	47.02
+	ROUTED TO	R2621S	268.	13.25	67.	17.	6.	47.02
+	HYDROGRAPH AT	26-21	629.	12.58	180.	54.	18.	.99
+	HYDROGRAPH AT	S75JW	97.	12.50	6.	1.	0.	37.64
+	ROUTED TO	R2621W	34.	13.42	6.	1.	0.	37.64
+	3 COMBINED AT	C26-21	731.	13.08	235.	67.	22.	41.28
+	DIVERSION TO	D2621W	190.	13.08	61.	17.	6.	41.28
+	HYDROGRAPH AT	D2621S	541.	13.08	174.	50.	17.	41.28
+	2 COMBINED AT	CTR6	675.	13.00	194.	55.	18.	41.28
+	DIVERSION TO	STR8S	173.	13.00	46.	11.	4.	41.28
+	HYDROGRAPH AT	STR8W	502.	13.00	148.	43.	14.	41.28
+	ROUTED TO	RTR12	497.	13.17	148.	43.	14.	41.28
+	HYDROGRAPH AT	D83IS	323.	12.92	155.	50.	17.	47.02
+	ROUTED TO	R83P	322.	13.08	155.	50.	17.	47.02
+	HYDROGRAPH AT	D2621W	190.	13.08	61.	17.	6.	41.28
+	2 COMBINED AT	C83H	501.	13.08	210.	65.	22.	57.03
+	DIVERSION TO	S83IW	148.	13.08	28.	7.	2.	57.03
+	HYDROGRAPH AT	S83IS	353.	13.08	182.	58.	20.	57.03
+	ROUTED TO	R83Q	351.	13.17	182.	58.	20.	57.03
+	2 COMBINED AT	CTR83	831.	13.17	325.	100.	34.	56.35
+	DIVERSION TO	D83TR	625.	13.17	274.	88.	29.	56.35
+	HYDROGRAPH AT	DTR83	206.	13.17	51.	13.	4.	56.35
+	ROUTED TO	RTR13	202.	13.33	51.	13.	4.	56.35
+	HYDROGRAPH AT	SIS7S	270.	13.08	59.	15.	5.	55.24
+	ROUTED TO	R2721S	255.	13.50	59.	15.	5.	55.24
+	HYDROGRAPH AT	27-21	618.	12.58	171.	49.	16.	1.00
+	DIVERSION TO	D2721R	31.	12.58	4.	1.	0.	1.00
+	HYDROGRAPH AT	RET27	587.	12.58	167.	48.	16.	1.00
+	HYDROGRAPH AT	S83IW	148.	13.08	28.	7.	2.	57.03
+	ROUTED TO	R2721W	133.	13.58	28.	7.	2.	57.03
+	3 COMBINED AT	C27-21	676.	13.42	227.	62.	21.	65.57
+	DIVERSION TO	D2721W	203.	13.42	68.	19.	6.	65.57
	HYDROGRAPH AT							

+	D2721S	473.	13.42	159.	44.	15.	65.57
2 COMBINED AT +	CTR7	667.	13.42	209.	56.	19.	66.67
DIVERSION TO +	STR9S	382.	13.42	112.	28.	9.	66.67
HYDROGRAPH AT +	STR9W	285.	13.42	97.	28.	9.	66.67
ROUTED TO +	RTR14	281.	13.50	97.	28.	9.	66.67
HYDROGRAPH AT +	D91IS	234.	13.17	120.	39.	13.	55.24
ROUTED TO +	R91M	232.	13.42	120.	39.	13.	55.24
HYDROGRAPH AT +	D2721W	203.	13.42	68.	19.	6.	65.57
2 COMBINED AT +	C91G	434.	13.42	187.	58.	19.	65.57
DIVERSION TO +	S91GW	43.	13.42	4.	1.	0.	65.57
HYDROGRAPH AT +	S91GS	391.	13.42	183.	57.	19.	65.57
ROUTED TO +	R91N	388.	13.50	182.	57.	19.	65.57
2 COMBINED AT +	CTR91	668.	13.50	278.	84.	28.	66.67
DIVERSION TO +	D91TR	521.	13.50	247.	77.	26.	66.67
HYDROGRAPH AT +	DTR91	147.	13.50	31.	8.	3.	66.67
ROUTED TO +	RTR15	144.	13.75	31.	8.	3.	66.67
HYDROGRAPH AT +	SIS8S	225.	13.33	57.	14.	5.	58.45
ROUTED TO +	R2821S	222.	13.58	57.	14.	5.	58.45
HYDROGRAPH AT +	28-21E	250.	12.75	80.	20.	7.	.53
HYDROGRAPH AT +	S91GW	43.	13.42	4.	1.	0.	65.57
ROUTED TO +	R2821W	40.	13.67	4.	1.	0.	65.57
3 COMBINED AT +	C28-21	386.	13.58	125.	32.	11.	69.31
DIVERSION TO +	D2821W	243.	13.58	79.	20.	7.	69.31
HYDROGRAPH AT +	D2821S	143.	13.58	46.	12.	4.	69.31
2 COMBINED AT +	CTR8	280.	13.67	77.	19.	6.	69.31
DIVERSION TO +	STR10S	78.	13.67	19.	5.	2.	69.31
HYDROGRAPH AT +	STR10W	202.	13.67	58.	15.	5.	69.31
HYDROGRAPH AT +	RISAF	1146.	13.25	372.	96.	32.	58.45
ROUTED TO +	RAF7	1147.	13.33	372.	96.	32.	58.45
HYDROGRAPH AT +	D2821W	243.	13.58	79.	20.	7.	69.31
2 COMBINED AT +	CAFC	1349.	13.42	445.	115.	38.	69.31
ROUTED TO +	RAF8	1347.	13.50	445.	115.	38.	69.31
2 COMBINED AT +	CTRAF	1537.	13.50	502.	130.	43.	69.31
DIVERSION TO +	DTRAFS	1537.	13.50	502.	130.	43.	69.31

+	HYDROGRAPH AT	DTRAF	0.	13.50	0.	0.	0.	69.31
+	HYDROGRAPH AT	D99IS	15.	13.25	7.	2.	1.	59.10
+	ROUTED TO	R99H	14.	14.00	7.	2.	1.	59.10
+	HYDROGRAPH AT	28-21W	198.	12.75	69.	18.	6.	.47
+	2 COMBINED AT	C99D	168.	12.75	63.	16.	5.	70.44
+	DIVERSION TO	S99DW	58.	12.75	19.	5.	2.	70.44
+	HYDROGRAPH AT	S99DS	109.	12.75	44.	11.	4.	70.44
+	ROUTED TO	R99I	108.	13.08	43.	11.	4.	70.44
+	2 COMBINED AT	CTR99	108.	13.08	43.	11.	4.	70.44
+	DIVERSION TO	D99TR	27.	13.08	11.	3.	1.	70.44
+	HYDROGRAPH AT	DTR99	81.	13.08	33.	9.	3.	70.44
+	ROUTED TO	RTR17	79.	13.42	32.	9.	3.	70.44
+	HYDROGRAPH AT	SIS9S	105.	13.25	31.	8.	3.	60.83
+	ROUTED TO	R2921S	97.	13.75	31.	8.	3.	60.83
+	HYDROGRAPH AT	29-21N	396.	12.67	119.	30.	10.	.76
+	HYDROGRAPH AT	S99DW	58.	12.75	19.	5.	2.	70.44
+	ROUTED TO	R2921W	58.	13.00	19.	5.	2.	70.44
+	3 COMBINED AT	C2921N	396.	12.75	151.	38.	13.	72.92
+	DIVERSION TO	D2921W	128.	12.75	49.	12.	4.	72.92
+	HYDROGRAPH AT	D2921S	259.	12.75	99.	25.	8.	72.92
+	2 COMBINED AT	CTR9	315.	13.17	130.	33.	11.	74.02
+	ROUTED TO	RES29S	0.	22.42	0.	0.	0.	74.02
+	HYDROGRAPH AT	D107IS	261.	13.50	94.	26.	9.	60.83
+	ROUTED TO	R107C	256.	13.75	93.	26.	9.	60.83
+	HYDROGRAPH AT	D2921W	128.	12.75	49.	12.	4.	72.92
+	2 COMBINED AT	C107B	355.	13.75	139.	38.	13.	72.92
+	ROUTED TO	RES29W	117.	15.50	50.	14.	5.	72.92
+	DIVERSION TO	D2921C	117.	15.50	50.	14.	5.	72.92
+	HYDROGRAPH AT	D2921B	0.	.00	0.	0.	0.	72.92
+	ROUTED TO	R2921A	0.	.00	0.	0.	0.	72.92
+	HYDROGRAPH AT	29-21S	144.	12.67	50.	14.	5.	.26
+	3 COMBINED AT	C107C	123.	12.67	42.	12.	4.	74.28
+	DIVERSION TO	D107TR	43.	12.67	15.	4.	1.	74.28

+	HYDROGRAPH AT	DTR107	80.	12.67	27.	8.	3.	74.28
+	ROUTED TO	RTR18	78.	13.00	27.	8.	3.	74.28
+	HYDROGRAPH AT	30-21S	1003.	12.17	112.	30.	10.	.75
+	DIVERSION TO	D3021X	701.	12.08	34.	9.	3.	.75
+	HYDROGRAPH AT	RET30S	968.	12.25	81.	22.	7.	.75
+	2 COMBINED AT	C3021S	840.	12.25	90.	24.	8.	75.03
+	DIVERSION TO	STR11S	495.	12.25	46.	11.	4.	75.03
+	HYDROGRAPH AT	STR11W	345.	12.25	44.	13.	4.	75.03
+	ROUTED TO	RTR19	268.	12.58	44.	13.	4.	75.03
+	DIVERSION TO	D115TR	115.	12.58	19.	6.	2.	75.03
+	HYDROGRAPH AT	DTR115	153.	12.58	25.	7.	3.	75.03
+	HYDROGRAPH AT	30-21N	907.	12.17	108.	31.	10.	.67
+	DIVERSION TO	D3021R	744.	12.17	56.	15.	5.	.67
+	HYDROGRAPH AT	RET30N	606.	12.42	57.	16.	5.	.67
+	DIVERSION TO	D3021W	127.	12.42	12.	3.	1.	.67
+	HYDROGRAPH AT	D3021S	479.	12.42	45.	13.	4.	.67
+	HYDROGRAPH AT	D2921C	117.	15.50	50.	14.	5.	72.92
+	ROUTED TO	R3021W	114.	15.92	49.	14.	5.	72.92
+	2 COMBINED AT	C3021N	1856.	12.42	193.	57.	19.	73.59
+	ROUTED TO	R3021R	279.	12.58	66.	23.	8.	73.59
+	HYDROGRAPH AT	D3021W	124.	13.25	38.	10.	3.	60.83
+	4 COMBINED AT	NULL8	1320.	12.50	561.	157.	53.	1.00
+	HYDROGRAPH AT	NULL4	3714.	13.17	1695.	519.	176.	1.00
+	HYDROGRAPH AT	11-22	558.	12.58	169.	53.	18.	1.01
+	DIVERSION TO	D1122W	117.	12.58	35.	11.	4.	1.01
+	HYDROGRAPH AT	D1122S	441.	12.58	133.	42.	14.	1.01
+	HYDROGRAPH AT	SGA1S	1140.	12.67	307.	94.	31.	2.54
+	ROUTED TO	R1122S	1136.	12.83	306.	94.	31.	2.54
+	2 COMBINED AT	C11-22	1537.	12.83	436.	135.	45.	3.50
+	DIVERSION TO	SD31AS	147.	12.00	126.	57.	19.	3.50
+	HYDROGRAPH AT	SD31A	1390.	12.83	310.	78.	26.	3.50
+	DIVERSION TO	SBH1W	695.	12.83	155.	39.	13.	3.50
+	HYDROGRAPH AT	SBH1E	695.	12.83	155.	39.	13.	3.50
	ROUTED TO							

+	RBH1	693.	12.92	155.	39.	13.	3.50
+ HYDROGRAPH AT	D27GA	231.	12.58	63.	20.	7.	.36
+ ROUTED TO	R27C	223.	12.83	63.	20.	7.	.36
+ HYDROGRAPH AT	12-22	205.	12.33	47.	15.	5.	.25
+ DIVERSION TO	D1222R	14.	12.33	3.	1.	0.	.25
+ HYDROGRAPH AT	RET120	191.	12.33	44.	14.	5.	.25
+ 3 COMBINED AT	CBH27	963.	12.92	245.	68.	23.	21.30
+ DIVERSION TO	D27BH	963.	12.92	245.	68.	23.	21.30
+ HYDROGRAPH AT	DBH27	0.	.00	0.	0.	0.	21.30
+ HYDROGRAPH AT	D35GA	79.	12.92	35.	12.	4.	2.10
+ ROUTED TO	R35E	78.	13.17	35.	12.	4.	2.10
+ HYDROGRAPH AT	D1122W	117.	12.58	35.	11.	4.	1.01
+ 2 COMBINED AT	C35C	178.	12.92	70.	23.	8.	3.10
+ ROUTED TO	R35F	175.	13.08	70.	23.	8.	3.10
+ HYDROGRAPH AT	SBH1W	695.	12.83	155.	39.	13.	3.50
+ ROUTED TO	RBH2	691.	12.92	155.	39.	13.	3.50
+ HYDROGRAPH AT	SGA2S	412.	12.67	149.	48.	16.	4.68
+ ROUTED TO	R1022S	408.	12.83	148.	48.	16.	4.68
+ HYDROGRAPH AT	10-22	526.	12.58	157.	48.	16.	.99
+ 2 COMBINED AT	C10-22	902.	12.75	302.	95.	32.	5.70
+ DIVERSION TO	SD39AS	164.	12.00	127.	51.	17.	5.70
+ HYDROGRAPH AT	SD39A	738.	12.75	176.	44.	15.	5.70
+ DIVERSION TO	D1022W	436.	12.75	104.	26.	9.	5.70
+ HYDROGRAPH AT	D1022E	303.	12.75	72.	18.	6.	5.70
+ 4 COMBINED AT	CBH35	1143.	12.92	294.	79.	26.	7.10
+ DIVERSION TO	D35BH	1143.	12.92	294.	79.	26.	7.10
+ HYDROGRAPH AT	DBH35	0.	.00	0.	0.	0.	7.10
+ HYDROGRAPH AT	D43GA	328.	12.83	139.	49.	16.	4.68
+ ROUTED TO	R43F	325.	13.00	139.	49.	16.	4.68
+ HYDROGRAPH AT	D1022W	436.	12.75	104.	26.	9.	5.70
+ 2 COMBINED AT	C43D	736.	12.92	243.	75.	25.	5.70
+ DIVERSION TO	S43DW	363.	12.92	87.	22.	7.	5.70
+ HYDROGRAPH AT	S43DS	373.	12.92	155.	53.	18.	5.70
+ ROUTED TO	R43G	371.	13.00	155.	53.	18.	5.70

+	2 COMBINED AT	CBH43	371.	13.00	155.	53.	18.	5.70
+	DIVERSION TO	D43BH	233.	13.00	119.	44.	15.	5.70
+	HYDROGRAPH AT	DBH43	138.	13.00	36.	9.	3.	5.70
+	ROUTED TO	RBH3	135.	13.25	36.	9.	3.	5.70
+	HYDROGRAPH AT	SGA3S	545.	13.08	166.	45.	15.	8.07
+	ROUTED TO	R922S	533.	13.33	166.	45.	15.	8.07
+	HYDROGRAPH AT	9-22	609.	12.58	180.	56.	19.	.99
+	HYDROGRAPH AT	S43DW	363.	12.92	87.	22.	7.	5.70
+	ROUTED TO	R922W	351.	13.25	87.	22.	7.	5.70
+	3 COMBINED AT	C9-22	1278.	13.25	425.	121.	40.	10.10
+	DIVERSION TO	D922W	435.	13.25	144.	41.	14.	10.10
+	HYDROGRAPH AT	D922S	844.	13.25	280.	80.	27.	10.10
+	2 COMBINED AT	CBH1	978.	13.25	316.	89.	30.	10.10
+	DIVERSION TO	SBH2S	705.	13.25	227.	63.	21.	10.10
+	HYDROGRAPH AT	SBH2W	273.	13.25	90.	26.	9.	10.10
+	ROUTED TO	RBH4	270.	13.42	90.	26.	9.	10.10
+	HYDROGRAPH AT	D51GA	278.	13.33	102.	33.	11.	8.07
+	ROUTED TO	R51H	275.	13.42	102.	33.	11.	8.07
+	HYDROGRAPH AT	D922W	435.	13.25	144.	41.	14.	10.10
+	2 COMBINED AT	C51D	695.	13.33	246.	73.	25.	10.10
+	DIVERSION TO	S51EW	259.	13.33	45.	11.	4.	10.10
+	HYDROGRAPH AT	S51ES	436.	13.33	200.	62.	21.	10.10
+	ROUTED TO	R51I	433.	13.50	200.	62.	21.	10.10
+	2 COMBINED AT	CBH51	703.	13.42	290.	88.	29.	10.10
+	DIVERSION TO	D51BH	310.	13.42	53.	13.	4.	10.10
+	HYDROGRAPH AT	DBH51	393.	13.25	237.	75.	25.	10.10
+	HYDROGRAPH AT	D822ES	355.	12.67	201.	65.	22.	12.60
+	HYDROGRAPH AT	D822E1	108.	12.25	11.	3.	1.	.52
+	HYDROGRAPH AT	S51EW	259.	13.33	45.	11.	4.	10.10
+	ROUTED TO	R822EW	251.	13.58	45.	11.	4.	10.10
+	3 COMBINED AT	C822E1	579.	13.58	253.	78.	26.	14.60
+	2 COMBINED AT	CBH51b	946.	13.58	477.	148.	50.	24.70
+	DIVERSION TO	SBH51	826.	13.58	358.	90.	30.	24.70

+	HYDROGRAPH AT	SBH51	120.	11.67	119.	59.	20.	24.70
+	ROUTED TO	R822WW	120.	12.25	119.	59.	20.	24.70
+	HYDROGRAPH AT	8-22W	807.	12.08	98.	32.	11.	.49
+	DIVERSION TO	D822WW	169.	12.08	21.	7.	2.	.49
+	HYDROGRAPH AT	D822WS	637.	12.08	78.	26.	9.	.49
+	2 COMBINED AT	C8-22W	725.	12.08	188.	83.	28.	15.10
+	DIVERSION TO	SBH3S	162.	12.08	9.	2.	1.	15.10
+	HYDROGRAPH AT	SBH3W	563.	12.08	180.	81.	27.	15.10
+	ROUTED TO	RBH5	545.	12.25	179.	81.	27.	15.10
+	HYDROGRAPH AT	D822WW	169.	12.08	21.	7.	2.	.49
+	DIVERSION TO	S59EW	78.	12.08	5.	1.	0.	.49
+	HYDROGRAPH AT	S59ES	91.	12.08	15.	5.	2.	.49
+	ROUTED TO	R59I	74.	12.33	15.	5.	2.	.49
+	2 COMBINED AT	CBH59	609.	12.25	193.	86.	29.	15.10
+	DIVERSION TO	D59BH	133.	12.25	8.	2.	1.	15.10
+	HYDROGRAPH AT	DBH59	476.	12.25	186.	84.	29.	15.10
+	ROUTED TO	RBH6	469.	12.33	186.	84.	29.	15.10
+	HYDROGRAPH AT	SGA5S	440.	14.42	111.	28.	9.	17.90
+	ROUTED TO	R722S	420.	14.92	110.	28.	9.	17.90
+	HYDROGRAPH AT	7-22	532.	12.58	166.	52.	17.	.97
+	HYDROGRAPH AT	S59EW	78.	12.08	5.	1.	0.	.49
+	ROUTED TO	R722W	37.	12.75	5.	1.	0.	.49
+	3 COMBINED AT	C7-22	548.	12.67	266.	77.	26.	19.30
+	DIVERSION TO	D722W	197.	12.67	96.	28.	9.	19.30
+	HYDROGRAPH AT	D722S	351.	12.67	171.	50.	17.	19.30
+	2 COMBINED AT	CBH2	756.	12.50	349.	131.	44.	25.80
+	DIVERSION TO	SBH4S	202.	12.50	22.	6.	2.	25.80
+	HYDROGRAPH AT	SBH4W	553.	12.50	326.	125.	42.	25.80
+	ROUTED TO	RBH7	552.	12.58	326.	125.	42.	25.80
+	HYDROGRAPH AT	D67GA	180.	14.58	52.	13.	4.	17.90
+	ROUTED TO	R67J	175.	14.75	52.	13.	4.	17.90
+	HYDROGRAPH AT	D722W	197.	12.67	96.	28.	9.	19.30
+	2 COMBINED AT	C67E	347.	14.83	147.	41.	14.	19.30
	DIVERSION TO							

+	S67FW	164.	14.83	64.	16.	5.	19.30
HYDROGRAPH AT +	S67FS	183.	14.83	82.	25.	8.	19.30
ROUTED TO +	R67K	177.	15.08	82.	25.	8.	19.30
2 COMBINED AT +	CBH67	654.	12.75	410.	150.	51.	21.30
DIVERSION TO +	D67BH	90.	12.75	17.	4.	1.	21.30
HYDROGRAPH AT +	DBH67	564.	12.75	394.	146.	49.	21.30
ROUTED TO +	RBH8	563.	12.83	393.	146.	49.	21.30
HYDROGRAPH AT +	SGA6S	182.	14.75	83.	21.	7.	27.66
ROUTED TO +	R1221S	177.	15.08	81.	21.	7.	27.66
HYDROGRAPH AT +	12-21	733.	12.50	178.	49.	16.	1.00
DIVERSION TO +	D1221R	44.	12.50	8.	2.	1.	1.00
HYDROGRAPH AT +	RET12	689.	12.50	170.	47.	16.	1.00
HYDROGRAPH AT +	S67FW	164.	14.83	64.	16.	5.	19.30
ROUTED TO +	R1221W	144.	15.25	64.	16.	5.	19.30
3 COMBINED AT +	C12-21	700.	13.00	315.	86.	29.	31.35
DIVERSION TO +	D1221W	246.	13.00	108.	30.	10.	31.35
HYDROGRAPH AT +	D1221S	402.	13.00	176.	48.	16.	31.35
2 COMBINED AT +	CBH3	959.	13.00	560.	191.	64.	31.35
DIVERSION TO +	SBH5S	115.	13.00	24.	6.	2.	31.35
HYDROGRAPH AT +	SBH5W	843.	13.00	536.	185.	62.	31.35
ROUTED TO +	RBH9	841.	13.08	536.	185.	62.	31.35
HYDROGRAPH AT +	D75GA	459.	14.83	238.	70.	24.	27.66
ROUTED TO +	R75K	453.	15.00	237.	70.	24.	27.66
HYDROGRAPH AT +	D1221W	246.	13.00	108.	30.	10.	31.35
2 COMBINED AT +	C75E	550.	15.08	333.	97.	34.	31.35
DIVERSION TO +	S75GW	173.	15.08	102.	27.	9.	31.35
HYDROGRAPH AT +	S75GS	378.	15.08	231.	71.	25.	31.35
ROUTED TO +	R75L	375.	15.25	230.	71.	25.	31.35
2 COMBINED AT +	CBH75	1183.	13.08	763.	253.	87.	31.35
DIVERSION TO +	D75BH	145.	13.08	43.	11.	4.	31.35
HYDROGRAPH AT +	DBH75	1038.	13.08	720.	242.	84.	31.35
ROUTED TO +	RBH10	1036.	13.17	720.	242.	84.	31.35
HYDROGRAPH AT +	SGA7S	231.	14.08	140.	35.	12.	30.20
ROUTED TO +	R1121S	227.	14.42	138.	35.	12.	30.20

+	HYDROGRAPH AT	11-21	635.	12.58	150.	41.	14.	.99
+	DIVERSION TO	D1121R	178.	12.58	28.	7.	2.	.99
+	HYDROGRAPH AT	RET11	457.	12.58	123.	34.	11.	.99
+	HYDROGRAPH AT	S75GW	173.	15.08	102.	27.	9.	31.35
+	ROUTED TO	R1121W	170.	15.33	101.	27.	9.	31.35
+	3 COMBINED AT	C11-21	634.	13.33	332.	90.	30.	34.87
+	DIVERSION TO	D1121W	190.	13.33	100.	27.	9.	34.87
+	HYDROGRAPH AT	D1121S	444.	13.33	233.	63.	21.	34.87
+	2 COMBINED AT	CBH4	1467.	13.17	943.	303.	104.	34.87
+	DIVERSION TO	SBH6S	133.	13.17	44.	11.	4.	34.87
+	HYDROGRAPH AT	SBH6W	1334.	13.17	899.	291.	100.	34.87
+	ROUTED TO	RBH11	1334.	13.25	898.	291.	100.	34.87
+	HYDROGRAPH AT	D83GA	91.	13.00	30.	8.	3.	30.20
+	ROUTED TO	R83J	81.	14.50	30.	8.	3.	30.20
+	HYDROGRAPH AT	D1121W	190.	13.33	100.	27.	9.	34.87
+	2 COMBINED AT	C83E	264.	13.25	128.	34.	11.	34.87
+	DIVERSION TO	S83FW	83.	13.25	39.	10.	3.	34.87
+	HYDROGRAPH AT	S83FS	181.	13.25	88.	24.	8.	34.87
+	ROUTED TO	R83K	180.	13.42	88.	24.	8.	34.87
+	2 COMBINED AT	CBH83	1498.	13.33	978.	313.	107.	37.34
+	HYDROGRAPH AT	RDC1B	211.	14.17	73.	18.	6.	34.80
+	ROUTED TO	RDC1B	210.	14.17	73.	18.	6.	34.80
+	HYDROGRAPH AT	RDC1	667.	13.67	226.	63.	21.	40.90
+	2 COMBINED AT	C@DC1	807.	13.75	292.	80.	27.	43.25
+	HYDROGRAPH AT	RGCDC2	687.	13.25	299.	93.	31.	37.08
+	2 COMBINED AT	C@DC2	1422.	13.67	587.	171.	57.	43.25 MARYVALE BASIN INFLOW
+	ROUTED TO	GCDCo	1024.	14.33	588.	171.	57.	43.25
+	ROUTED TO	RDC2-3	1024.	14.33	587.	171.	57.	43.25
+	HYDROGRAPH AT	RDC3A	470.	13.33	183.	50.	17.	41.03
+	2 COMBINED AT	C@DC3A	1315.	13.58	749.	216.	72.	50.96
+	HYDROGRAPH AT	RDC3B	127.	13.33	40.	10.	3.	41.03
+	2 COMBINED AT	C@DC3B	1428.	13.50	785.	225.	75.	50.96
+	ROUTED TO	RDC3-4	1427.	13.58	785.	225.	75.	50.96

+	2 COMBINED AT	C@DC4	2855.	13.33	1720.	527.	179.	50.96
+	DIVERSION TO	D83BH	0.	13.33	0.	0.	0.	50.96
+	HYDROGRAPH AT	DBH83	2854.	13.33	1720.	527.	179.	50.96
+	ROUTED TO	RBH12A	2853.	13.33	1719.	527.	179.	50.96
+	ROUTED TO	RBH12B	2839.	13.50	1717.	527.	179.	50.96
+	ROUTED TO	RBH12C	2834.	13.58	1715.	527.	179.	50.96
+	HYDROGRAPH AT	SGA8S	126.	13.00	47.	12.	4.	34.46
+	ROUTED TO	R1021S	119.	13.33	47.	12.	4.	34.46
+	HYDROGRAPH AT	10-21	586.	12.58	160.	45.	15.	.98
+	DIVERSION TO	D1021R	410.	12.58	81.	21.	7.	.98
+	HYDROGRAPH AT	RET10	312.	13.50	84.	24.	8.	.98
+	HYDROGRAPH AT	S83FW	83.	13.25	39.	10.	3.	34.87
+	ROUTED TO	R1021W	77.	13.58	39.	10.	3.	34.87
+	3 COMBINED AT	C10-21	309.	13.83	144.	39.	13.	43.32
+	DIVERSION TO	D1021W	133.	13.83	62.	17.	6.	43.32
+	HYDROGRAPH AT	D1021S	176.	13.83	82.	22.	7.	43.32
+	ROUTED TO	D91det	88.	15.25	63.	20.	7.	43.32
+	HYDROGRAPH AT	D91GA	327.	13.17	145.	36.	12.	34.46
+	ROUTED TO	R91G	320.	13.33	145.	36.	12.	34.46
+	HYDROGRAPH AT	D1021W	133.	13.83	62.	17.	6.	43.32
+	2 COMBINED AT	C91D	421.	13.33	200.	51.	17.	43.32
+	DIVERSION TO	S91DW	180.	13.33	85.	21.	7.	43.32
+	HYDROGRAPH AT	S91DS	241.	13.33	115.	30.	10.	43.32
+	ROUTED TO	R91H	236.	13.50	114.	30.	10.	43.32
+	3 COMBINED AT	CBH5	3062.	13.58	1848.	566.	192.	57.17
+	DIVERSION TO	SBH7S	0.	13.50	0.	0.	0.	57.17
+	HYDROGRAPH AT	SBH7W	3061.	13.58	1848.	565.	192.	57.17
+	DIVERSION TO	D91BH	0.	.00	0.	0.	0.	57.17
+	HYDROGRAPH AT	DBH91	3061.	13.58	1848.	565.	192.	57.17
+	ROUTED TO	RBH13A	3061.	13.67	1848.	565.	192.	57.17
+	HYDROGRAPH AT	9-21S4	52.	12.33	12.	3.	1.	.07
+	2 COMBINED AT	CBH5-1	3071.	13.67	1854.	568.	193.	57.24
+	ROUTED TO	RBH13B	3065.	13.75	1852.	568.	193.	57.24
	HYDROGRAPH AT							

+		9-21S3	226.	12.17	41.	14.	5.	.15
	DIVERSION TO							
+		D921R3	0.	.00	0.	0.	0.	.15
	HYDROGRAPH AT							
+		RET9S3	226.	12.17	41.	14.	5.	.15
	2 COMBINED AT							
+		CBH5-2	3080.	13.75	1865.	580.	197.	57.39
	ROUTED TO							
+		RBH13C	3073.	13.75	1864.	580.	197.	57.39
	HYDROGRAPH AT							
+		9-21S2	222.	12.08	33.	12.	4.	.12
	DIVERSION TO							
+		D921R2	0.	.00	0.	0.	0.	.12
	HYDROGRAPH AT							
+		RET9S2	222.	12.08	33.	12.	4.	.12
	2 COMBINED AT							
+		CBH5-3	3084.	13.75	1873.	589.	200.	57.51
	HYDROGRAPH AT							
+		SGA9S	0.	.00	0.	0.	0.	35.26
	ROUTED TO							
+		R921S	0.	.00	0.	0.	0.	35.26
	HYDROGRAPH AT							
+		9-21NE	417.	12.25	82.	26.	9.	.45
	DIVERSION TO							
+		D921NR	205.	12.25	38.	11.	4.	.45
	HYDROGRAPH AT							
+		RET9NE	212.	12.25	46.	15.	5.	.45
	HYDROGRAPH AT							
+		S91DW	180.	13.33	85.	21.	7.	43.32
	ROUTED TO							
+		R921W	177.	13.58	85.	21.	7.	43.32
	3 COMBINED AT							
+		C9-21N	212.	13.50	122.	35.	12.	44.56
	HYDROGRAPH AT							
+		DGAAFS	1316.	13.33	824.	317.	127.	35.26
	ROUTED TO							
+		RAF2	1312.	13.42	823.	317.	127.	35.26
	2 COMBINED AT							
+		CAFA	1466.	13.42	907.	341.	136.	45.82
	ROUTED TO							
+		RAF3	1465.	13.50	906.	341.	136.	45.82
	HYDROGRAPH AT							
+		9-21S1	112.	12.08	14.	5.	2.	.06
	2 COMBINED AT							
+		CBHAF1	1469.	13.50	909.	343.	137.	45.88
	2 COMBINED AT							
+		CBHAF2	4430.	13.67	2750.	907.	335.	58.90 AGUA FRIA FWY
	HYDROGRAPH AT							
+		9-21W	31.	12.83	13.	4.	1.	.11
	DIVERSION TO							
+		S99AW	31.	12.83	13.	4.	1.	.11
	HYDROGRAPH AT							
+		S99AS	0.	12.42	0.	0.	0.	.11
	ROUTED TO							
+		R99C	0.	12.92	0.	0.	0.	.11
	2 COMBINED AT							
+		CBH6	4430.	13.67	2750.	907.	335.	59.01
	DIVERSION TO							
+		D99BH	0.	.00	0.	0.	0.	59.01
	HYDROGRAPH AT							
+		DBH99	4429.	13.67	2749.	907.	334.	59.01
	ROUTED TO							
+		RBH14	4422.	13.67	2749.	907.	334.	59.01
	HYDROGRAPH AT							
+		8-21E	216.	12.58	55.	14.	5.	.51
	HYDROGRAPH AT							
+		S99AW	31.	12.83	13.	4.	1.	.11

```
          ROUTED TO
+                        R821EW      30.   13.25        13.        4.        1.      .11
          2 COMBINED AT
+                        C8-21E     216.   12.58        66.       17.        6.    46.01
          DIVERSION TO
+                        D821EW     105.   12.67        32.        8.        3.    46.01
          HYDROGRAPH AT
+                        D821ES      82.   12.67        25.        6.        2.    46.01
          2 COMBINED AT
+                          CBH7    4461.   13.67      2764.      912.      336.    59.51
          HYDROGRAPH AT
+                         8-21W     173.   12.42        34.        9.        3.      .27
          2 COMBINED AT
+                        C8-21W    4485.   13.67      2778.      919.      338.    59.79          NEW RIVER CONFLUENCE
          HYDROGRAPH AT
+                        D821EW     105.   12.67        32.        8.        3.    46.01
          ROUTED TO
+                         RES8N       0.   19.08         0.        0.        0.    46.01
          3 COMBINED AT
+                         NULL5    8835.   13.58      5166.     1634.      583.     1.00
          2 COMBINED AT
+                        NULL5A    9803.   13.58      5724.     1791.      635.     1.00

 *** NORMAL END OF HEC-1 ***
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Appendix B

Hydraulic Calculations

B.1 Discharge through Storm Drain

Storm Drain Hydraulics

The BHOC Reach D storm drain system was analyzed as two systems, one upstream of the weir structure used to determine the head over the weir and one downstream of the weir structure to determine the depth of the submerged weir. Different combinations of weir lengths, pipe sizes, and pipe types were used for the hydraulic analysis.

The proposed storm drain system hydraulically connects Sunset Basin with Maryvale Basin. The system comprises of four components: Inlet, transition, weir, and outlet structures connected with concrete pipes. Figure 1 below provides the schematic diagram of the proposed storm drain system for the BHOC Reach D project.

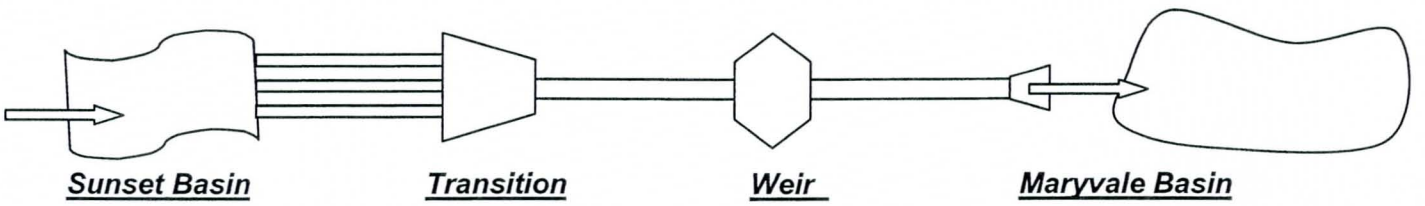


Figure 1 Schematic Diagram of Proposed Storm Drain System for BHOC Reach D

Calculation Procedure: (Storm Drain System Upstream of the weir using 96" Concrete pipe)

Step: 1 Flow over the weir

The flow over the weir was computed using the Broad-crested Weir Equation for various weir lengths of 14, 18, 20, and 22 ft. The equation for a broad-crested weir is

$$Q = CLH^{3/2} \qquad (1)$$

Where,

Q = Flow over weir, in cfs

C = Weir coefficient, based on weir width and weir head

L = Length of the weir, in ft

H = Head over the weir crest, in ft

The total energy head above the weir crest is the combination of potential energy (H) and the approaching velocity head (H_v).

$$H_{Total} = H + H_V \qquad (2a)$$

$$H_V = \frac{V^2}{2g} \qquad (2b)$$

The flow over the weir was analyzed assuming the crest elevation of the weir is equal to the water surface elevation (WSE) at the Maryvale Detention Basin (MDB). This WSE was obtained from the latest HEC-RAS model received from the FCDMC for the Reach B Design. The model indicated a WSE of 1092.45 at the MDB. The weir coefficient 'C' is a function of the crest breadth and head and was obtained from a hydraulic manual.

The elevation from the HEC-1 rating table (SE Card) for the sunset basin routing was used to determine the head over the weir. Column (a) SE Elevation in Table 1 shows the elevations from the HEC-1 model used for head calculation over the weir. Column (b) is the elevation head over the weir and is computed by subtracting 1092.45 from column (a). Equation (1) was used to compute the discharge, which was used in StormCAD to determine the approaching velocity at the weir. Equation (2b) above was then used to calculate the velocity head in column (c). Column (d) is the total head over the weir including elevation head and velocity head.

Table: 1

Weir Crest: 1092.45 ft

(a) SE Elevation	(b) H (ft)	(c) Velocity Head (ft)	(d) Total Head (ft)	(e) C	(f) Weir Length L (ft)	(g) Q_{weir} (cfs)	(h) Total Q	(i) US HGL	
1092.50	0.05	0.00	0.05	2.37	22	0.6	55.6	1092.5	
1094.64	**2.19**	**0.16**	**2.35**	**2.67**	**22**	**210.9**	**265.9**	**1096.70**	(interpolated)
1094.80	2.35	0.20	2.55	2.67	22	239.2	294.2	1097.27	
1095.00	2.55	0.27	2.82	2.67	22	278.2	333.2	1098.14	
1095.22	2.77	0.37	3.14	2.66	22	325.6	380.6	1098.38	
1095.80	3.35	1.15	4.50	2.74	22	575.4	630.4	1100.25	

(a) Elevation from HEC- 1 model
(b) Head over weir elevation of 1092.45
(c) Velocity head at the weir
(d) Total Head Col. (2)+Col.(3)
(e) Weir coefficient based on head and crest width
(f) Length of weir
(g) Flow over broad-crested weir based on $Q=CLH^{1.5}$
(h) Total Q at Sunset Basin, adding 55 cfs to Q in (g)
(i) Upstream HGL elevation from StormCAD, using elev. from (a) as tailwater

Step: 2 Water surface elevation determination at Sunset Basin.

The hydraulic grade line was determined from the weir location back to the Sunset Basin using StormCAD. Setting column (a) SE Elevation from the above table as the tailwater depth for the model, the hydraulic grade line at Sunset Basin was determined for each corresponding flow from column (g) through the storm drain system, shown in column (i) in Table 1.

The HEC-1 rating table **(SQ Card)** and **(SE card)** was revised using **Column (h) Q** and **Column (i) US HGL** from Table 1 and the model was run to determine the routing through the basin. The result shows a total of 266 cfs routed through Sunset Basin, with 55 cfs going into the existing storm drain along Indian School Rd and 211 cfs flowing into the new storm drain. The water surface elevation at the Sunset Basin was interpolated from Table 1 to be 1096.70 for a discharge of 266 cfs. The SE elevation in column (a) was interpolated to be 1094.64 for a weir flow of 211 cfs. This corresponds to a head of 2.19' over the weir. The StormCAD model was ran again using a discharge of 211 cfs and 1094.64 as the tailwater elevation. This resulted in a hydraulic grade line of 1096.57 at Sunset Basin, which is in agreement with the 1096.70 interpolated values. When the 0.12' loss through the trash rack was added, the final WSE at Sunset Basin was computed to be 1096.69. The outfall elevation at Sunset basin was determined to be 1097.83 based on survey data. This results in 1.14' of freeboard at the Sunset Basin. This process was repeated for weir lengths of 18' and 20'.

Step: 3 Storm Drain System Downstream of the weir using 96" Concrete Pipe

The downstream storm drain system is from the weir structure to the Maryvale Basin. The hydraulic grade line for the downstream storm drain system was determined using StormCAD. The proposed conflict structure for the 36" irrigation lateral was also considered during storm drain analysis. A junction was placed at the location where the 36" irrigation lateral crosses the storm drain to account for the losses through the structure.

The StormCAD model was ran using a discharge of 211 cfs and 1092.45 as the tailwater elevation. This resulted in an HGL of 1092.79 at the upstream end of the storm drain system (at the weir structure). The submerged ratio for the broad-crested weir was computed (head downstream/head upstream = 0.34/2.19 = 0.15) and determined to be below the threshold limit of 0.66 to 0.85. This indicates the downstream storm drain segment with the conflict structure will not adversely impact the WSE of the upstream storm drain system.

BETHANY HOME OUTFALL CHANNEL-REACH D DESIGN
FCD PROJECT NO. 2006C027
Hydraulic Calculations

Strom Drain Size: 96"
Weir Crest: 1092.45 ft

$\phi = 96''$, $L = 22'$

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
SE Elevation	H (ft)	Velocity Head (ft)	Total Head (ft)	C	L (ft)	Q_{weir} (cfs)	Total Q	US HGL	
1092.50	0.05	0.00	0.05	2.37	22	0.6	55.6	1092.5	
1094.64	**2.19**	**0.16**	**2.35**	**2.67**	**22**	**210.9**	**265.9**	**1096.70**	(interpolated)
1094.80	2.35	0.20	2.55	2.67	22	239.2	294.2	1097.27	
1095.00	2.55	0.27	2.82	2.67	22	278.2	333.2	1098.14	
1095.22	2.77	0.37	3.14	2.66	22	325.6	380.6	1098.38	
1095.80	3.35	1.15	4.50	2.74	22	575.4	630.4	1100.25	

(1) Elevation from HEC- 1 model
(2) Head over weir elevation of 1092.45
(3) Velocity head at the weir
(4) Total Head Col. (2)+Col.(3)
(5) Weir coefficient based on head and crest width
(6) Length of weir
(7) Flow over broad-crested weir based on $Q=CLH^{1.5}$
(8) Total Q at Sunset Basin, adding 55 cfs to Q in (7)
(9) Upstream HGL elevation from StormCAD, using elev. from (1) as tailwater

HEC-1 Rating Table for Sunset Basin

SV	0	0.93	2.05	4.79	15.29	30.43	31.05	62.09	69.2	71.3	86.8
SQ	0	6	10	20	30	40	40.4	294.2	333.2	380.6	630.4
SE	1085	1086	1086.5	1087.3	1089.6	1092.4	1092.5	1097.27	1098.14	1098.38	1100.25

HEC-1 Results

Basin ID	Q	Comments
PA63	**266**	Route through Sunset Basin
D63S	**55**	Divert to existing Storm Drain at Indian School RD
D63	**211**	Flow in new Storm Drain

WSE at Q=266 cfs:	1096.57 ft (from StormCAD)
Velocity head through trash rack (50% clogged)	0.12
WSE at Sunset Basin	1096.69
Outfall Elevation of Sunset Basin:	1097.83 ft
Freeboard at Sunset Basin:	1.14 ft

BETHANY HOME OUTFALL CHANNEL-REACH D DESIGN
FCD PROJECT NO. 2006C027
Hydraulic Calculations

Weir Crest: 1092.45 ft $\phi = 90''$, $L = 20'$

(1) SE Elevation	(2) Elevation Head (ft)	(3) Velocity Head (ft)	(4) Total Head (ft)	(5) C	(6) L (ft)	(7) Q_{weir} (cfs)	(8) Total Q	(9) US HGL	
1092.50	0.05	0.00	0.05	2.37	20	**0.5**		1092.5	
1094.80	2.35	0.13	2.48	2.66	20	**207.8**	262.8	1097.11	
1094.79	**2.34**	**0.16**	2.50	**2.67**	**20**	**207.0**	**262.0**	**1097.43**	(Interpolated)
1095.22	2.77	0.21	2.98	2.66	20	**273.7**	328.7	1098.52	
1098.00	5.55	1.98	7.53	2.88	20	**1190.2**	1245.2	1107.75	
1100.80	8.35	6.76	15.11	2.88	20	**3383.1**	3438.1	1176.74	

(1) Elevation from HEC model
(2) Head over weir elevation of 1092.45
(3) Velocity head at the weir
(4) Total Head Col. (2)+Col.(3)
(5) Weir coefficient based on head and crest width
(6) Length of weir
(7) Flow over broad-crested weir based on $Q=CLH^{1.5}$
(8) Total Q at Sunset Basin, adding 55 cfs to Q in (5)
(9) Upstream HGL elevation from StormCAD, using elev. from (1) as tailwater

HEC-1 Rating Table for Sunset Basin

SV	0	0.8	1.8	4.3	13.8	28	28.6	58.13	69.5	83.3	85.0
SQ	0	6	10	20	30	40	40.4	262.8	328.7	1245	3438
SE	1085	1086	1086.5	1087.3	1089.6	1092.4	1092.5	1097.11	1098.52	1107.75	1176.74

HEC-1 Results

Basin ID	Q	Comments
PA63	**262**	Route through Sunset Basin
D63S	**55**	Divert to existing Storm Drain at Indian School RD
D63	**207**	Flow in new Storm Drain

WSE at Q=270 cfs:	1097.38 ft (from StormCAD)
Velocity head through trash rack (50% clogged)	0.12
WSE at Sunset Basin	1097.50
Outfall Elevation of Sunset Basin:	1097.83 ft
Freeboard at Sunset Basin:	0.33 ft

BETHANY HOME OUTFALL CHANNEL-REACH D DESIGN
FCD PROJECT NO. 2006C027
Hydraulic Calculations

Weir Crest: 1092.45 ft $\phi = 96''$, $L = 20'$

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
SE Elevation	Elevation Head (ft)	Velocity Head (ft)	Total Head (ft)	C	L (ft)	Q_{weir} (cfs)	Total Q	US HGL	
1092.50	0.05	0.00	0.05	2.37	20	**0.5**		1092.5	
1094.80	2.35	0.13	2.48	2.66	20	**207.8**	262.8	1096.77	
1094.85	**2.40**	**0.16**	2.56	**2.67**	**20**	**215.0**	**270.0**	**1096.94**	(Interpolated)
1095.22	2.77	0.21	2.98	2.66	20	**273.7**	328.7	1098.52	
1098.00	5.55	1.98	7.53	2.88	20	**1190.2**	1245.2	1107.75	
1100.80	8.35	6.76	15.11	2.88	20	**3383.1**	3438.1	1176.74	

(1) Elevation from HEC model
(2) Head over weir elevation of 1092.45
(3) Velocity head at the weir
(4) Total Head Col. (2)+Col.(3)
(5) Weir coefficient based on head and crest width
(6) Length of weir
(7) Flow over broad-crested weir based on $Q=CLH^{1.5}$
(8) Total Q at Sunset Basin, adding 55 cfs to Q in (5)
(9) Upstream HGL elevation from StormCAD, using elev. from (1) as tailwater

HEC-1 Rating Table for Sunset Basin

SV	0	0.8	1.8	4.3	13.8	28	28.6	55.59	69.5	83.3	85.0
SQ	0	6	10	20	30	40	40.4	262.8	328.7	1245	3438
SE	1085	1086	1086.5	1087.3	1089.6	1092.4	1092.5	1096.77	1098.52	1107.75	1176.74

HEC-1 Results

Basin ID	Q	Comments
PA63	**270**	Route through Sunset Basin
D63S	**55**	Divert to existing Storm Drain at Indian School RD
D63	**215**	Flow in new Storm Drain

WSE at Q=270 cfs:	1096.96 ft (from StormCAD)
Velocity head through trash rack (50% clogged)	0.12
WSE at Sunset Basin	1097.08
Outfall Elevation of Sunset Basin:	1097.83 ft
Freeboard at Sunset Basin:	0.75 ft

Broad-Crested Weir

$$Q = C_{BCW} L H^{1.5}$$

Where: Q = discharge in cfs

C_{CBW} = broad-crested weir coefficient (2.34 – 3.32)

L = broad-crested weir length in ft

H = head above weir crest in ft

See Table F-2 for C Values as a function of weir crest breadth and head.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest

Broad-Crested Weir Coefficient C Values as a function of Weir Crest Breadth and Head (coefficient has units of $ft^{0.5}$/sec).											
Head	Breadth of Crest of Weir (ft)										
(ft)	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	5.60	2.60	2.678	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	0.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

F.2. References

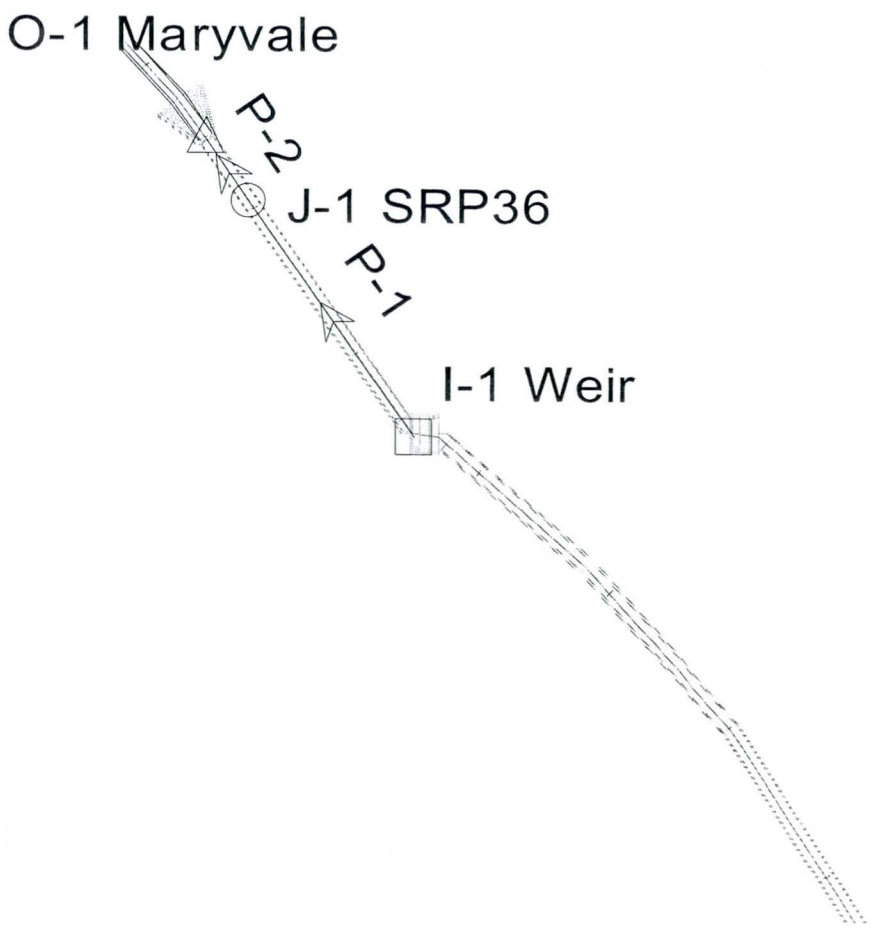
Rajaratnam, N. 1989. Hydraulics of culvert fishways III: slotted-weir culvert fishways. Canadian Journal of Civil Engineering. 16:3:375-383.

Rajaratnam, N. and C. Katopodis. 1990. Hydraulics of culvert fishways III: weir baffle culvert fishways. Canadian Journal of Civil Engineering. Vol. 17: 4:558-568.

Shoemaker, R.H.. 1956. Hydraulics of box culverts with fish-ladder baffles. Proceedings of the 35th Annual Meeting, Highway Research Board, Engineering Experiment Station, Oregon State College. Report No. 53.

WDFW (Washington Department of Fish and Wildlife). 2003. Design of Road Culverts for Fish Passage. May 2003.

Scenario: BHOC-D Storm Drain- Down Stream With SRP Structure (K=0.4)



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Olsson Associates

Project Engineer: Duc
StormCAD v5.5 [5.5003]

Calculation Results Summary

==========
Scenario: BHOC-D Storm Drain- Down Stream With SRP Structure (K=0.4)

>>>> Info: Subsurface Network Rooted by: O-1 Maryvale
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1 Weir	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1 Maryvale

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-2	1	96 inch	Circular	58.00	211.00	5.38	1,092.50	1,092.45
P-1	1	96 inch	Circular	142.00	211.00	5.85	1,092.79	1,092.70

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1 Maryvale	211.00	1,097.00	1,092.45	1,092.45
J-1 SRP36	211.00	1,097.50	1,092.70	1,092.50
I-1 Weir	211.00	1,098.00	1,092.89	1,092.79

==========
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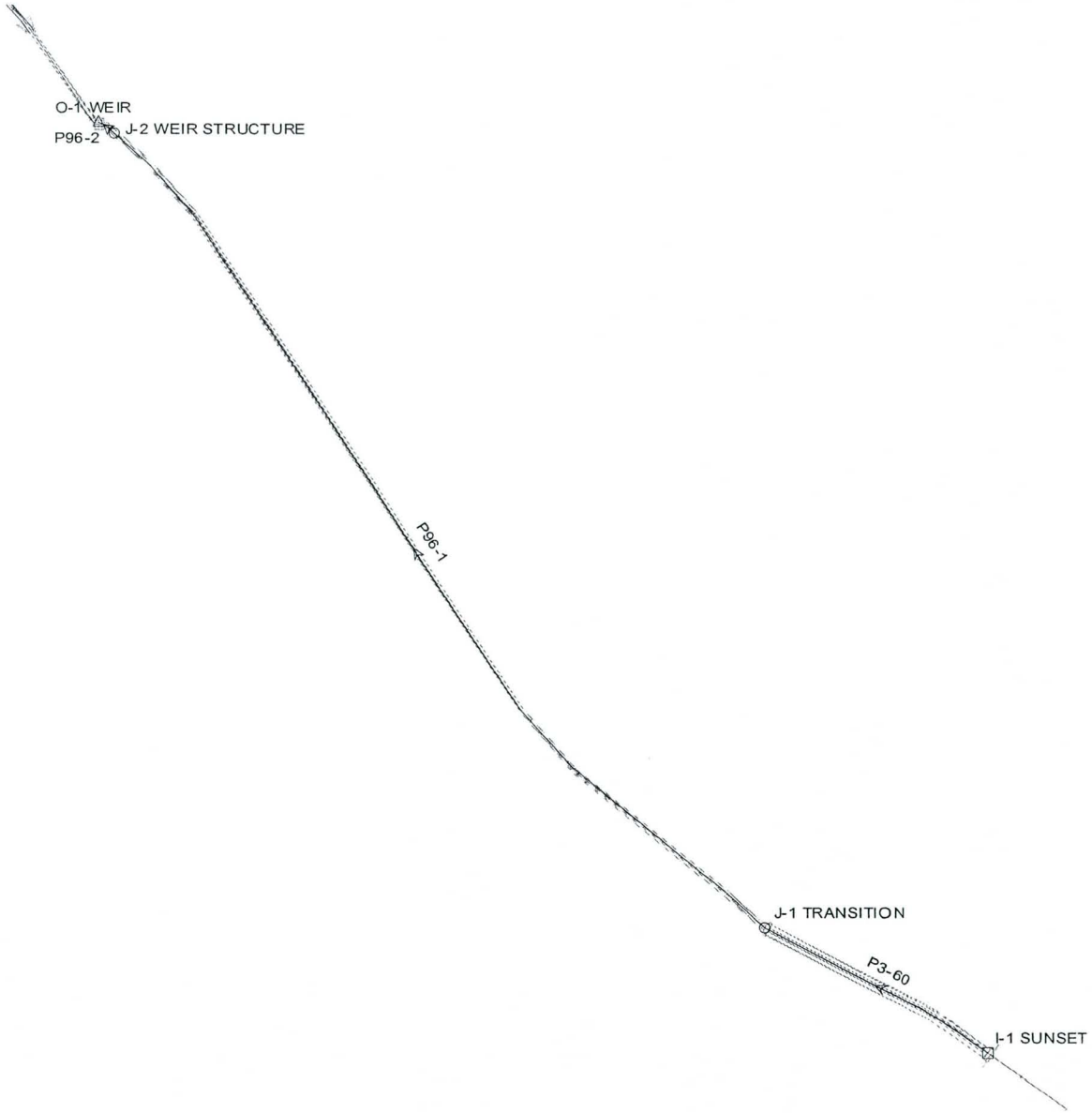
Scenario: BHOC-D Storm Drain- Down Stream With SRP Structure (K=0.4)

Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Velocity Out (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-1 Weir	J-1 SRP36	211.00	142.00	0.000845	96 inch	0.013	5.44	265.13	1,087.05	1,086.93	1,098.00	1,097.50	2.95	2.57	1,092.79	1,092.70
P-2	J-1 SRP36	O-1 Maryvale	211.00	58.00	0.000690	96 inch	0.013	5.66	239.51	1,086.93	1,086.89	1,097.50	1,097.00	2.57	2.11	1,092.50	1,092.45

Scenario: BHOC-D Storm Drain Upstream Structure



Title: BHOC-D (PCN 620 03 32)
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Project Engineer: Duc
StormCAD v5.5 [5.5003]
Page 1 of 1

Calculation Results Summary

==========
Scenario: BHOC-D Storm Drain Upstream Structure

>>>> Info: Subsurface Network Rooted by: O-1 WEIR
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1 SUNSET	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1 WEIR

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P96-2	1	96 inch	Circular	1.00	211.00	4.20	1,094.64	1,094.64
P96-1	1	96 inch	Circular	1,894.00	211.00	4.20	1,095.91	1,094.90
P3-60	3	60 inch	Circular	453.00	211.00	3.58	1,096.53	1,096.20

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1 WEIR	211.00	1,098.00	1,094.64	1,094.64
J-2 WEIR STRUCTURE	211.00	1,098.00	1,094.90	1,094.64
J-1 TRANSITION	211.00	1,097.50	1,096.20	1,095.91
I-1 SUNSET	211.00	1,100.00	1,096.57	1,096.53

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Scenario: BHOC-D Storm Drain Upstream Structure

Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Velocity Out (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P3-60	I-1 SUNSE	J-1 TRANSIT	211.00	453.00	-0.000508	60 inch	0.013	3.58	-176.05	1,085.00	1,085.23	1,100.00	1,097.50	10.00	7.27	1,096.53	1,096.20
P96-1	J-1 TRAN	J-2 WEIR ST	211.00	894.00	-0.000950	96 inch	0.013	4.21	-281.16	1,085.23	1,087.03	1,097.50	1,098.00	4.27	2.97	1,095.91	1,094.90
P96-2	J-2 WEIR	O-1 WEIR	211.00	1.00	0.000000	96 inch	0.013	4.27	0.00	1,087.03	1,087.03	1,098.00	1,098.00	2.97	2.97	1,094.64	1,094.64

Head loss through the storm drain system

The head losses in the storm drain system were computed for three different structures, namely the **inlet**, **transition**, and **weir** structure. Methods for determining the head losses were selected from the FCDMC's *Drainage Design Manual Volume II* and the FHWA's *HEC-22 Manual*. Friction loss in the storm drain pipe was considered in the StormCAD model with Manning's roughness coefficient of n = 0.013.

Inlet Structure:

A beveled edge inlet type was designed as an inlet structure for the storm drain system. Adding bevels to the square-edged inlet increases capacity by 5 to 20 percent. Thus, an entrance loss coefficient of 0.2 is considered for the beveled edge inlet structure based on Table 5.3 of the *Drainage Design Manual Volume II*.

Transition Structure:

A storm drain transition is a structure of varying cross-section designed to provide smooth flow between two conduits. A transition is usually required to change conduit size, to change type of conduit, or to avoid obstructions. The transition structure for the BHOC Reach D storm drain system has three 60-inch concrete pipes transitioning into a 96-inch concrete pipe as shown in Figure 2 below. Three different types of losses were computed at the transition structure, including, A. Exit loss, B. Transition loss, and C. Entrance loss.

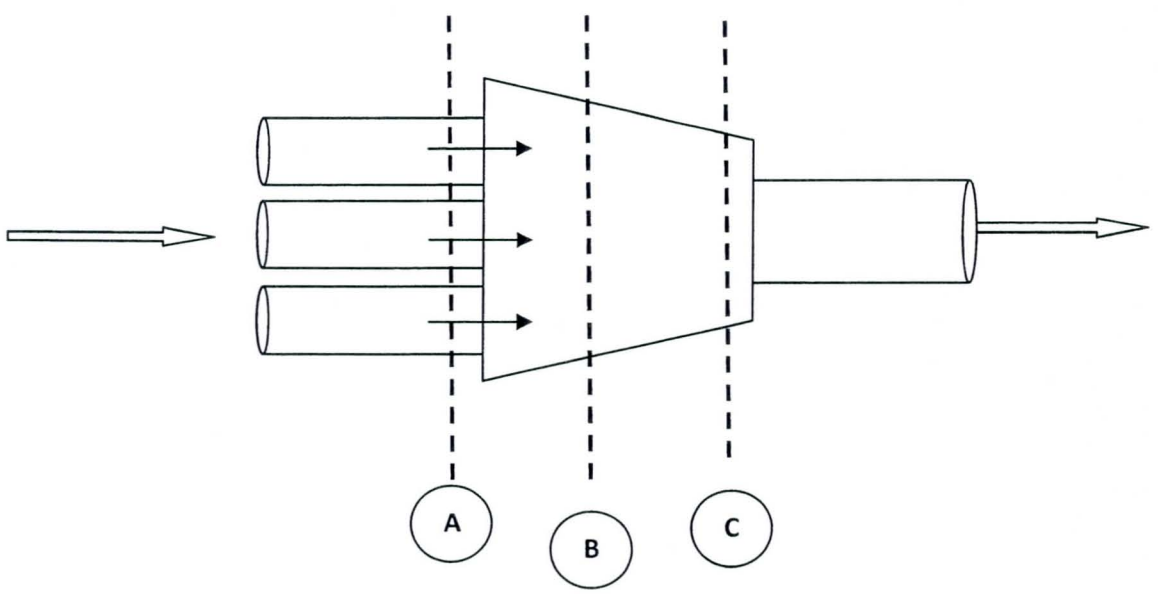


Figure 2: Transition Structure

Sample calculations for transition loss are computed below:

TABLE 5.1
ENTRANCE LOSS COEFFICIENTS
OUTLET CONTROL, FULL OR PARTLY FULL ENTRANCE HEAD LOSS
(USDOT, FHWA, HDS-5, 1985)

Type of Structure and Design of Entrance	Coefficient, K_e
Pipe, Concrete	
Projecting from fill, socket end (grove-end)	0.2
Projecting from fill, square cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (grove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12 D)	0.2
Mitered to conform to fill slope	0.7
End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled on sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwalls at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

A) Exit Loss: The exit loss is a function of the change in velocity at the outlet of the pipe. The exit loss is expressed as:

$$H_o = \left(\frac{V_A^{\ 2}}{2g} - \frac{V_B^{\ 2}}{2g} \right)$$

Where,

V_A = average velocity in ft/sec

V_B = channel velocity downstream of outlet in ft/sec

Please refer to the calculation sheet attached:

Exit loss at sec-A

For weir length 22 ft and storm drain pipe size 96" dia standard flow (100-Year) through storm drain is 211 cfs. **

Thus, velocity at Section-A for $Q_{100} = 218$ cfs

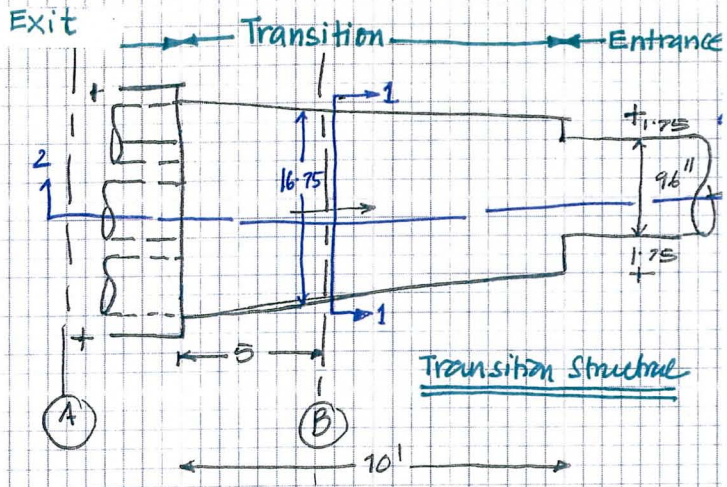
$V_A = 3.58$ ft/sec

Velocity at section-B

$$V_B = \frac{Q_{100}}{A_B}$$

where,

A_B = area of transition structure at section-B



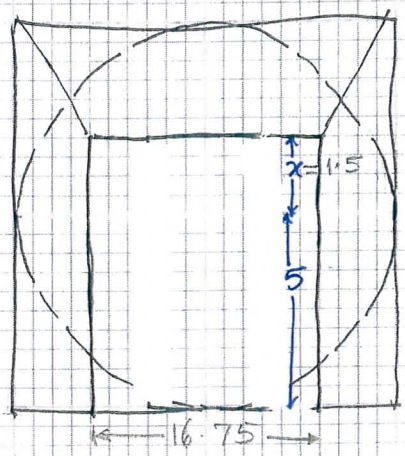
Transition Structure

$\therefore A_B = 16.75 \times (5 + 1.5)$

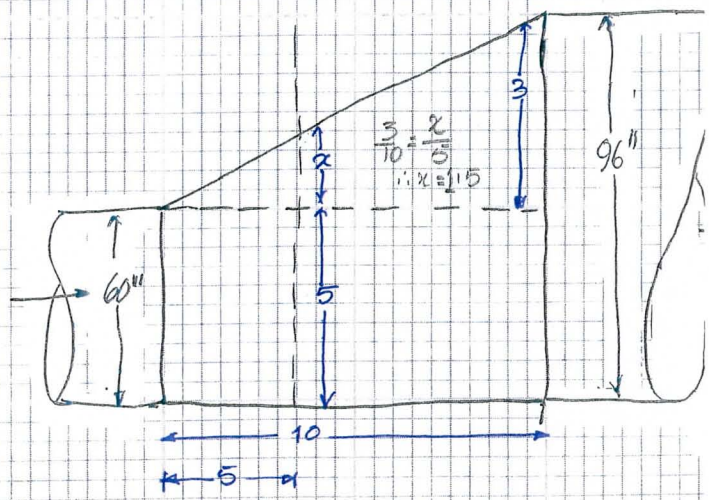
$= 108.87$ ft^2

$$V_B = \frac{211}{108.87}$$

$= 1.94$ ft/sec



Section 1-1



Section-2-2

OLSSON ASSOCIATES

PROJECT: BETHANY HOME OUTFALL CHANNEL REACH-D

project no.:
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date:
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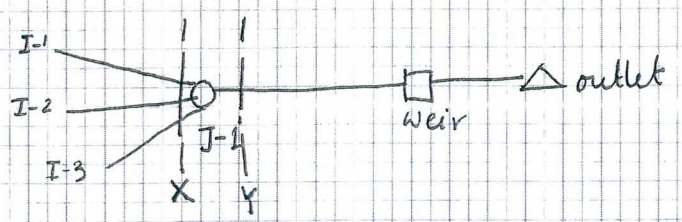
Exit Head loss (H_o) at $Q_{100} = 218$ cfs.

$$H_o = \left(\frac{V_A^2 - V_B^2}{2g} \right)$$

$$= \left[\frac{(3.58)^2 - (1.94)^2}{2 \times 32.2} \right] = 0.14 \text{ ft}$$

Computing standard head loss-coefficient from storm CAD, for head loss of 0.14 ft, at junction J-1



With standard headloss-co-efficient at junction J-1 = 0.5 & Q_{100} = 211 cfs the loss in head from section X to section-Y is 0.14 ft,** which matches above exit head loss (H_o) calculation. Thus, Exit head loss coefficient of "0.5" is considered at Junction-1 for StormCAD Model.

** Please refer attached storm CAD output to compute head loss at junction J-1 when head loss co-efficient of 0.5 is used at junction-1.

OLSSON ASSOCIATES

PROJECT:

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drawn by:
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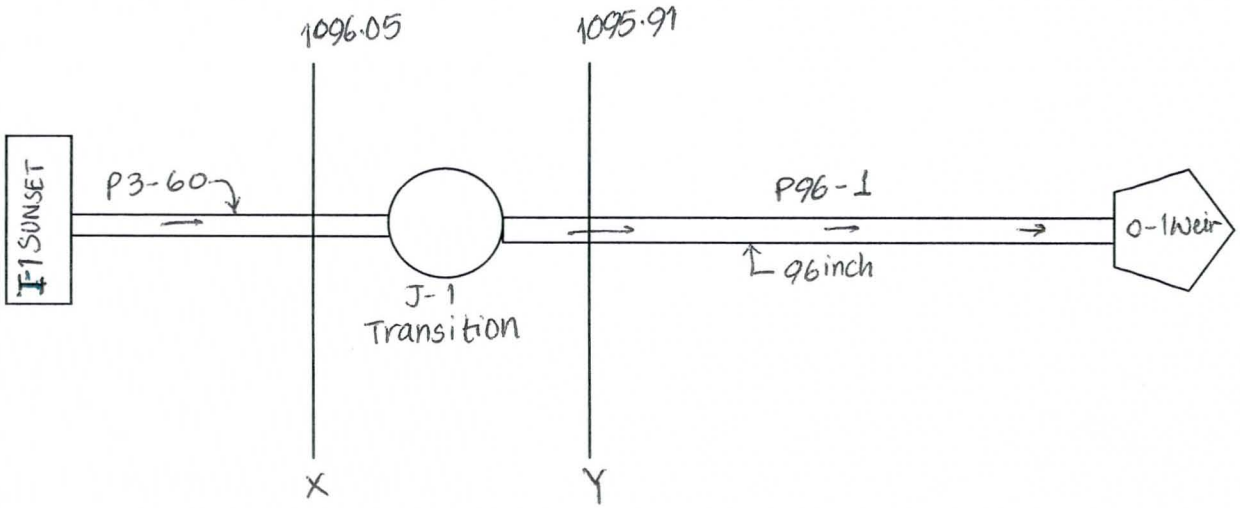
Scenario: BHOC-D Storm Drain Upstream Structure

Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Velocity Out (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P3-60	I-1 SUNSE	J-1 TRANSIT	211.00	453.00	-0.000508	60 inch	0.013	3.58	-176.05	1,085.00	1,085.23	1,100.00	1,097.50	10.00	7.27	1,096.38	1,096.05
P96-1	J-1 TRAN	J-2 WEIR ST	211.00	894.00	-0.000950	96 inch	0.013	4.21	-281.16	1,085.23	1,087.03	1,097.50	1,098.00	4.27	2.97	1,095.91	1,094.90
P96-2	J-2 WEIR	O-1 WEIR	211.00	1.00	0.000000	96 inch	0.013	4.27	0.00	1,087.03	1,087.03	1,098.00	1,098.00	2.97	2.97	1,094.64	1,094.64



Note:- Calculation done considering exit loss coeff only.

B) Transition Loss: A transition is a location where a conduit changes size. Transition includes expansion, contraction, or both. For gradual contractions, it has been observed that $K_c=0.5K_e$. Typical values of K_e for gradual expansion are shown in the tables below. The angle of cone that forms the transition is defined in Figure 3 below.

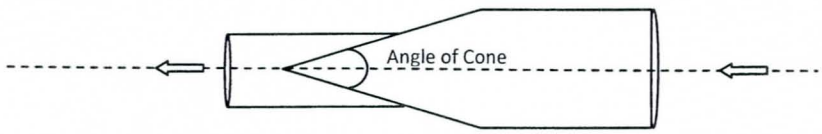


Figure 3: Angle of cone for pipe diameter changes

K_e = expansion coefficient
K_c = contraction coefficient

Table 7-4a. Typical Values for K_e for Gradual Enlargement of Pipes in Non-Pressure Flow.

D_2/D_1	Angle of Cone						
	10°	20°	45°	60°	90°	120°	180°
1.5	0.17	0.40	1.06	1.21	1.14	1.07	1.00
3	0.17	0.40	.86	1.02	1.06	1.04	1.00

Table 7-4b. Typical Values of K_c for Sudden Pipe Contractions.

D_2/D_1	K_c
0.2	0.5
0.4	0.4
0.6	0.3
0.8	0.1
1.0	0.0
D_2/D_1 = Ratio of diameter of smaller pipe to large pipe. (Source: Reference 8)	

Table 7-4d. Values of K_e for Determining Loss of Head due to Gradual Enlargement in Pipes.

D_2/D_1	Angle of Cone										
	2°	6°	10°	15°	20°	25°	30°	35°	40°	50°	60°
1.1	0.01	0.01	0.03	0.05	0.10	0.13	0.16	0.18	0.19	0.21	0.23
1.2	0.02	0.02	0.04	0.09	0.16	0.21	0.25	0.29	0.31	0.35	0.37
1.4	0.02	0.03	0.06	0.12	0.23	0.30	0.36	0.41	0.44	0.50	0.53
1.6	0.03	0.04	0.07	0.14	0.26	0.35	0.42	0.47	0.51	0.57	0.61
1.8	0.03	0.04	0.07	0.15	0.28	0.37	0.44	0.50	0.54	0.61	0.65
2.0	0.03	0.04	0.07	0.16	0.29	0.38	0.46	0.52	0.56	0.63	0.68
2.5	0.03	0.04	0.08	0.16	0.30	0.39	0.48	0.54	0.58	0.65	0.70
3.0	0.03	0.04	0.08	0.16	0.31	0.40	0.48	0.55	0.59	0.66	0.71
inf	0.03	0.05	0.08	0.16	0.31	0.40	0.49	0.46	0.60	0.67	0.72
D_2/D_1 = ratio of diameter of larger pipe to diameter of smaller pipe Angle of cone is the angle in degrees between the sides of the tapering section (Source: Reference 8)											

Transition loss:-

"K_c" contraction coefficient for gradual contraction

$$K_c = 0.5 K_e$$

for design discharge $Q_{100} = 218$ cfs the storm drain pipe will be under pressure flow.

Considering transition structure to be 10ft long, angle of cone $\alpha = 55°$, and $D_2/D_1 = 1.9$

therefore, from Table

value of "K_e" for corresponding values of cone angle $\alpha = 55°$ and $D_2/D_1 = 1.9$ is "0.68".

where, # D_2/D_1 = ratio of diameter of large pipe to diameter of smaller pipe

Angle of cone is the angle in degree between the sides of the tapered section

$$\therefore K_c = 0.5 \times 0.68$$
$$= 0.35$$

c) Entrance Loss:- Beveled edge 96" storm drain was assumed at the transition structure. Therefore, the entrance loss co-efficient of 0.2 was used as an entrance loss.

$\therefore$ Head loss Coefficent at Transition Structure = Head loss Coefficient at Exit (sec-A) + transition (sec-B) + En (sec-

$$= 0.5 + 0.35 + 0.2$$
$$= 1.05$$

$\therefore$ standard head loss Coefficient of 1.05 is used at Junction J-1 in storm CAD Mod

OLSSON ASSOCIATES

PROJECT:

project no.:

drawn by:

date:

page of

C) Entrance Loss: A beveled edge was designed at the face of the 96" storm drain pipe at the transition structure, thus the entrance loss coefficient of 0.2 was considered.

Weir Structure:

Exit loss is the major loss that takes place at the weir structure. Please refer to the hand calculations for detail.

Exit Loss Calculation at Weir Structure.

Entrance Loss Calc

The entrance loss co-efficient of 0.2 was used assuming beveled edge entrance.

Exit Loss Calc

$Q_A = Q_B = 211$ cfs

$V_A = 4.21$ ft/sec

Head loss

$$H_o = \frac{V_A^2 - V_B^2}{2 \times g}$$

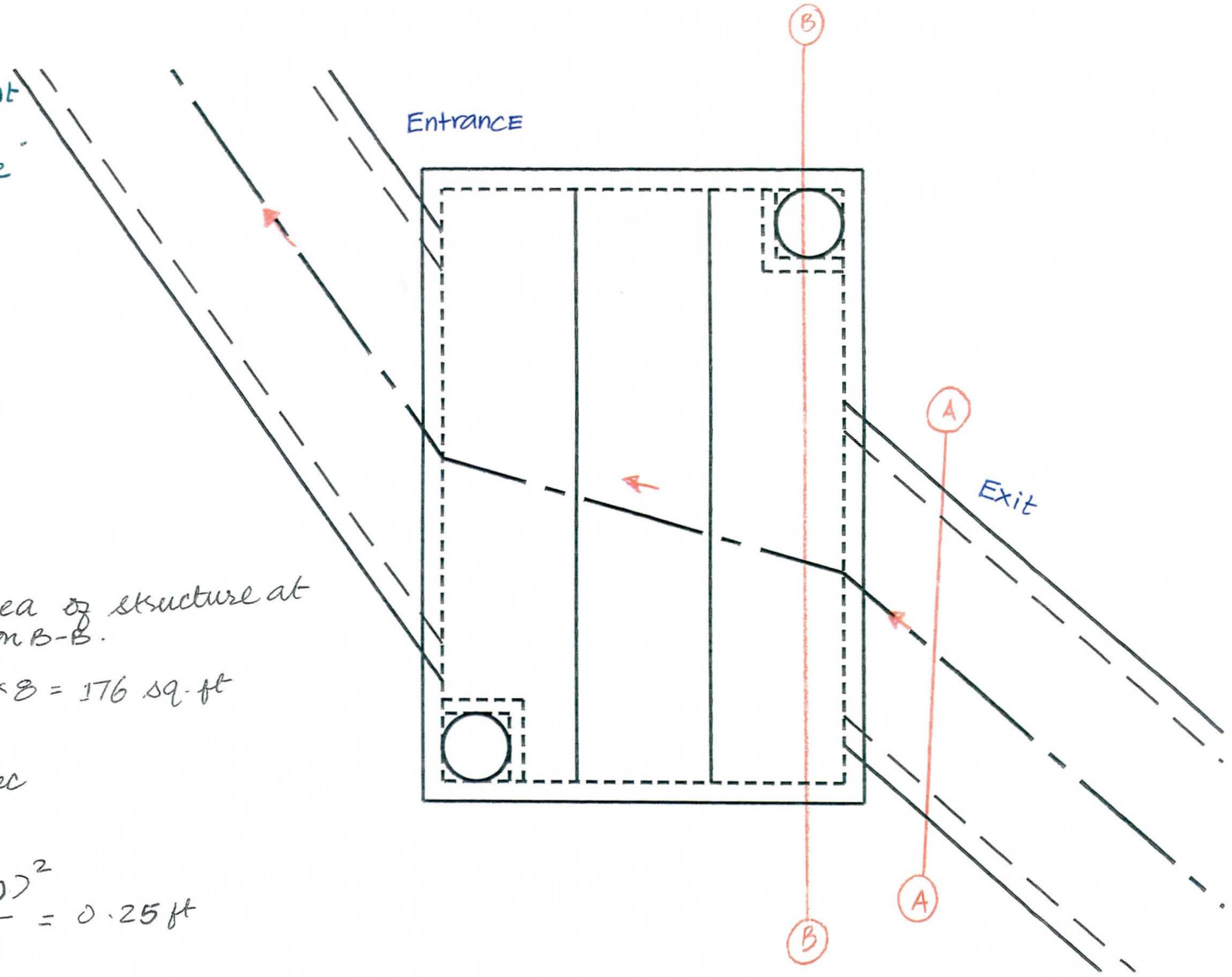
$$V_B = \frac{Q_B}{A_B}$$

A_B = x-Area of structure at section B-B.

$A_B = 22 \times 8 = 176$ sq. ft

$$V_B = \frac{211}{176} = 1.20 \text{ ft/sec}$$

$$H_o = \frac{(4.21)^2 - (1.20)^2}{2 \times 32.2} = 0.25 \text{ ft}$$



∴ At design discharge (Q = 211 cfs) head loss at weir structure (Junction-2) is 0.25 ft considering "0.9" standard head loss Coefficient.

1" = 6'

B.2 Storm Drain Replacement at 67th Avenue

Storm Drain Replacement 67th Avenue

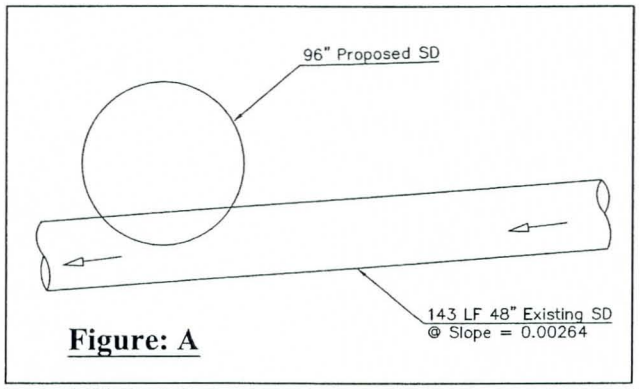


Figure: A

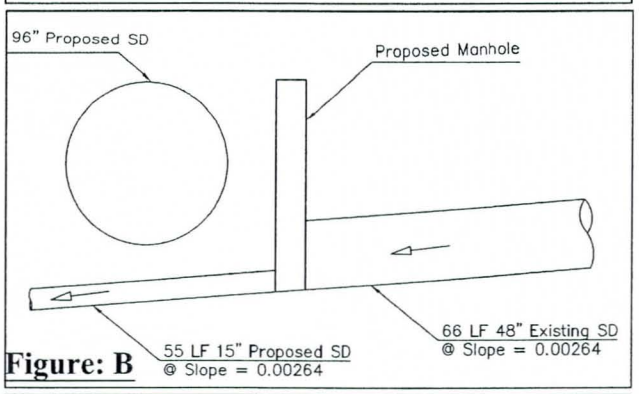


Figure: B

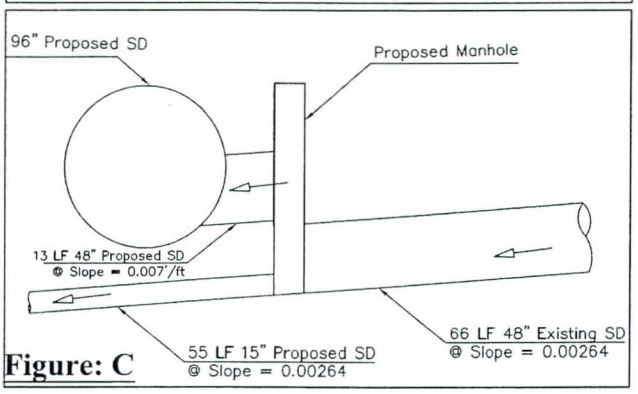
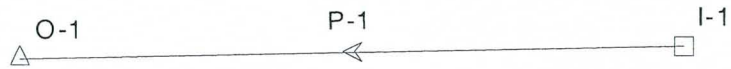


Figure: C

As shown in Figure A above, the existing 48" storm drain (SD) conflicts with the proposed 96" SD at 67th Avenue. Under pressure flow condition, the capacity of the existing 48" SD was calculated to be approximately 74 cfs. To eliminate the conflict, a 15" diameter storm drain pipe is proposed to replace the existing 48" SD pipe segment in conflict, as shown in Figure B. The 15" pipe will convey low flows, with a capacity of 3.32 cfs. Flows in excess of 3.32 cfs will be conveyed to the 96" pipe through a 48" pipe connection to the BHOC-D storm drain, as shown in Figure C. Please refer to following Storm CAD results for the existing and the proposed conditions layout, and for the pipe reports.

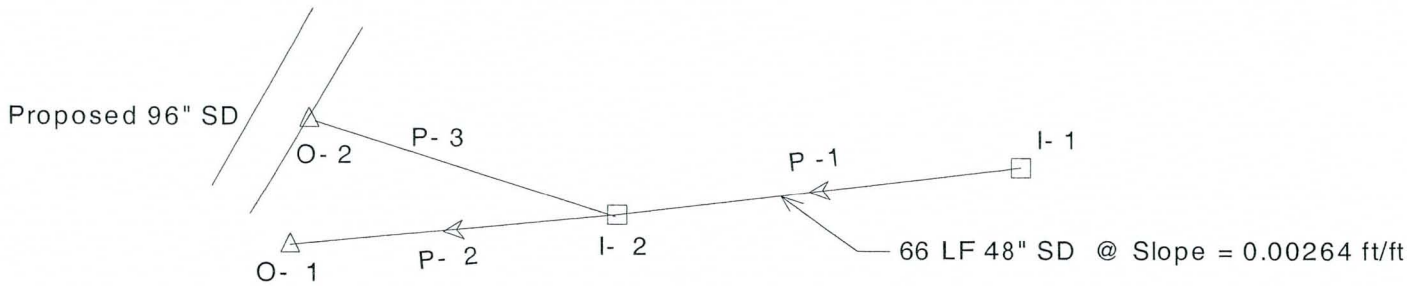
Scenario: 67th Avenue Storm Drain Replacement

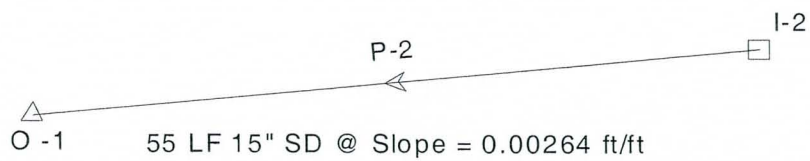
Existing Condition : 48" StormDrain Pipe

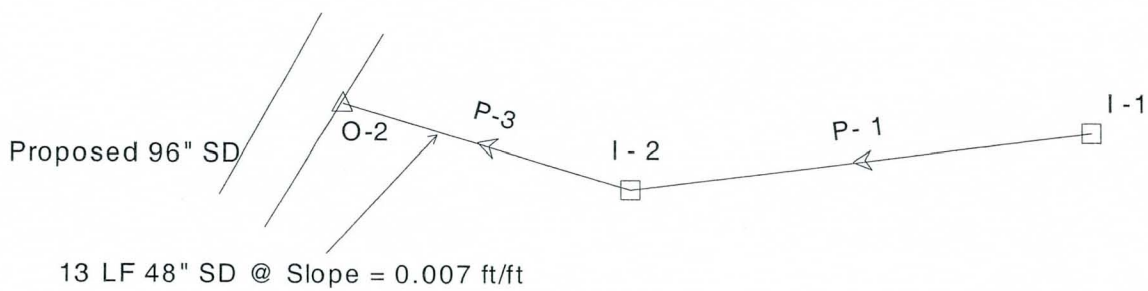


Length : 143 ft @ S = 0.00264

Proposed Condition Pipe Layout







Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Velocity Out (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-1	O-1	74.00	143.10	0.002655	48 inch	0.013	5.89	74.02	1,083.69	1,083.31	1,097.93	1,097.55	10.24	10.24	1,097.43	1,097.05

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Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Velocity Out (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-2	I-2	O-1	3.32	55.00	0.002727	15 inch	0.013	2.71	3.37	1,083.52	1,083.37	1,097.80	1,097.90	13.03	13.28	1,097.26	1,097.11

Pipe Report

Label	Upstream Node	Downstream Node	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Mannings n	Velocity Out (ft/s)	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	I-1	I-2	372.55	65.00	0.002154	48 inch	0.013	29.65	66.66	1,083.69	1,083.55	1,097.93	1,097.80	10.24	10.25	1,097.43	1,093.05
P-3	I-2	O-2	372.55	13.00	0.007692	48 inch	0.013	29.66	125.98	1,087.60	1,087.50	1,097.80	1,097.90	6.20	6.40	1,092.37	1,091.49

B.3 Street Capacity Calculations

Worksheet for Indian School Rd

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00120	ft/ft
Discharge	26.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+05	100.07
0+10	100.00
0+10	99.50
0+42	100.14
0+74	99.50
0+74	100.00
0+79	100.07

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+05, 100.07)	(0+79, 100.07)	0.015

Results

Normal Depth	0.60	ft
Elevation Range	99.50 to 100.14 ft	
Flow Area	18.52	ft^2
Wetted Perimeter	70.89	ft
Top Width	69.82	ft
Normal Depth	0.60	ft
Critical Depth	0.44	ft
Critical Slope	0.00557	ft/ft
Velocity	1.40	ft/s
Velocity Head	0.03	ft
Specific Energy	0.63	ft

Worksheet for Indian School Rd

Results

Froude Number	0.48	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.60	ft
Critical Depth	0.44	ft
Channel Slope	0.00120	ft/ft
Critical Slope	0.00557	ft/ft

Cross Section for Indian School Rd

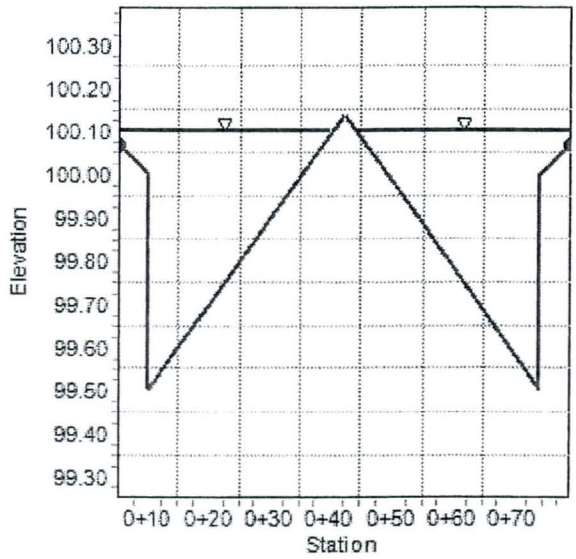
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00120	ft/ft
Normal Depth	0.60	ft
Discharge	26.00	ft^3/s

Cross Section Image



Street Capacity Computations

6" Vertical Curb

Description: Calculation of Street Flow Conveyance Capacity - 100 year storm

Date: 11/05/07

References: Federal Highway Administration, Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", March 1984

Known Values:

Depth of Flow =	0.5 ft
Cross Slope =	0.02 ft/ft
Street Width (F/C to F/C) =	28 ft
Manning's "n" Value=	0.015

Calculated Values:

Referenced Equations:

$Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$ for flow below crown (FHWA Procedure)

$Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$ for flow above crown (Manning's equation)

where Q = flow rate, cfs; S_x = cross slope, ft/ft; S = longitudinal slope, ft/ft; T = width of flow, ft; A = conveyance area, sq ft; R = hydraulic radius, ft

	Longitudinal Slope (ft/ft)	Conveyance Area (ft^2)	Velocity (fps)	Hydraulic Capacity (cfs)	Half-Street Hydraulic Capacity (cfs)
	0.0023	10.08	2.31	23	14
	0.0028	10.08	2.56	26	15
	0.0033	10.08	2.78	28	17
	0.0038	10.08	2.99	30	18
	0.0043	10.08	3.18	32	19
	0.0048	10.08	3.36	34	20
	0.0053	10.08	3.54	36	21
	0.0058	10.08	3.70	37	22
	0.0063	10.08	3.86	39	23
	0.0068	10.08	4.01	40	24
	0.0073	10.08	4.15	42	25
	0.0078	10.08	4.30	43	26
	0.0083	10.08	4.43	45	27
	0.0088	10.08	4.56	46	27
	0.0093	10.08	4.69	47	28
	0.0098	10.08	4.82	49	29
	0.0103	10.08	4.94	50	30
	0.0108	10.08	5.06	51	30
	0.0113	10.08	5.18	52	31
	0.0118	10.08	5.29	53	32
	0.0123	10.08	5.40	54	32
	0.0128	10.08	5.51	56	33
	0.0133	10.08	5.62	57	34
	0.0138	10.08	5.72	58	34
	0.0143	10.08	5.82	59	35
	0.0148	10.08	5.93	60	36
	0.0153	10.08	6.03	61	36
64 th Drive	**0.0020**	**10.08**	**2.18**	**22**	**13**
63 rd Drive	**0.0020**	**10.08**	**2.18**	**22**	**13**
66th Drive	**0.0050**	**10.08**	**3.45**	**35**	**21**
Devonshire Drive	**0.0040**	**10.08**	**3.09**	**31**	**19**
Glenrosa Avenue	**0.0057**	**10.08**	**3.68**	**37**	**22**
Roma Avenue	**0.0060**	**10.08**	**3.78**	**38**	**23**

Worksheet for 64th Drive

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00200	ft/ft
Discharge	43.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	100.00
0+03	100.00
0+03	99.50
0+17	99.78
0+31	99.50
0+31	100.00
0+34	100.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 100.00)	(0+34, 100.00)	0.015

Results

Normal Depth	0.68	ft
Elevation Range	99.50 to 100.00 ft	
Flow Area	16.28	ft²
Wetted Perimeter	35.37	ft
Top Width	34.00	ft
Normal Depth	0.68	ft
Critical Depth	0.57	ft
Critical Slope	0.00478	ft/ft
Velocity	2.64	ft/s
Velocity Head	0.11	ft
Specific Energy	0.79	ft

Worksheet for 64th Drive

Results

Froude Number	0.67	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.68	ft
Critical Depth	0.57	ft
Channel Slope	0.00200	ft/ft
Critical Slope	0.00478	ft/ft

Cross Section for 64th Drive

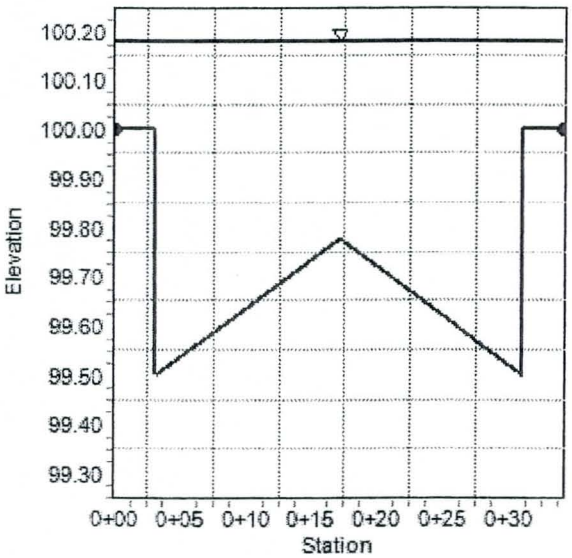
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00200	ft/ft
Normal Depth	0.68	ft
Discharge	43.00	ft^3/s

Cross Section Image



Worksheet for 63rd Drive

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00200	ft/ft
Discharge	39.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	100.00
0+03	100.00
0+03	99.50
0+17	99.78
0+31	99.50
0+31	100.00
0+34	100.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 100.00)	(0+34, 100.00)	0.015

Results

Normal Depth	0.65	ft
Elevation Range	99.50 to 100.00 ft	
Flow Area	15.35	ft^2
Wetted Perimeter	35.32	ft
Top Width	34.00	ft
Normal Depth	0.65	ft
Critical Depth	0.55	ft
Critical Slope	0.00488	ft/ft
Velocity	2.54	ft/s
Velocity Head	0.10	ft
Specific Energy	0.76	ft

Worksheet for 63rd Drive

Results

Froude Number	0.67	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.65	ft
Critical Depth	0.55	ft
Channel Slope	0.00200	ft/ft
Critical Slope	0.00488	ft/ft

Cross Section for 63rd Drive

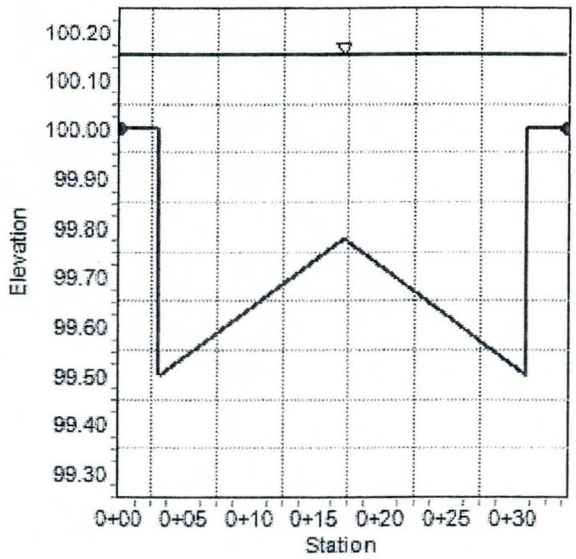
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00200	ft/ft
Normal Depth	0.65	ft
Discharge	39.00	ft^3/s

Cross Section Image



Worksheet for 66th Drive

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Discharge	30.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	100.00
0+03	100.00
0+03	99.50
0+17	99.78
0+31	99.50
0+31	100.00
0+34	100.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 100.00)	(0+34, 100.00)	0.015

Results

Normal Depth	0.47	ft
Elevation Range	99.50 to 100.00 ft	
Flow Area	9.20	ft^2
Wetted Perimeter	28.94	ft
Top Width	28.00	ft
Normal Depth	0.47	ft
Critical Depth	0.47	ft
Critical Slope	0.00496	ft/ft
Velocity	3.26	ft/s
Velocity Head	0.17	ft
Specific Energy	0.63	ft

Worksheet for 66th Drive

Results

Froude Number	1.00	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.47	ft
Critical Depth	0.47	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00496	ft/ft

Cross Section for 66th Drive

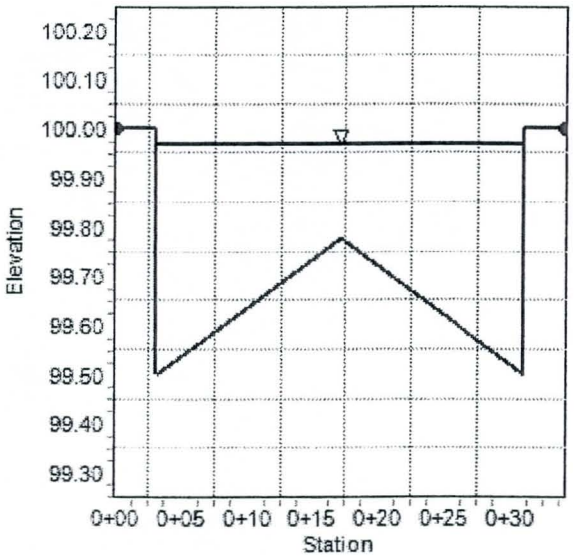
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	0.47	ft
Discharge	30.00	ft^3/s

Cross Section Image



Worksheet for Devonshire Avenue

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00400	ft/ft
Discharge	63.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	100.00
0+03	100.00
0+03	99.50
0+17	99.78
0+31	99.50
0+31	100.00
0+34	100.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 100.00)	(0+34, 100.00)	0.015

Results

Normal Depth	0.69	ft
Elevation Range	99.50 to 100.00 ft	
Flow Area	16.63	ft^2
Wetted Perimeter	35.39	ft
Top Width	34.00	ft
Normal Depth	0.69	ft
Critical Depth	0.68	ft
Critical Slope	0.00443	ft/ft
Velocity	3.79	ft/s
Velocity Head	0.22	ft
Specific Energy	0.92	ft

Worksheet for Devonshire Avenue

Results

Froude Number	0.95	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.69	ft
Critical Depth	0.68	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00443	ft/ft

Cross Section for Devonshire Avenue

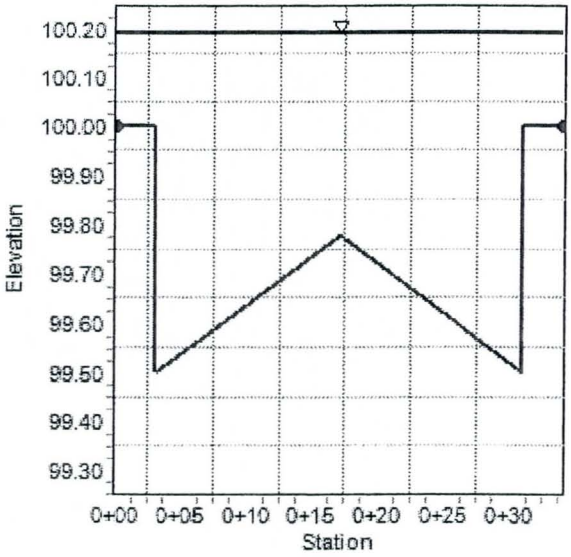
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00400	ft/ft
Normal Depth	0.69	ft
Discharge	63.00	ft^3/s

Cross Section Image



Worksheet for Glenrosa Ave

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00600	ft/ft
Discharge	214.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	100.00
0+03	100.00
0+03	99.50
0+17	99.78
0+31	99.50
0+31	100.00
0+34	100.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 100.00)	(0+34, 100.00)	0.015

Results

Normal Depth	1.11	ft
Elevation Range	99.50 to 100.00 ft	
Flow Area	30.97	ft^2
Wetted Perimeter	36.23	ft
Top Width	34.00	ft
Normal Depth	1.11	ft
Critical Depth	1.28	ft
Critical Slope	0.00353	ft/ft
Velocity	6.91	ft/s
Velocity Head	0.74	ft
Specific Energy	1.86	ft

Worksheet for Glenrosa Ave

Results

Froude Number	1.28	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.11	ft
Critical Depth	1.28	ft
Channel Slope	0.00600	ft/ft
Critical Slope	0.00353	ft/ft

Cross Section for Glenrosa Ave

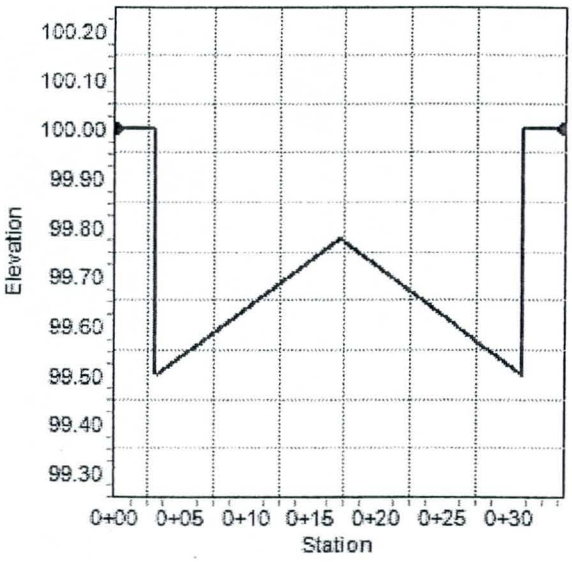
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00600	ft/ft
Normal Depth	1.11	ft
Discharge	214.00	ft^3/s

Cross Section Image



Worksheet for Roma Avenue

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00600	ft/ft
Discharge	123.00	ft^3/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	100.00
0+03	100.00
0+03	99.50
0+17	99.78
0+31	99.50
0+31	100.00
0+34	100.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 100.00)	(0+34, 100.00)	0.015

Results

Normal Depth	0.85	ft
Elevation Range	99.50 to 100.00 ft	
Flow Area	22.08	ft^2
Wetted Perimeter	35.71	ft
Top Width	34.00	ft
Normal Depth	0.85	ft
Critical Depth	0.94	ft
Critical Slope	0.00389	ft/ft
Velocity	5.57	ft/s
Velocity Head	0.48	ft
Specific Energy	1.34	ft

Worksheet for Roma Avenue

Results

Froude Number	1.22	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.85	ft
Critical Depth	0.94	ft
Channel Slope	0.00600	ft/ft
Critical Slope	0.00389	ft/ft

Cross Section for Roma Avenue

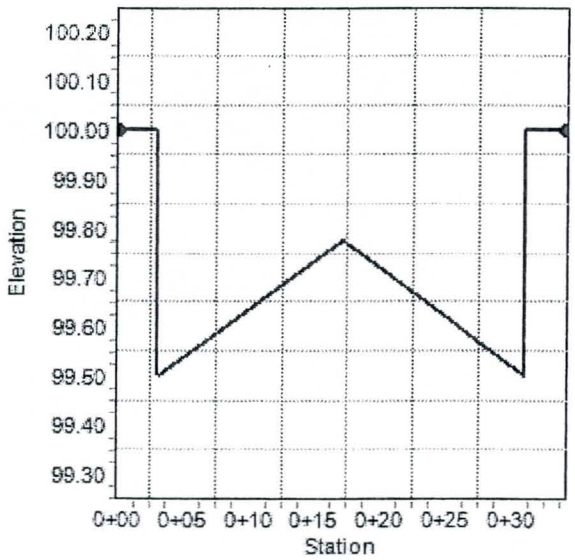
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00600	ft/ft
Normal Depth	0.85	ft
Discharge	123.00	ft^3/s

Cross Section Image



Street Capacity Computations of Indian School Road

6" Vertical Curb

Description: Calculation of Street Flow Conveyance Capacity - 100 year storm

Date: 11/05/07

References: Federal Highway Administration, Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", March 1984

Known Values:

Depth of Flow =	0.5 ft
Cross Slope =	0.02 ft/ft
Street Width (F/C to F/C) =	64 ft
Manning's "n" Value=	0.015
Longitudinal Slope =	0.0012 ft/ft

Calculated Values:

Referenced Equations:

$Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$ for flow below crown (FHWA Procedure)

$Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$ for flow above crown (Manning's equation)

where Q = flow rate, cfs; S_x = cross slope, ft/ft; S = longitudinal slope, ft/ft; T = width of flow, ft; A = conveyance area, sq ft; R = hydraulic radius, ft

	Longitudinal Slope (ft/ft)	Conveyance Area (ft^2)	Velocity (fps)	Hydraulic Capacity (cfs)	Half-Street Hydraulic Capacity (cfs)
	0.0023	12.50	2.23	28	14
	0.0028	12.50	2.46	31	15
	0.0033	12.50	2.68	33	17
	0.0038	12.50	2.87	36	18
	0.0043	12.50	3.06	38	19
	0.0048	12.50	3.23	40	20
	0.0053	12.50	3.40	43	21
	0.0058	12.50	3.56	44	22
	0.0063	12.50	3.71	46	23
	0.0068	12.50	3.86	48	24
	0.0073	12.50	4.00	50	25
	0.0078	12.50	4.13	52	26
	0.0083	12.50	4.26	53	27
	0.0088	12.50	4.39	55	27
	0.0093	12.50	4.51	56	28
	0.0098	12.50	4.63	58	29
	0.0103	12.50	4.75	59	30
	0.0108	12.50	4.87	61	30
	0.0113	12.50	4.98	62	31
	0.0118	12.50	5.09	64	32
	0.0123	12.50	5.19	65	32
	0.0128	12.50	5.30	66	33
	0.0133	12.50	5.40	68	34
	0.0138	12.50	5.50	69	34
	0.0143	12.50	5.60	70	35
	0.0148	12.50	5.70	71	36
	0.0153	12.50	5.80	72	36
Indian School Rd	**0.0012**	**12.50**	**1.63**	**20**	**10**

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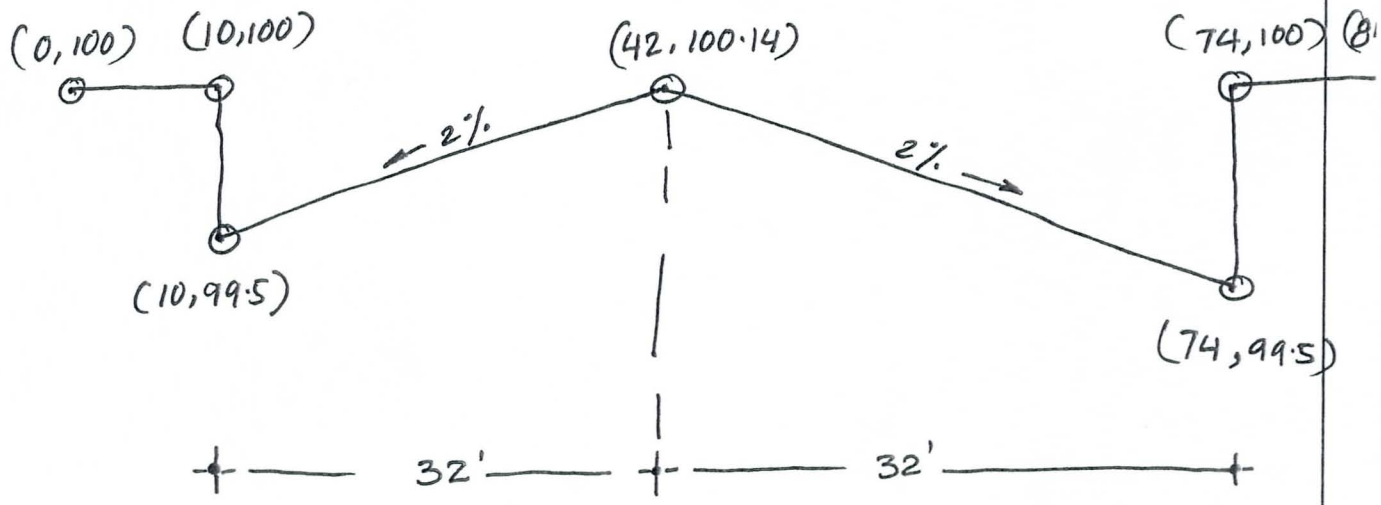
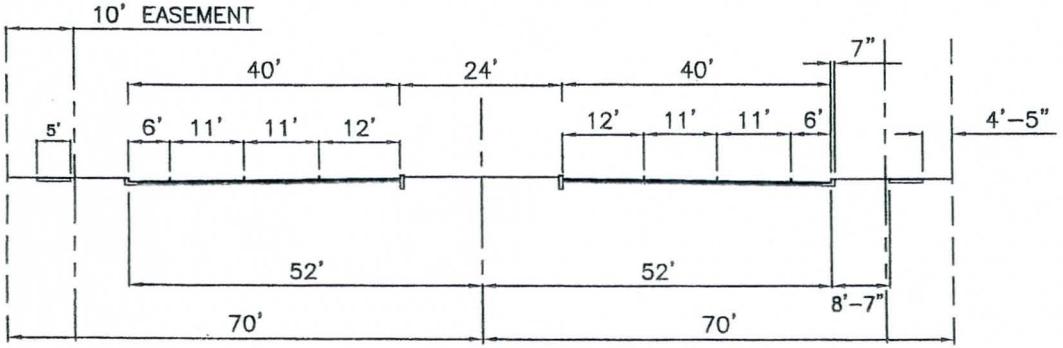


$$0.02 = \frac{\text{Top} - 99.5}{32'}$$

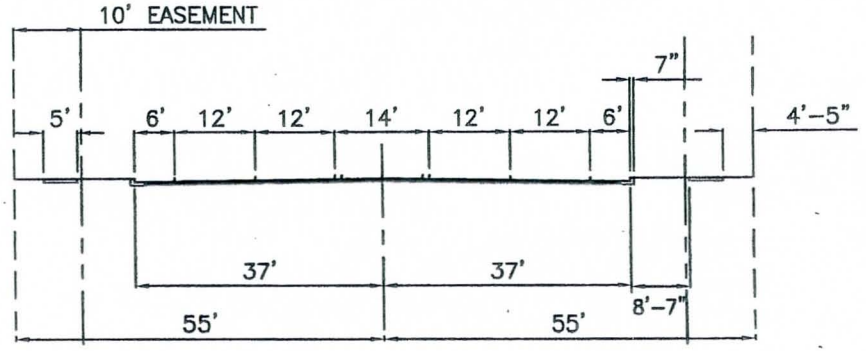
* Curb Top = 100.14

street longitudinal slope = $\frac{1104 - 1098}{4929} = 0.0012$ ft/ft

project:	Bethany home outfall Channel				
subject:	Indian School roadway Section				
drawn by:	Gajendra	date: 07-10-07	project no.: 07-1033	sheet	of

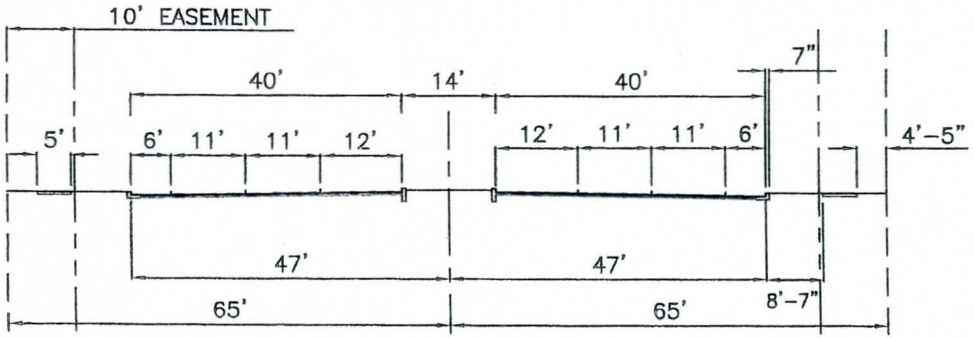


CROSS SECTION A

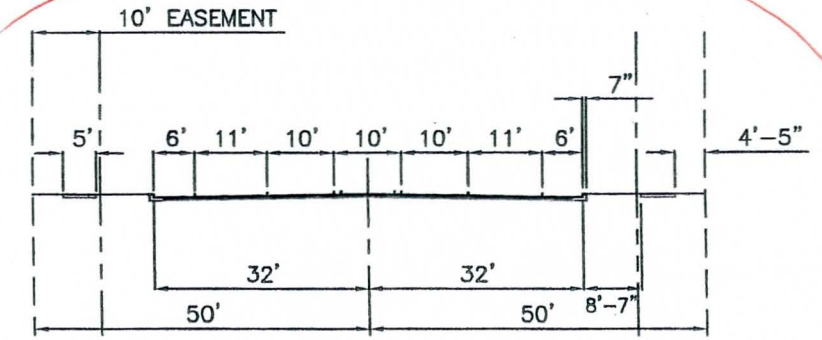


CROSS SECTION C

CROSS SECTION C-M. (SEE NOTE 3)



CROSS SECTION B



CROSS SECTION D

NOTES:

1. TEN (10) FOOT EASEMENTS MAY BE ALLOWED IN LIEU OF RIGHT-OF-WAY ON CROSS SECTIONS A, B, C, D, AT THE DISCRETION OF THE STREET TRANSPORTATION DEPARTMENT OR DEVELOPMENT SERVICES DEPARTMENT.
2. ADDITIONAL RIGHT-OF-WAY MAY BE REQUIRED FOR DRAINAGE, UTILITIES, SLOPE RIGHTS, IRRIGATION FACILITIES OR TRAILS.**
3. CROSS SECTION "C" HAS A 14' TWO WAY LEFT TURN LANE.
   CROSS SECTION C-M HAS A 14' RAISED MEDIAN.

** ACCORDING TO THE TRAILS PLAN, A - 10 FOOT SIDEWALK MAY BE REQUIRED ON CROSS SECTIONS A,B,C,D,E,F, & G.

ALL DIMENSIONS ARE TO THE FACE OF CURB.

DETAIL NO.	City of Phoenix STANDARD DETAIL	MINIMUM ARTERIAL STREET CROSS SECTION	APPROVED Mario Saldamando CITY ENGINEER	2-11-02 DATE	DETAIL NO.
P1010					P1010

B.4 Area Inlet Calculations

BETHANY HOME OUTFALL CHANNEL
REACH D DESIGN
AREA DRAIN CALCULATIONS

Weir: $Q = CLh^{3/2}$ C = 3.33

Orifice: $Q = C_d A\sqrt{2gh}$ C_d = 0.6

h (ft)	Single Inlet (MAG Det. 535)							
	L (ft)	L (ft) (50% clogged)	A (sf)	A (sf) (50% clogged)	Q_{weir} (cfs)	Q_{weir} (cfs) (50% clogged)	$Q_{orifice}$ (cfs)	$Q_{orifice}$ (cfs) (50% clogged)
0.05	8.42	6.71	5.54	2.77	0.31	0.25	5.96	2.98
0.10	8.42	6.71	5.54	2.77	0.89	0.71	8.44	4.22
0.15	8.42	6.71	5.54	2.77	1.63	1.30	10.33	5.17
0.20	8.42	6.71	5.54	2.77	2.51	2.00	11.93	5.96
0.25	8.42	6.71	5.54	2.77	3.50	2.79	13.34	6.67
0.30	8.42	6.71	5.54	2.77	4.61	3.67	14.61	7.31
0.35	8.42	6.71	5.54	2.77	5.81	4.63	15.78	7.89
0.40	8.42	6.71	5.54	2.77	7.09	5.65	16.87	8.44
0.45	8.42	6.71	5.54	2.77	8.46	6.75	17.89	8.95
0.50	8.42	6.71	5.54	2.77	9.91	7.90	18.86	9.43
0.55	8.42	6.71	5.54	2.77	11.44	9.11	19.78	9.89
0.60	8.42	6.71	5.54	2.77	13.03	10.38	20.66	10.33
0.65	8.42	6.71	5.54	2.77	14.69	11.71	21.51	10.75
0.70	8.42	6.71	5.54	2.77	16.42	13.09	22.32	11.16
0.75	8.42	6.71	5.54	2.77	18.21	14.51	23.10	11.55
0.80	8.42	6.71	5.54	2.77	20.06	15.99	23.86	11.93
0.85	8.42	6.71	5.54	2.77	21.97	17.51	24.59	12.30
0.90	8.42	6.71	5.54	2.77	23.94	19.08	25.31	12.65
0.95	8.42	6.71	5.54	2.77	25.96	20.69	26.00	13.00
1.00	8.42	6.71	5.54	2.77	28.04	22.34	26.67	13.34

h (ft)	Double Inlet (MAG Det. 535)							
	L (ft)	L (ft) (50% clogged)	A (sf)	A (sf) (50% clogged)	Q_{weir} (cfs)	Q_{weir} (cfs) (50% clogged)	$Q_{orifice}$ (cfs)	$Q_{orifice}$ (cfs) (50% clogged)
0.05	11.83	8.42	11.08	5.54	0.44	0.31	11.93	5.96
0.10	11.83	8.42	11.08	5.54	1.25	0.89	16.87	8.44
0.15	11.83	8.42	11.08	5.54	2.29	1.63	20.66	10.33
0.20	11.83	8.42	11.08	5.54	3.52	2.51	23.86	11.93
0.25	11.83	8.42	11.08	5.54	4.92	3.50	26.67	13.34
0.30	11.83	8.42	11.08	5.54	6.47	4.61	29.22	14.61
0.35	11.83	8.42	11.08	5.54	8.16	5.81	31.56	15.78
0.40	11.83	8.42	11.08	5.54	9.97	7.09	33.74	16.87
0.45	11.83	8.42	11.08	5.54	11.89	8.46	35.79	17.89
0.50	11.83	8.42	11.08	5.54	13.93	9.91	37.72	18.86
0.55	11.83	8.42	11.08	5.54	16.07	11.44	39.57	19.78
0.60	11.83	8.42	11.08	5.54	18.31	13.03	41.32	20.66
0.65	11.83	8.42	11.08	5.54	20.64	14.69	43.01	21.51
0.70	11.83	8.42	11.08	5.54	23.07	16.42	44.64	22.32
0.75	11.83	8.42	11.08	5.54	25.59	18.21	46.20	23.10
0.80	11.83	8.42	11.08	5.54	28.19	20.06	47.72	23.86
0.85	11.83	8.42	11.08	5.54	30.87	21.97	49.19	24.59
0.90	11.83	8.42	11.08	5.54	33.64	23.94	50.61	25.31
0.95	11.83	8.42	11.08	5.54	36.48	25.96	52.00	26.00
1.00	11.83	8.42	11.08	5.54	39.39	28.04	53.35	26.67

BETHANY HOME OUTFALL CHANNEL
REACH D DESIGN
AREA DRAIN CALCULATIONS

Weir: $Q = CLh^{3/2}$ C = 3.33

Orifice: $Q = C_d A\sqrt{2gh}$ C_d = 0.6

h (ft)	Single Inlet (ADOT Det. C-15.80)							
	L (ft)	L (ft) (50% clogged)	A (sf)	A (sf) (50% clogged)	Q_{weir} (cfs)	Q_{weir} (cfs) (50% clogged)	$Q_{orifice}$ (cfs)	$Q_{orifice}$ (cfs) (50% clogged)
0.05	7.00	5.5	4.9	2.45	0.26	0.20	5.28	2.64
0.10	7.00	5.5	4.9	2.45	0.74	0.58	7.46	3.73
0.15	7.00	5.5	4.9	2.45	1.35	1.06	9.14	4.57
0.20	7.00	5.5	4.9	2.45	2.08	1.64	10.55	5.28
0.25	7.00	5.5	4.9	2.45	2.91	2.29	11.80	5.90
0.30	7.00	5.5	4.9	2.45	3.83	3.01	12.92	6.46
0.35	7.00	5.5	4.9	2.45	4.83	3.79	13.96	6.98
0.40	7.00	5.5	4.9	2.45	5.90	4.63	14.92	7.46
0.45	7.00	5.5	4.9	2.45	7.04	5.53	15.83	7.91
0.50	7.00	5.5	4.9	2.45	8.24	6.48	16.68	8.34
0.55	7.00	5.5	4.9	2.45	9.51	7.47	17.50	8.75
0.60	7.00	5.5	4.9	2.45	10.83	8.51	18.28	9.14
0.65	7.00	5.5	4.9	2.45	12.22	9.60	19.02	9.51
0.70	7.00	5.5	4.9	2.45	13.65	10.73	19.74	9.87
0.75	7.00	5.5	4.9	2.45	15.14	11.90	20.43	10.22
0.80	7.00	5.5	4.9	2.45	16.68	13.11	21.10	10.55
0.85	7.00	5.5	4.9	2.45	18.27	14.35	21.75	10.88
0.90	7.00	5.5	4.9	2.45	19.90	15.64	22.38	11.19
0.95	7.00	5.5	4.9	2.45	21.58	16.96	23.00	11.50
1.00	7.00	5.5	5.54	2.45	23.31	18.32	26.67	11.80

LOSS THROUGH TRASH RACKS

OPEN AREAS:

NO CLOG: 193.6 SF

50% CLOG: 96.8 SF

$$Q = VA \implies V = \frac{Q}{A}$$

$$= \frac{266 \text{ cfs}}{96.8 \text{ sf}} = 2.75 \frac{ft}{s} \quad (50\% \text{ clogged})$$

$$= \frac{266}{193.6} = 1.37 \frac{ft}{s} \quad (\text{no clog})$$

$$h = \frac{V^2}{2g} = \frac{(2.75)^2}{2(32.2)} = 0.12 \text{ ft} \quad (50\% \text{ clogged})$$

$$= \frac{(1.37)^2}{2(32.2)} = 0.03 \text{ ft} \quad (\text{no clog})$$

OLSSON ASSOCIATES

PROJECT: BHOC - D

project no.: 07-1033

drawn by: DVD

date: 7/1/08

page 1 of 1

B.5 Drainage Memos

OLSSON ASSOCIATES

MEMO

TO:	Scott Vogel, Project Manager
CC:	Steven Tucker
FROM:	Jeff Ford
RE:	Evaluation of Feasibility of Reducing Pipe Size from 96" to 84" Between Maryvale Basin and Weir Structure
DATE:	July 8, 2008
PROJECT :	Bethany Home Outfall Channel – Reach D Design 67th Avenue to Indian School Road – PCN 620 03 32
PROJECT #:	007-1033

PURPOSE:

The purpose of this memo is to address Steven Tucker's comment from the 70% Submittal of the BHOC-D Project to evaluate the feasibility of reducing the size of the storm drain pipe from 96" to 84" between the Maryvale Basin and the weir structure (Sta 251+53.83 to Sta 253+54.53).

BACKGROUND:

The proposed BHOC-D storm drain runs from the Sunset Basin south of Indian School Road to the Maryvale Basin just east of 67th Avenue. The design of the storm drain from the 70% Submittal consists of three (3) segments:

1. Segment 1 runs from Sunset Basin to a transition structure just north of Indian School Road. This segment consists of 453 LF of 3-60" diameter pipes. The profile was lowered to avoid the Qwest duct bank and was sloped towards the Sunset Basin. Positive drainage during low flow is provided by the existing 30" storm drain that flows into the Indian School Road storm drain system.
2. The second segment consists of approximately 1894 LF of 96" diameter pipe that runs from the transition structure to a weir structure located at the Qwest duct bank at 67th Avenue. A broad-crested weir (22' long and 5' wide) will completely encase the duct

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bank to protect it, eliminating the need to relocate the utility, which Qwest has indicated will be an expensive and time consuming effort. The crest of the weir was set at 1092.45' to match the tailwater elevation at the Maryvale Basin. This segment also drains towards the Sunset Basin.

3. Segment 3 runs from the weir structure to Maryvale Basin and is the subject of this evaluation. The segment consists of approximately 200 LF of 96" diameter pipe that flows from the weir structure to the basin at a slope of approximately 0.0008'/ft.

EVALUATION:

The hydraulics of the storm drain was analyzed as two systems: one upstream of the weir and one downstream of the weir, using the program StormCAD to determine the hydraulic grade line (HGL) through the storm drain system. The analysis procedure, including calculations of the loss coefficients through the different structures, are documented in detail in the 70% Design Report. The results of the storm drain hydraulic analysis are summarized below.

The total 100-yr flow routed through Sunset Basin is 274 cfs, with 55 cfs going into the existing Indian School Road storm drain system and 218 cfs flowing through the new BHOC-D storm drain. The resulting water surface elevation (WSE) at Sunset Basin is 1096.83, which provides 1' of freeboard. The WSE upstream of the weir is 1094.66, which is 2.21 feet of head over the weir crest elevation of 1092.45. The WSE just downstream of the weir is 1092.72, based on a 96" diameter pipe for Segment 3. The storm drain is under pressure flow condition upstream of the weir (Segments 1 and 2) and is under open flow condition downstream of the weir (Segment 3).

The storm drain was analyzed for an 84" diameter pipe for Segment 3. The StormCAD model maintains the 1092.45 tailwater elevation condition at Maryvale Basin. The resulting WSE upstream of Segment 3 (or just downstream of the weir) is raised 0.13' to 1092.85. This does not affect the water surface elevation upstream at Sunset Basin, because even though the weir is submerged downstream, the submergence ratio (head downstream / head upstream = 0.40'/2.21' = 0.18) is still below the threshold limit of 0.66 to 0.85 found in various literatures.

The broad-crested equation, $Q=CLH^{3/2}$, remains valid until the submergence ratio becomes larger than 0.66 to 0.85. Therefore, the storm drain is not affected hydraulically if the pipe diameter in Segment 3 is changed to 84".

However, even though an 84" diameter pipe is hydraulically feasible for Segment 3, there are other factors to consider besides the hydraulic performance criteria. First, the FCDMC's *Drainage Design Manual for Maricopa County, Hydraulics*, limits the size a downstream pipe may be reduced. Section 4.3.1 states that "For slopes of 0.0025 ft/ft (0.25 percent) or less, only conduits 78 inches and greater may be decreased in size a maximum of 6 inches." (Page 4-8). Base on this guideline, the pipe in Segment 3 can be reduced to 90 inches. Second, the proposed storm drain is accepting water from the existing 48" storm drain in 67th Avenue. The flow in the 48" storm drain is unknown, but could be over 74 cfs for a larger storm event. The larger pipe size provides a safety factor for this additional unknown flow. Finally, there is the economic factor to consider. Reducing the pipe size from 96" to 84" will not significantly reduce the overall project cost. Typically, there is a set up fee for each pipe size that is produced. For the small quantity of pipe (200 LF), the additional set up fee to change the pipe size is at best a wash in the overall project cost.

Therefore, based on the above factors, it is recommended that the pipe size in Segment 3 remain at 96".

Broad-Crested Weir

$$Q = C_{BCW} L H^{1.5}$$

Where: Q = discharge in cfs

C_{CBW} = broad-crested weir coefficient (2.34 – 3.32)

L = broad-crested weir length in ft

H = head above weir crest in ft

See Table F-2 for C Values as a function of weir crest breadth and head.

Broad-Crested Weir Coefficient C Values as a Function of Weir Crest

Broad-Crested Weir Coefficient C Values as a function of Weir Crest Breadth and Head (coefficient has units of $ft^{0.5}$/sec).											
Head	Breadth of Crest of Weir (ft)										
(ft)	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.00	15.00
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	5.60	2.60	2.678	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	0.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

F.2. References

Rajaratnam, N. 1989. Hydraulics of culvert fishways III: slotted-weir culvert fishways. Canadian Journal of Civil Engineering. 16:3:375-383.

Rajaratnam, N. and C. Katopodis. 1990. Hydraulics of culvert fishways III: weir baffle culvert fishways. Canadian Journal of Civil Engineering. Vol. 17: 4:558-568.

Shoemaker, R.H.. 1956. Hydraulics of box culverts with fish-ladder baffles. Proceedings of the 35th Annual Meeting, Highway Research Board, Engineering Experiment Station, Oregon State College. Report No. 53.

WDFW (Washington Department of Fish and Wildlife). 2003. Design of Road Culverts for Fish Passage. May 2003.

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Chapter A5

MEASUREMENT OF PEAK DISCHARGE AT DAMS BY INDIRECT METHOD

By Harry Hulsing

Book 3

APPLICATIONS OF HYDRAULICS

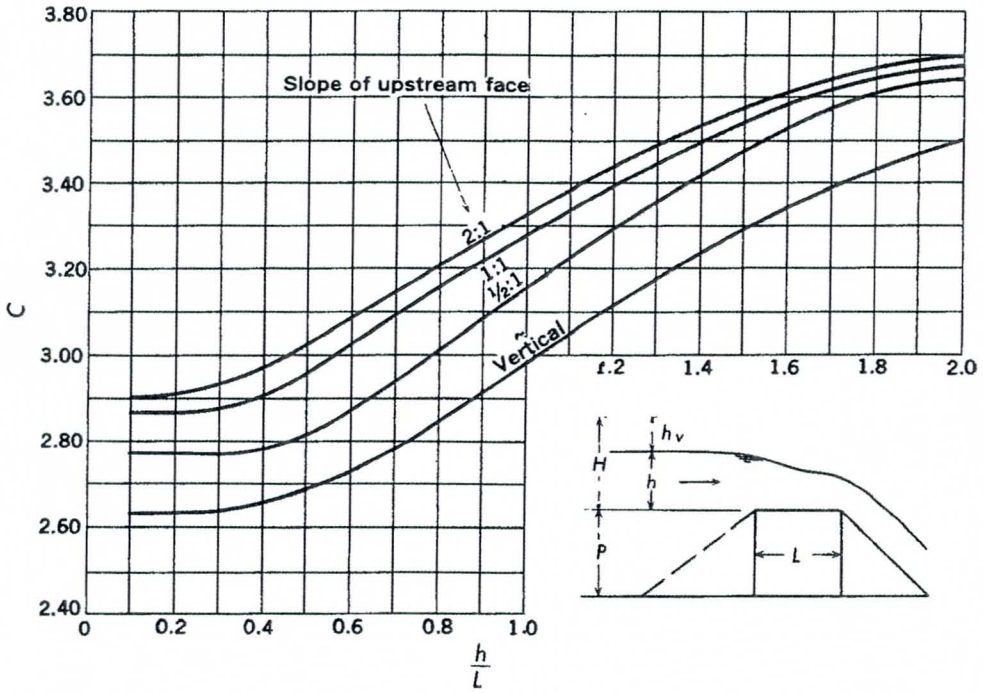


Figure 7.—Coefficients of discharge for full width, broad-crested weirs with downstream slope ≧ 1:1 and various upstream slopes.

Side contractions (abutments) reduce the effective length of the weir crest. This effect is accounted for by multiplying the value of C determined by the procedures given above by a correction factor, k_c. If the abutment corners are square, use the factor obtained from figure 3. If the abutment corners are round and $r/b > 0.12$, assume that $k = 1.00$. For lesser values of r/b, interpolate between these two values.

Submerged broad-crested weirs

The degree of submergence of a broad-crested weir is defined by the ratio of the downstream static head h_t to the upstream static head, h. Submergence has no effect on the discharge coefficient if the submergence ratio h_t/h is less than 0.85. At larger ratios submergence has an appreciable effect, but test data to quantitatively define the effect are not available.

Round-Crested Weirs

Round-crested weirs are defined as weirs with crests that are smooth single-curved (cylindrical) surfaces. The longitudinal profile of the crest generally is not a circular arc, as the name may imply; often it is a complex curve which cannot be described in simple geometric terms. The crests of overfall spillways of most modern high dams, which have the form of the lower surface of the nappe from a full-width thin-plate weir, are special examples of round-crested weirs. These are commonly called ogee or design-head dams.

The profile geometry of round-crested weirs shows that they are in a class intermediate between thin-plate weirs and broad-crested weirs. The crest is long enough (in the direction of flow) to provide support for the nappe through the control section, but it is short enough that the flow over the crest is markedly curvilinear. The fixed lower boundary of the nappe is therefore subject to much variation in pressure; for any given head the pressure may vary considerably from point to point, and at any given point the pressure varies appreciably with the head.

The geometry and flow pattern for a simple round-crested weir are illustrated on figure 8. The intersection of the curvilinear crest and the vertical (or inclined) face of the weir is

OLSSON ASSOCIATES

MEMO

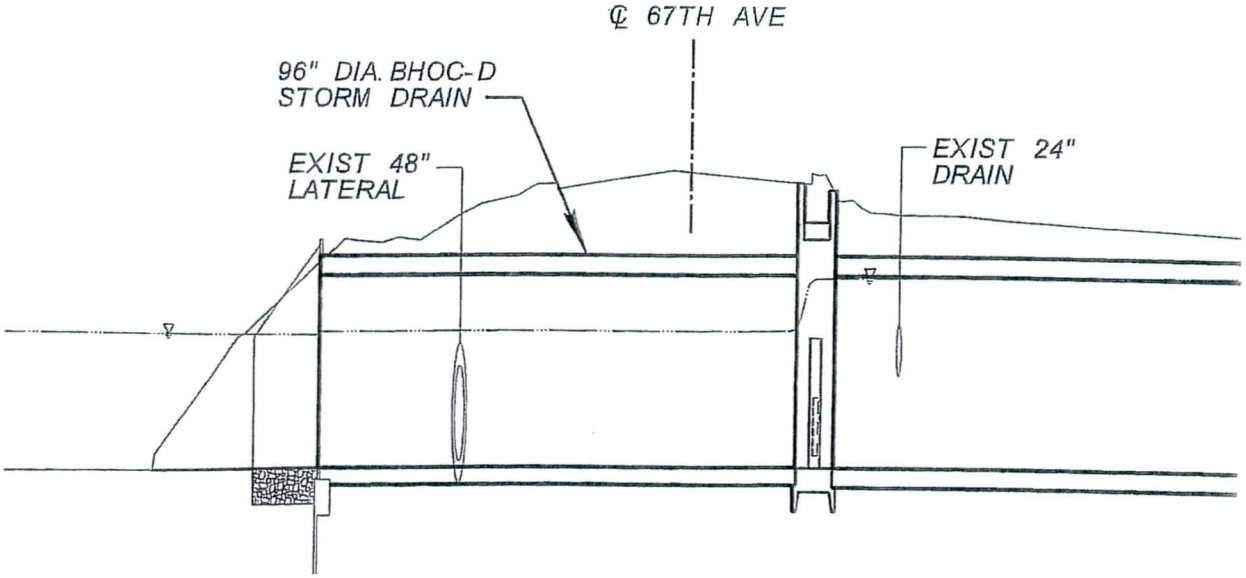
TO:	Scott Vogel, Project Manager
CC:	
FROM:	Jeff Ford
RE:	Evaluation of Hydraulic Impact of Proposed SRP Irrigation Relocation Design on the BHOC-D Storm Drain Design
DATE:	July 15, 2008
PROJECT :	Bethany Home Outfall Channel – Reach D Design 67th Avenue to Indian School Road – PCN 620 03 32
PROJECT #:	007-1033

PURPOSE:

The purpose of this memo is to evaluate the hydraulic impact of SRP's proposed pass-through structures on the BHOC-D storm drain.

BACKGROUND:

The BHOC-D Storm Drain Design proposes a 96" dia. pipe that crosses 67th Avenue. SRP Irrigation has an existing 48" dia. lateral along the west side of 67th Avenue and an existing 24" dia. drain along the east side of 67th Avenue, both of which will be in conflict with the proposed 96" pipe, as shown below:



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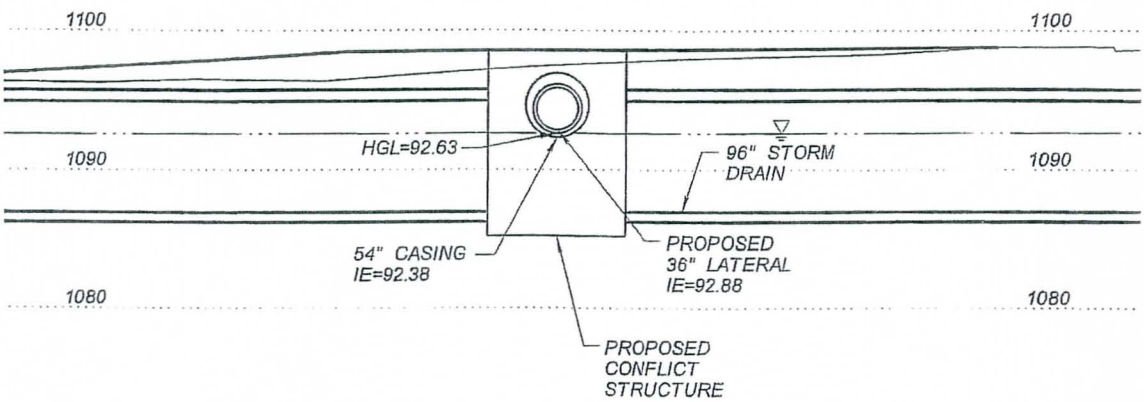
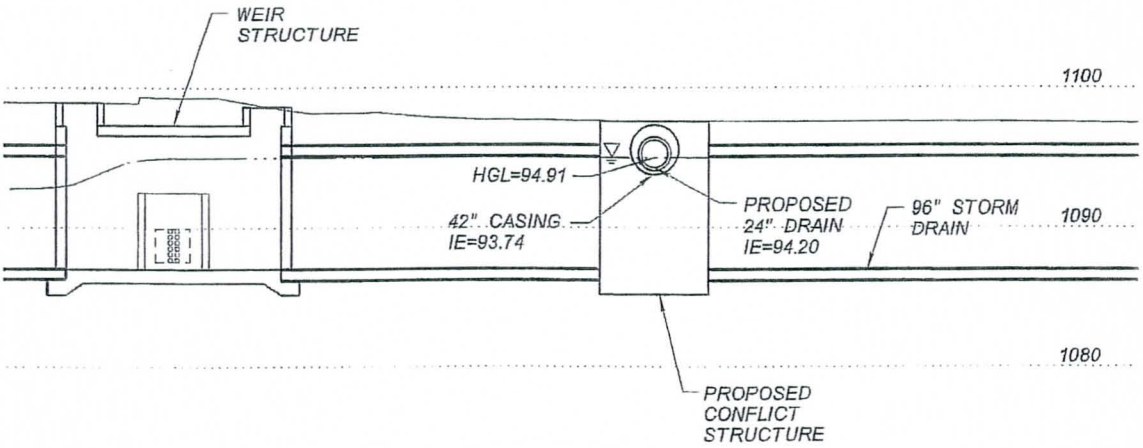
www.oaconsulting.com

A Pre-Design Meeting with SRP was held on June 26, 2008, to discuss the relocation design options of the irrigation lateral and drain. SRP indicated that a siphon is not a preferred alternative, as this option would require a maintenance agreement with the City of Phoenix to maintain the siphon. SRP's preferred option is to go through the storm drain with a pass-through structure. The 48" lateral would be reduced to 36" and the invert would be set as high as possible to minimize the impact to the flow. The 24" drain would be replaced with a 24" drain and also set as high as possible to minimize impact to the flow. SRP suggested taking the 24" drain into the BHOC-D storm drain or existing 48" storm drain on 67th Avenue as an option, but the City of Phoenix is not agreeable to this due to water quality concerns. The proposed SRP irrigation relocation design is shown below:





EVALUATION:

The BHOC-D storm drain system has been analyzed as two systems, one upstream of the weir structure used to determine the head over the weir and one downstream of the weir structure to determine the depth of the submerged weir. The segment upstream of the weir is under pressure flow, while the segment downstream of the weir has a free surface.

36" Lateral:

The proposed pass-through structure for the 36" irrigation lateral is within the open flow segment of the BHOC-D storm drain system and is located downstream of the weir. The HGL at this crossing is 1092.63, with the invert of the new 36" lateral at 1092.88. Additionally, a 54-inch casing will be provided with a bottom outside elevation of 1092.29. This results in the carrier pipe approximately 0.34 feet into the flow.

Losses through this structure were calculated as three parts: the structure loss, contraction loss, and expansion loss. The parameters used for this structure are:

- Structure loss, k=0.05
- Contraction loss, k=0.12
- Expansion loss, k =0.23

The StormCAD model was revised to add the conflict junction structure to pass through the 36" irrigation pipe inside of a 54" casing. Based on the above calculations, a head loss coefficient of 0.40 was used through the junction structure. In the original model without the junction structure, the HGL for the pipe at the upstream end was 1092.72. With the junction added with k=0.40, the HGL was raised 0.17' to 1092.89. The submergence ratio for the broad-crested weir (head downstream / head upstream = 0.44' / 2.21' = 0.20) is still below the threshold limit of 0.66 to 0.85. Therefore, the proposed conflict structure to pass through the 36" irrigation pipe will not affect the upstream WSE of the BHOC-D storm drain.

24" Drain:

The proposed pass-through structure for the 24" irrigation lateral is within the pressure flow segment of the BHOC-D storm drain system and is located upstream of the weir. The HGL at this crossing is 1094.91, with the invert of the new 24" lateral at 1094.20. Additionally, a 42"

casing will be provided with a bottom outside elevation of 1093.66. This results in the carrier pipe approximately 1.25' feet into the flow.

Losses through this structure were calculated as three parts, the structure loss, contraction loss, and expansion loss. The parameters used for this structure are:

- Structure loss, k=0.05
- Contraction loss, k=0.18
- Expansion loss, k =0.35

The StormCAD model was revised to add the conflict junction structure to pass through the 24" irrigation pipe inside of a 42" casing. Based on the above calculations, a head loss coefficient of 0.58 through the junction structure was used. In the original model without the junction structure, the HGL within Sunset Basin was 1096.82. With the junction added with k=0.58, the HGL was raised 0.17' to 1096.99. This results in a freeboard within Sunset Basin of 0.84'.

The model was refined to include the storage capacity in the storm drain pipes to increase the storage values of the SV card in the HEC-1 model. The volume in the pipe was computed at each SE card elevation, and the resulting rating table for the additional volume is shown below:

Additional Pipe Storage Volume

ELEVATION	ADDITIONAL VOLUME (ac-ft)
1086.00	0.13
1086.50	0.25
1087.30	0.49
1089.60	1.49
1092.40	2.43
1092.50	2.45
1094.80	2.79
1095.00	2.80
1095.22	2.80
1095.80	2.80

The additional volume was added to the surveyed volume, and the routing rating table was updated as shown below:

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Updated Routing Rating Table

SV	0	0.93	2.05	4.79	15.29	30.43	31.05	62.09	69.2	71.3	86.8
SQ	0	6	10	20	30	40	40.4	294.2	333.2	380.6	630.4
SE	1085	1086	1086.5	1087.3	1089.6	1092.4	1092.5	1097.27	1098.14	1098.38	1100.25

The updated routing rating table reduced the flow through the BHOC-D storm drain from 218 cfs to 211 cfs and extended the peak time from 14.08 to 14.17 hour. Using Q=211 cfs in the StormCAD model results in a WSE of 1096.73 at Sunset Basin. When the loss through the trash rack was added, the final WSE at Sunset Basin is 1096.85. This provides 0.98' of freeboard at Sunset Basin.

SUMMARY & RECOMMENDATION:

The addition of the conflict structure to pass through the 36" irrigation pipe does not raise the HGL at the Sunset Basin.

For the storm drain segment upstream of the weir structure, the addition of the conflict structure to pass through the 24" irrigation pipe will raise the WSE 0.17' at Sunset Basin, reducing the freeboard to 0.84'. The routing rating table was revised to add the storage volume available in the storm drain pipes. This reduced the Q being routed through the storm drain from 218 cfs to 211 cfs. The reduced Q resulted in a WSE of 1096.85 at Sunset Basin for a freeboard of 0.98'.

It should be noted that the 0.98' of freeboard is to the outfall to the Grand Canal, and 1' of freeboard will be maintained to all structures.

Under pressure flow conditions, the headloss due to contraction and expansion of flow can be expressed as:

$$h = k\frac{V^2}{2g} \tag{4.9}$$

where: h = Headloss due to a contraction or expansion, ft

k = Coefficient for contraction (k_c) or coefficient for expansion (k_e), see below.

V = Velocity of flow in the smallest diameter pipe, ft/sec

The values for the transition coefficient, k_e, for gradual enlargements are given in Table 4.3a. For sudden enlargements, values for the transition coefficients are listed Table 4.3b. Values for the transition loss coefficient, k_c, for sudden contractions can be found in Table 4.4.

Table 4.3a

COEFFICIENT k_e FOR GRADUAL ENLARGEMENT UNDER PRESSURE FLOW CONDITIONS

(AISI, 1990)

	Angle of Cone, degrees													
D_2/D_1	2	4	6	8	10	15	20	25	30	35	40	45	50	60
1.1	.01	.01	.01	.02	.03	.05	.10	.13	.16	.18	.19	.20	.21	.23
1.2	.02	.02	.02	.03	.04	.09	.16	.21	.25	.29	.31	.33	.35	.37
1.4	.02	.03	.03	.04	.06	.12	.23	.30	.36	.41	.44	.47	.50	.53
1.6	.03	.03	.04	.05	.07	.14	.26	.35	.42	.47	.51	.54	.57	.61
1.8	.03	.04	.04	.05	.07	.15	.28	.37	.44	.50	.54	.58	.61	.65
2.0	.03	.04	.04	.05	.07	.16	.29	.38	.46	.52	.56	.60	.63	.68
2.5	.03	.04	.04	.05	.08	.16	.30	.39	.48	.54	.58	.62	.65	.70
3.0	.03	.04	.04	.05	.08	.16	.31	.40	.48	.55	.59	.63	.66	.71
∞	.03	.04	.05	.06	.08	.16	.31	.40	.49	.56	.60	.64	.67	.72

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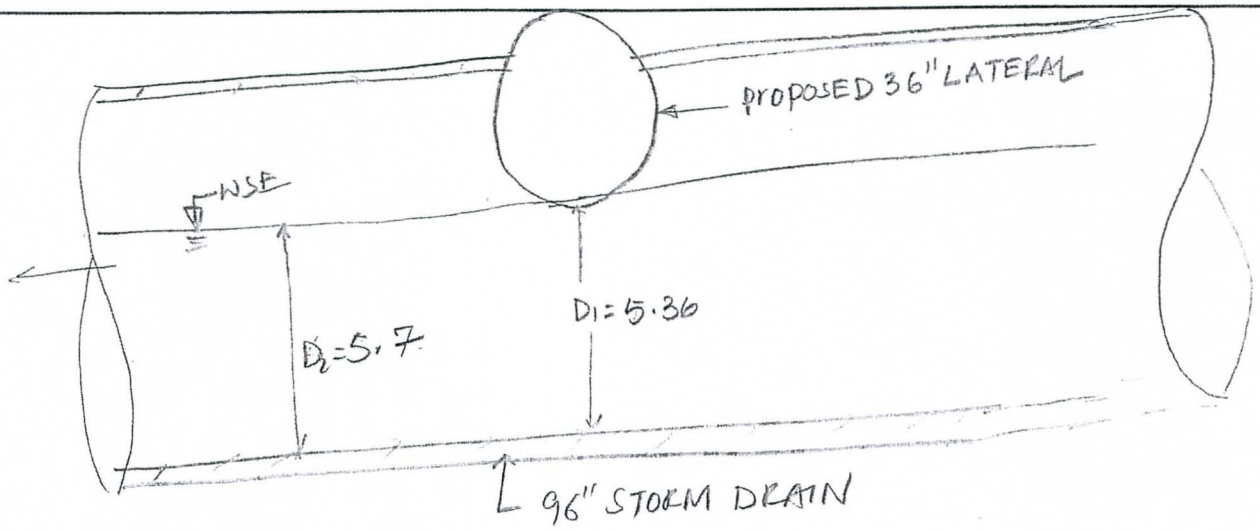
2)



$$\frac{D_2}{D_1} = \frac{5.7}{5.36} = 1.06$$

Angle of Cone = 60°

Coefficient of Expansion = $K_e = \underline{0.21}$

Coefficient of Contraction = $K_c = 0.5 \times 0.21 = \underline{0.105}$

project: BHOC - REACH D

subject: LOSS - CO-EFFICIENT CALC AT 36" LATERAL

drawn by: date project no.: 007-1033 sheet of

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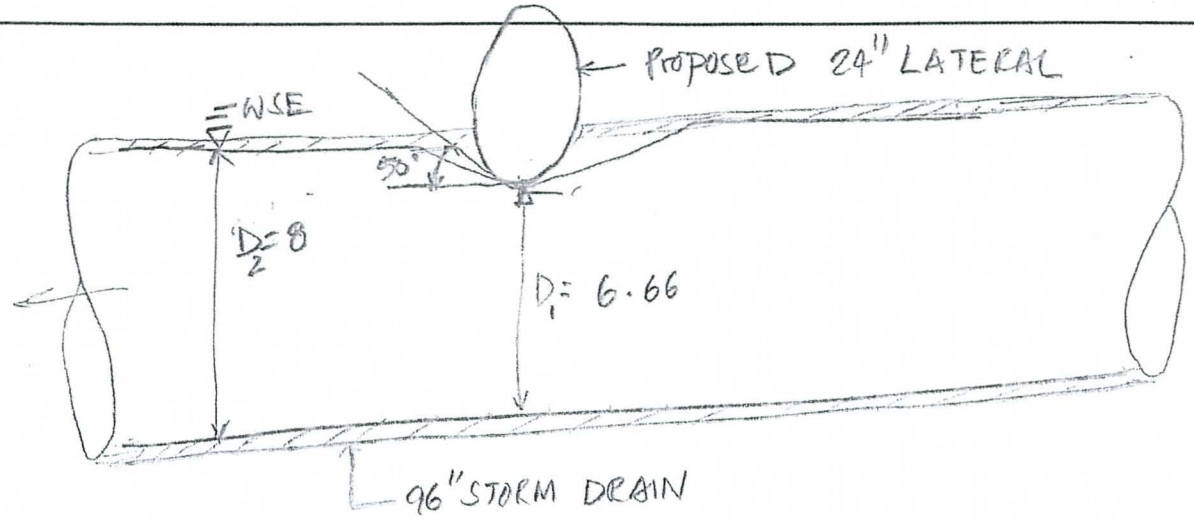
1)



$$\frac{D_2}{D_1} = \frac{8}{6.66} = 1.2$$

Angle of Cone = 50°

Coefficient of Expansion = K_e = 0.35

Coefficient of Contraction = K_c = 0.5 × 0.35 = 0.175

project: BHOC - REACH D

subject: LOSS CO-EFFICIENT CALC AT 24" LATERAL

drawn by: date project no.: 007-1033 sheet of

Scenario: Base

STORM CAD PLAN - DOWNSTREAM SEGMENT
WITH SRP STRUCTURE

Calculation Results Summary

==========
Scenario: Base

BHOC-D STORM DRAIN
DOWNSTREAM SEGMENT w/o SRP STRUCTURE

>>>> Info: Subsurface Network Rooted by: O-1
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-1	1	96 inch	Circular	199.00	218.00	5.77	1,092.62	1,092.45

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1	218.00	1,097.00	1,092.45	1,092.45
I-1	218.00	1,098.00	1,092.72	1,092.62

==========
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Calculation Results Summary

==========

Scenario: Base

BHOC-D STORM DRAIN
DOWNSTREAM SEGMENT WITH SRP STRUCTURE

>>>> Info: Subsurface Network Rooted by: O-1 Maryvale
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1 Weir	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1 Maryvale

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-2	1	96 inch	Circular	58.00	211.00	5.38	1,092.50	1,092.45
P-1	1	96 inch	Circular	142.00	211.00	5.85	1,092.79	1,092.70

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1 Maryvale	211.00	1,097.00	1,092.45	1,092.45
J-1 SRP36	211.00	1,097.50	1,092.70	1,092.50
I-1 Weir	211.00	1,098.00	1,092.89	1,092.79

==========

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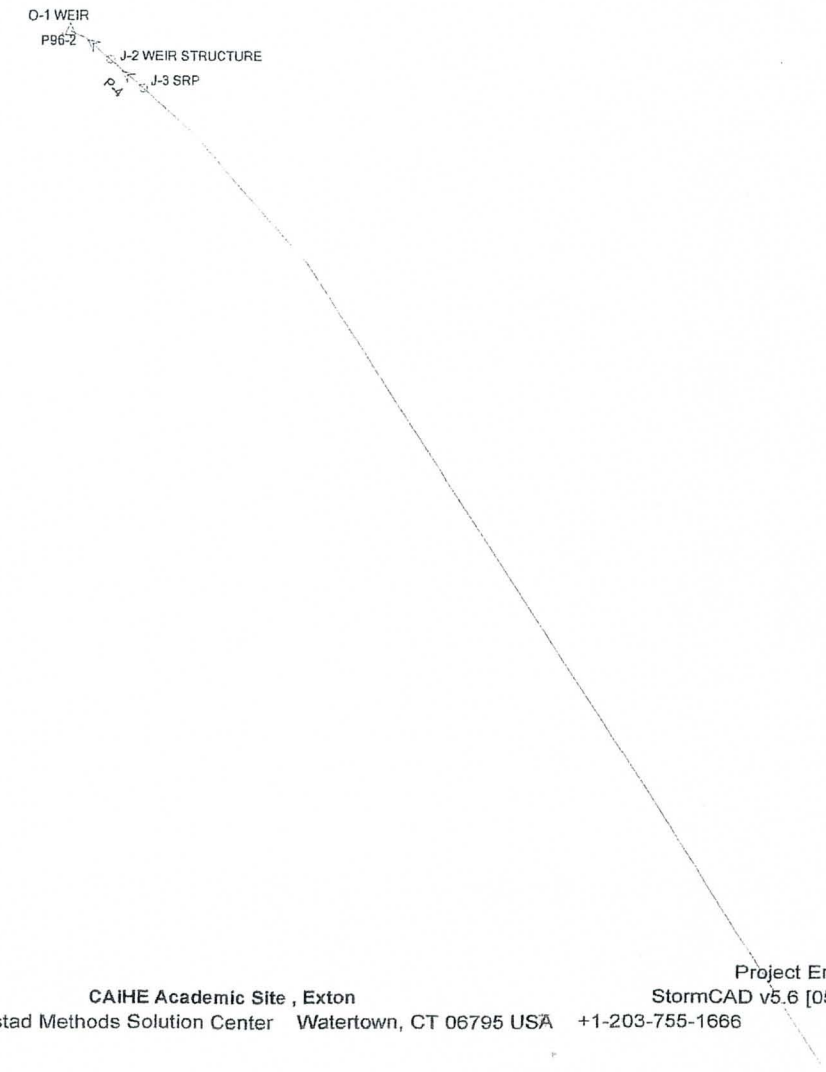
Scenario: Base

STORMCAD PLAN - UPSTREAM SEGMENT
WITH SRP STRUCTURE



Calculation Results Summary

==========

Scenario: Base

BHOC-D STORM DRAIN
UPSTREAM SEGMENT w/o JUNCTION STRUCTURE
Q = 218 cfs

>>>> Info: Subsurface Network Rooted by: O-1 WEIR
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1 SUNSET	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1 WEIR

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P96-2	1	96 inch	Circular	1.00	218.00	4.34	1,094.64	1,094.64
P96-1	1	96 inch	Circular	1,894.00	218.00	4.34	1,095.99	1,094.91
P3-60	3	60 inch	Circular	453.00	218.00	3.70	1,096.65	1,096.30

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1 WEIR	218.00	1,098.00	1,094.64	1,094.64
J-2 WEIR STRUCTURE	218.00	1,098.00	1,094.91	1,094.64
J-1 TRANSITION	218.00	1,097.50	1,096.30	1,095.99
I-1 SUNSET	218.00	1,100.00	1,096.70	1,096.65

+0.12 FOR TRASH RACK
96.82

==========

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OUTFALL = 97.83
FB = 1.01

Calculation Results Summary

==========
Scenario: Base UPSTREAM SEGMENT WITH SRP STRUCTURE, Q= 218 cfs

>>>> Info: Subsurface Network Rooted by: O-1 WEIR
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1 SUNSET	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1 WEIR

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P96-2	1	96 inch	Circular	1.00	218.00	4.34	1,094.64	1,094.64
P-4	1	96 inch	Circular	27.00	218.00	4.34	1,094.93	1,094.91
P-3	1	96 inch	Circular	1,867.00	218.00	4.34	1,096.17	1,095.10
P3-60	3	60 inch	Circular	453.00	218.00	3.70	1,096.83	1,096.47

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1 WEIR	218.00	1,098.00	1,094.64	1,094.64
J-2 WEIR STRUCTURE	218.00	1,098.00	1,094.91	1,094.64
J-3 SRP	218.00	1,097.50	1,095.10	1,094.93
J-1 TRANSITION	218.00	1,097.50	1,096.47	1,096.17
I-1 SUNSET	218.00	1,100.00	1,096.87	1,096.83

+ 0.12 TRASH RACK

==========
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1096.99
1097.83 OUTFALL
0.84 FREE BOARD

Calculation Results Summary

==========
Scenario: Base UPSTREAM SEGMENT WITH SRP STRUCTURE, Q= 211 cfs

>>>> Info: Subsurface Network Rooted by: O-1 WEIR
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-1 SUNSET	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1 WEIR

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P96-2	1	96 inch	Circular	1.00	211.00	4.20	1,094.64	1,094.64
P-4	1	96 inch	Circular	27.00	211.00	4.20	1,094.91	1,094.90
P-3	1	96 inch	Circular	1,867.00	211.00	4.20	1,096.07	1,095.07
P3-60	3	60 inch	Circular	453.00	211.00	3.58	1,096.69	1,096.36

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1 WEIR	211.00	1,098.00	1,094.64	1,094.64
J-2 WEIR STRUCTURE	211.00	1,098.00	1,094.90	1,094.64
J-3 SRP	211.00	1,097.50	1,095.07	1,094.91
J-1 TRANSITION	211.00	1,097.50	1,096.36	1,096.07
I-1 SUNSET	211.00	1,100.00	1,096.73	1,096.69

+ 0.12 TRASH RACK

==========
Completed: 07/15/2008 05:26:18 PM

1096.85

1097.83 OUT FALL

0.98 FREEBOARD

Appendix C

Geotechnical Investigation Report

GEOTECHNICAL EVALUATION
BETHANY HOME OUTFALL
CHANNEL REACH D
PHOENIX, ARIZONA

PREPARED FOR:
Olsson Associates
7250 North 16th Street, Suite 210
Phoenix, Arizona 85020

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
3001 South 35th Street, Suite 6
Phoenix, Arizona 85034

March 26, 2008
(Revised September 16, 2008)
Project No. 601850001

March 26, 2008
(Revised September 16, 2008)
Project No. 601850001

Mr. Jeff Ford, P.E.
Olsson Associates
7250 North 16th Street, Suite 210
Phoenix, Arizona 85020

Subject: Geotechnical Evaluation
Bethany Home Outfall Channel Reach D
Phoenix, Arizona

Dear Mr. Ford:

In accordance with your request, Ninyo & Moore has revised our geotechnical evaluation for the above-referenced site. The attached revised report presents our methodology, findings, conclusions, and recommendations regarding the geotechnical conditions at the project site.

We appreciate the opportunity to be of service to you during this phase of the project. If you have any questions or comments regarding this report, please call at your convenience.

Respectfully submitted,
NINYO & MOORE

Registered Professional Engineer (Civil) CERTIFICATE NO. 41716 KEVIN L. PORTER Date Signed 9/16/08 ARIZONA, U.S.A.

Kevin L. Porter, P.E.
Senior Engineer

EXPIRES 12/31/2010

Registered Professional Engineer (Civil) CERTIFICATE NO. 21663 STEVEN D. NOWACZYK Date Signed 9/16/08 ARIZONA, U.S.A.

Steven D. Nowaczyk, P.E.
Principal Engineer

EXPIRES 6/30/09

KLP/SAH/SDN/zvs

Distribution: (6) Addressee

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Figure 4 – Lateral Earth Pressures for Braced Excavation
Figure 5 – Lateral Earth Pressures for Underground Structures

Appendices

Appendix A – Boring Logs
Appendix B – Laboratory Testing

1. INTRODUCTION

In accordance with your authorization, we have performed a geotechnical evaluation for the proposed Bethany Home Outfall Channel Reach D project in Phoenix, Arizona. The purpose of our evaluation was to assess the subsurface conditions at the project site in order to formulate geotechnical recommendations for design and construction. This report presents the results of our evaluation and our geotechnical conclusions and recommendations regarding the proposed construction.

2. SCOPE OF SERVICES

The scope of our services for the project generally included:

- Reviewing readily available aerial photographs and published geologic literature, including maps and reports pertaining to the project site and vicinity.
- Marking out the boring locations, obtaining needed permits, and notifying Arizona Blue Stake of the boring locations prior to drilling.
- Coring the existing pavement at 67th Avenue and Indian School Road to evaluate the existing pavement sections.
- Drilling, logging, and sampling five small-diameter exploratory borings that extended approximately 20 to 40 feet below ground surface (bgs). The boring logs are presented in Appendix A.
- Performing laboratory tests of selected samples obtained from the borings to evaluate in-situ moisture content and dry density, sieve analyses, Atterberg limits, maximum dry density and optimum moisture content, and corrosivity characteristics (including pH, minimum electrical resistivity, soluble sulfates, and chlorides). The results of the laboratory testing are presented on the boring logs and in Appendix B.
- Preparing this report presenting our findings, conclusions, and recommendations regarding the design and construction of the project.

Our scope of services did not include environmental consulting services, such as hazardous waste sampling or analytical testing, at the site. A detailed scope of services and estimated fee for such services can be provided upon request.

3. SITE DESCRIPTION

The project site is located in Section 19 of Township 2 North, Range 2 East. The project is located within the City of Phoenix, Arizona, extending along the northern bank of the Grand Canal from west of 67th Avenue to south of Indian School Road. The approximate location of the site is depicted on the Site Location Map (Figure 1). At the time of our evaluation, the planned outfall channel alignment was generally bounded by private and residential properties along the northeast, paralleled the existing SRP Grand Canal, which is located along the southwesterly side, and crosses 67th Avenue and Indian School Road to the north and south, respectively.

According to the *Fowler, Arizona 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Map (1982),* the site lies at an average elevation of roughly 1,100 feet relative to mean sea level (MSL). Based on the information from the quadrangle map, the project site generally slopes from the northeast to the southwest.

Six aerial photographs from the Flood Control District of Maricopa County were reviewed for this project. Aerial photographs from 1937, 1949, and 1959 depict the project site as a lined canal cross cutting agricultural land. Scattered residential structures were noted near the site. A 1964 aerial photograph showed the agricultural land north of the Grand Canal as being developed with residential structures and paved roadways. Aerial photographs from 1993 and 2007 depicted residential development along the north side of the canal, and a commercial structure and parking lot along the south side of the canal, similar to its current condition.

4. PROPOSED CONSTRUCTION

The project will generally consist of the design and construction of the Bethany Home Outfall Channel from 67th Avenue to Indian School Road in Phoenix, Arizona. The planned outfall channel is anticipated to be concrete pipe situated approximately 10 to 15 feet below existing grade and generally sloping from southeast to northwest. The outfall channel will connect the existing Sunset Retention Basin, located at the southeast end of the alignment, to the existing Maryvale Basin, located at the northwest end of the alignment.

We also understand there are existing utilities located within the proposed channel alignment which may need to be relocated.

5. FIELD EXPLORATION AND LABORATORY TESTING

On August 14 and 20, 2007, Ninyo & Moore conducted a subsurface exploration, which consisted of the drilling, logging, and sampling of five small-diameter borings, along the proposed storm drain alignment, as depicted on the Boring Location Map (Figure 2). The borings were drilled using a CME-75 truck-mounted drill rig equipped with hollow-stem augers. The borings, denoted as B-1 through B-5, extended approximately 20 to 40 feet bgs. Bulk and relatively undisturbed soil samples were collected at selected intervals. Detailed descriptions of the soils encountered at each boring location are presented on the boring logs in Appendix A.

Ninyo & Moore personnel logged the borings in general accordance with the Unified Soil Classification System (USCS) and American Society for Testing and Materials (ASTM) D 2488) by observing cuttings and drive samples. Collected ring samples were trimmed in the field, wrapped in plastic bags, and placed in cylindrical plastic containers to retain in-place moisture conditions. Similarly, the Standard Penetration Test and bulk samples were sealed in plastic bags to retain their approximate in-place moisture.

The soil samples collected from our field activities were transported to the Ninyo & Moore laboratory in Phoenix, Arizona for geotechnical laboratory analysis. The laboratory testing included evaluation of in-situ moisture content and dry density, grain-size distribution, Atterberg limits, maximum dry density and optimum moisture, and corrosion characteristics (including pH, minimum electrical resistivity, soluble sulfates, and chlorides). The results of the laboratory tests are presented on the boring logs in Appendix A and in Appendix B. Appendix B also describes in detail each laboratory tests performed.

6. GEOLOGY AND SUBSURFACE CONDITIONS

The geology and subsurface conditions at the site are described in the following sections.

6.1. Geologic Setting

The project site is located in the Sonoran Desert Section of the Basin and Range physiographic province, which is typified by broad alluvial valleys separated by steep, discontinuous, subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 10 to 18 million years ago during the mid- to late-Tertiary. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with alluvium from the erosion of the surrounding mountains as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is generally described as being Holocene (<10,000 years old) alluvial terrace and fan deposits, generally consisting of well-sorted (poorly graded) sand with silt. Very little soil development has occurred in this deposit. Stage I to Stage II caliche cementation is common within this unit (Demsey, 1988).

6.2. Subsurface Conditions

Our knowledge of the subsurface conditions at the project site is based on our field exploration and laboratory testing, and our understanding of the general geology of the area. The following sections provide a generalized description of the materials encountered. More detailed descriptions are presented on the boring logs in Appendix A.

6.2.1. Asphaltic Concrete and Aggregate Base

Asphaltic concrete (AC), which ranged in thickness from about 2 to 11 inches, was encountered at the surface in borings B-1, B-4 and B-5. Aggregate base (AB) was

encountered below the AC in these borings and typically consisted of silty gravel with sand and ranged in thickness from about 3.5 to 8 inches.

6.2.2. Fill

Fill soils were encountered at the ground surface in boring B-3 and below the AB material in borings B-1 and B-5. The fill generally consisted of clayey sand, sandy clay, poorly graded sand, and sandy gravel in our borings.

6.2.3. Alluvium

Alluvium was encountered below the fill or AB and extended to the total depths explored. The alluvium generally consisted of silty sand, sandy silt, clayey sand, sand, sandy clay, and sandy gravel in our borings.

6.2.4. Groundwater

Groundwater was not encountered in our exploratory borings. Based on well data from the Arizona Department of Water Resources (ADWR), the approximate depth to regional groundwater has been estimated to be as shallow as 140 feet bgs. Groundwater levels can fluctuate due to seasonal variations, potential seepage from the adjacent canal, irrigation, groundwater withdrawal or injection, and other factors. In general, groundwater is not expected to be a constraint to the construction of the project; however, any cracks or flaws in the concrete lining of the adjacent canal could result in seepage into any excavations below the canal water level.

7. GEOLOGIC HAZARDS

The following sections describe regional geologic hazards, including land subsidence, earth fissures, and seismicity.

7.1. Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land (Schumann and Genualdi, 1986). Since 1948, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation, resulting in large areas of land subsidence.

In Arizona, earth fissures are generally associated with land subsidence and pose an ongoing geologic hazard. Earth fissures generally form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Reportedly, earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces (Schumann and Genualdi, 1986).

Based on our field reconnaissance and review of the referenced material, there are no known earth-fissures underlying the subject site. Based on our research, the closest documented earth fissure to this site is approximately 13 miles to the northwest. Therefore, land subsidence and earth fissures are not expected to be a constraint to this project. However, continued groundwater withdrawal in the area may result in subsidence of the valley and the formation of new fissures, or the extension of existing fissures, and the prediction of the location of new fissures or subsidence bowls can not accurately be predicted.

7.2. Faulting and Seismicity

The site lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations and on our review of readily available published geo-

logical maps and literature, there are no known active faults underlying the subject site or adjacent areas. The closest Quaternary fault to the site is the Carefree fault zone, located approximately 30 miles to the northeast of the site (Pearthree, 1998). Approximately 2 meters of displacement has occurred along this fault within middle Pleistocene deposits (<750,000 years), but the upper Pleistocene and Holocene deposits (<250,000 years) are not displaced.

Based on a probabilistic seismic hazard assessment for the Western United States, issued by the USGS (2000), the site is located in a zone where the peak ground accelerations that have a 10 percent, and 2 percent probability of being exceeded in 50 years are 0.04g and 0.08g, respectively. These ground motion values are calculated for "firm rock" sites, which correspond to a shear-wave velocity of approximately 2,500 feet per second in approximately the top 100 feet bgs. Different soil or rock types may amplify or de-amplify these values. Seismic design parameters according to the 2003 International Building Code (IBC) are presented in Table 1.

Table 1 – Seismic Design Parameters

Parameter	Value	2003 IBC Reference
Site Coefficient, F_a	1.6	Table 1615.1.2(1)
Site Coefficient, F_v	2.4	Table 1615.1.2(2)
Site Class Definition	D	Table 1615.1.1

7.3. Liquefaction Potential

Considering the density and consistency of the soils encountered at the site during our subsurface evaluation, the lack of near-surface water, and the low ground motion hazard (relatively low peak ground accelerations), the likelihood or potential for liquefaction is considered to be negligible, and, therefore, liquefaction is not a design consideration.

8. CONCLUSIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, it is our opinion that the proposed construction is feasible from a geotechnical standpoint, provided that

the recommendations presented in this report are incorporated into the design and construction of the proposed project, as appropriate. Geotechnical considerations include the following:

- The on-site soils should generally be excavatable to the proposed excavation depths, with earth moving construction equipment in good working condition. However, some locations of very dense materials were encountered in our borings, which could slow the rate of excavation.
- Due to interbedded layers of sandy material, possible vibrations near open excavations (due to the adjacent roadway and construction activity), and the potential consequence of slope instability, an Occupational Safety and Health Administration (OSHA) soil-type "C" should be used for planning excavation side slopes.
- Because the proposed below-grade structure is to be in close proximity to other existing structures, a temporary earth retention system may be needed to maintain the stability and integrity of the sides of the excavation during construction of the planned improvements.
- We estimate an earthwork (shrinkage) factor of 15 to 20 percent for this project.
- New grade slabs, pavements and flatwork should also be founded in engineered fill soil.
- Imported soils and soils generated from on-site excavation activities that exhibit low plasticity and very low to low expansion potential can generally be used as engineered fill.
- Corrosivity test results indicate that subgrade soils at the site may be corrosive to ferrous metals, and the sulfate content of the soils present a negligible sulfate exposure to concrete.
- Groundwater was not observed in our exploratory borings. The static groundwater table at the site is anticipated to be approximately 140 feet bgs or deeper. However, seepage from the adjacent canal, if present, could cause perched groundwater conditions and/or wet soils and should be anticipated.
- No known or documented geologic hazards are present underlying or immediately adjacent to the site.

9. RECOMMENDATIONS

The following sections present our geotechnical recommendations for the proposed construction. In general, the recommendations and guidelines outlined in the Maricopa Association of Governments (MAG) Standard Specifications and Details (2005) should be used except where different in this report. If the proposed construction is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations.

9.1. Earthwork

The following sections provide our earthwork recommendations.

9.1.1. Excavations

Our evaluation of the excavation characteristics of the on-site materials is based on the results of our exploratory borings, our site observations, and our experience with similar materials. In our opinion, excavation of the on-site materials, to the anticipated depths, can generally be accomplished with excavation equipment in good operating condition. However, some locations of very dense materials were encountered in our borings, which could slow the rate of excavation.

The contractor should provide a safely sloped excavation or an adequately constructed and braced shoring system, in compliance with OSHA regulations, for employees working in an excavation that may expose them to the danger of moving ground. If construction or earth material is stored or equipment is operated near an excavation, flatter slope geometry or stronger shoring should be used during construction. Discussions related to temporary sloped excavations and earth retention systems are presented in Sections 9.2 and 9.3 of this report, respectively.

9.1.2. Grading, Fill Placement, and Compaction

Demolition debris should be removed from the site and disposed of at a legal dumpsite. In pavement and exterior flatwork areas, obstructions that extend below finish grade, if present, should be removed and the resulting holes filled with compacted soil. Also in these areas, the geotechnical consultant should carefully evaluate any areas of loose or soft and wet soils prior to placement of grade-raise fill or other construction. Drying or overexcavation of some materials may be appropriate, in addition to the earthwork preparation recommendations presented below.

Soils generated from on-site excavation activities that exhibit relatively low plasticity indices and very low to low expansion potential are generally suitable for reuse as engineered fill. Relatively low plasticity indices are defined as a Plasticity Index (by ASTM

4318) value of 20 or less. Very low to low expansion potential soils are defined as having an Expansion Index (by ASTM D 4829) of 50 or less. Our two Atterberg Limits tests indicated plasticity indices ranging from 22 to 26. As such, some of the on-site soils may not be suitable for re-use as engineered fill during construction.

In addition, fill soils should not include organic material (greater than about 4 percent organic content), clay lumps, construction debris, rock particles, and other non-soil fill materials larger than 6 inches in dimension. This material should be disposed of offsite or in non-structural areas. An earthwork (shrinkage) factor of 15 to 20 percent for the on-site soils is estimated.

Due to the presence of relatively loose and/or soft supporting soils, the new outfall structure should be founded on a zone of adequately moisture-conditioned and re-compacted engineered fill. This improved zone may be accomplished by overexcavating to a depth of 1 foot and scarifying an additional 1 foot beneath the bearing elevation. However, in areas where this creates a conflict with existing utilities, the improved zone should extend to the top of the existing utility. The improved zone associated with this structure should also extend horizontally by 2 feet or more beyond the foundation footprint. The engineered fill should be placed in horizontal lifts no more than 9 inches in loose thickness and compacted by appropriate mechanical methods to 95 percent, or more, relative compaction in accordance with ASTM D698 and at a moisture content slightly above its laboratory optimum.

In addition, we recommend that the new grade slabs, pavements and exterior flatwork that are situated near the existing ground surface be supported on 1 foot or more of adequately moisture-conditioned and compacted structural fill. The fill thickness should be measured from the bottom of the AB layer and should be compacted by appropriate mechanical methods to 95 percent, or more, relative compaction in accordance with ASTM D698 and at a moisture content slightly above its laboratory optimum. Acceptance criteria for imported fill materials were provided above.

Following the overexcavation as described above, and prior to the placement of new fill, the resulting exposed surface should be carefully evaluated by the geotechnical consultant. This evaluation could consist of proof-rolling, soil probing, visual assessment and/or additional laboratory testing. Based on this evaluation, additional remediation may be needed, which could include additional improvement of the exposed surface. This additional remediation (if needed) should be resolved by the geotechnical consultant during the earthwork operations.

Backfill material used in excavations should be moisture conditioned to a moisture slightly above its laboratory optimum moisture content. Backfill should be mechanically compacted to a relative compaction of 95 percent or more as evaluated by ASTM D698. Lift thickness for backfill will be dependent on the type of compaction equipment utilized, but should generally be placed in uniform lifts not exceeding 9 inches in loose thickness. Special care should be exercised to avoid damaging the pipe or other structures during the compaction of the backfill.

9.1.3. Imported Fill Material

Imported fill, if utilized, should consist of granular material with low plasticity and a very low to low expansion potential. Import material in contact with ferrous metals should have low corrosion potential (minimum resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million (ppm)). Import material in contact with concrete should have a soluble sulfate content of less than 0.1 percent. The geotechnical consultant should evaluate such materials and details of their placement prior to importation.

9.2. Temporary Cut Slopes

Based on the information we received from your office, we understand that temporary excavations will be needed for this project to construct the below-grade structure. Based on the subsurface information obtained from our exploratory borings and our experience with similar projects, we recommend that cut slopes associated with temporary excavations be

constructed at a slope ratio no steeper than 1.5:1 (horizontal to vertical) up to a height of 20 feet. If the depth of excavation exceeds 20 feet, the cut slopes should be re-evaluated. These cut slope recommendations assume that no groundwater is present and no surcharge loading will be located adjacent to the top of the cut. If existing structures or utilities are located near the proposed excavation, such that a sloped excavation would not be appropriate, we recommend a temporary retention system be incorporated as an alternative to a sloped excavation. Recommendations related to temporary retention systems are presented below.

9.3. Temporary Earth Retention Systems

Based on our understanding of the proposed construction, temporary excavations up to an average depth of approximately 10 feet below the existing grade may be needed to accommodate the below-grade structure. Due to the proximity of the proposed construction to existing structures (e.g., Grand canal, residences, various utilities), it may not be feasible to perform the excavation at a stable slope ratio without causing loss of lateral support to the adjacent improvements. For this reason, temporary shoring may be needed for some portions of the proposed construction of the below-grade structure. The temporary shoring system may be incorporated into a permanent retaining structure upon excavating down to the subgrade elevation.

The shoring system should be designed for a minimum safety factor of 1.5, and the lateral deformation of the ground surface should be managed by structural design in order to protect the adjacent structures. The shoring should be designed to support the surcharge loads from the adjacent structures in addition to the earth pressures exerted by the native backfill soils. Recommended design values with respect to distribution of earth pressures on shoring elements are presented below.

Shoring systems such as soldier piles and lagging, sheet piles, or soil nails may be used to support the sidewalls of the temporary excavations as needed along the perimeter of the proposed construction. In areas where sensitive structures are located close to the proposed excavations, driven piles may not be a viable alternative due to the possible damage that

could occur to nearby structures while the piles are being driven or vibrated into place. In comparison, soldier piles and lagging (wood or precast concrete) or soil nails are considered to offer a more practical and safe method of shoring within the site.

The soldier piles should be on the order of 24 inches in diameter. The final depth and spacing of the piles should be evaluated by the project structural engineer based on the estimated total service (dead and live) and lateral loads. However, the piles should extend on the order of 15 feet below the bottom of the excavation. Once the soldier piles are installed and the concrete is cured, excavation of the site may begin. Care should be taken to ensure that the lagging drops down as the excavation advances to lower elevations. Any gaps in the lagging could cause undermining of the adjacent structures.

The excavations for the soldier piles should be observed by a representative of the project geotechnical consultant to verify total embedment depths determined by the project structural engineer. The drilled holes should be cleared of loose soil and/or construction debris prior to pouring concrete. The excavation should be conducted with continuous monitoring of the retained soil and all the adjacent structures for any signs of potential lateral and vertical movements. If any movement is observed, it should be brought to the immediate attention of the project geotechnical engineer and the excavation suspended until appropriate corrective measures are taken.

For design of cantilever temporary shoring, the lateral earth pressures noted on Figure 3 should be used. For cantilever soldier piles, an active earth pressure of 35 pounds per square foot (psf) per foot of depth may be considered for the backfill materials. It should be noted that under this condition, movement of the soldier piles are not restrained so that the soil internal strength can be fully developed. If the soldier piles or shoring system is braced using struts or tie-backs, the lateral earth pressures in Figure 4 should be used. A passive earth pressure increasing at a rate of 300 psf per foot of depth, to a value of 3,000 or more psf per foot of depth, may be used to estimate lateral resistance for soldier piles. The passive resistance should be ignored for the upper one diameter of the soldier pile embedded below the subgrade level.

Soil nail retaining walls are common in the Phoenix area. Soil nailing involves reinforcing and strengthening the existing ground by installing closely-spaced steel bars, called "nails," into an excavation face as construction proceeds from the "top down." Soil nailed structures behave like gravity walls and are typically installed in 5 foot excavation lifts.

For a conventional soil nail wall face with horizontal ground behind the wall, the nail lengths would be estimated to be 0.5 to 0.8 times the height of the wall. In some cases, the nail lengths could be 70 to 100 percent of the wall height. The soil nail spacing could range from about 3 to 6 feet, but is typically in the 5 to 6 foot range. The bars are usually installed at a 10 to 20 degree angle below the horizontal plane. After installation, the space between the bar and drill hole is grouted with cement grout. Reinforcement consisting of wire mesh or walers composed of reinforcing bars, is then installed across the excavation face between the nails. Typically a shotcrete face is then applied.

If seepage behind the soil nail wall is anticipated, a drainage system is provided along the soil excavation face. This drainage system could consist of prefabricated drains. The drain mats should be extended down the full height of the excavation, and discharge into a collector pipe at the bottom of the excavation, suitably outletted.

One advantage of soil nailed walls is their relative ease of construction and reduced construction time. Construction equipment is relatively small, mobile and quiet when compared to soldier pile installations. Soil nail wall movements are typically higher than movements from soldier piles and lagging. If soil nails are used, knowledge of easement rights and avoidance of existing utilities and structures is imperative. Due to the lateral extent of the soil nails into the adjacent ground, we do not recommend the use of soils nails if right-of-way or limited lateral space is a constraint.

The contractor performing the earth retention system work should have 5 or more years of experience in temporary earth retention systems and provide evidence of similar projects. Geotechnical information, including parameters for design, may be developed from the subsurface information provided herein. Due to the sensitive nature of adjacent structures, we

also recommend a monitoring program be developed. This monitoring program may be performed by the contractor or an independent representative of the Owner.

9.4. Below-Grade Walls

For below-grade structures that are rigidly restrained so as not to rotate sufficiently to reach active earth pressure conditions, at-rest pressure conditions will exist. We anticipate below-grade walls will be in an at-rest state. For at-rest earth pressure conditions, an equivalent fluid unit weight of 55 pcf should be used for the drained condition as depicted in Figure 5.

For passive resistance to lateral loads, we recommend that an equivalent fluid weight of 300 pcf be used up to a value of 3,000 psf. This value assumes that the ground is horizontal for a distance of 10 feet or more behind the wall or three times the height generating the passive pressure, whichever is greater. We recommend that the upper 12 inches of soil not protected by pavement or a concrete slab be neglected when calculating passive resistance.

For frictional resistance to lateral loads, we recommend that a coefficient of friction of 0.40 be used between soil and concrete. If passive and frictional resistances are to be used in combination, we recommend that the friction coefficient be reduced by two-thirds. The passive resistance values may be increased by one-third when considering loads of short duration such as wind or seismic forces.

Precautions should be considered to avoid overstressing below-grade walls during backfilling. Temporary bracing of the walls during backfilling may be needed to help avoid this problem.

9.5. Construction Dewatering

A shallow groundwater table is not anticipated along the alignment during construction. However, as indicated above, seepage and surface run-off could be anticipated near the Grand Canal or other drainage features. The need for dewatering should be considered along

the alignment near these features. Surface run-off will vary seasonally depending on local rainfall.

Given the low possibility of encountering significant seepage along the alignment, we anticipate that the excavations that do encounter nuisance seepage or surface run-off could be dewatered by sumping the water from the bottom of the excavation. However, saturated sands, if encountered, may need more aggressive means of dewatering such as well points. If discharged water from the excavations is diverted to natural drainage channels, a special permit may be needed.

9.6. Corrosion

The corrosion potential of the on-site soil materials was analyzed to evaluate its potential effect on the foundations and structures. Corrosion potential was evaluated using the results of laboratory testing of a representative near-surface sample obtained during our subsurface evaluation.

Laboratory testing consisted of pH, minimum electrical resistivity, and soluble sulfate and chloride contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236b, while sulfate and chloride tests were performed in accordance with Arizona Test 733 and 736, respectively. The results of the corrosivity tests are presented in Appendix B.

The soil pH value of the samples tested ranged from 7.8 to 8.5, which is considered to represent an alkaline environment. The minimum electrical resistivity measured in the laboratory ranged from 752 ohm-cm to 2,395 ohm-cm, which is considered corrosive to ferrous metals. The chloride content of the samples tested ranged from 43 ppm to 146 ppm, which is considered to have a potential corrosive effect to ferrous metals. The soluble sulfate content of the soil samples tested ranged from 0.001 percent to 0.006, which is considered to represent a negligible corrosive effect on exposed concrete.

The results of the laboratory testing indicate that the on-site soils may be corrosive to ferrous metals. Therefore, special consideration should be given to the use of heavy gauge, corrosion protected, underground steel pipe, if any are planned. As an alternative, wrapped/plastic pipe or reinforced concrete pipe should be considered. In addition, metallic elements used for excavation support systems will need to be protected from potentially corrosive soils. A corrosion specialist should be consulted for further recommendations.

9.7. Concrete

Laboratory chemical tests performed on an on-site soil samples indicated a sulfate content ranging from 0.001 percent to 0.006 percent by weight. Based on the following UBC table, the on-site soils should be considered to have a negligible sulfate exposure to concrete.

Table 2 – UBC Requirements for Concrete Exposed to Sulfate-Containing Soil

Sulfate Exposure	Water-Soluble Sulfate (SO_4) in Soil, Percentage by Weight	Cement Type	Water-Cementitious Materials Ratio, by Weight, Normal-Weight Aggregate Concrete[1]	f'_c, Normal-Weight and Lightweight Aggregate Concrete, psi x 0.00689 for MPa
Negligible	0.00 - 0.10	--	--	--
Moderate[2]	0.10 - 0.20	II, IP(MS), IS (MS)	0.50 or less	4,000 or more
Severe	0.20 - 2.00	V	0.45 or less	4,500 or more
Very severe	Over 2.00	V plus pozzolan[3]	0.45 or less	4,500 or more

[1] A lower water-cementitious materials ratio or higher strength may be needed for low permeability or for protection against corrosion of embedded items or freezing and thawing (Table 19-A-2).
[2] Seawater.
[3] Pozzolan that has been evaluated by test or service record to improve sulfate resistance when used in concrete containing Type V cement.

Notwithstanding the sulfate test results and due to the limited number of chemical tests performed, as well as our experience with similar soil conditions and local practice, we recommend the use of Type II cement for construction of concrete structures at this site.

The concrete should have a water-cementitious materials ratio no more than 0.45 by weight for normal weight aggregate concrete. The structural engineer should ultimately select the concrete design strength based on the project specific loading conditions. However, higher strength concrete may be selected for increased durability, resistance to slab curling and shrinkage cracking.

9.8. Pavements

For the paved areas, we understand that AC pavement is considered for this project. The pavement sections recommended below are assumed to bear on imported or on-site soils with an average soil R-value of 30 or more.

The AASHTO method was also used to evaluate the asphalt pavement thicknesses recommended below. Specifically, the recommendations were based on the following input parameters:

Design Period:	20 years
Average Daily Traffic (2007)	38,000
Percent Trucks	5%
Percent Growth	5%
ESALs:	9,750,000
Reliability:	95 percent
Overall Deviation:	0.45
Soil Resilient Modulus:	18,000 psi
Initial Serviceability:	4.5
Terminal Serviceability:	2.5

An asphalt pavement section consisting of 6 or more inches of plant-mix asphalt (per MAG Section 710) over 10 or more inches of graded AB can be considered for pavement replacement along Indian School or 67th Avenue. For light duty areas (parking lots, driveways, etc), an asphalt pavement section consisting of 3 or more inches of plant-mix asphalt (per MAG Section 710) over 6 or more inches of graded AB can be utilized.

For asphalt pavement sections, we recommend the underlying subgrade soils be prepared as described in Section 9.1.2 of this report. AB material should be compacted to a relative compaction of 95 percent or more, as evaluated by ASTM D698, at a moisture content slightly above its laboratory optimum.

9.9. Site Drainage

Surface drainage should be provided to divert water away from buildings and off of paved surfaces. Surface water should not be permitted to drain toward the structures or to pond adjacent to footings or on pavement areas. Positive drainage is defined as a slope of 2 percent or more over a distance of 5 feet or more away from the structures.

9.10. Instrumentation and Documentation

Consideration should be given to implementing documentation and instrumentation programs to evaluate design assumptions, existing conditions, and to monitor movements, levels, and deformations during construction. The monitoring programs may include the use of inclinometers, convergence points, and an array of surface control points. The resulting data should be reviewed and evaluated during construction. These programs should be in-place or conducted prior to the start of construction.

9.10.1. Documentation of Existing Conditions

We recommend that a pre-construction survey be performed prior to construction on residences and structures within approximately 50 feet of the proposed trench excavations. The pre-construction survey should consist of photographic documentation of the exterior portions of the buildings, including distress features, such as cracks and/or separations that may be present. Consideration may be given to videotaping the survey. In addition, interviews with owners should be conducted to provide knowledge of the age and type of the buildings as well as maintenance history and utility problems.

9.10.2. Lateral Movement of Shoring Support System

We recommend that inclinometers or survey points be established behind excavations located in areas where structures are located above a 1:1 (horizontal to vertical) plane projected from the bottom of the proposed excavations. The inclinometers or survey points should be monitored and evaluated daily during excavation activities to provide an advanced warning system of potential problems.

9.10.3. Ground Surface Settlement

We also recommend that an array of ground survey points be installed along the project alignment to monitor settlement. The survey points should be installed as close as practical to the excavation and incrementally away from the excavation. The contractor should be responsible for maintaining the total settlement beneath adjacent buildings to less than ½-inch. If settlements reach ¼-inch, we recommend that a review of the contractor's methods be performed and appropriate changes be made, if needed.

Consideration should be given to placing survey monitoring points on nearby structures to monitor the performance of the structures. In this way, a record of the performance of the structure will be maintained and available. This information, in conjunction with pre-construction surveys, is helpful in reducing potential claims and expediting and limiting settlement of legitimate claims.

9.11. Pre-Construction Conference

We recommend that a pre-construction conference be held. Representatives of the owner, civil engineer, the geotechnical consultant, and the contractor should be in attendance to discuss the project plans and schedule. Our office should be notified if the project description included herein is incorrect, or if the project characteristics are significantly changed.

9.12. Construction Observation and Testing

During construction operations, we recommend that a qualified geotechnical consultant perform observation and testing services for the project. These services should be performed to

evaluate exposed subgrade conditions, including the extent and depth of overexcavation, to evaluate the suitability of proposed borrow materials for use as fill and to observe placement and test compaction of fill soils. If another geotechnical consultant is selected to perform observation and testing services for the project, we request that the selected consultant provide a letter to the owner, with a copy to Ninyo & Moore, indicating that they fully understand our recommendations and that they are in full agreement with the recommendations contained in this report. Qualified subcontractors utilizing appropriate techniques and construction materials should perform construction of the proposed improvements.

10. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The

independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

11. REFERENCES

American Concrete Institute, 2005, Building Code Requirements for Structural Concrete (ACI 318-05) and Commentary (ACI 318R-05).

American Society for Testing and Materials (ASTM), 2005 Annual Book of ASTM Standards.

Euge, K.M., Schell, B.A., and Lam, I.P., 1992, Development of Seismic Acceleration Contour Maps for Arizona: Arizona Department of Transportation Report No. AZ 92-344, dated September.

International Conference of Building Officials, 2003, Uniform Building Code: Whittier California.

Landiscor, 1999, Real Estate Photo Book for the Greater Phoenix Area.

Maricopa Association of Governments, 2007, Uniform Standard Specifications and Details for Public Works Construction.

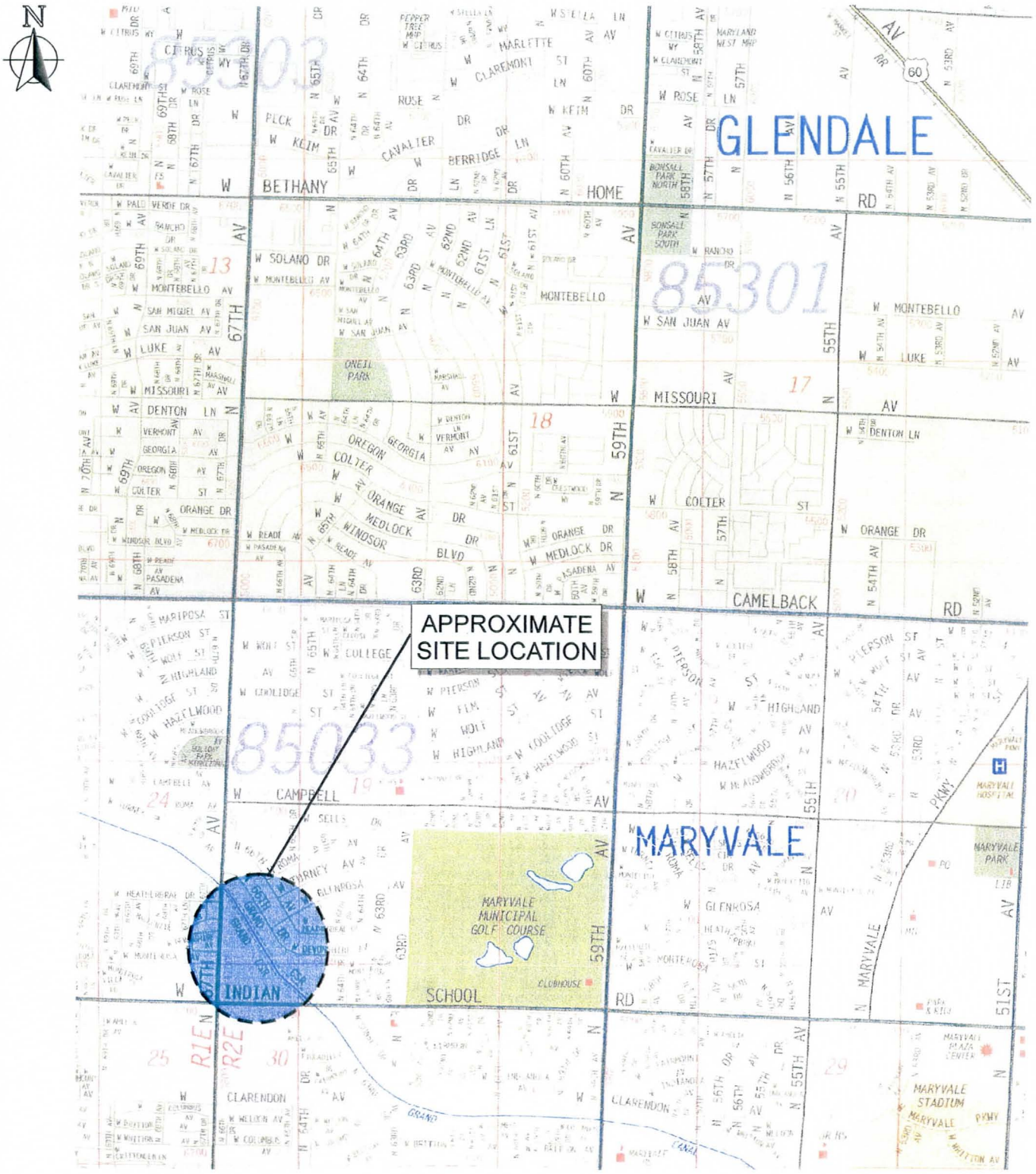
Ninyo & Moore, In-house proprietary information.

Pearthree, P.A., 1998, Quaternary Fault Data and Map for Arizona: Arizona Geological Survey, Open-File Report 98-24, 122 p.

Schumann, H.H. and Genualdi, R., 1986, Land Subsidence, Earth Fissures, and Water-level Changes in Southern Arizona: Arizona Geological Survey OFR 86-14, Scale 1:500,000.

United States Geological Survey, 1982, Fowler, Arizona, 7.5-Minute Series (Topographic): Scale 1 = 24,000.

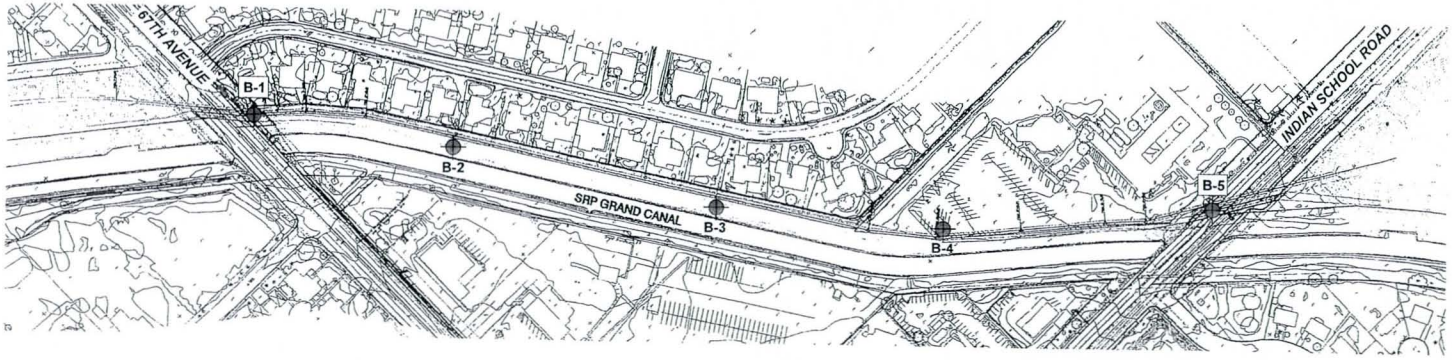
United States Geological Survey, 2000, National Seismic Hazard Mapping Project, World Wide Web, http://geohazards.cr.usgs.gov/eq.



Source: Thomas Guide, Phoenix Metro Edition, 2006.

Ninyo & Moore	SITE LOCATION MAP	FIGURE
PROJECT NO: 601850001 / DATE: 9/08	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	1

file no: 1850vmap1007



LEGEND

B-5 Approximate Boring Location

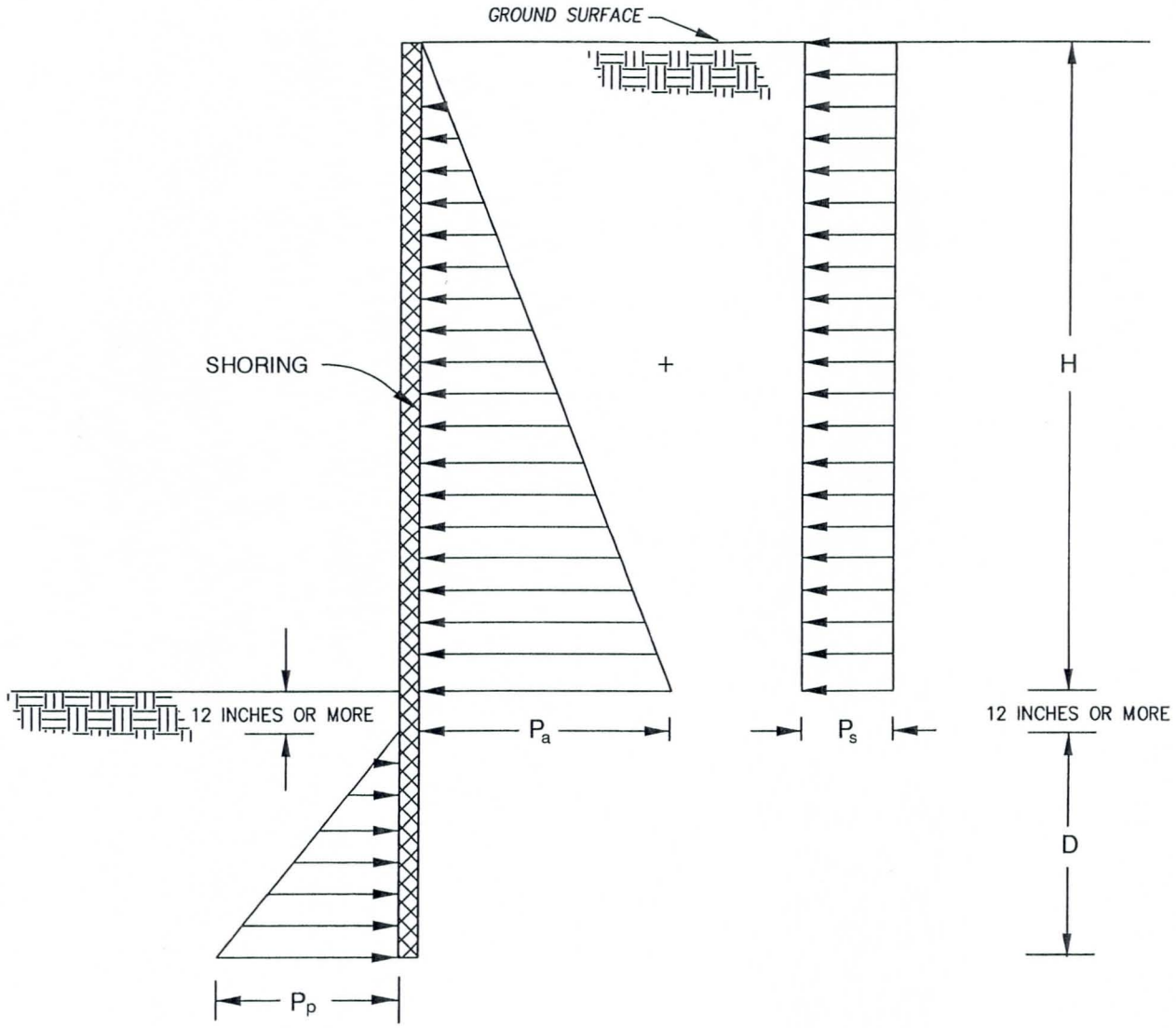
0 170

Approximate Scale:
1 inch = 170 feet

Source: Basemap modified after OLSSON ASSOCIATES, 2007.

Ninyo & Moore	BORING LOCATION MAP	FIGURE
PROJECT NO: 601850001 / DATE: 9/08	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	2

1850bim1007



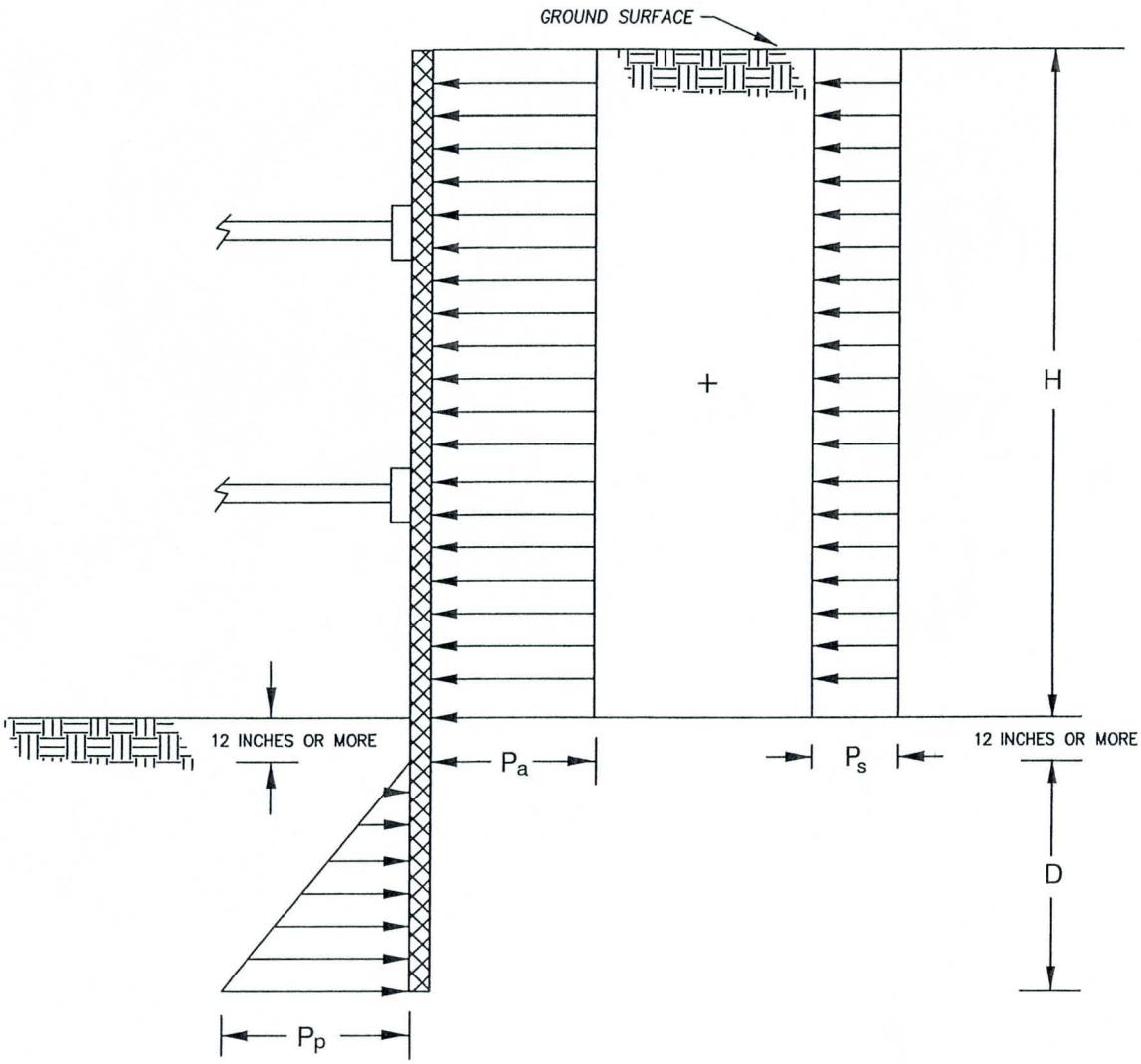
NOTES:

1. ACTIVE LATERAL EARTH PRESSURE, P_a
   P_a = 35 H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 300 D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. H AND D ARE IN FEET

NOT TO SCALE

1850

Ninyo & Moore	LATERAL EARTH PRESSURES FOR TEMPORARY CANTILEVERED SHORING	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	3
601850001 / 10/07		



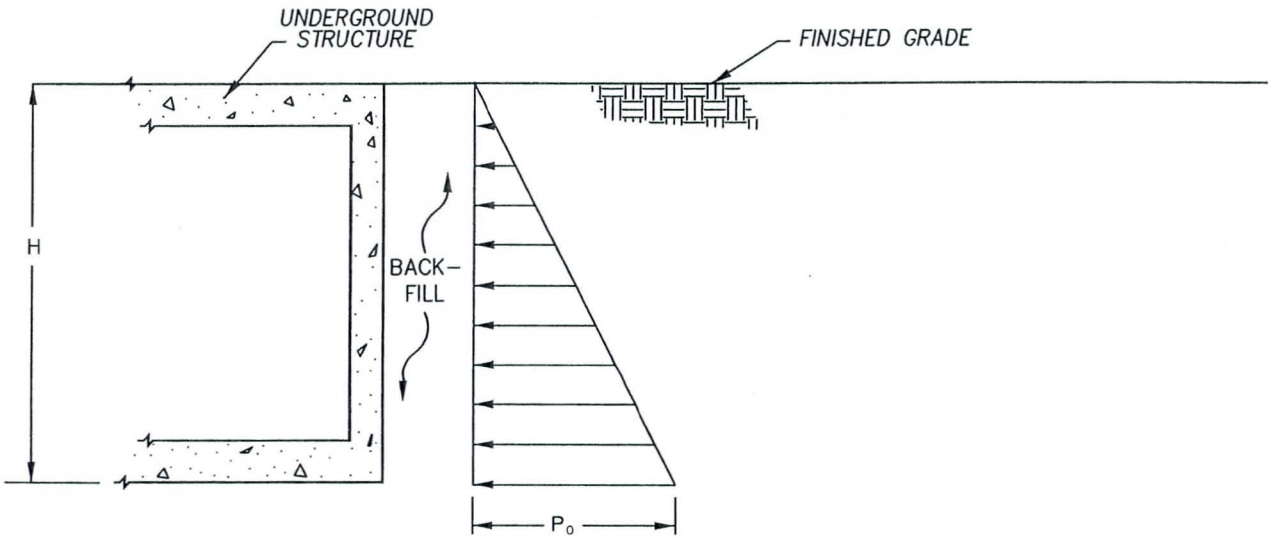
NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_a
   P_a = 22 H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 345 D psf
4. ASSUMES GROUNDWATER NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

50dt1

Ninyo & Moore	LATERAL EARTH PRESSURES FOR BRACED EXCAVATION (GRANULAR SOIL)	FIGURE
PROJECT NO. / DATE	BETHANY HOME ROAD OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	4
601850001 / 10/07		



STATIC PRESSURE

NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_0
   $P_0 = 55\ H$ psf
2. SURCHARGE PRESSURES CAUSED BY VEHICLES OR NEARBY STRUCTURES ARE NOT INCLUDED
3. H IS IN FEET
4. ASSUMES NO GROUNDWATER

NOT TO SCALE

Ninyo & Moore	LATERAL EARTH PRESSURES FOR UNDERGROUND STRUCTURES	FIGURE
PROJECT NO. / DATE	BETHANY HOME ROAD OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	5
601850001 / 10/07		

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test Spoon

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test spoon sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The spoon was driven up to 18 inches into the ground with a 140-pound hammer free-falling from a height of 30 inches in general accordance with ASTM D 1586-99. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the spoon, bagged, sealed, and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following method.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with a 140-pound hammer free-falling from a height of 30 inches in general accordance with ASTM D 1586-99. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

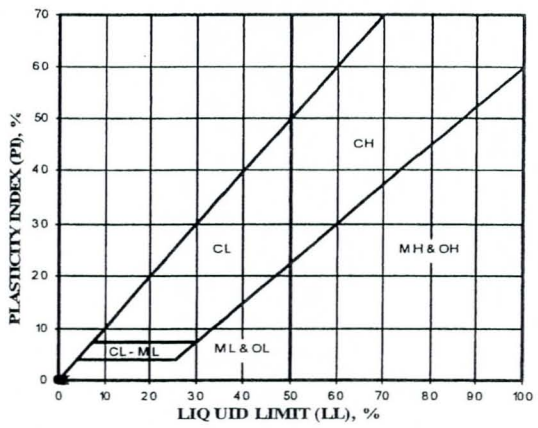
U.S.C.S. METHOD OF SOIL CLASSIFICATION

MAJOR DIVISIONS		SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (More than 1/2 of soil >No. 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction <No. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than 1/2 of soil <No. 200 sieve size)	SILTS & CLAYS Liquid Limit <50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean
		OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

GRAIN SIZE CHART

CLASSIFICATION	RANGE OF GRAIN SIZE	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL Coarse Fine	3" to No. 4 3" to 3/4" 3/4" to No. 4	76.2 to 4.76 76.2 to 19.1 19.1 to 4.76
SAND Coarse Medium Fine	No. 4 to No. 200 No. 4 to No. 10 No. 10 to No. 40 No. 40 to No. 200	4.76 to 0.075 4.76 to 2.00 2.00 to 0.420 0.420 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

PLASTICITY CHART



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U.S.C.S. METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0	■							Bulk sample.
		■						Modified split-barrel drive sampler.
		☒						No recovery with modified split-barrel drive sampler.
		▬						Sample retained by others.
		◥						Standard Penetration Test (SPT).
5		◤						No recovery with a SPT.
		▭	XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
		◤						No recovery with Shelby tube sampler.
		▭						Continuous Push Sample.
				♀				Seepage.
10				▽				Groundwater encountered during drilling.
				▼				Groundwater measured after drilling.
						▦	SM	ALLUVIUM: Solid line denotes unit change.
								Dashed line denotes material change.
15								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Sheared Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG

EXPLANATION OF BORING LOG SYMBOLS

PROJECT NO.	DATE	FIGURE
	Rev. 01/03	

DATE DRILLED 08/14/07 BORING NO. B-1

GROUND ELEVATION -- SHEET 1 OF 2

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0								ASPHALT CONCRETE: Approximately 11 inches thick.
							GP-GM	AGGREGATE BASE: Approximately 7 inches thick. Brown, damp, medium dense, fine to coarse GRAVEL with silt and sand.
			28				GP	FILL: Brown, damp, medium dense, poorly graded GRAVEL with sand.
			22				SP	Brown, damp, dense, poorly graded SAND; few fine to coarse gravel.
5								
			22				SW-SM	ALLUVIUM: Brown, damp, medium dense, well-graded SAND with silt and gravel.
			50/5"					Very dense.
10								
			14	2.6	114.6			Loose to medium dense.
15								
			5				SM	Brown, damp, loose, silty fine to medium SAND; trace fine gravel.
20								

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BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-1

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20								Total Depth = 20 feet. Groundwater not encountered during drilling. Backfilled and asphalt patched on 08/14/07 promptly after completion of drilling. Groundwater, though not encountered at the time of drilling, may rise to higher levels due to seasonal variations in precipitation and several other factors as discussed in the report.
25								
30								
35								
40								

DATE DRILLED 08/14/07 BORING NO. B-1

GROUND ELEVATION -- SHEET 2 OF 2

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-2

DATE DRILLED 08/14/07 BORING NO. B-2

GROUND ELEVATION -- SHEET 1 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						ML	ALLUVIUM: Brown, damp, medium dense, sandy SILT.
	Driven	8					
	Driven	11	20.5	100.0			Moist, loose.
5	Driven	5					
	Driven	11	7.9	105.7			Damp.
10							
	Driven	6					
15							
	Driven	31					Dense; scattered caliche nodules.
20							

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-3

DATE DRILLED 08/14/07 BORING NO. B-2

GROUND ELEVATION -- SHEET 2 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20						ML	ALLUVIUM: (continued) Brown, damp, dense, fine to medium sandy SILT; scattered caliche nodules.
						SC	Brown, damp, dense, clayey fine to medium SAND.
		32					
25							
		54					
						SP	Brown, damp, dense, poorly graded SAND; trace fine to coarse gravel.
30							
		43					Very dense; few fine to coarse gravel.
35							
						SC	Brown, damp, very dense, clayey fine to coarse SAND; trace fine gravel; scattered caliche nodules.
		74/11"					
40							

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BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-4

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40								Total Depth = 39.9 feet.
								Groundwater not encountered during drilling.
								Backfilled on 08/14/07 promptly after completion of drilling.
								Groundwater, though not encountered at the time of drilling, may rise to higher levels due to seasonal variations in precipitation and several other factors as discussed in the report.
45								
50								
55								
60								

DATE DRILLED 08/14/07 BORING NO. B-2

GROUND ELEVATION -- SHEET 3 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-5

DATE DRILLED 08/20/07 BORING NO. B-3

GROUND ELEVATION -- SHEET 1 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY JLS LOGGED BY JLS REVIEWED BY KJT

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0		19				SC	FILL: Brown, damp, loose, clayey SAND.
5		9				CL	ALLUVIUM: Brown, damp, stiff, sandy CLAY.
		6	18.8	89.1			Moist; firm to stiff.
10		4				SM	Brown, damp, loose, silty fine SAND.
15		6				CL	Brown, moist, firm to stiff, CLAY.
20		1/18"					Very soft.

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-6

DATE DRILLED 08/20/07 BORING NO. B-3

GROUND ELEVATION -- SHEET 2 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY JLS LOGGED BY JLS REVIEWED BY KJT

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20							CL	ALLUVIUM: (continued) Brown, moist, very soft, CLAY.
			38	19.6	106.0			Hard; scattered caliche nodules.
25								
							SC	Brown, moist, medium dense, clayey SAND; trace fine gravel.
			15					
30								
							GP	Brown, damp, dense, poorly graded GRAVEL with sand; cobbles and possible boulders.
			50					
35								
			50/5"					Very dense.
								Total Depth = 39.4 feet.
40								

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-7

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40								Groundwater not encountered during drilling. Backfilled on 08/20/07 promptly after completion of drilling. Groundwater, though not encountered at the time of drilling, may rise to higher levels due to seasonal variations in precipitation and several other factors as discussed in the report.
45								
50								
55								
60								

DATE DRILLED 08/20/07 BORING NO. B-3

GROUND ELEVATION -- SHEET 3 OF 3

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY JLS LOGGED BY JLS REVIEWED BY KJT

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-8

DATE DRILLED 08/20/07 BORING NO. B-4

GROUND ELEVATION -- SHEET 1 OF 2

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ASPHALT CONCRETE: Approximately 2 inches thick.
						GP-GM	AGGREGATE BASE: Approximately 3.5 inches thick.
						CL	Brown, damp, medium dense, fine to coarse GRAVEL with silt and sand.
		7					ALLUVIUM: Brown, damp, stiff, CLAY with sand.
		19					Very stiff.
5							
		5				ML	Brown, damp, loose, sandy SILT.
		21	10.5	102.1		SM	Brown, damp, medium dense, silty fine to medium SAND.
10							
		6				ML	Brown, damp, loose, sandy SILT.
15							
		7				CL	Brown, damp, stiff, sandy CLAY.
20							

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-9

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20								Total Depth = 20 feet. Groundwater not encountered during drilling. Backfilled on 08/20/07 promptly after completion of drilling. Groundwater, though not encountered at the time of drilling, may rise to higher levels due to seasonal variations in precipitation and several other factors as discussed in the report.
25								
30								
35								
40								

DATE DRILLED 08/20/07 BORING NO. B-4

GROUND ELEVATION -- SHEET 2 OF 2

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-10

DATE DRILLED 08/20/07 BORING NO. B-5

GROUND ELEVATION -- SHEET 1 OF 2

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ASPHALT CONCRETE: Approximately 4 inches thick.
						GP	AGGREGATE BASE: Approximately 8 inches thick.
		20				CL	FILL: Brown, damp, very stiff, sandy CLAY.
5		5				CL	ALLUVIUM: Brown, damp, firm to stiff, sandy CLAY.
		3	14.4	96.9		ML	Brown, moist, very loose, sandy SILT.
10		3				CL	Brown, damp, soft to firm, sandy CLAY.
15		11				SM	Brown, damp, loose, silty SAND with gravel.
20		5				ML	Brown, damp, loose, sandy SILT.

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-11

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20								Total Depth = 20 feet. Groundwater not encountered during drilling. Backfilled on 08/20/07 promptly after completion of drilling. Groundwater, though not encountered at the time of drilling, may rise to higher levels due to seasonal variations in precipitation and several other factors as discussed in the report.
25								
30								
35								
40								

DATE DRILLED 08/20/07 BORING NO. B-5

GROUND ELEVATION -- SHEET 2 OF 2

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY KJT

Ninyo & Moore

BORING LOG

BETHANY HOME OUTFALL CHANNEL REACH D
PHOENIX, ARIZONA

PROJECT NO.	DATE	FIGURE
601850001	9/08	A-12

APPENDIX B

LABORATORY TESTING

Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488-00. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937-04. The test results are presented on the logs of the exploratory borings in Appendix A.

Gradation Analysis

Gradation analyses were performed on selected representative soil samples in general accordance with ASTM D 422-63 (02). The grain-size distribution curves are presented on Figures B-1 through B-5. The test results were utilized in evaluating the soil classifications in accordance with the Unified Soil Classification System.

Atterberg Limits

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318-05. These test results were utilized to evaluate the soil classification in accordance with the Unified Soil Classification System. The test results are incorporated in the logs in Appendix A and are shown on Figure B-6 in Appendix B.

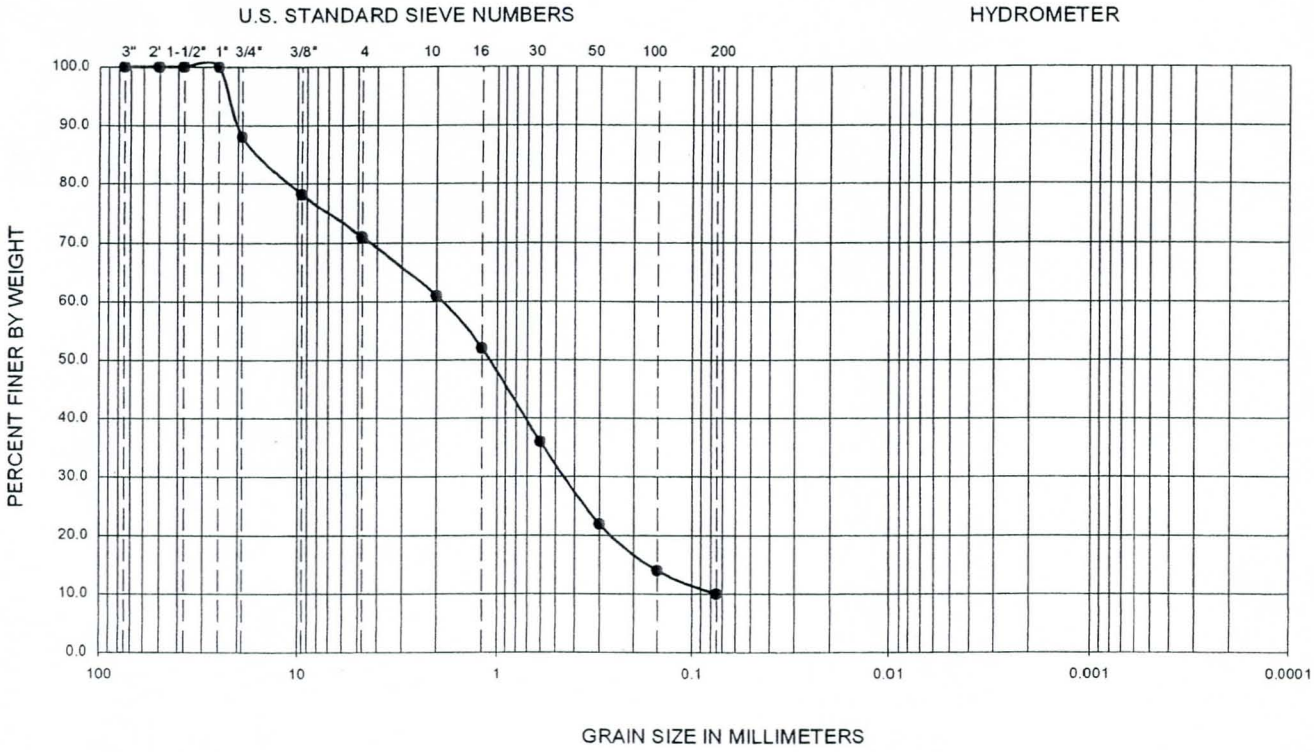
Maximum Dry Density and Optimum Moisture Content Tests

The maximum dry density and optimum moisture content of selected representative soil samples were evaluated in general accordance with ASTM D 698-00. The results of these tests are summarized on Figure B-7.

Soil Corrosivity Tests

Soil pH and minimum resistivity tests were performed on representative samples in general accordance with Arizona Test 236b. The chloride content of selected samples was evaluated in general accordance with Arizona Test 736. The sulfate content of selected samples was evaluated in general accordance with Arizona Test 733. The test results are presented on Figure B-8.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

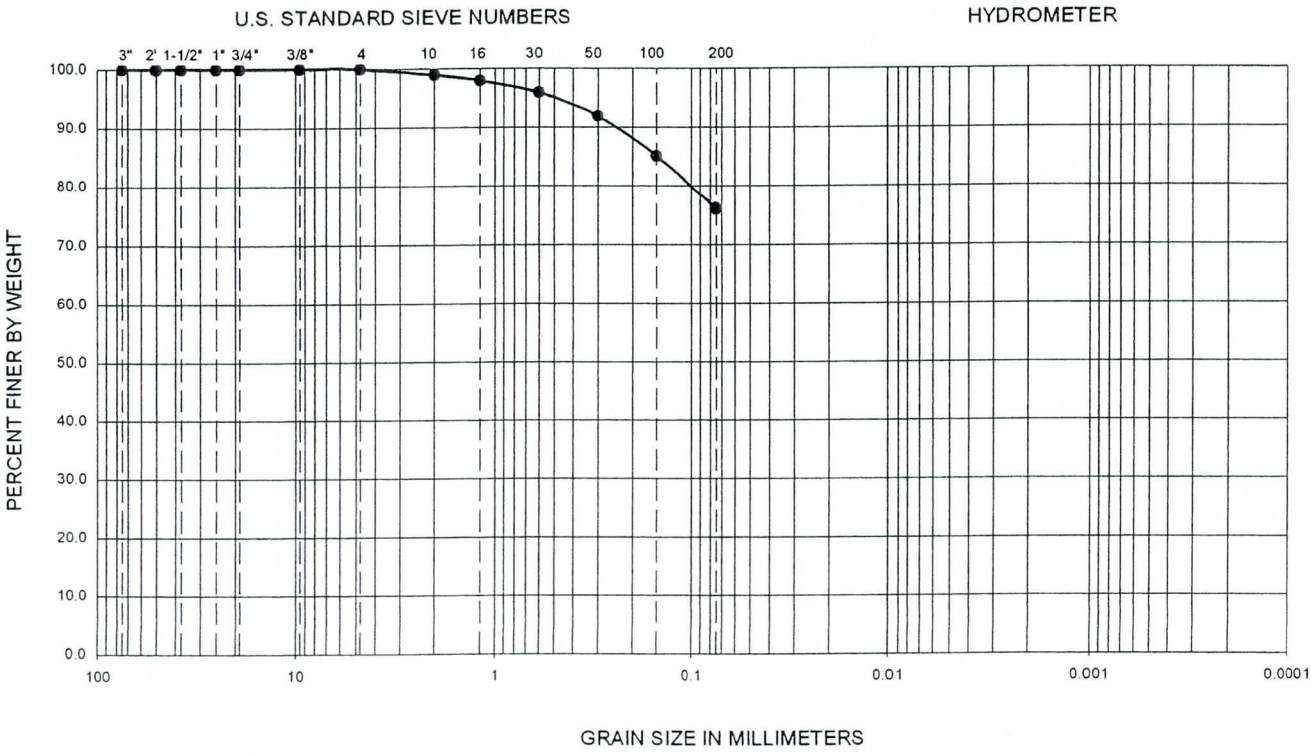


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	6-7.5	--	--	--	0.08	0.46	1.90	25.3	1.5	10	SW-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-1
601850001 / 9/08		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

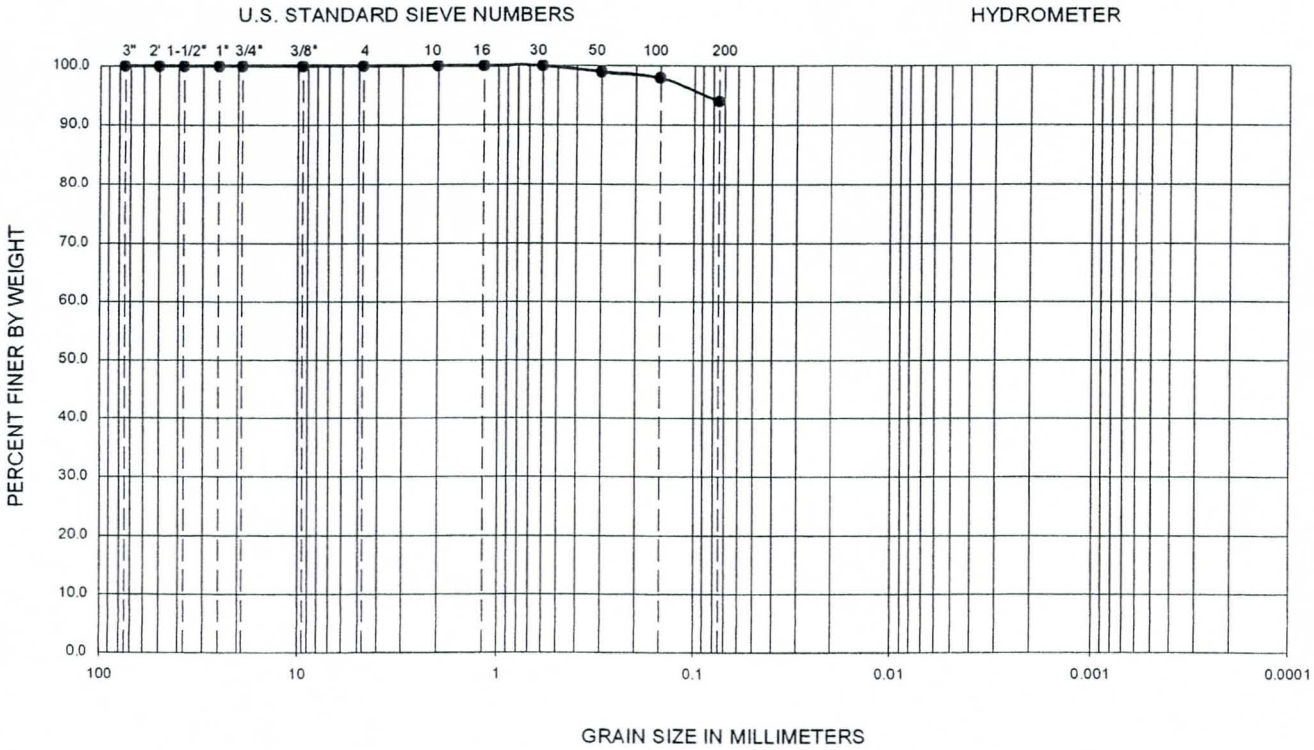


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-2	6-7.5	--	--	--	--	--	--	--	--	76	ML

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-2
601850001 / 9/08		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

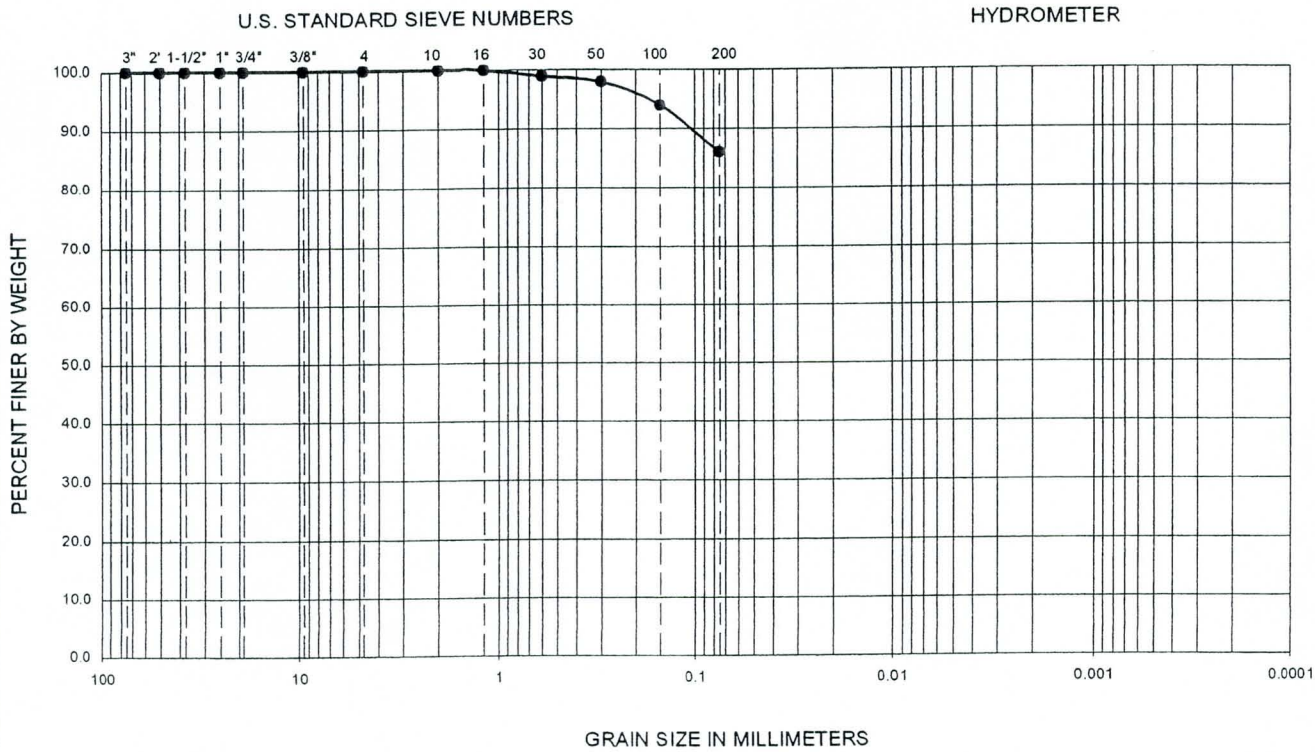


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-3	3.5-5	40	18	22	--	--	--	--	--	94	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-3
601850001 / 9/08		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

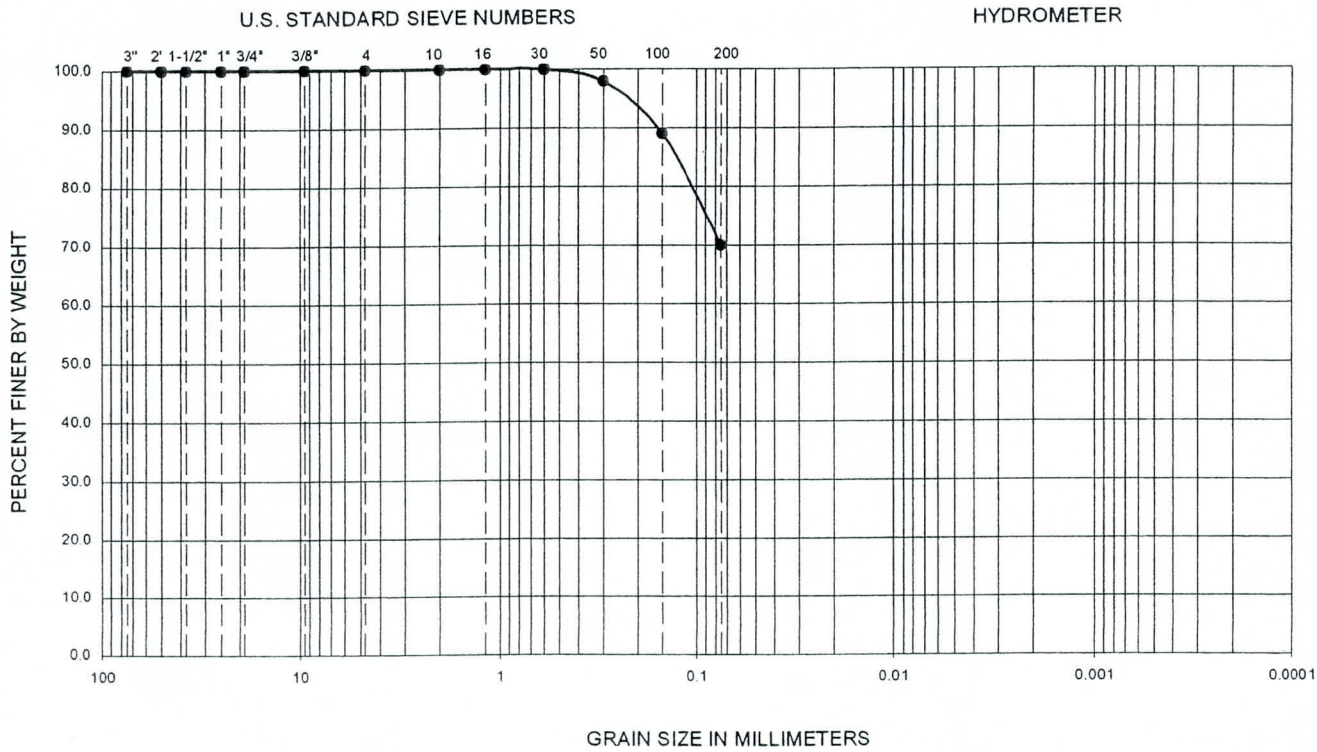


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-4	3.5-5	44	18	26	--	--	--	--	--	86	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-4
601850001 / 9/08		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

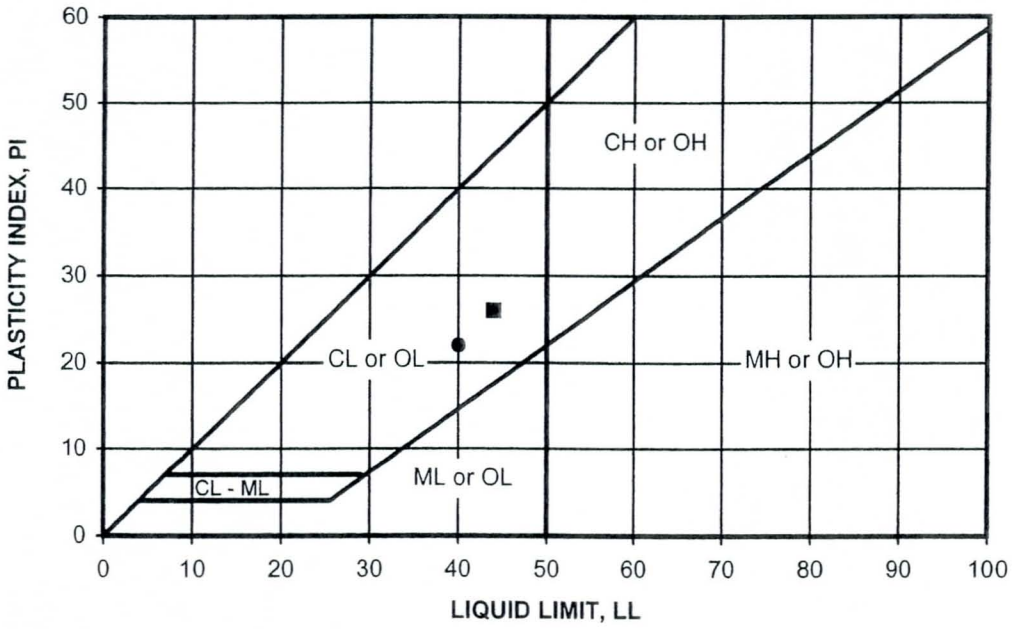


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-5	6-7.5	--	--	--	--	--	--	--	--	70	ML

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

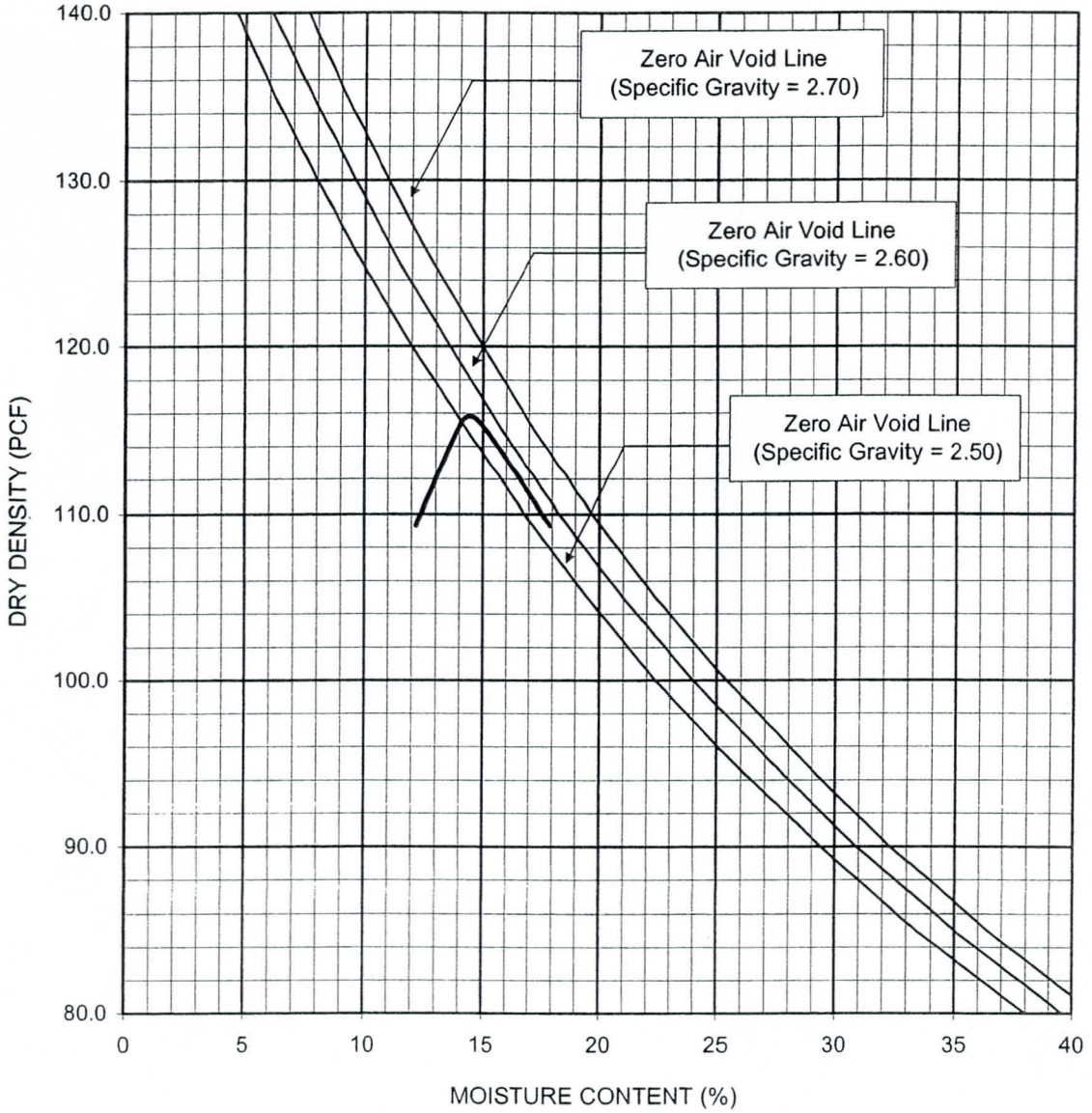
Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-5
601850001 / 9/08		

SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
●	B-3	3.5-5	40	18	22	CL	CL
■	B-4	3.5-5	44	18	26	CL	CL



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318-05

Ninyo & Moore	ATTERBERG LIMITS TEST RESULTS	FIGURE
PROJECT NO. 601850001 / DATE 9/08	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-6



Sample Location	Depth (ft)	Soil Description	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
B-3	0-3	SC	115.8	14.6
Dry Density and Moisture Content Values Corrected for Oversize (ASTM D 4718-87)			N/A	N/A

PERFORMED IN GENERAL ACCORDANCE WITH ☐ ASTM D 1557-02 ☑ ASTM D 698-00a METHOD ☑ A ☐ B ☐ C

Ninyo & Moore	PROCTOR DENSITY TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-7
60185001 / 9/08		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-1	5-10	8.5	2,394	8	0.001	43
B-3	0-3	7.8	752	57	0.006	146

[1] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236b
[2] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733
[3] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736

Ninyo & Moore	CORROSIVITY TEST RESULTS	FIGURE
PROJECT NO. / DATE	BETHANY HOME OUTFALL CHANNEL REACH D PHOENIX, ARIZONA	B-8
601850001 / 9/08		

Appendix D

Survey Data

```
1,907732.3940,614710.3080,1100.3130,SRB W/ALUM.CAP BASE
2,906875.7540,615124.9410,1092.5000,SET NAIL
3,907743.7090,614428.0770,1095.9590,SET NAIL
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11,910456.5760,612745.4880,1098.6010,BCHH
12,913102.7510,612763.1840,1108.0110,BCHH
13,913133.6130,615233.3840,1114.2310,BCF
14,913166.6420,617885.0550,1121.1110,BCHH
15,910524.4650,617865.8600,1113.2610,ACF
16,907884.8820,617846.4860,1105.0410,BCHH
17,907846.4820,615199.4730,1100.6510,BCHH
102,906875.7540,615124.9410,1092.4910,SET NAIL
103,907743.7090,614428.0770,1095.9810,SET NAIL
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111,910456.5930,612745.4880,1098.5970,BCHH
112,913102.9340,612763.2080,1108.9280,FPK
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117,907846.6410,615199.5770,1100.7070,BCHH
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10003,906813.7110,615183.1310,1096.4970,BCV01
10004,906803.8330,615184.4260,1097.8740,B GDR01
10005,906803.8330,615184.4260,1097.8740,C3 GDR01
10006,906827.5050,615171.9400,1096.1520,GDR01
10007,906853.6500,615169.4300,1097.5450,GDR01
10008,906811.0940,615179.0280,1096.5860,B EOS01
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10021,906869.9590,615164.6340,1097.6940,WMT
10022,906871.8530,615164.6510,1097.4690,WMT
10023,906870.4540,615160.1510,1099.8530,BFP
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10030,906880.2100,615170.2450,1097.4540,EOC02
10031,906880.4020,615159.1670,1097.4690,EOC02
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10040,906822.7690,615143.8340,1096.3610,B RIP01
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10043,906840.2380,615098.1970,1088.5220,RIP01
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10045,906847.3260,615110.9230,1088.7980,GDR02
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10050,906852.4850,615112.8760,1088.7990,HWL01
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10067,907053.6710,615156.5390,1098.1950,TOP
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10114,906901.7590,615096.1680,1087.1980,TOE
10115,906876.0130,615095.5420,1087.0340,TOE
10116,906850.4310,615078.7730,1086.6350,TOE
10117,906853.8670,615047.9430,1086.2500,TOE
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10135,906864.1780,615037.7000,1086.1850,TOE
10136,906903.8830,615070.6590,1086.4050,BTM
10137,906784.1670,615019.7160,1097.9200,DTR
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10150,906871.1450,614934.0590,1098.6910,GRATE
10151,906865.3910,614932.3360,1098.7320,GRATE
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10153,906860.4800,614914.4980,1098.8130,E BCV06
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10155,906854.8880,614893.5730,1099.0480,TOP
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10157,906896.9300,614930.0560,1096.3910,DTR
10158,906887.3510,614952.7140,1094.4680,DTR
10159,906939.9260,614972.1180,1085.6680,TOE
10160,906931.2850,614979.1980,1085.6010,DW
10161,906979.5640,615007.5200,1086.1640,BTM
10162,907018.4040,615042.3700,1087.3680,BTM
10163,907058.1770,615077.9960,1088.1350,BTM
10164,906888.1420,614923.6720,1097.2320,TOP
10165,906888.4600,614852.6670,1098.0590,CLD02
10166,906890.1660,614854.6530,1098.8750,TOP
10167,906924.4040,614886.4450,1097.3920,BCV05
10168,906924.5730,614886.6510,1097.0550,TOP
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10170,906970.3020,614928.9320,1086.2800,IVL
10171,906971.5480,614927.5500,1086.3050,IVL
10172,906972.7200,614926.2020,1086.4260,IVL
10173,906976.6390,614933.8130,1085.7740,TOE
10174,907014.5040,614968.2360,1086.4310,BTM
10175,907055.0750,615005.7950,1087.2980,BTM
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10177,906925.6180,614818.4680,1099.0390,TOP
10178,906958.2150,614851.3000,1097.8570,BCV5
10179,906958.6570,614851.6100,1097.5260,TOP
10180,907008.6640,614900.1770,1085.8370,TOE
10181,907003.0490,614905.0320,1085.5860,CB
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10183,907084.5170,614974.8240,1087.1060,BTM
10184,906957.9270,614780.0640,1098.1230,CLD02
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10205,907170.2150,615083.2610,1098.4100,IRR STUB
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10211,907223.6270,614916.0180,1090.1180,IVL
10212,907225.1350,614914.9550,1090.3430,IVL
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10215,907072.4470,614746.0030,1097.4110,BCV05
10216,907072.8510,614746.5020,1097.2510,TOP
10217,907116.0140,614798.5690,1085.6300,TOE
10218,907151.3390,614841.3650,1086.1600,BTM
10219,907187.6350,614882.0570,1086.7200,BTM
10220,907208.6400,614905.9120,1087.2880,TOE
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10222,907080.2740,614671.8960,1098.0670,CLD02
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10225,907114.2390,614714.4820,1097.1180,TOP
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10227,907153.1530,614771.9430,1085.3920,CB
10228,907164.5460,614756.9010,1086.1970,IVL
10229,907192.8490,614808.1680,1085.8490,BTM
10230,907225.2990,614848.0070,1086.5170,BTM
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10232,907285.9180,614912.7080,1097.2020,TOP
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10234,907293.6290,614920.7850,1097.6510,UGG
10235,907284.1670,614936.0730,1099.5180,FOP
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10239,907157.1040,614681.1000,1097.5560,BCV05
10240,907157.5710,614681.5140,1097.3350,TOP
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10243,907267.9720,614816.7190,1086.6560,BTM
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10245,907323.2810,614884.2310,1097.2140,TOP
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10247,907334.2730,614900.5070,1098.1010,GAT
10248,907336.4060,614898.9750,1098.1210,GAT
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10256,907164.1720,614606.9030,1098.1380,TOP
10257,907197.5150,614649.9680,1097.3310,BCV05
10258,907197.7930,614650.4820,1097.3120,TOP
10259,907240.7380,614703.8360,1085.3080,TOE
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10262,907307.2790,614786.6130,1086.4450,BTM
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10264,907361.9100,614854.5430,1097.2640,TOP
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10267,907333.5600,614856.4410,1093.9550,CCW02
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10314,907564.7820,614719.9400,1097.5390,TOP
10315,907570.3200,614737.5490,1097.6830,LP
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10317,907516.3110,614677.4070,1088.1090,TOE
10318,907564.2560,614680.5560,1090.8760,TOE
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10329,907751.8470,614683.1360,1100.1560,TOP
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10419,907526.4340,614353.2130,1098.0730,CLD02
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```

07-1033

BETHANY OUTFALL

SEWER/STORM ASBUILTS

7-11-2007

SUNNY & HOT 100°

S. OLSON

T. SHAFFER

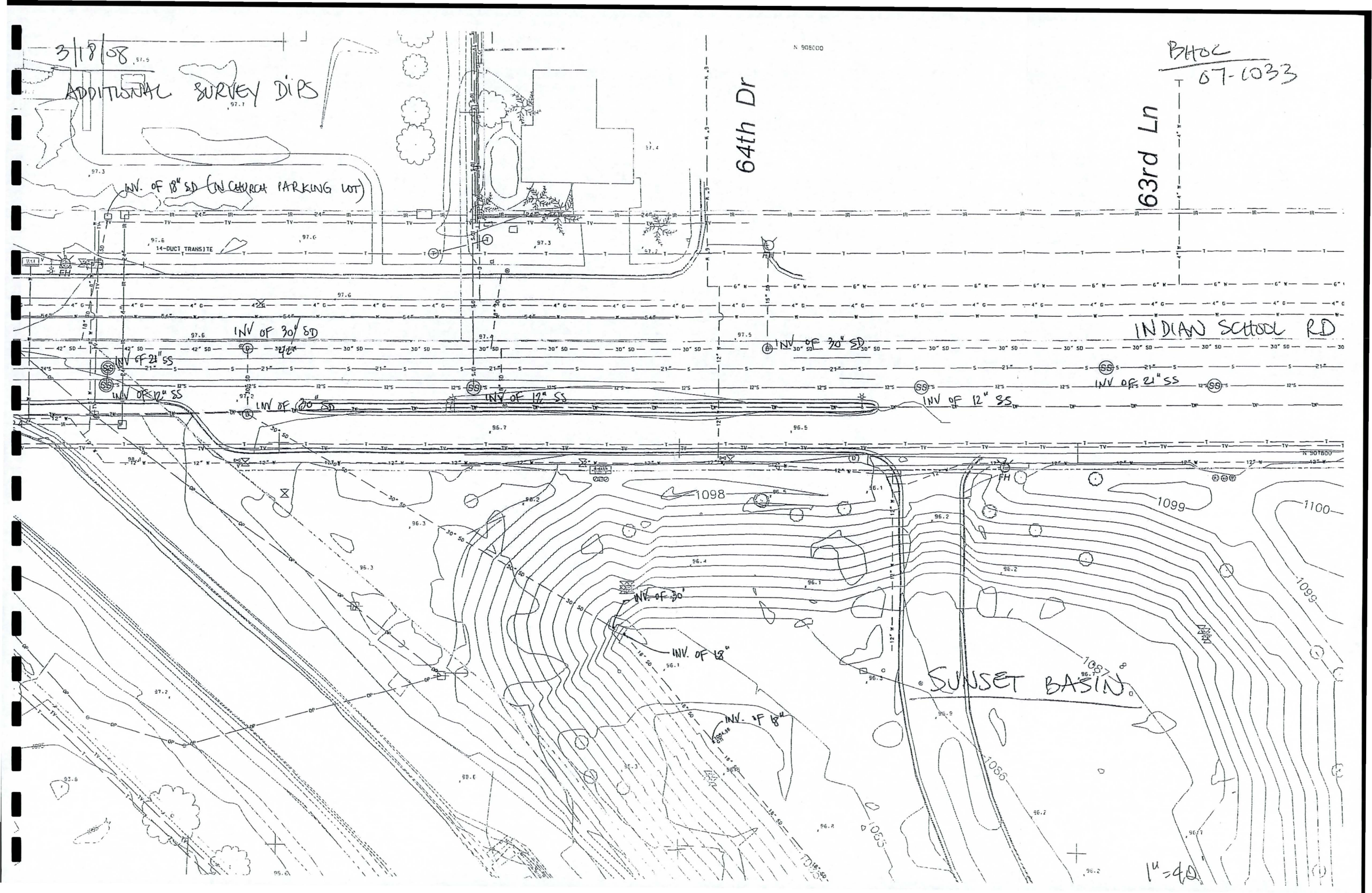
MEADOWRE DOWNS

Sta.	N	S	E	W	(NAVD 88) Rim
10493	—	—	—	—	1099.01
#5 11297	18.43	17.95 SW	17.17 SE		1099.34
#6 11299		18.99	18.95	19.62	1099.93
11319	14.77	14.83			1097.96
10072	5.01		5.76		1099.68
10333	7.07		6.99		1099.69
10357		13.52	13.89	13.84	1100.20
#10 10669	9.26	9.28 SE			1098.91
#11 10799	6.02	5.98			1098.31
#12 10800	7.97	7.97			1098.73
10923	14.05	14.16			1099.61
#8 11300	4.85 26" SD	15.98	16.61 LOW 13.18 HIGH	16.79	1100.23
#7 11301	15.81	16.02 SE			1100.20
11302	16.94	16.96 SE			1100.43
11323	16.77	16.13	16.78		1099.93
11324			13.13	13.32	1096.29
11325			17.81	17.81	1096.72
#9 11326	6.54	6.54			1098.34

= (NGVD 29) + 1.68'

	Rim	N	Desc. S.	E.	W.
CBMH	97.33				
SDMH (30")	97.66	79.23	79.71 (SW)	80.49 (SE)	
SDMH (35/41")	98.25		79.26	79.30	78.63
SDMH	96.28	81.49	81.45		
SSMH	98.00	90.93		92.24	
SSMH	98.01	90.94		91.02	
SSMH	98.52		85.00	84.63	84.68
SSMH	97.23	87.97	87.95 (SE)		
SSMH	96.63	90.61	90.65		
SSMH	97.05	89.08	89.08		
SDMH	97.93	83.88	83.77		
SSMH (21")	98.55	90.70	82.57	81.94 85.37	81.76
SSMH (12")	98.52	82.71	82.50 (SE)		
SSMH	98.75	81.81	81.79		
SSMH	98.25	81.48	82.12		81.47
SSMH	94.61			81.48	81.29
SDMH	95.04			77.23	77.23
SSMH	96.66	90.12	90.12		

Sta.	N	S	E	W	Rim	Desc.
		MEASURE DOWNS				
10493	—	—	—	—	1099.01	CBMH
11297	18.43	17.95 SW	17.17 SE		1099.34	SDMH
11299		18.99	18.95	19.62	1099.93	SDMH
11319	14.79	14.83			1097.96	SDMH
10072	5.01		5.76		1099.68	SSMH
10333	7.07		6.99		1099.69	SSMH
10357		13.52	13.89	13.84	1100.20	SSMH
10668	9.26	9.28 SE			1098.91	SSMH
10799	6.02	5.98			1098.31	SSMH
10800	7.97	7.97			1098.73	SSMH
10923	14.05	14.16			1099.61	SDMH
11300	7.85	15.98	16.61 LOW 13.18 HIGH	16.79	1100.23	SSMH
11301	15.81	16.02 SE			1100.20	SSMH
11302	16.94	16.96 SE			1100.43	SSMH
11323	16.77	16.13	16.78		1099.93	SSMH
11324			13.13	13.32	1096.29	SSMH
11325			17.81	17.81	1096.72	SDMH
11326	6.54	6.54			1098.34	SSMH
—	—	—	—	—	—	
11327	13.37		14.53	14.52	1099.30	SSMH
11328			14.02	14.00	1099.57	SSMH
11329			11.52	11.46	1099.97	SSMH
11330	SEE PT # 11300		ABOVE	FOR MEASURE DOWNS		SSMH


3/18/08
ADDITIONAL SURVEY DIPS
BHOC
07-1033
64th Dr
63rd Ln
INDIAN SCHOOL RD
INV. OF 18" SD (IN CHURCH PARKING LOT)
14-DUCT TRANSITE
INV OF 30" SD
INV OF 21" SS
INV OF 12" SS
INV OF 30" SD
INV OF 12" SS
INV OF 30" SD
INV OF 21" SS
INV OF 12" SS
INV. OF 30"
INV. OF 18"
INV. OF 18"
SUNSET BASIN
1" = 40'

07-1033

— B.H. O.C. —

vicinity of 64th Dr/Indian School

Phoenix, Maricopa Co, Arizona

Utility

DIPS

3/21/08 - Scott Clouds

PBrodsic

MSteele

JHachel

STA/PT	DESC	
18" S.D. INV (in church parking)	from	S. edge grate = -4.80
21" S.S. INV (W side)	from	MH Rim = -16.65
12" SS INV (W. side)	from	MH Rim = -15.93
30" S.D. INV (S of church)	from	MH Rim = -18.90 E INV -19.01 S INV
30" S.D. INV (S of above)	from	MH Rim -18.48 N INV -17.19 SE INV
12" S.S. INV (mid-pt)	from	MH Rim -14.59 E INV -14.64 W INV -13.44 N. INV

→ INV S = -16.01

→ INV N = -15.80

72/pt Date

30" S.D. INV (S. of UH to UR) from MH Rim
- 16.32 e. INV
- 16.29 w. INV
- 14.99 N. INV

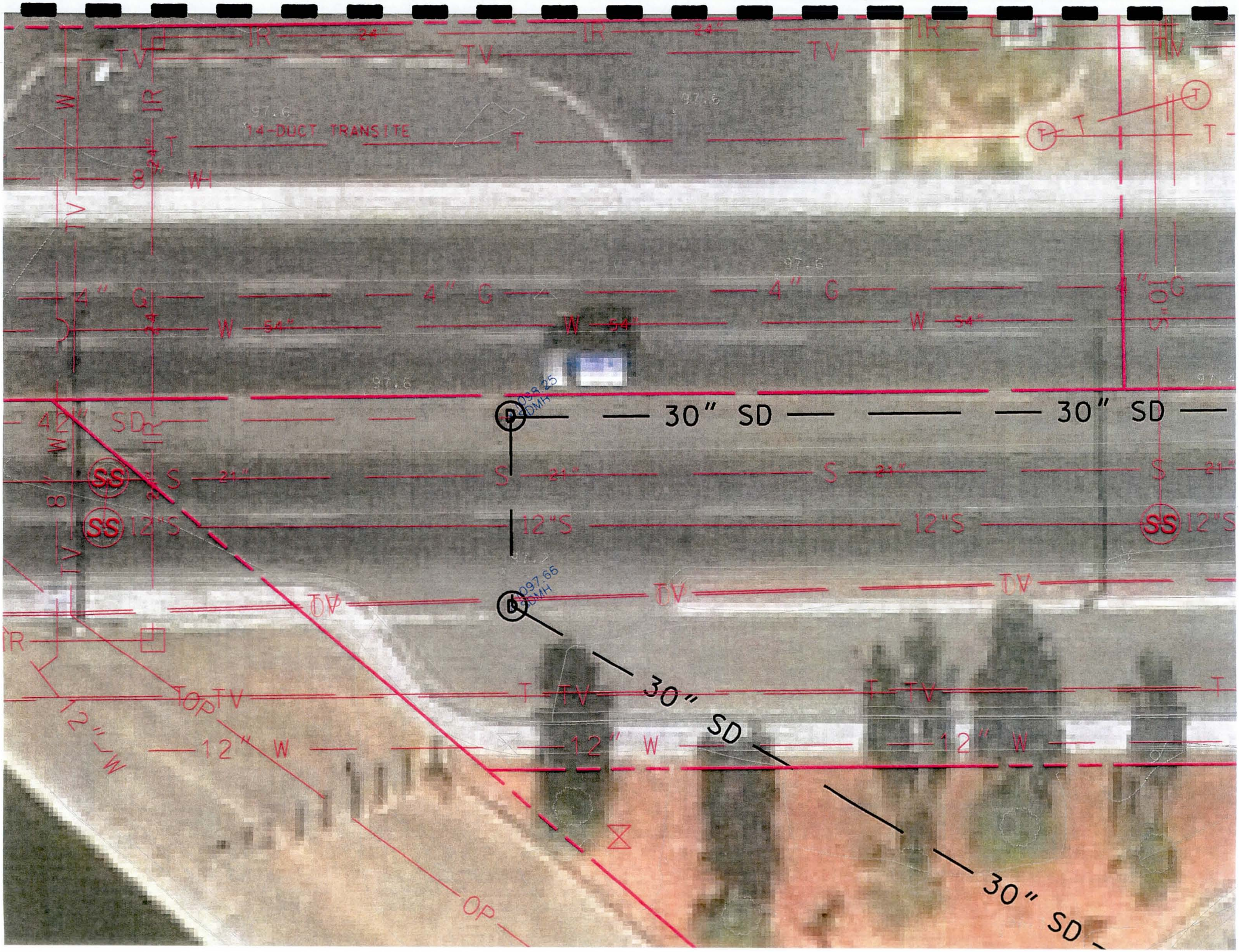
12" S.S. INV (e. end) from MH Rim =
- 14.05 e. INV
- 14.06 w. INV

21" SS. INV (e. end) from MH Rim =
- 11.51 e. INV
- 11.61 w. INV

30" S.D. INV (in basin) from Top HDWL
= - 6.50

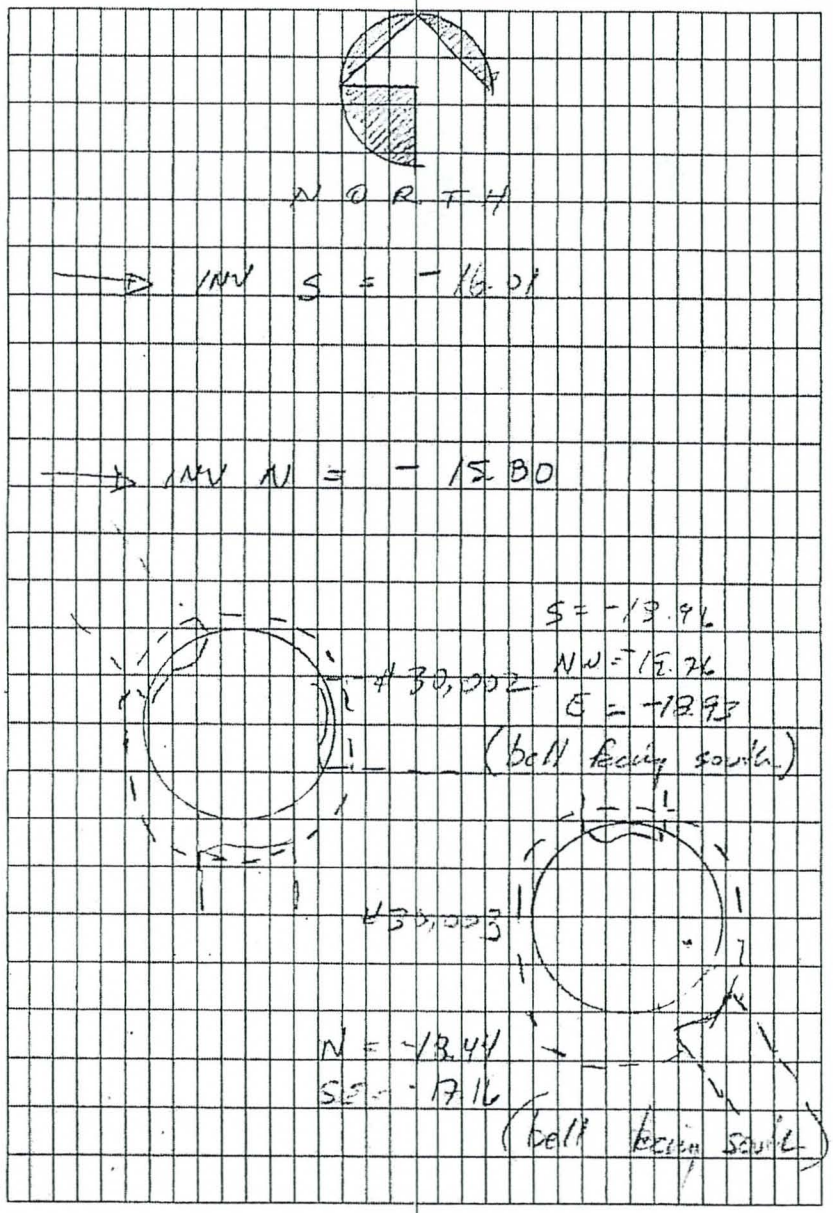
18" S.D. INV (NW end in basin) from Top HDWL since
= - 3.42

18" S.D. INV (SE end in basin) from Top Grate
= - 2.74

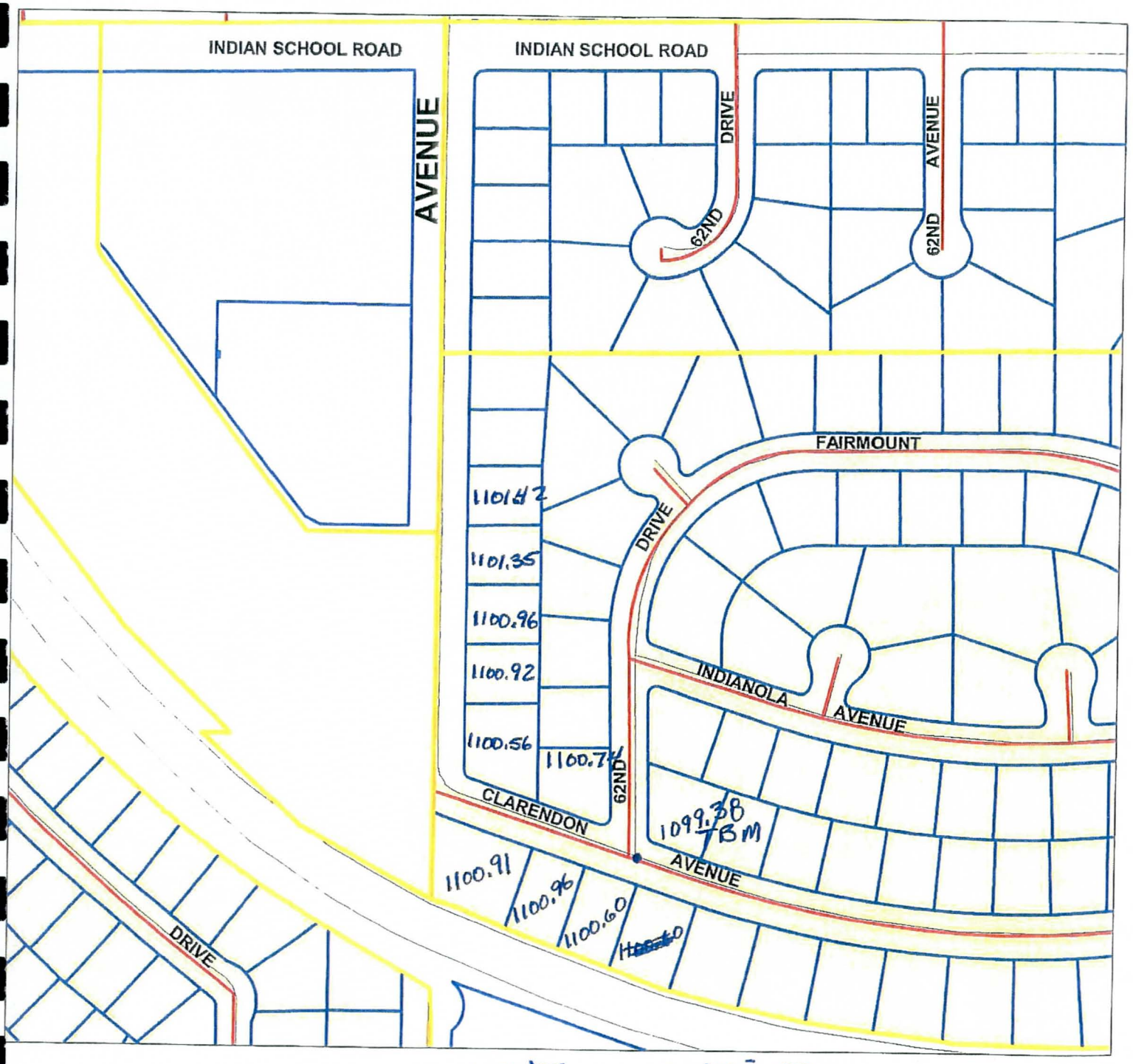


14-DUCT TRANSITE
IR
24"
TV
T
W
WH
4" G
W 54"
30" SD
30" SD
42" SD
S 21"
12"S
SS
DMH
TV
TOP
12" W
12" W
OP
30" SD
30" SD

STA/PT	DESC	
18" S.D. INV (in church parking)	from	S. edge grate = − 4.80
21" S.S. INV (W side)	from	MH Rim = − 16.65
12" SS INV (W. side)	from	MH Rim = − 15.93
30" S.D. INV (S of church) #30,002	from	MH Rim = − 18.90 E INV
	18.96	− 19.01 S INV
30" S.D. INV (S of church) #30,003	from	MH Rim − 18.48 N INV
		− 17.19 SE INV
12" S.S. INV (mid pt)	from	MH Rim − 14.59 E INV
		− 14.64 W INV
		− 13.44 N. INV



County Parcels

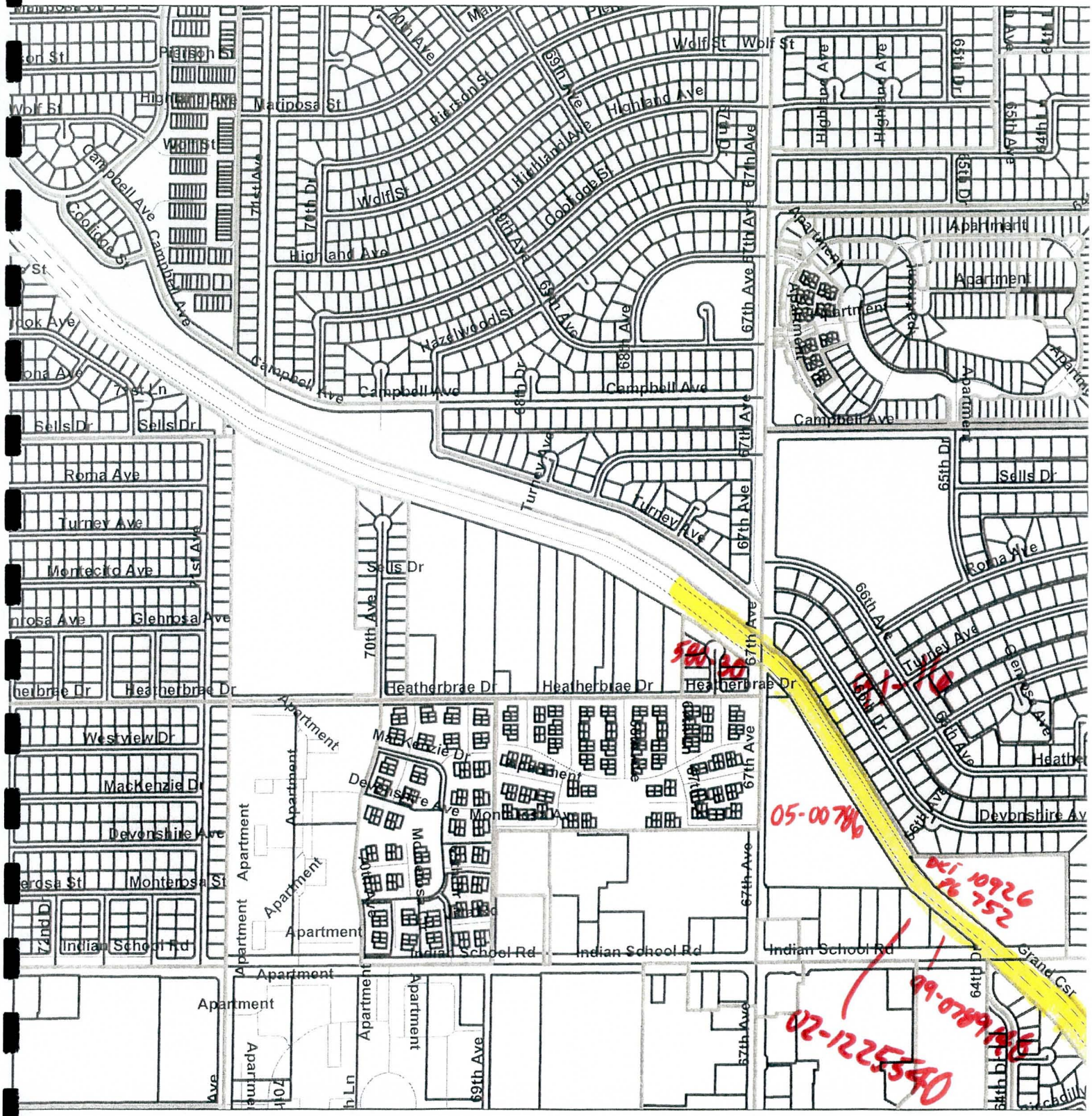


FF ELEVATIONS

Appendix E

Right-of-Way Data

County Parcels

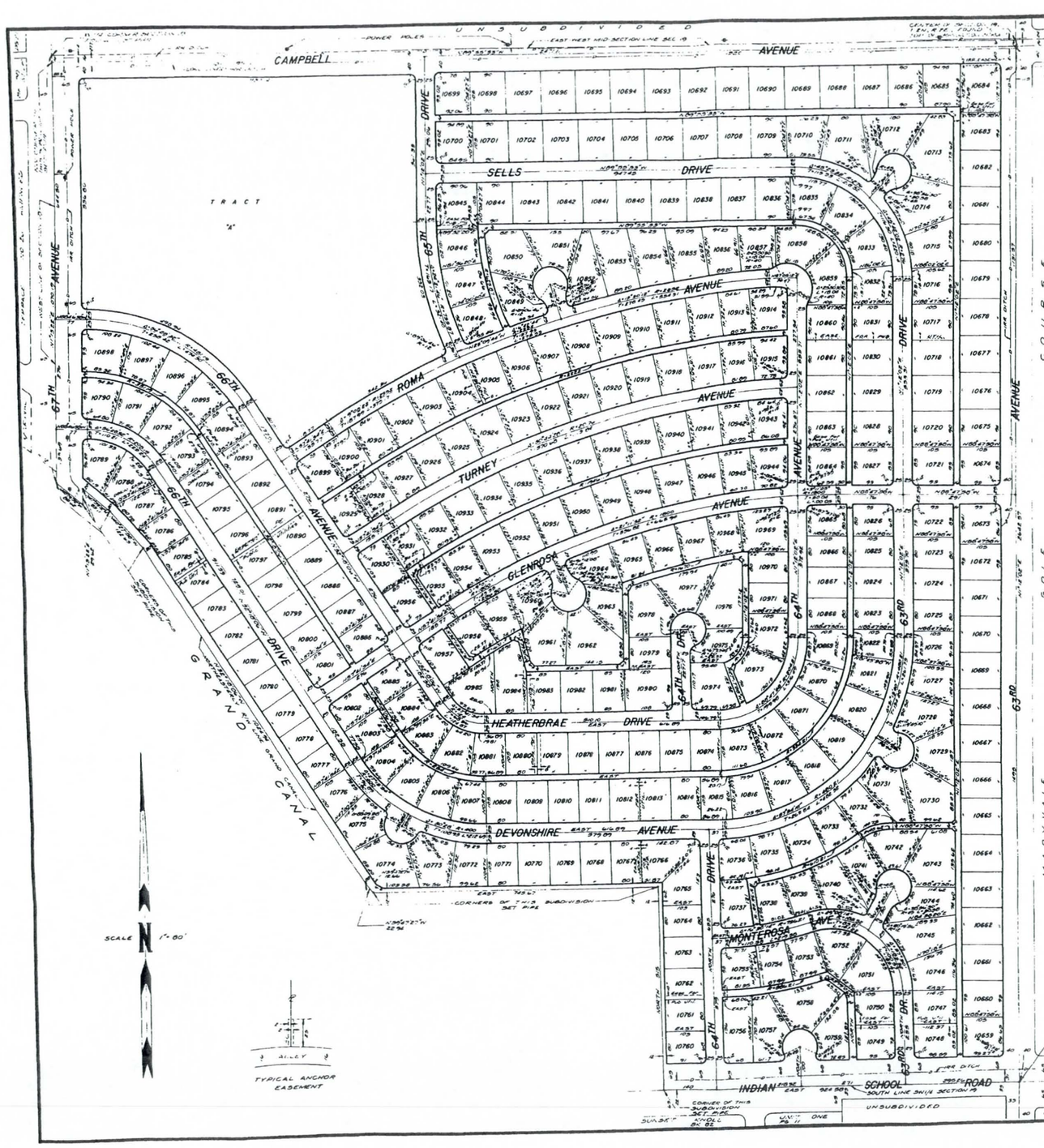


UNOFFICIAL DOCUMENT

91-16

MARYVALE TERRACE NO. 27

A SUBDIVISION OF A PORTION OF THE SW1/4, SECTION 19, T.2N., R.2E., G.&S.R.B.&M., MARICOPA COUNTY, ARIZONA



Maddock & Associates
ENGINEERS SURVEYORS
JOB NO 1-591027

DEDICATION

KNOW ALL MEN BY THESE PRESENTS: That the Phoenix Title and Trust Company, an Arizona Corporation, as Trustee, has subdivided under the name of MARYVALE TERRACE NO 27, a portion of the SW1/4, Section 19, T2N, R2E, G&S.R.B&M, Maricopa County, Arizona, as shown platted hereon, and hereby publishes this plat as and for the plat of said MARYVALE TERRACE NO 27, and hereby declares that said plat sets forth the locations and gives the dimensions of the lots, tract, streets, and alleys constituting same, and that each lot, tract and street shall be known by the number, letter or name given each, respectively, on said plat, and hereby dedicates to the public, for use as such, the streets and alleys shown on said plat and included in the above described premises. Easements are dedicated for the purposes shown.

IN WITNESS WHEREOF: The Phoenix Title and Trust Company, as Trustee, has hereunto caused its corporate name to be signed and its corporate seal to be affixed and the same to be attested by the signatures of J. S. Hull, its Vice President and Jack V. Bishop, its Assistant Secretary, thereunto duly authorized.

PHOENIX TITLE AND TRUST COMPANY TRUSTEE

BY J. S. Hull VICE PRESIDENT ATTEST Jack V. Bishop ASSISTANT SECRETARY

ACKNOWLEDGEMENT

STATE OF ARIZONA
COUNTY OF MARICOPA ss

On this, the 10th day of August, 1960, before me, the undersigned officer, personally appeared J. S. Hull and Jack V. Bishop, who acknowledged themselves to be Vice President and Assistant Secretary, respectively, of the Phoenix Title and Trust Company, a corporation, and acknowledged that they, as such officers, respectively, being authorized so to do, executed the foregoing instrument for the purpose therein contained by signing the name of the corporation, as Trustee, by themselves, as such officers, respectively.

IN WITNESS WHEREOF: I hereunto set my hand and official seal. My commission expires 1-5-61

NOTARY PUBLIC

APPROVAL

Approved by the Council of the City of Phoenix, Arizona this 11th day of August 1960.

BY Harold M. Snow MAYOR ATTEST John T. Bruner CITY CLERK

CERTIFICATE

This is to certify that the survey and subdivision of the premises described and platted hereon were made under my direction during the month of July, 1960.

REGISTERED CIVIL ENGINEER

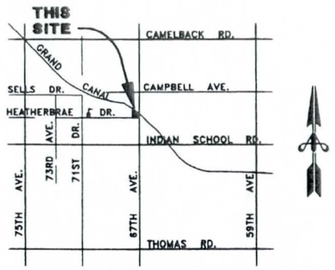
142160

S.NO. 6052
1-17-13

UNOFFICIAL DOCUMENT

FINAL PLAT
OF
"HEATHERBRAE ESTATES"
AN 8 LOT R1-6 CONVENTIONAL SUBDIVISION
SUBJECT TO SINGLE FAMILY DESIGN REVIEW
67TH AVENUE & HEATHERBRAE DRIVE
PHOENIX, ARIZONA

A SUBDIVISION OF A PORTION OF THE NORTHEAST QUARTER AND THE SOUTHEAST QUARTER OF SECTION 24, TOWNSHIP 2 NORTH, RANGE 1 EAST OF THE GILA & SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA.



VICINITY MAP
N.T.S.

AREAS:

GROSS AREA:
104,293.5329 S.F. = 2.3943 AC.

NET AREA:
69,919.7048 S.F. = 1.6051 AC.

LEGEND:

AC.	–	ACRE
N.V.A.E.	–	NON VEHICULAR ACCESS EASEMENT
R/W	–	RIGHT-OF-WAY
T.4N.	–	TOWNSHIP 4 NORTH
R.3E.	–	RANGE 3 EAST
FND.	–	FOUND
P.U.E.	–	PUBLIC UTILITY EASEMENT
M.C.R.	–	MARICOPA COUNTY RECORDS
SEC	–	SECTION
COR	–	CORNER
(TYP)	–	TYPICAL
⊗	–	FOUND BRASS CAP
○	–	FOUND 1/2" REBAR
	–	MONUMENT LINE, EXISTING
	–	RIGHT-OF-WAY, EXISTING
	–	EASEMENT LINE
B.C. IN H.H.	–	BRASS CAP IN HAND HOLE
	–	SUBDIVISION BOUNDARY
	–	RIGHT-OF-WAY/PROPERTY LINE, PROPOSED
⊗	–	BRASS CAP TO BE SET PER MAG 120-1, TYPE "B" OR AS NOTED
•	–	SET 1/2" REBAR W/CAP RLS. No. 16490
(00)	–	LOT NUMBER

BENCHMARK:

FOUND CITY OF PHOENIX BRASS CAP IN HAND HOLE AT THE INTERSECTION OF 67TH AVENUE AND INDIAN SCHOOL ROAD.

ELEVATION = 1090.91 – CITY OF PHOENIX DATUM

BASIS OF BEARING:

THE BASIS OF BEARING FOR THIS PLAT IS THE MONUMENT LINE OF 67TH AVENUE, N 01°13'22" E PER THE PLAT OF MARYVALE TERRACE NO. 27 AS RECORDED IN BOOK 91, PAGE 16, RECORDS OF MARICOPA COUNTY.

OWNER\DEVELOPER:

NWB, INC.
17235 NORTH 75TH AVENUE
SUITE F 100 G
GLENDALE, ARIZONA 85308
TEL NO. (623) 878-8500
FAX NO. (623) 878-0255
CONTACT PERSON: NICHOLAS W. BONANNO, JR.

GENERAL NOTES:

1. DEVELOPMENT AND USE OF THIS SITE WILL CONFORM WITH ALL APPLICABLE CODES AND ORDINANCES.
2. THIS PROJECT IS LOCATED IN THE CITY OF PHOENIX WATER SERVICES AREA AND HAS BEEN DESIGNATED AS HAVING AN ASSURED WATER SUPPLY.
3. ALL NEW OR RELOCATED UTILITIES WILL BE PLACED UNDERGROUND.
4. STRUCTURES AND LANDSCAPING WITHIN A TRIANGLE MEASURING 33' X 33' ALONG THE PROPERTY LINES WILL BE MAINTAINED AT A MAXIMUM HEIGHT OF 3'.
5. A MINIMUM 20' SETBACK (18' IF VERTICALLY OPENING GARAGE DOORS ARE PROVIDED) WILL BE PROVIDED FROM BACK OF SIDEWALK TO FACE OF GARAGE DOOR.
6. EACH LOT CONSTITUTES A BUILDING ENVELOPE AN ACCESSORY USES AND STRUCTURES SUCH AS POOLS AND PRIVACY WALLS ARE PERMITTED EXCEPT AS OTHERWISE REGULATED BY OTHER CITY CODES AND ORDINANCES.
7. ON-LOT RETENTION FOR THE LOTS IN THIS SUBDIVISION MUST REMAIN IN PERPERUITY. ALTERNATIONS TO LOTS, INCLUDING, BUT NOT LIMITED TO HOUSE ADDITIONS, SWIMMING POOLS, OR ACCESSORY STRUCTURES SHALL NOT REDUCE ON-LOT RETENTION PROVIDED ON EACH LOT. THIS MAY INCLUDE REMOVAL OF SPOILS RELATED TO CONSTRUCTION OF ANY TYPE ON EACH LOT.
8. ADDITIONAL INDIVIDUAL LOT REQUIREMENTS (I.E. SETBACKS, WALL ELEVATIONS) ARE LOCATED ON THE APPROVED SUBDIVISION SETBACK EXHIBIT.
9. NO STRUCTURE OF ANY KIND SHALL BE CONSTRUCTED ON, OVER, OR PLACED WITHIN THE PUBLIC UTILITIES EASEMENTS EXCEPT PAVING NOR ANY PLANTING EXCEPT GRASS. IT SHALL BE FURTHER UNDERSTOOD THAT THE CITY OF PHOENIX SHALL NOT BE REQUIRED TO REPLACE ANY OBSTRUCTION OR PLANTING THAT MUST BE REMOVED DURING THE COURSE OF MAINTENANCE, CONSTRUCTION, OR RECONSTRUCTION OF CITY UTILITIES.
10. THIS PROJECT HAS ADDITIONAL CONDITIONS OF APPROVAL (DESCRIBED IN A AGREEMENT AND/OR DESIGN REVIEW DIVERSITY EXHIBIT ON FILE WITH THE CITY OF PHOENIX DEVELOPMENT SERVICES DEPARTMENT) WHICH MUST BE SATISFIED PRIOR TO INDIVIDUAL BUILDING PERMIT RELEASE.

ACKNOWLEDGEMENT:

STATE OF ARIZONA |
|S.S.
COUNTY OF MARICOPA |

BEFORE ME THIS 30th DAY OF November, 2001, THE FOLLOWING PERSON APPEARED BEFORE ME, THE UNDERSIGNED NOTARY PUBLIC:

NICHOLAS W. BONANNO, JR., WHO ACKNOWLEDGED HIMSELF TO BE TO PRESIDENT OF N.W.B., INC., AN ARIZONA CORPORATION, AND ACKNOWLEDGED THAT HE, BEING AUTHORIZED SO TO DO, EXECUTED THIS INSTRUMENT FOR THE PURPOSES HEREIN CONTAINED.

IN WITNESS WHEREOF, I HEREUNTO SET MY HAND AND OFFICIAL SEAL.

MY COMMISSION EXPIRES: 8-26-02

Gail E Wafer
NOTARY PUBLIC

OFFICIAL SEAL
GAIL E. WAFER
NOTARY PUBLIC-ARIZONA
MARICOPA COUNTY
My Comm. Expires Aug. 26, 2002

CERTIFICATION:

THIS IS TO CERTIFY THAT THE SURVEY AND SUBDIVISION OF THE PREMISES DESCRIBED AND PLATTED HEREON WERE MADE UNDER MY DIRECTION DURING THE MONTH OF AUGUST, 2001; THAT THE SURVEY IS TRUE AND COMPLETE AS SHOWN; THAT ALL MONUMENTS SHOWN ACTUALLY EXIST OR WILL BE SET AS SHOWN; THAT THEIR POSITIONS ARE CORRECTLY SHOWN; AND THAT SAID MONUMENTS ARE SUFFICIENT TO ENABLE THE SURVEY TO BE REFERENCED.

BY: Robert B. Atherton 11/29/01
ROBERT B. ATHERTON, R.L.S NO. 16490 DATE

BOOK 580 PAGE 30
OFFICIAL RECORDS OF
MARICOPA COUNTY RECORDER
HELEN PURCELL
2001-1202172
12/20/2001 03:36 PM

DEDICATION:

STATE OF ARIZONA |
|S.S.
COUNTY OF MARICOPA |

KNOW ALL MEN BY THESE PRESENTS:

THAT N.W.B., INC., AN ARIZONA CORPORATION, AS LEGAL OWNER OF SAID REAL PROPERTY HAS SUBDIVIDED UNDER THE NAME OF "HEATHERBRAE ESTATES", A PLAT OF A PORTION OF THE NORTHEAST QUARTER AND SOUTHEAST QUARTER OF SECTION 24, TOWNSHIP 2 NORTH, RANGE 1 EAST OF THE GILA AND SALT RIVER BASE AND MERIDIAN, MARICOPA COUNTY, ARIZONA, AS SHOWN AND PLATTED HEREON AND HEREBY PUBLISHES THIS PLAT AS AND FOR THE PLAT OF "HEATERBRAE ESTATES", A SUBDIVISION, AND HEREBY DECLARES THAT SAID PLAT SETS FORTH THE LOCATION AND GIVES THE DIMENSIONS OF THE LOTS, STREETS AND EASEMENTS CONSTITUTING SAME AND THAT THE LOTS AND STREETS SHALL BE KNOWN BY THE NUMBER OR NAME GIVEN TO EACH RESPECTIVELY ON THIS PLAT AND THAT N.W.B. INC., AN ARIZONA CORPORATION, AS OWNER, HEREBY DEDICATES TO THE PUBLIC FOR USE AS SUCH THE STREETS AND EASEMENTS AS SHOWN ON SAID PLAT AND INCLUDED IN THE ABOVE DESCRIBED PREMISES.

IN WITNESS WHEREOF:

NICHOLAS W. BONANNO, JR., PRESIDENT OF N.W.B., INC., AN ARIZONA CORPORATION, AS OWNER, HAS HEREUNTO AFFIXED HIS SIGNATURE THIS [redacted] DAY OF [redacted], 2001.

BY: Nicholas W. Bonanno Jr.
NICHOLAS W. BONANNO, JR.
PRESIDENT
N.W.B., INC.

APPROVALS:

BY: FOR DEVELOPMENT SERVICES DEPARTMENT 11/30/01 DATE

APPROVED BY THE CITY COUNCIL OF THE CITY OF PHOENIX, ARIZONA. ON THE 19th DAY OF December, 2001.

ATTEST:

BY: Vicky Miel
CITY CLERK

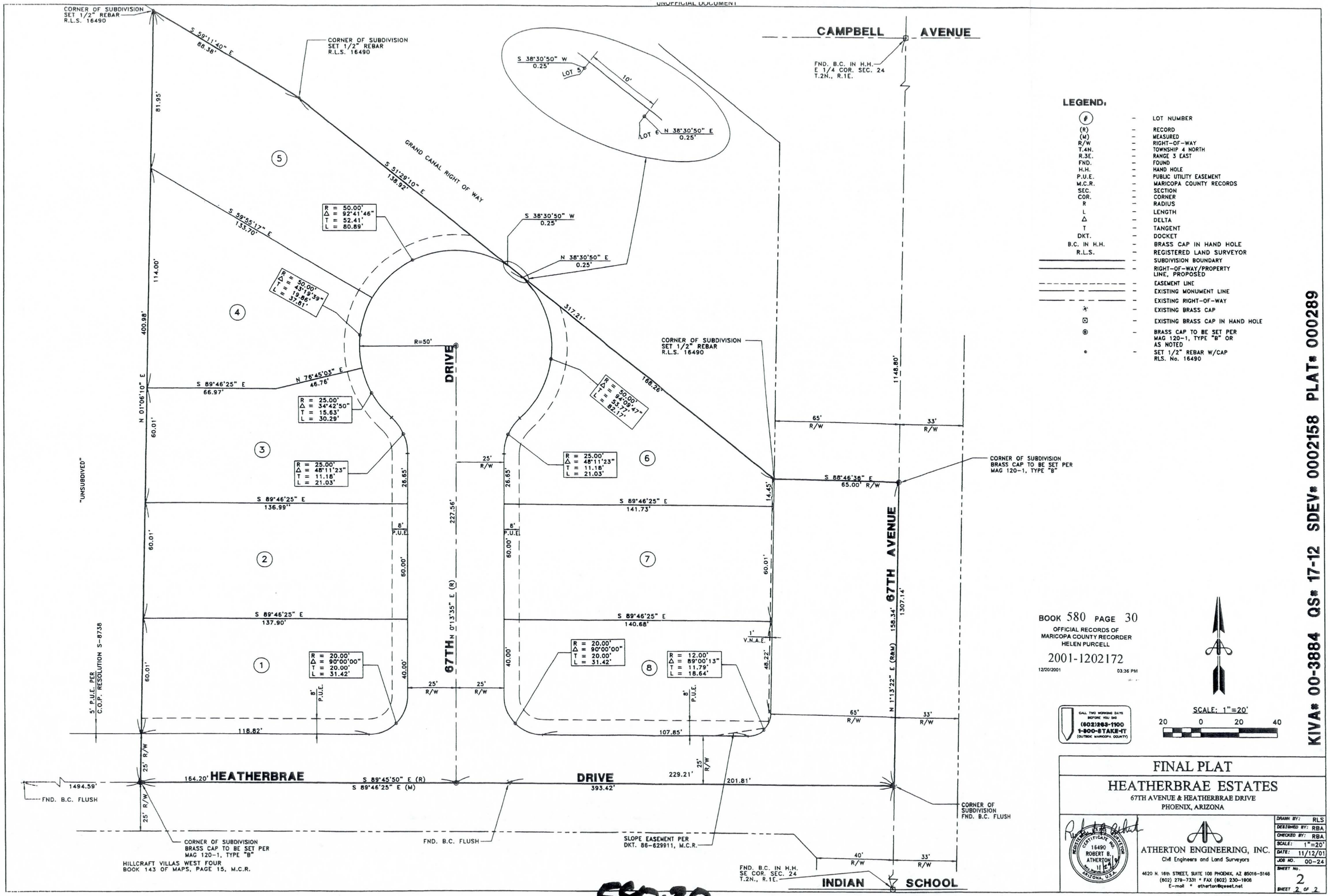
KIVA# 00-3884 QS# 17-12 SDEV# 0002158 PLAT# 000289

HEATHERBRAE ESTATES

COVER SHEET - FINAL PLAT	
HEATHERBRAE ESTATES 67TH AVENUE & HEATHERBRAE DRIVE PHOENIX, ARIZONA	
REGISTERED LAND SURVEYOR CERTIFICATE NO. 16490 ROBERT B. ATHERTON 11/29/01 ARIZONA, U.S.A.	DRAWN BY: RLS DESIGNED BY: RBA CHECKED BY: RBA SCALE: N/A DATE: 11/12/01 JOB NO. 00-24 SHEET No. 1 SHEET 1 OF 2
ATHERTON ENGINEERING, INC. Civil Engineers and Land Surveyors 4630 N. 16th STREET, SUITE 108 PHOENIX, AZ 85016-5148 (602) 279-7331 • FAX (602) 230-1948 E-mail • atherton@qwest.net	

580-30

UNOFFICIAL DOCUMENT



LEGEND:

(#)	–	LOT NUMBER
(R)	–	RECORD
(M)	–	MEASURED
R/W	–	RIGHT-OF-WAY
T.4N.	–	TOWNSHIP 4 NORTH
R.3E.	–	RANGE 3 EAST
FND.	–	FOUND
H.H.	–	HAND HOLE
P.U.E.	–	PUBLIC UTILITY EASEMENT
M.C.R.	–	MARICOPA COUNTY RECORDS
SEC.	–	SECTION
COR.	–	CORNER
R	–	RADIUS
L	–	LENGTH
Δ	–	DELTA
T	–	TANGENT
DKT.	–	DOCKET
B.C. IN H.H.	–	BRASS CAP IN HAND HOLE
R.L.S.	–	REGISTERED LAND SURVEYOR
———	–	SUBDIVISION BOUNDARY
———	–	RIGHT-OF-WAY/PROPERTY LINE, PROPOSED
- - - - -	–	EASEMENT LINE
———	–	EXISTING MONUMENT LINE
———	–	EXISTING RIGHT-OF-WAY
⊛	–	EXISTING BRASS CAP
⊡	–	EXISTING BRASS CAP IN HAND HOLE
⊛	–	BRASS CAP TO BE SET PER MAG 120-1, TYPE "B" OR AS NOTED
•	–	SET 1/2" REBAR W/CAP RLS. No. 16490

KIVA# 00-3884 QS# 17-12 SDEV# 0002158 PLAT# 000289

BOOK 580 PAGE 30
OFFICIAL RECORDS OF MARICOPA COUNTY RECORDER HELEN PURCELL
2001-1202172
12/20/2001 03:36 PM

CALL TWO WORKING DAYS BEFORE YOU DIG (602)263-1100 1-800-STAKE-IT (OUTSIDE MARICOPA COUNTY)

SCALE: 1"=20'
20 0 20 40

FINAL PLAT

HEATHERBRAE ESTATES

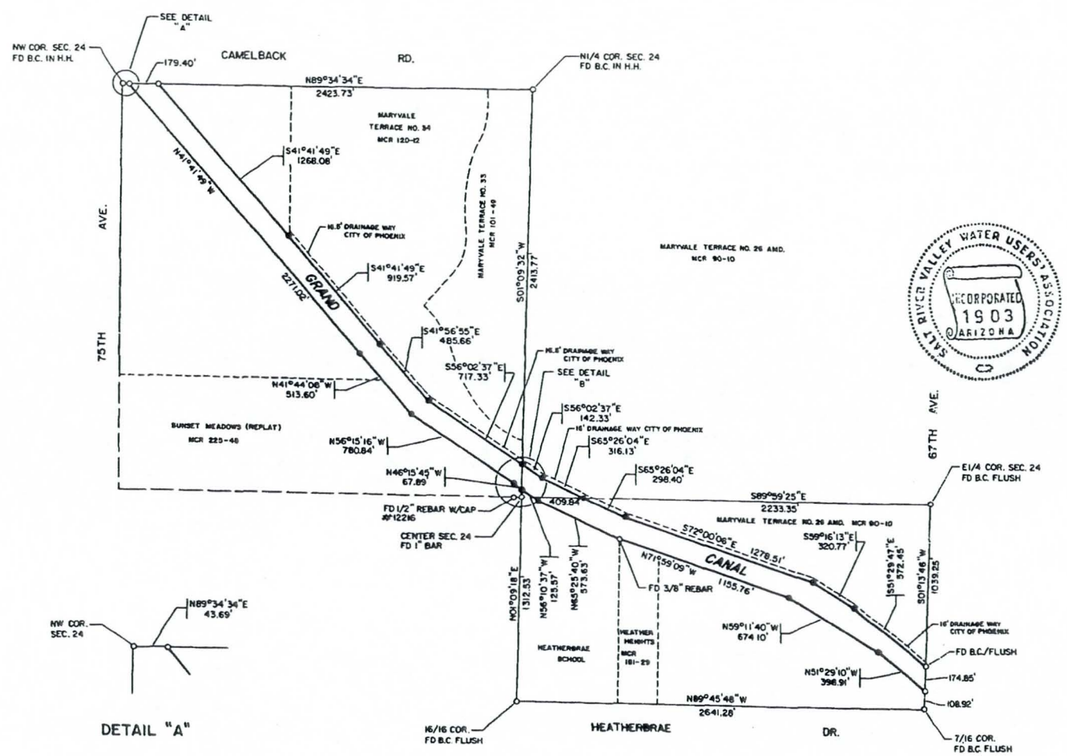
67TH AVENUE & HEATHERBRAE DRIVE
PHOENIX, ARIZONA

REGISTERED LAND SURVEYOR CERTIFICATE NO. 16490 ROBERT B. ATHERTON ARIZONA, U.S.A.

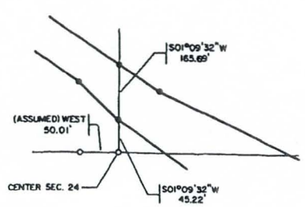
ATHERTON ENGINEERING, INC.
Civil Engineers and Land Surveyors
4620 N. 16th STREET, SUITE 108 PHOENIX, AZ 85016-5146
(602) 279-7331 * FAX (602) 230-1906
E-mail * atherton@qwest.net

DRAWN BY:	RLS
DESIGNED BY:	RBA
CHECKED BY:	RBA
SCALE:	1"=20'
DATE:	11/12/01
JOB NO.	00-24
SHEET No.	2
SHEET 2 OF 2	

580-30



DETAIL "A"



DETAIL "B"

LEGEND:

- ● INDICATES 1/2" REBAR & S.R.P. CAP
- ⊕ INDICATES POINT NOT SET
- ○ INDICATES COTTON PICKER SPINDLE (C.P.S.) UNLESS NOTED

N

STATE OF ARIZONA
COUNTY OF MARICOPA } S. S.

KNOW ALL MEN BY THESE PRESENTS:

That the Salt River Valley Water Users' Association, an Arizona Corporation, hereby publishes this plat showing the right of way necessary for the operation and maintenance of the present

GRAND CANAL
IN SEC. 24 T2N R1E
G.&S.R. B.&M.

Said plat does not show and it is not the intention to show or refer to all rights of way and rights possessed by the United States of America and neither the execution or recordation of said plat shall result in or constitute any diminution or other disposal in whole or in part, of any rights of way or rights which the United States of America is entitled to utilize or enforce.

IN WITNESS WHEREOF: The Salt River Valley Water Users' Association has hereunto caused its corporate name to be signed and its corporate seal to be affixed by the undersigned officers thereunto duly authorized this 31st day of January, 1989

SALT RIVER VALLEY WATER USERS' ASSOCIATION

Attest [signature] Secretary

By [signature] President

STATE OF ARIZONA
COUNTY OF MARICOPA } S. S.

On this, the 31st day of January 1989 before me, the undersigned officer, personally appeared John R. Lassen and Paul D. Rice who acknowledged themselves to be President and Secretary, respectively, of the Salt River Valley Water Users' Association and that they, as such officers, respectively, being duly authorized so to do, executed the foregoing instrument for the purposes therein contained by signing the name of the corporation by themselves as such officers respectively.

IN WITNESS WHEREOF: I hereunto set my hand and seal

[signature]
Notary Public

My commission expires _____

Arizona
COUNTY
May 3, 1991

This is to certify that the survey described and plotted hereon was made under my direction during the month of January

[signature]
Registered Land Surveyor

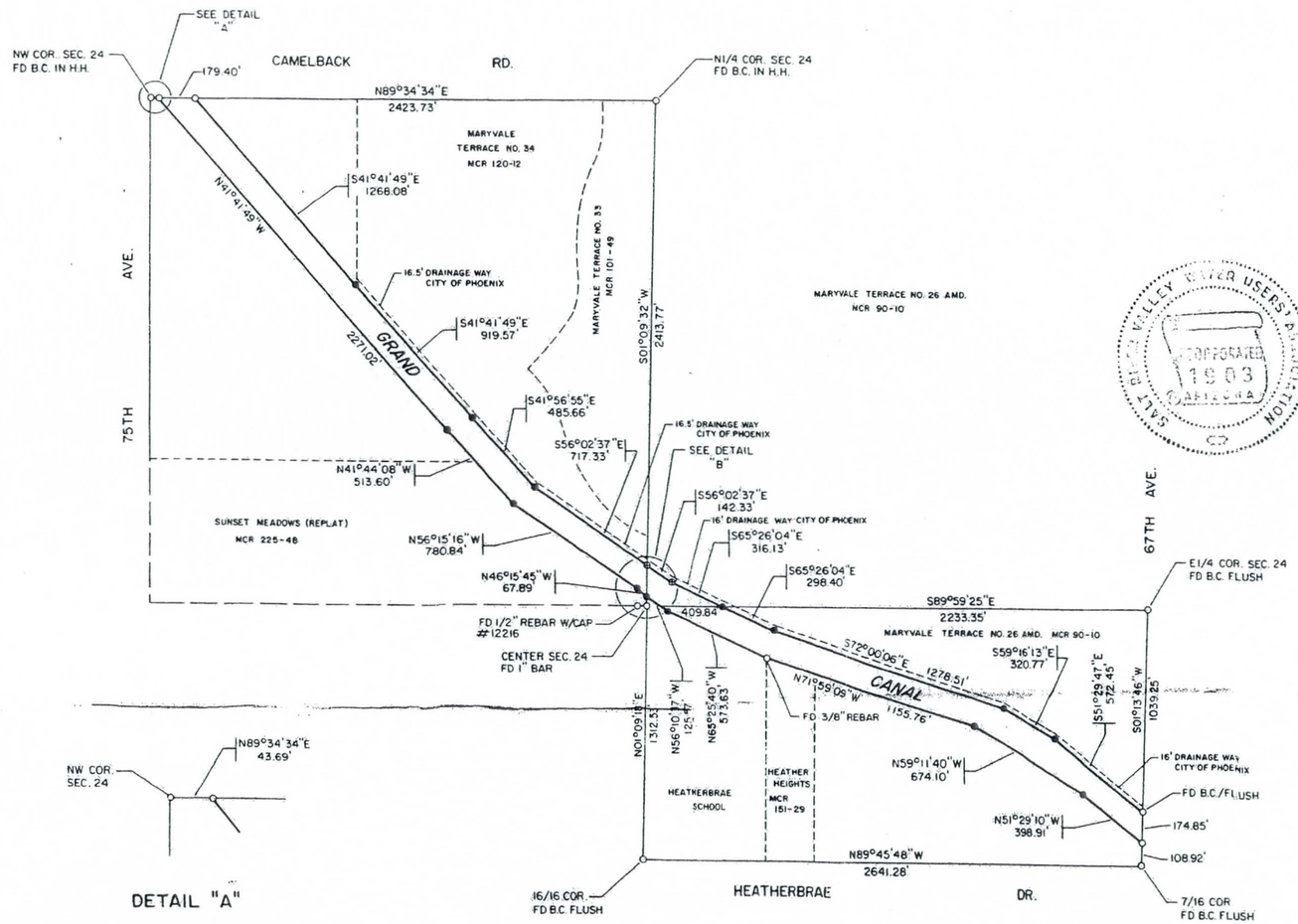
SALT RIVER VALLEY WATER USERS' ASSOCIATION
PHOENIX, ARIZONA

GRAND CANAL RIGHT OF WAY
SEC. 24 T2N R1E

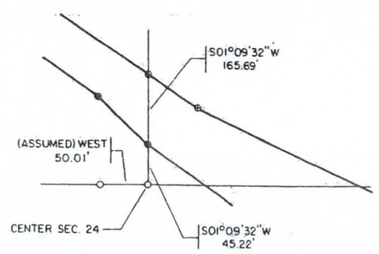
Checked [signature] Scale 1"=800'	Recommended _____ Approved [signature]
Date JANUARY, 1988	Dwg No. 8-2-212

RECORDED IN OFFICIAL RECORDS
OF MARICOPA COUNTY, ARIZONA
FEB 14 '89 -1 00
HELEN PURCELL, County Recorder
FEE 7 — PGS 1 HL

89-0067426



DETAIL "A"



DETAIL "B"

LEGEND:

- ● INDICATES 1/2" REBAR & S.R.P. CAP
- ⊕ INDICATES POINT NOT SET
- O INDICATES COTTON PICKER SPINDLE (C.P.S.) UNLESS NOTED

N

STATE OF ARIZONA
COUNTY OF MARICOPA } S. S.

KNOW ALL MEN BY THESE PRESENTS:

That the Salt River Valley Water Users' Association, an Arizona Corporation, hereby publishes this plat showing the right of way necessary for the operation and maintenance of the present

GRAND CANAL
IN SEC. 24 T2N R1E
G.&S.R.B.&M.

Said plat does not show and it is not the intention to show or refer to all rights of way and rights possessed by the United States of America and neither the execution or recordation of said plat shall result in or constitute any diminution or other disposal in whole or in part, of any rights of way or rights which the United States of America is entitled to utilize or enforce.

IN WITNESS WHEREOF: The Salt River Valley Water Users' Association has hereunto caused its corporate name to be signed and its corporate seal to be affixed by the undersigned officers thereunto duly authorized this 31st day of January, 1989

SALT RIVER VALLEY WATER USERS' ASSOCIATION

Attest: [signature] Secretary

By [signature] President

SALT RIVER VALLEY WATER USERS' ASSOCIATION INCORPORATED 1903 ARIZONA

STATE OF ARIZONA
COUNTY OF MARICOPA } S. S.

On this, the 31st day of January, 1989 before me, the undersigned officer, personally appeared John R. Lassen and Paul D. Rice who acknowledged themselves to be President and Secretary, respectively, of the Salt River Valley Water Users' Association and that they, as such officers, respectively, being duly authorized so to do, executed the foregoing instrument for the purposes therein contained by signing the name of the corporation by themselves as such officers respectively.

IN WITNESS WHEREOF I hereunto set my hand and seal

[signature]
Notary Public

My commission expires _____

This is to certify that the survey described and plotted hereon was made under my direction during the month of January

[signature]
Registered Land Surveyor

SALT RIVER VALLEY WATER USERS' ASSOCIATION
PHOENIX, ARIZONA

GRAND CANAL RIGHT OF WAY
SEC. 24 T2N RIE

Checked [signature]	Recommended _____
Scale 1"=600'	Approved [signature]
Date JANUARY, 1988	Dwg No. B-2-212

Return to: Maricopa County
Board of Supervisors

DKT 2804 PAGE 410 EASEMENT

Z-No. B/P 75204
R/W. DD-No. 1235

Presbytery of Phoenix, an Arizona corporation, Grantors

for and in consideration of the sum of One Dollar and other valuable consideration, receipt of which is hereby acknowledged, do hereby grant to MARICOPA COUNTY, a political subdivision of the State of Arizona, its successors and assigns, a permanent easement and right-of-way, for the following purposes, namely: The right to enter upon the hereinafter described land and grade, level, fill, drain, pave, build, maintain, repair and rebuild a road or highway, together with such bridges, culverts, ramps, and cuts as may be necessary, on, over, under, and across the ground embraced within the right-of-way situated in the County of Maricopa, State of Arizona, and described as follows:

Sixteen(16) feet off the Southwest side, adjacent to the Grand Canal, and the South Sixty-five(65) feet of that part of the Southwest One-quarter (SW¼) of Section Nineteen(19), Township Two(2) North, Range Two(2) East, of the Gila and Salt River Base and Meridian, described as follows: COMMENCING at the Southwest corner of Section 19; thence East 1317.30 feet along the South line of Section 19, to a point which is the intersection of the South line of Section 19 and the North right-of-way line of the Grand Canal and which point is the true point of beginning; thence East 230.32 feet along the South line of Section 19; thence North 515.00 feet; thence West 774.44 feet to the North right-of-way line of the Grand Canal; thence South 39° 47' 27" East, 189.20 feet; thence South 49° 58' 42" East, 350.80 feet; thence South 46° 59' 18" East, 211.14 feet to the true point of beginning.

DKT 2804 PAGE 410

To have and to hold the said easement and right-of-way unto Maricopa County, a political subdivision of the State of Arizona and unto its successors and assigns forever, together with the right of ingress and egress to permit the economical operation and maintenance of said public highway and all incidents thereto.

And the Grantors hereby covenant that they are lawfully seized and possessed on this aforementioned tract or parcel of land; that they have a good and lawful right to sell and convey it; that it is free from all encumbrances; and that they will warrant the title and quiet possession thereto against the lawful claim of all persons.

The said easement to include the right to cut back and trim such portion of the branches and tops of the trees now growing or that may hereafter grow upon the above described premises, as may extend over said right-of-way, so as to prevent the same from interfering with the efficient maintenance and operation of said public highway.

In the event the right, privilege and easement herein granted shall be abandoned and permanently cease to be used for the purpose herein granted all rights herein granted shall cease and revert to the grantors, their heirs or assigns.

Wherever in the foregoing instrument the plural is used it will be read as singular, and when necessary, and wherever words indicating gender are employed, they will apply to either masculine, feminine or neuter as the context requires.

Dated this 26th day of March, 19 59

PRESBYTERY OF PHOENIX

(Seal) William C. Sills, President (Seal)

(Seal) Douglas S. Vance, Secretary (Seal)

(Seal) (Seal)

STATE OF ARIZONA,
County of Maricopa } ss.

Before me, Claude L. Martin, Notary Public in and for said County, State of Arizona, on this day personally appeared William C. Sills and Douglas S. Vance known to me to be the persons whose names are subscribed to the foregoing instrument as President and Secretary of the Corporation described in the foregoing instrument, and as such they acknowledged to me that they executed the same for said Corporation, for the purpose and consideration therein expressed, as its free act and deed and by each of them voluntarily executed.

Given under my hand and seal of office, this 27th day of March A.D., 19 59.

Claude L. Martin
Notary Public

(My Commission Expires March 20 1961)

Unofficial Document

Recording Requested by:
FIRST AMERICAN TITLE

When recorded mail to:

Cholla Academy DBA Westland School
Kathy Couch
4141 N. 67th Ave
Phoenix, AZ 85033

2/3

200.000.1281035

Escrow No. 293-019-149477

WARRANTY DEED

(without liens or encumbrances)

For the consideration of TEN AND NO/100 DOLLARS, and other valuable considerations which is paid to an accommodator pursuant to a 1031 exchange, I or we,

SKIP SPENST, husband of SANDRA L. SPENST, dealing with his sole and separate property;
JOHN L. ZAIGER, husband of VIRGINIA ZAIGER, dealing with his sole and separate property;
BEN LaPARNE, husband of JUDY LaPARNE, dealing with his sole and separate property;
JEROME CHOCEK, an unmarried man

the GRANTOR

do hereby convey to

CHOLLA ACADEMY, an Arizona corporation DBA WESTLAND SCHOOL

the GRANTEE

the following described real property situate in Maricopa County, Arizona:

SEE EXHIBIT "A" ATTACHED HERETO AND BY THIS REFERENCE MADE A PART HEREOF.

SUBJECT TO: Existing taxes, assessments, covenants, conditions, restrictions, rights of way and easements of record.

And the GRANTOR does warrant the title against all persons whomsoever, subject to the matters above set forth.

DATED: June 22, 2000

SKIP SPENST

JOHN L. ZAIGER by Skip Spenst his attorney in fact P.O.A.

BEN LaPARNE

JEROME CHOCEK

STATE OF ARIZONA)
) ss.
County of Mohave)

On 6-22-00, before me, the undersigned Notary Public, personally appeared SKIP SPENST, BEN LaPARNE, JEROME CHOCEK, personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s) or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

Notary Public

My Commission Expires: 10-6-01

OFFICIAL SEAL
ROSIE R. MESISCA
NOTARY PUBLIC-ARIZONA
MOHAVE COUNTY
My Comm. Expires Oct. 6, 2001

STATE OF ARIZONA)
) ss.
County of Mohave)

On 6-22-00, before me, the undersigned Notary Public, personally appeared SKIP SPENST AS ATTORNEY IN FACT FOR JOHN L. ZAIGER, personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s) or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

Rosie R. Mesisca
Notary Public

My Commission Expires:
10-6-01

OFFICIAL SEAL
ROSIE R. MESISCA
NOTARY PUBLIC-ARIZONA
MOHAVE COUNTY
My Comm. Expires Oct. 6, 2001

Unofficial Document

20000500786

EXHIBIT "A"

SECOND AMENDED
NO. 200-000-1281035

20000500786

A portion of the Southwest quarter of Section 19, Township 2 North, Range 2 East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona, more particularly described as follows:

COMMENCING at the Southwest corner of said Section 19, said point being a City of Phoenix brass cap in handhole;

thence North 01 degrees 13 minutes 22 seconds East coincident with the West line of said Southwest quarter of said Section, 376.98 feet;

thence South 88 degrees 46 minutes 38 seconds East 43 feet to the East right-of-way line of 67th Avenue as recorded in Docket 11967, Page 601 of M.C.R. office and the TRUE POINT OF BEGINNING, said point being a 1/2 inch iron bar with bronze cap stamped LS 11121;

thence North 01 degrees 13 minutes 22 seconds East coincident with said East right-of-way line, 10.00 feet to a 1/2 inch iron bar with bronze cap stamped LS 11121;

thence North 88 degrees 46 minutes 38 seconds West coincident with said East right-of-way line, 7.50 feet to a chiseled "+" in concrete sidewalk;

thence North 13 degrees 09 minutes 31 seconds West coincident with said East right-of-way line, 10.07 feet to a chiseled "+" in concrete sidewalk;

Unofficial Document

thence North 01 degrees 13 minutes 22 seconds East coincident with the East right-of-way line of 67th Avenue as recorded in Book 2 of said Road Maps, Page 14 of M.C.R. office, 901.94 feet to a chiseled "+" in concrete sidewalk;

thence leaving said roadway right-of-way South 88 degrees 57 minutes 24 seconds East 109.57 feet to a 1/2 inch iron bar with bronze cap stamped LS 15925, said point being on the Southwesterly right-of-way of the Grand Canal;

thence South 31 degrees 54 minutes 52 seconds East coincident with the Southwesterly right-of-way of the Grand Canal, 470.91 feet to a 1/2 inch bar with bronze cap stamped LS 11121;

thence South 32 degrees 46 minutes 00 seconds East 636.45 feet to a 1/2 inch iron bar with bronze cap, from which an iron bar lies North 81 degrees 14 minutes 30 seconds West 0.39 feet;

thence leaving said canal right-of-way line, North 88 degrees 46 minutes 38 seconds West 712.8 feet to the TRUE POINT OF BEGINNING.

OFFICIAL RECORDS OF
ER
G

Unofficial Document

Recorded at the Request of:
Chicago Title Insurance Company

When Recorded, mail to:

PUNJAB MEDICAL, LLC
6524 W. INDIAN SCHOOL ROAD
PHOENIX, Arizona 85031

2/20

Order No: 2210855 46

Warranty Deed

For the consideration of Ten Dollars, and other valuable consideration, I or we,

FORREST M. HILL and CYNTHIA D. HILL, Co-Trustees of the Hill Family Trust dated August 1, 1994

do hereby convey to

PUNJAB MEDICAL, LLC, an Arizona limited liability company

the following real property located in Maricopa County, Arizona:

Legal Description - Continued

Subject to current taxes and other assessments, reservations in patents and all easements, rights-of-way, encumbrances, liens, covenants, conditions, restrictions, obligations and liabilities as may appear of record, the Grantor warrants the title against all persons whomsoever.

Dated: November 18, 2002

FORREST M. HILL, TRUSTEE

CYNTHIA D. HILL, TRUSTEE

State of ARIZONA
County of MARICOPA } ss. Date of Acknowledgement Nov. 18, 2002

Acknowledgement of FORREST M. HILL, TRUSTEE and CYNTHIA D. HILL, TRUSTEE

This instrument was acknowledged before me this date by the persons above-subscribed and if subscribed in a representative capacity, then for the principal named and in the capacity indicated.

OFFICIAL SEAL
ARNOLD L. PETERSEN
Notary Public State of Arizona
MARICOPA COUNTY
My Comm Expires Jan. 2, 2003

Notary Public

My commission expires: Jan 2, 2003

State of ARIZONA
County of MARICOPA } ss. Date of Acknowledgement

Acknowledgement of

This instrument was acknowledged before me this date by the persons above-subscribed and if subscribed in a representative capacity, then for the principal named and in the capacity indicated.

Notary Public

My commission expires:

NOTE; The parties are cautioned that by completing and executing this document, legal rights, duties and obligations are created. By signing, the parties acknowledge that they have been advised to seek and obtain independent legal counsel as to all matters contained in the within document prior to signing same and that said parties have obtained advice or choose to proceed without same.

WDEED 7/28/95 JEH

LEGAL DESCRIPTION

Order No: 2210855 46

The West 150 feet of the following described property:

That part of the Southwest quarter of the Southwest quarter of Section 19, Township 2 North, Range 2 East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona, described as follows:

Beginning at a point which lies East (assumed bearing) along the South line of said Section 19, a distance of 715.00 feet and North 01 degrees 13 minutes 22 seconds East 65.01 feet from the Southwest corner of said Section 19;

thence North 01 degrees 13 minutes 22 seconds East 296.73 feet;

thence South 88 degrees 46 minutes 38 seconds East 40.89 feet to a point on the Westerly right of way line of the Grand Canal;

thence following the said Westerly right of way line South 32 degrees 46 minutes 00 seconds East 3.29 feet;

thence South 49 degrees 13 minutes 40 seconds East 448.93 feet to a point 65.00 feet Northerly of the South line of said Section 19;

thence West parallel to and 65.00 feet Northerly of the South line of said Section 19, 389.04 feet to the True Point of Beginning.

Unofficial Document

IN COMPLIANCE WITH ARS 33-401, THE BENEFICIARIES OF THE HILL FAMILY TRUST ARE SET FORTH BELOW

1. JEFFREY D. HILL
   PO BOX 4803
   CAVE CREEK, AZ 85237

2. CASSIE D. KEMP
   525 WEST EL CAMINO
   PHOENIX, AZ. 85021

3. DAVID M. HILL
   3271 S. VINE STREET
   CHANDLER, ARIZONA 85248-3845

Unofficial Document

Unofficial Document

CHICAGO TITLE INSURANCE COM

WHEN RECORDED RETURN TO:
BVB
1819 E. Southern Avenue
Mesa, Arizona 85204

ED 99152988-11 HAll

SPECIAL

For Ten Dollars ($10.00) and other
limited liability comapny ("Grantor") conve
Limited partnership,. Viel Gluck Limited Pa
Fatto Limited Partnership, an Arizona Limi
(the "Property"), situated in Maricopa County, Arizona.

See Exhibit A
attached hereto and incorporated herein.

SUBJECT TO current taxes and other assessments, reservations in patents and all easements, rights-of-way, encumberances, liens, covenants, conditions, restrictions, obligations and liabilities as may appear of record,

AND GRANTOR hereby binds itself and its successors to warrant and defend the title against all acts of the Grantor herein and no other, subject to the matters set forth above.

IN WITNESS WHEREOF, Grantor has caused this Special Warranty Deed to be executed this 17th day of August, 1999.

GRANTORS:

Ditta, L.L.C., an Arizona limited liability company.
Dublan, an Arizona general partnersip, Member

Wilford A. Cardon, general partner

STATE OF ARIZONA)
)SS.
COUNTY OF MARICOPA)

The foregoing instrument was acknowledged before me this 18th day of August, 1999 by Wilford A. Cardon who is the general partner of Dublan, the Member of Ditta, L.L.C.

OFFICIAL SEAL
Douglas A. Cheesman
NOTARY PUBLIC-ARIZONA
MARICOPA COUNTY
My Commission Expires June 1, 2000

Notary Public

EXHIBIT "A"

LEGAL DESCRIPTION

Escrow No. 9915298B 11

That part of the Southwest quarter of the Southwest quarter of Section 19, Township 2 North, Range 2 East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona, described as follows:

BEGINNING at a point which lies East (assumed bearing) along the South line of said Section 19, a distance of 715.00 feet and North 1 degree 13 minutes 22 seconds East 65.01 feet from the Southwest corner of the said Section 19; thence North 1 degree 13 minutes 22 seconds East, 296.73 feet; thence South 88 degrees 46 minutes 38 seconds East, 40.89 feet to a point on the Westerly right of way line South 32 degrees 46 minutes 00 seconds East, 3.29 feet; thence South 49 degrees 13 minutes 40 seconds East, 448.93 feet to a point 65.00 feet Northerly of the South line of said Section 19; thence West parallel to and 65.00 feet Northerly of the South line of said Section 19, a distance of 389.04 feet to the true point of beginning.

EXCEPT the West 150 feet.

Unofficial Document

19741126_DKT_10926_750 14
Unofficial Document

D E E D

THIS INDENTURE made as of the 30 by and between THE PRESBYTERY OF PHOENIX, an Arizona corporation, party of the first part, and THE PRESBYTERY OF THE GRAND CANYON, an Arizona corporation, party of the second part.

WITNESSETH, that the party of the first part, in consideration of one dollar ($1.00) lawful money of the United States of America and other valuable considerations paid by the party of the second part does hereby quit claim and release unto the party of the second part, its successors and assigns forever, all those certain tracts or parcels of land together with the appurtenances, and all estate and rights of the party of the first part in and to the same, situated in the County of Maricopa, State of Arizona, TO WIT:

PARCEL NO. 1. DESERT HILLS UNITED PRESBYTERIAN CHURCH, CAREFREE, ARIZONA
The South 500 feet of that part of the Southeast Quarter (SE4) of Section Three (3), Township Five (5) North, Range Four (4) east of the Gila and Salt River Base and Meridian, lying east of Center line of Scottsdale Road as set forth in Book 13 of Maps, page 18, Records of Maricopa County, Arizona.

PARCEL NO. 2. FIRST UNITED PRESBYTERIAN CHURCH, CHANDLER, ARIZONA
Lot Four (4) Valet Homes in the Town of Chandler, a sub-division of part of Block "B" of Chandler, being part of the Northeast quarter of the Southeast quarter of Section Twenty Eight (28) Township One (1) South, Range Five (5) East, of the Gila and Salt River Base and Meridian, Maricopa County, Arizona according to the plat of record in the office of the County Recorder of Maricopa County, Arizona in Book 46 of Maps, page 34.

Reserving all oil, gas, etc. as set forth in deed from United States of America to George D. Hoy, et al, recorded November 2, 1945 in Book 460 of Deeds, page 257

PARCEL NO. 3 FIRST UNITED PRESBYTERIAN CHURCH MANSE, CHANDLER, ARIZONA
Lot 15 in Block One (1) in Westwood Manor, according to the plat thereof of record in the Office of the County Recorder of the County of Maricopa, Arizona in Book 52 of Maps at page 13 thereof.

SUCH PROPERTY BEING SUBJECT TO:
(1) Regulations and restrictions imposed by any planning authority.
(2) The provisions of that certain Water Right recorded on September 8, 1917 in Book 8 of Water Right Application at page 87 thereof, records of Maricopa County, Arizona; made for the purpose of obtaining a water right under the Reclamation Laws of the United States of America, for all that portion of the within described property set forth in said application.
(3) Liabilities and obligations incident to the inclusion of the within described property in the Drainage District No. 1.

(4) Restrictions as set forth in instrument of record, executed by P. G. Chitwood and Patricia Chitwood, dated February 5, 1952, recorded February 6, 1952 in Docket 871 at Page 503 thereof, records of Maricopa County, Arizona.

(5) FHA Mortgage to the Valley National Bank, now of record.

PARCEL NO. 4. CHURCH OF THE MASTER UNITED PRESBYTERIAN CHURCH, MESA, ARIZONA
The North 834.13' of the West 470' of the East ½ of the NE¼ of section 24, Township 1 North, Range 6 East of the G&SRB&M, Maricopa County, Arizona. Also, the parcel adjacent to the south, which is legally described as the South 370.72' of the North 834.13' of the West 470' of the East ½ of the NE¼ of Section 24, T1N, R6E of the G&SRB&M, Maricopa County, Arizona.
EXCEPT the West 30', the North 55', and the East 30' for roads.

PARCEL NO. 5. FIRST UNITED PRESBYTERIAN CHURCH, MESA, ARIZONA
South Half of the South Half of the West Half of the Northwest quarter of the Northwest quarter of Section Twenty Three (23) Township One (1) North, Range Five (5) East of the Gila and Salt River Base and Meridian Maricopa County, Arizona.

PARCEL NO. 6. SKYWAY VILLAGE, MESA, ARIZONA
Tract "B" Skyway Village, Unit Two (2), according to the plat of record in the office of the County Recorder of Maricopa County, Arizona in Book 99 of Maps, Page 26.

Unofficial Document

PARCEL NO. 7. FIRST UNITED PRESBYTERIAN CHURCH, PEORIA, ARIZONA
Lot Nine (9) and the North 37½ feet of Lot Eight (8) Mendenhall Manor in the Town of Peoria according to the plat of record in the office of the County Recorder of Maricopa County, Arizona, Book 49 of Maps, Page 42.

PARCEL NO. 8. BETANIA UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Lot One (1), Three (3), and Five (5) on Block Two (2) in Hampton Place according to the plat thereof of record in the office of the County Recorder of Maricopa County, Arizona, in Book of Maps 37 thereof.

PARCEL NO. 9. BETHANY UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Beginning at the Northeast corner of Section 3, Township 2 North, Range 2 East of the Gila and Salt River Base and Meridian; thence South along the East line of said Section 3 a distance of 586.44 feet to the true point of beginning; thence continue South along said section line 680.46 feet; thence South 89 degrees 26 minutes 15 seconds West 98 feet; thence South 32.44 feet; thence South 89 degrees 26 minutes 15 seconds West, a distance of 228 feet; thence North 715.10 feet; thence East 326.00 feet to the true point of beginning.
EXCEPT beginning at a point of 40 feet West and 1244 feet South of the Northeast corner of said section 3; thence South 23 feet; thence West 58 feet; thence North 23 feet; thence East 58 feet to the point of beginning.

PARCEL NO. 10. CAMELBACK UNITED PRESBYTERIAN CHURCH, SCOTTSDALE, ARIZONA
That portion of the Southwest quarter of Section Twelve (12), Township Two (2) North, Range Three (3) East, Gila and Salt River Base and Meridian, Maricopa County, Arizona, being a strip of land adjoining the present Presbyterian Church property, as follows:

Beginning at the Northeast corner of said Southwest Quarter, as appears in plat of Stanford Hills Plat Two (2), in Book 76 of Maps, Page 41, in the office of the County Recorder of Maricopa County, Arizona; thence Westerly along the North line of said Southwest quarter a distance of 591.50 feet, this being the true point of beginning; thence South parallel to the East line of said Southwest quarter a distance of 501.50 feet, thence South 89 degrees 45 minutes 22 seconds East 243.26 feet to a point on the West line of lot 11, Stanford Hills Plat Two, aforesaid; thence North 5 degrees 24 minutes 33 seconds west along the West line of lot 11 and lot 12 Stanford Hills Plat Two a distance of 140.68 feet to the Northwest corner of lot 12 Stanford Hills Plat Two; thence North, parallel to the East line of said Southwest quarter, a distance of 361.50 feet West of the Northeast corner of said Southwest quarter, thence Westerly along the North line of said Southwest quarter a distance of 230 feet to the true point of beginning.

SUBJECT TO: Right of way for road over the North 65 feet of the premises.

PARCEL NO. 11. CENTRAL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
All that piece or parcel of land located in the County of Maricopa, State of Arizona, more particularly described as follows:

Lot number Eight (8) in PARK TERRACE addition, a subdivision of a part of the Northwest Quarter of the Northeast Quarter of Section Twenty-nine (29) in Township Two (2) North of Range Three (3) East of the Gila and Salt River Base and Meridian, according to the map or plat of said addition now on file and of record in the office of the County Recorder of Maricopa County, Arizona.

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Lot number Seven (7) in PARK TERRACE addition, a subdivision of a part of the Northwest Quarter of the Northeast Quarter of Section Twenty-nine (29) in Township Two (2) North of Range Three (3) East of the Gila and Salt River Base and Meridian, according to the map or plat of said addition now on file and of record in the office of the County Recorder of Maricopa County, Arizona.

PARCEL NO. 12. CHRIST UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Part of the Southwest quarter of Section Nineteen (19), Township Two (2) North, Range Two (2) East of the Gila and Salt River Base and Meridian, described as follows:

COMMENCING at the Southwest corner of Section 19; thence East 1317.30 feet along the South line of Section 19, to a point which is the intersection of the South Line of Section 19 and North right of way line of the Grand Canal and which point is the true point of beginning; thence East 240.37 feet along the South line of Section 19; thence North 513.00 feet; thence West 774.44 feet to the North right of way line of the Grand Canal; thence South 32 degrees 47 minutes 21 seconds East, 183.20 feet; thence South 49 degrees 58 minutes 42 seconds East 350.80 feet; thence South 46 degrees 52 minutes 19 seconds East, 211.14 feet to the true point of beginning.

PARCEL NO. 13. CHRIST UNITED PRESBYTERIAN CHURCH MANSE, PHOENIX, ARIZONA
Lot Ten Thousand Seven Hundred Thirty-one (10731) Maryvale Terrace No. 27 according to the plat of record in the office of the County Recorder of Maricopa County, Arizona, in Book 91 of Maps, Page 16.

PARCEL NO. 14. COVENANT UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Lots 115, 116, Lots 117 of South Country Club Manor as per map recorded in Book 32, Page 18 of Maps in Office of the County Recorder, Maricopa County, Arizona.

PARCEL NO. 15. COVENANT UNITED PRESBYTERIAN CHURCH MANSE AND PARKING LOT, PHOENIX, ARIZONA
Lots 85 and 118 of South Country Club Manor as per map recorded in Book 32, Page 18 of Maps in the Office of the County Recorder, Maricopa County, Arizona.

PARCEL NO. 16. COVENANT UNITED PRESBYTERIAN CHURCH CUSTODIAN HOUSE, PHOENIX, ARIZONA
Lot One Hundred Nineteen (119), South Country Club Manor according to Plat of Record in the Office of the County Recorder, Maricopa County, Arizona, in Book 32 of Maps, Page 18.

PARCEL NO. 17. EMMANUEL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The North 354 feet of the East one-third of Lot Three (3), of Paradise Foothills, per map recorded in Book 48, Page 41 of Maps, in the office of the County Recorder of said County.

SUBJECT TO: Any charge upon said land by reason of its inclusion in Verde River Irrigation and Power District; Rights of way for roads, canals, laterals and ditches; An easement in instrument recorded in Docket 631, Page 109, and Docket 941, Page 369; an easement in instruments recorded in Docket 1463, Page 88, and in Docket 1543, Page 167, and as shown on map recorded in Book 9, Page 97 of Road Maps.

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PARCEL NO. 18. EMMANUEL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The East one-half of Lot Three (3), of Paradise Foothills, per map recorded in Book 48, Page 41 of Maps, in the office of the County Recorder of said County; EXCEPT the North 354 feet.

SUBJECT TO: Any charge upon said land by reason of its inclusion in Verde River Irrigation and Power District; Rights of way for roads, canals, laterals and ditches.

PARCEL NO. 19. EMMANUEL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
That certain real property situate in the County of Maricopa, State of Arizona, described as follows:

The North 354 feet of Lot Three (3), of Paradise Foothills, per map recorded in Book 48, Page 41 of Maps, in the office of the County Recorder of said County; EXCEPT the West 200 feet thereof and the East one-third thereof.

SUBJECT TO: Any charge upon said land by reason of its inclusion in Verde River Irrigation and Power District; Rights of way for roads, canals, laterals and ditches; An easement in instrument recorded in Docket 631, Page 109, and Docket 941, Page 369; An easement in instrument recorded in Docket 1543, Page 167 and as shown on the map recorded in Book 9, Page 97 of Road Maps.

PARCEL NO. 20. MEMORIAL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
A triangular piece of land described as follows: Beginning at a point 40 feet South of a point on the North line of Lot 1, Section 31, T. 2N, R. 4E, Gila and Salt River Base and Meridian, from which the Northwest corner of said Lot 1 bears North 88 degrees, 25 minutes West 1037.0 feet, thence South 294.80 feet to a point on the South line of the North half of the North half of said Lot 1, from which the Southwest corner of said North half of the North half of Lot 1 bears North 88 degrees 34 minutes West 1037.0 feet, thence North 88 degrees 34 minutes West 8.15 feet, thence North 1 degree 35 minutes East 294.71 feet to point of beginning.

PARCEL NO. 21. MEMORIAL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
A parcel of land partly in the Northeast Quarter of the Northwest Quarter and partly in Lot 1, Section 31, Township 2 North, Range 4 East of the Gila and Salt River Base and Meridian described as follows, the courses given being based on an assumed bearing of South 88 degrees 25 minutes East of the North line of Lot 1 of said Section 31, to-wit:

Beginning at the Northeast corner of said Lot 1 (identical with the Northwest corner of the Northeast Quarter of the Northwest Quarter of Section 31); thence South 88 degrees 25 minutes East along the North line of said Northeast Quarter of the Northwest Quarter, 14.40 feet; thence South 334.15 feet to a point on the South line of the North Half of the North Half of the Northeast Quarter of the Northwest Quarter of Section 31; thence North 88 degrees 34 minutes West along the South line of the North Half of the North Half of the Northeast Quarter of the Northwest Quarter of Section 31, 14.90 feet to the Southwest corner of the North Half of the North Half of the Northeast Quarter of the Northwest Quarter of Section 31 (identical with the Southeast corner of the North Half of the North Half of said Lot 1) from which the Northeast corner of said Lot 1 bears North 0 degrees 4 minutes East 334.19 feet; thence North 88 degrees 34 minutes West along the South line of the North Half of the North Half of said Lot 1 215.82 feet to a point from which the Southwest corner of the North Half of the North Half of said Lot 1 bears North 88 degrees 34 minutes West 1037.0 feet; thence North parallel with the West line of said Lot 1 334.80 feet to a point on the North line of said Lot 1 from which the Northwest corner of said Lot 1 bears North 88 degrees 25 minutes West 1037.0 feet; thence South 88 degrees 25 minutes East along the North line of said Lot 1 216.55 feet to the point of beginning.

SUBJECT TO: Right of way for Thomas Road over the North 33.0 feet thereof and an alleyway over the South 12.0 feet thereof.

PARCEL NO. 22. MEMORIAL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
PARCEL #1: Lot Seventy-two (72), CAMELBACK DEL ESTE, in the City of Phoenix, according to the plat of record in the office of the County Recorder of Maricopa County, Arizona, in Book 70 of Maps, page 29.

SUBJECT TO: Easement for irrigation over the North 4 feet of said premises, as shown on plat recorded in Book 79 of Maps, page 29; Restrictions recorded March 1, 1957 in Docket 2116, page 69; Reservations contained in Patent recorded August 21, 1891 in Book 26 of Deeds, page 490.

PARCEL NO. 23. MEMORIAL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA MANSE #2: Lot Seven (7), OLIVE GROVE, in the City of Phoenix according to the plat of record in the office of the County Recorder of Maricopa County, Arizona, in Book 81 of Maps, page 31.

PARCEL NO. 24. MEMORIAL UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA PARKING LOT: That part of the Northwest quarter of the Northeast quarter of the Northwest quarter of Section Thirty-one(31), Township Two (2) North, Range Four (4) East of the Gila and Salt River Base and Meridian, lying within the corporate limits of the City of Phoenix, described as follows: reference being made to the plat of Rancho Ventura, Tract No. 7, of record in Book 48 of Maps, page 4, and to the plat of Rancho Ventura Tract No. 14, of record in Book 52 of Maps, page 50, records of Maricopa County, Arizona, to-wit:

Beginning at the Southeast corner of the West 32.2 feet of the West half of the East half of the Northwest quarter of the Northeast quarter of the Northwest quarter of said Section 31; thence North 88 degrees 28 minutes 30 seconds West (assumed bearing) along the South line of the Northwest quarter of the Northeast quarter of the Northwest quarter of said Section 31, identical with the North line of Rancho Ventura Tract No. 7 aforesaid, 336.28 feet to the East line of 42nd Street, according to the plat of Rancho Ventura Tract No. 14, aforesaid; thence North 0 degrees 16 minutes 30 seconds East along the East line of said 42nd Street 0.65 feet; thence along a curve to the right, tangent to said last mentioned line and continuing along the East line of 42nd Street, said curve having a radius of 498.99 feet, a distance of 79.0 feet; thence along a curve to the left tangent to said last mentioned curve and continuing along the East line of 42nd Street, said curve having a radius of 554.31 feet, a distance of 48.53 feet; thence South 88 degrees 28 minutes 30 seconds East along a line which is 128.0 feet North from and parallel with the South line of the Northwest quarter of the Northeast quarter of the Northwest quarter of said Section 31 a distance of 323.10 feet to a point on the East line of the West 32.2 feet of the West half of the East half of the Northwest quarter of the Northeast quarter of the Northwest quarter of said Section 31; thence South 0 degrees 17 minutes 30 seconds West along the East line of the West 32.2 feet of the West half of the East half of the Northwest quarter of the Northeast quarter of the Northwest quarter of said Section 31 a distance of 128.00 feet to the point of Beginning.

PARCEL NO. 25. BROADMOOR UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA The West half of the West half of the South half of the Southeast quarter of the Northeast quarter of Section 15, Township 2 North, Range 3 East of the Gila and Salt River Base and Meridian.

PARCEL NO. 26. NORTHRIDGE UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The West 16.5 feet of the East half of the West half of the South half of the Southwest quarter of the Northeast quarter of Section 15, Township 2 North, Range 3 East of the Gila and Salt River Base and Meridian.

PARCEL NO. 27. NORTHRIDGE UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The South 348.50 feet of the West 500.00 feet of the Northwest quarter of Section 14, Township 3 North, Range 2 East of the Gila and Salt River Base and Meridian.

PARCEL NO. 28. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The South 311.15 feet of the West 280.0 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4), Township Two (2) North, Range Three (3) East, of the Gila and Salt River Base and Meridian, Maricopa County, Arizona,
EXCEPT the South 194.47 feet thereof.

PARCEL NO. 29. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The South 194.47 feet of the west 280.0 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4), Township Two (2) North, Range Three (3) East of the Gila and Salt River Base and Meridian.

SUBJECT TO: Roadway over the West 30 feet of the South 183 feet of the within property, as conveyed to the County of [illegible] a by instrument recorded in Docket 1250, page 73; records of Maricopa County, Arizona; and Rights of way for canals, laterals and ditches.

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PARCEL NO. 30. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The North 38.89 feet of the South 350.04 feet of the West 280 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4) Township Two (2) North, Range Three (3) East, of the Gila and Salt River Base and Meridian, Maricopa County, Arizona, subject to a road over the West 30 feet thereof.

PARCEL NO. 31. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The North 116.68 feet of the South 466.72 feet of the West 280 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4) Township Two (2) North, Range Three (3) East, of the Gila and Salt River Base and Meridian, Maricopa County, Arizona, subject to a road over the West 30 feet thereof.

PARCEL NO. 32. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The North 10 feet of the South 476.72 feet of the West 373.33 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4), Township Two (2) North, Range Three (3) East of the Gila and Salt River Base and Meridian.
EXCEPTING WITH a 4 foot wide easement for an irrigation line, 2 feet wide on each side of the following described centerline:
COMMENCING for a tie at the Northwest corner of the Northeast quarter of the Southwest quarter of Section Four (4), Township 2 North, Range 3 East of the Gila and Salt River Base and Meridian; thence South along the West line of the Northeast quarter of the Southwest quarter of said Section 4, 132.19 feet; thence South 83 degrees 05 minutes East along the Westerly

prolongation of the North line and along the North line itself, of the property described in Docket 2612, page 166, Maricopa County records, 361.63 feet, from whence the Northeast corner of said property lies South 89 degrees 04 minutes East, 11.50 feet; thence North 10 feet to the point of beginning of the easement centerline; thence North 155.00 feet at the end of the easement.

SUBJECT TO: Easement for telephone and telegraph poles and aerial cable, granted by instrument recorded in Docket 1049, Page 231, records of Maricopa County, Arizona; Rights of way for canals, laterals and ditches.

PARCEL NO. 33. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The North 80 feet of the South 466.72 feet of the East 125 feet of the West 155 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4), Township Two (2) North, Range Three (3) East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona.

PARCEL NO. 34. ORANGEWOOD UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The South 466.72 feet of the West 373.33 feet of the North half of the Northeast quarter of the Southwest quarter of Section Four (4), Township Two (2) North, Range Three (3) East of the Gila and Salt River Base and Meridian;
EXCEPT the West 283 feet thereof.

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SUBJECT TO: Easement for telephone and telegraph poles and aerial cable, granted by instrument recorded in Docket 1049, page 231, records of Maricopa County, Arizona; and Rights of way for canals, laterals and ditches.

PARCEL NO. 35. PARADISE VALLEY UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Lot Fifty-five (55) Northern Hills (amended) according to plat record in the office of the County Recorder of Maricopa County, Arizona in Book 61 of Maps, Page 17.

PARCEL NO. 36. PARADISE VALLEY UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Lot Thirteen (13) of Kay Acres as per map recorded in Book 33, page 28 of Maps in the office of the County Recorder of said County, Maricopa County, Arizona.

PARCEL NO. 37. WESTMINSTER UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The West 175 feet of that part of the Northeast quarter of the Northwest quarter of Section Twenty-seven (27), Township One (1) North, Range Three (3) East of the Gila and Salt River Base and Meridian, described as follows:

BEGINNING at a stone at the Northeast corner of the Northwest quarter of said Section; running thence South along the half Section line 1292 feet to a stone in the bottom of a ditch running North and South; thence West [illegible] feet to a stone at the Northwest corner of the tract identical with the Southeast corner of the Kingston tract; thence North [illegible] feet to a stone at the Northwest corner of the tract, being identical with the Northeast corner of the Kingston tract; thence East [illegible] feet along the center of the [illegible] to the point of beginning.

PARCEL NO. 38. SOUTHWESTERN UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
That part of the Northwest quarter of Section Twenty-seven (27), Township One (1) North, Range Three (3) East of the Gila and Salt River Base and Meridian, described as follows:

Beginning at a point on the North line of the Northwest quarter of said Section 27 which bears West (assumed bearing) 541.50 feet from the Northeast corner thereof and running thence South 2 degrees 35 minutes West, along the East line of Carlotta Place No. 2, as shown by the plat of record in the office of the County Recorder of Maricopa County, Arizona, in Book 40 of Maps, page 1, and the Northerly prolongation thereof, a distance of 1289.06 feet to the Southeast corner thereof; thence South 89 degrees 38 minutes East a distance of 26.57 feet to the West line of premises conveyed to The Presbytery of Phoenix, an Arizona corporation, by Deed recorded June 1, 1954, in Docket 1361, page 514; thence Northerly along said Presbytery premises, 1288 feet, more or less, to the point of beginning.

PARCEL NO. 39. WESTMINSTER UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The West half of Lots Seventeen (17), Eighteen (18), and all of Lots Nineteen (19) and Twenty (20), Elm Acres, according to the plat of record in the office of the County Recorder of Maricopa County, Arizona, Book 27 of Maps, page 2.

PARCEL NO. 40. WESTMINSTER UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The South 114 feet of the East 60 feet of Lot Eighteen (18), Elm Acres as per map recorded in Book 27, Page 2 of Maps in the office of the County Recorder of said County.

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PARCEL NO. 41. WESTMINSTER UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
The East half of Lots Seventeen (17) and Eighteen (18) and all of Lot Sixteen (16), Elm Acres, according to the plat of record in the office of the County Recorder of Maricopa County, Arizona, Book 27 of Maps, page 2. EXCEPT the South 114 feet of the East half of said Lot Eighteen (18).

PARCEL NO. 42. WESTMINSTER UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
Lot Fourteen (14), of Elm Acres as per map in Book 27 page 2 in the office of the County Recorder of Maricopa County, Arizona.

PARCEL NO. 43. WESTMINSTER UNITED PRESBYTERIAN CHURCH, PHOENIX, ARIZONA
MANSE: Lot 91 of Melrose Estates as per map in Book 42 of Maps, page 47 in the office of the County Recorder of Maricopa County, Arizona.

PARCEL NO. 44. SCOTTSDALE UNITED PRESBYTERIAN CHURCH, SCOTTSDALE, ARIZONA
Lot [illegible] Scottsdale Estate Six, according to the plat of record in the office of the Maricopa County Recorder in Book of Maps [illegible], page [illegible].

PARCEL NO. [illegible] [illegible]

Commencing at the southwest corner of said [illegible] Section 5 run thence N. 89 degrees 56 minutes 10 seconds E. along the south line thereof a distance of 112.57 feet to the northwest corner of tract H, Sun City Unit Twenty-three A as recorded in Book 127 at Page 44 in the office of the Maricopa County Arizona Recorder and the true Point of Beginning; thence N. 68 degrees 49 minutes 05 seconds E. a distance of 501.00 ft. to a point on a curve on the westerly right-of-way line of Del Webb Blvd. from which the radius point thereof bears S. 68 degrees 49 minutes 07 seconds W. a distance of 3,142.66 ft.; thence northerly along said westerly right-of-way line along the arc of a 3,142.66 ft. radius curve through a central angle of 03 degrees 44 minutes 36 seconds a distance of 205.32 ft. to a point of compound curvature; thence northerly and westerly along the arc of a 15.00 ft. radius curve concave south-westerly through a central angle of 86 degrees 41 minutes 19 seconds a distance of 22.69 ft. to a point of compound curvature at the junction of the westerly right-of-way line of Del Webb Blvd. with the southerly right-of-way line of future street to be opened and dedicated by grantor herein; thence westerly along the southerly right-of-way line of said future street, and the arc of a 637.62 ft. radius curve that is concave southerly, through a central angle of 18 degrees 27 minutes 18 seconds a distance of 205.38 ft. to a point of reverse curvature; thence continuing westerly along the southerly right-of-way line of said future street and along the arc of a 655.00 ft. radius curve that is concave northerly through a central angle of 23 degrees 28 minutes [illegible] onds a distance of 268.39 ft.; thence S. 16 degrees 35 minutes 28 seconds E. a distance of 152.21 ft. to the True Point of Beginning. The above described parcel contains 2.044 acres.

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This conveyance is made upon the express condition and covenant, which is hereby declared to run with and bind the land hereby conveyed, as provided in Warranty Deed 174552 from Del E. Webb Development Co. to the Presbytery of Phoenix as recorded in Docket 2873, Page 509 of the Records of Maricopa County, Arizona, that the herein conveyed property shall be used for church purposes only for a period of twenty (20) years following the date of recording hereof. This restriction shall be enforceable by Del E. Webb Development Co., or by the Grantor herein, or by the then owner of any lot or parcel of land adjoining the property herein conveyed, by means of an injunction against any other use. Grantor reserves for a period of twenty (20) years following the recording hereof the right of prior approval as to the site, exterior design of any structures, signs and improvements, and of any expansion, modification, or replacement thereto or thereof, in order to preserve the orderly development and beauty of Sun City. This right may be enforced by Grantor or its successors by injunctive procedures. Grantor's approval shall not be unreasonably withheld.

PARCEL NO. 2. FIRST BAPTIST CHURCH OF SUN CITY, SUN CITY, ARIZONA. The West 361 feet of the South 519.29 feet of the southeast quarter of Section 17, Township 3 North, Range 1 East of the Gila and Salt River Base and Meridian; except the South 233 feet of the West 233 feet, and except the South 40 feet of the West 111 feet and except the West [illegible] feet of the South [illegible] feet.

PARCEL NO. 48. UNIVERSITY UNITED PRESBYTERIAN CHURCH, TEMPE, ARIZONA
Tract A. Nu-Vista Unit Two, according to plat of record in the Office of the Maricopa County Recorder in Book 89 of Maps, page 13.
EXCEPT the west 107.26 feet thereof.

PARCEL NO. 49. UNIVERSITY UNITED PRESBYTERIAN CHURCH, TEMPE, ARIZONA
West 107.26 feet of Tract A. Nu-Vista Unit Two, according to the plat of record in the Office of the Maricopa County Recorder in Book 89 of Maps, page 13.

PARCEL NO. 50 GUADALUPE UNITED PRESBYTERIAN CHURCH, TEMPE, ARIZONA
That portion of the SW¼ of Section 4, Township 1 South, Range 4 East, G. & S. R. B. & M., Maricopa County, Arizona, lying West of the Highline Canal more particularly described as follows:

Commencing at the W¼ corner of Section 4, Township 1 South, Range 4 East, G. & S. R. B. & M., Maricopa County, Arizona; thence South (assumed bearing) along the West line of said SW¼, Section 4 a distance of 904.70 ft. to the true point of beginning; thence East 331.32 ft.; thence South 455.0 ft.; thence West 331.32 ft. to a point on the said West line of the SW¼ Section 4; thence North along the said West line of the SW¼ Section 4 a distance of 455.0 ft. to the true point of beginning.

Containing 3.461 acres more or less.

Unofficial Document

TO HAVE AND TO HOLD unto the said PRESBYTERY OF GRAND CANYON, an Arizona corporation, its successors and assigns forever. PROVIDED ALWAYS, HOWEVER, that the above-described property shall revert to BIEHN COLONY TRUST, INC., an Arizona corporation, if and when it is no longer used for church, public health, or similar public purposes.

PARCEL NO. 51. ASU CAMPUS MINISTRY, TEMPE, ARIZONA
Lot 998 of Knoell Tempe, Unit Five (5), according to Book 148 of Maps, page 28, and recorded in Book 150 of Maps, page 9, Records of Maricopa County, Arizona.

PARCEL NO. 52. WICKENBURG FIRST UNITED PRESBYTERIAN CHURCH, WICKENBURG, ARIZONA
Lots 7, 8, 9 and 10 Block Ten (10) Collins Addition to Wickenburg according to the plat of record in the Office of the County Recorder of Maricopa County, Arizona, Book 3 of Maps, Page 1.

PARCEL NO. 53. WICKENBURG FIRST UNITED PRESBYTERIAN CHURCH, WICKENBURG, ARIZONA
Lots Twenty-four (24) and Twenty-five (25) Block Six (6) Collins Addition to Wickenburg, according to the plat of record in the Office of the County Recorder, Maricopa County, Arizona, Book 3 of Maps, Page 1.

PARCEL NO. 54. WICKENBURG FIRST UNITED PRESBYTERIAN CHURCH, WICKENBURG, ARIZONA MANSE: Lots Twenty-six (26) and Twenty-seven (27) Block Six (6) Collins Addition to Wickenburg, according to the plat of record in the Office of the County Recorder of Maricopa County, Arizona, Book 3 of Maps, page 1.

TO HAVE AND TO HOLD the premises herein quit claimed and released unto the party of the second part, its successors and assigns forever.

DKT 10926 PG 763

STATE OF ARIZONA)
) ss:
COUNTY OF MARICOPA)

On this 30th day of August, 1974, before me, a notary public in and for said County and State, personally appeared G. William Vogel, Jr., to me personally known, who, being by duly sworn, did depose and say that he is the President (or Vice-President) of THE PRESBYTERY OF PHOENIX, the corporation named in the foregoing instrument and that he is duly authorized to execute the same.

Notary Public

My Commission expires:

My Commission Expires Nov. 3, 1976

STATE OF ARIZONA)
) ss:
COUNTY OF MARICOPA)

Unofficial Document

On this 30th day of August, 1974, before me, a notary public in and for said County and State, personally appeared Thomas E. Duggan, to me personally known, who, being by me duly sworn, did depose and say that he is the President (or Vice-President) of THE PRESBYTERY OF THE GRAND CANYON, the corporation named in the foregoing instrument and that he is duly authorized to execute the same.

Notary Public

My Commission expires:

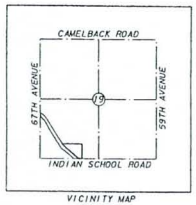
STATE OF ARIZONA } ss
County of Maricopa }
I hereby certify that the within instrument was filed and recorded at request of United Presbyterian Church
NOV 26 1974 - 10 10
in Docket 10926
on page 750-763
Witness my hand and official seal the day and year aforesaid.
Fern Tessalone
County Recorder
By R Lande
Deputy Recorder
6.50

10 E. Roanoke Ave.
Suite 31
Phx., Az. 85004

14.

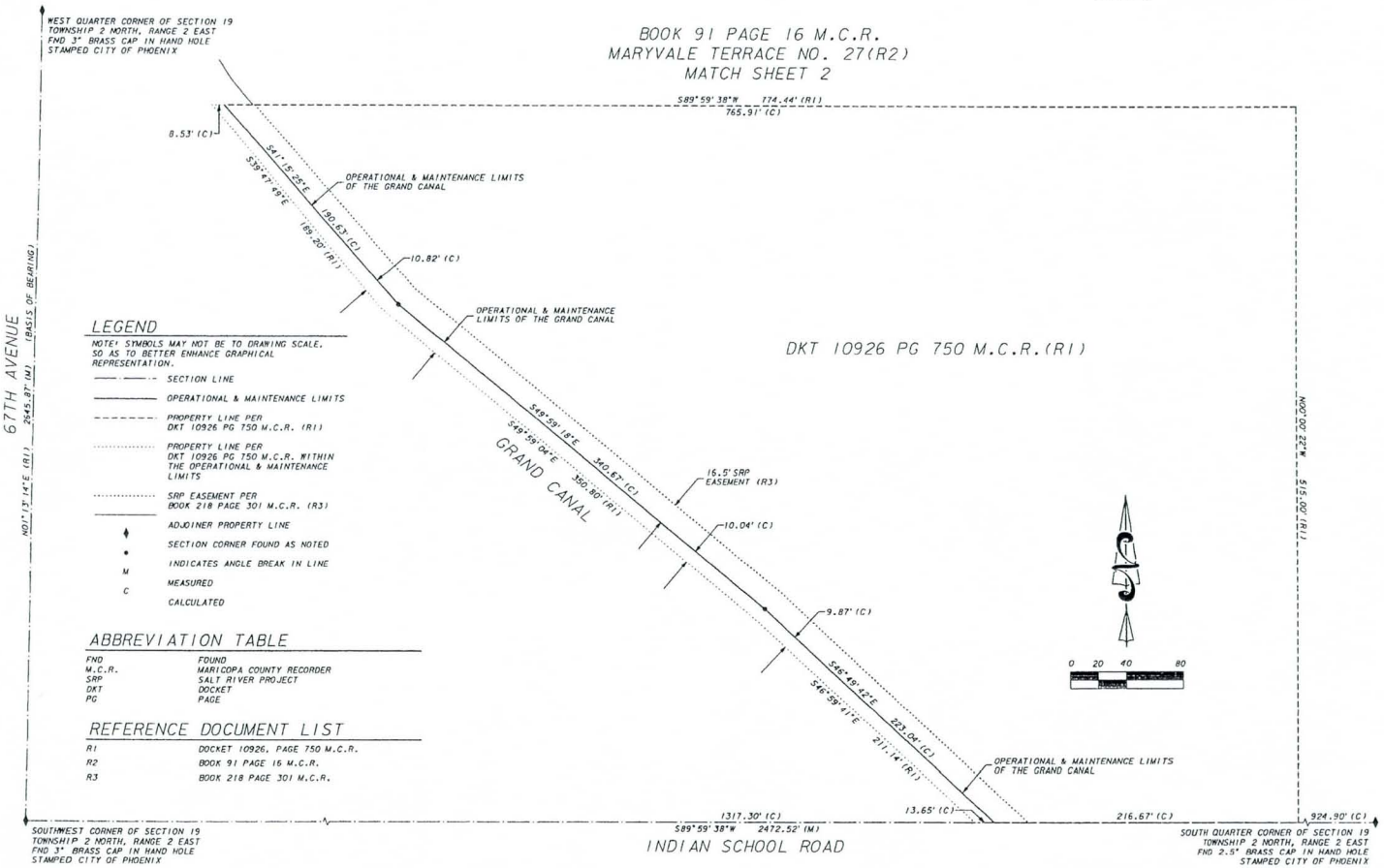
DELINEATION MAP

SHOWING THE OPERATIONAL & MAINTENANCE LIMITS OF THE GRAND CANAL
BEING A PORTION OF THE SOUTHWEST QUARTER OF SECTION 19, TOWNSHIP 2 NORTH, RANGE 2 EAST,
GILA AND SALT RIVER MERIDIAN, MARICOPA COUNTY, ARIZONA
OWNER - UNITED STATES OF AMERICA



VICINITY MAP
T2N R2E
G&SRM

OFFICIAL RECORDS OF
MARICOPA COUNTY RECORDER
HELEN PURCELL
20080646007 07/24/2008 02:50
BOOK 997 PAGE 34
ELECTRONIC RECORDING
GRANDCANALINDSCHOOL-2-1-1-M-
fraustoj



LEGEND

NOTE: SYMBOLS MAY NOT BE TO DRAWING SCALE, SO AS TO BETTER ENHANCE GRAPHICAL REPRESENTATION.

- SECTION LINE
- OPERATIONAL & MAINTENANCE LIMITS
- PROPERTY LINE PER DKT 10926 PG 750 M.C.R. (R1)
- PROPERTY LINE PER DKT 10926 PG 750 M.C.R. WITHIN THE OPERATIONAL & MAINTENANCE LIMITS
- SRP EASEMENT PER BOOK 218 PAGE 301 M.C.R. (R3)
- ADJOINER PROPERTY LINE
- SECTION CORNER FOUND AS NOTED
- INDICATES ANGLE BREAK IN LINE
- M MEASURED
- C CALCULATED

ABBREVIATION TABLE

FND	FOUND
M.C.R.	MARICOPA COUNTY RECORDER
SRP	SALT RIVER PROJECT
DKT	DOCKET
PG	PAGE

REFERENCE DOCUMENT LIST

R1	DOCKET 10926, PAGE 750 M.C.R.
R2	BOOK 91 PAGE 16 M.C.R.
R3	BOOK 218 PAGE 301 M.C.R.

BASIS OF BEARING

THE WEST LINE OF THE SOUTHWEST QUARTER OF SECTION 19, T2N, R2E OF THE GILA AND SALT RIVER MERIDIAN, MARICOPA COUNTY, ARIZONA. BEARING N01°13'14"E AS SHOWN ON AN UNRECORDED CHECK PRINT COMPLETED BY SRP, DATED 12/1987.

KNOW ALL MEN BY THESE PRESENTS:

THAT THE SALT RIVER VALLEY WATER USERS' ASSOCIATION, AN ARIZONA CORPORATION, HEREBY PUBLISHES THIS PLAT SHOWING THE RIGHT OF WAY NECESSARY FOR THE OPERATION AND MAINTENANCE OF THE PRESENT GRAND CANAL IN SECTION 19, TOWNSHIP 2 NORTH, RANGE 2 EAST, GILA AND SALT RIVER MERIDIAN, MARICOPA COUNTY. SAID PLAT DOES NOT SHOW AND IT IS NOT THE INTENTION TO SHOW OR REFER TO ALL RIGHTS OF WAY AND RIGHTS POSSESSED BY THE UNITED STATES OF AMERICA AND NEITHER THE EXECUTION OR RECORDATION OF SAID PLAT SHALL RESULT IN OR CONSTITUTE ANY DIMINUTION OR OTHER DISPOSAL IN WHOLE OR IN PART, OF ANY RIGHTS OF WAY OR RIGHTS WHICH THE UNITED STATES OF AMERICA IS ENTITLED TO UTILIZE OR ENFORCE.

NOTE

1) NO LIABILITY IS ACCEPTED BY SRP LAND-SURVEYS DIVISION FOR ANY USE OF THIS DATA OTHER THAN AS A GENERAL PRESENTATION OF APPROXIMATE LOCATIONAL RELATIONSHIPS BETWEEN THE VARIOUS DATA-SETS AS NOTED, AND, AS COMBINED.

2) THERE ARE OBVIOUS DISSIMILARITIES BETWEEN THE DISPARATE DATA-SET SOURCE MATERIALS.

3) ALL (R)ECORD, (M)EASURED AND (C)ALCULATED DIMENSIONS SHOWN ON THIS DRAWING REPRESENT HORIZONTAL GROUND DISTANCES, REPORTED IN FEET AND DECIMALS OF FEET, UNLESS SPECIFICALLY NOTED DIFFERENTLY.

4) "RIGHTS OF WAY FOR CANALS AND DITCHES" DERIVED FROM:

"THE ACT OF JULY 26TH, 1866"

R.S. SEC. 2339 DERIVED FROM ACT JULY 26, 1866, CH. 262, SEC. 9, 14 STAT. 253.

5) LOCATION OF SRP EASEMENT (R3) IS BASED ON THE OPERATIONAL & MAINTENANCE LIMITS OF THE GRAND CANAL OR MCR BOOK 91 PAGE 16.

DELINEATION NOTE

THIS DELINEATION MAP IS NOT A BOUNDARY SURVEY THEREFORE NO MONUMENTS WERE SET.

THIS DELINEATION MAP IS BASED ON INFORMATION GATHERED FROM RECORDED AND/OR UNRECORDED DOCUMENTS AND SUPPLEMENTED WITH SURVEYED MEASUREMENTS.

THIS DELINEATION MAP IS MEANT TO ILLUSTRATE AN OPERATIONAL AREA THAT IS MAINTAINED AND MANAGED BY SRP THAT MAY OR MAY NOT BE COINCIDENT WITH THE OCCUPATIONAL LIMITS OF THE ADJOINING PROPERTIES, AS ESTABLISHED BY SUCH VISUAL EVIDENCE AS ADJOINERS' FENCES, ETC.

THIS DELINEATION MAP IS INTENDED SOLELY FOR THE PREPARATION OF SRP ELECTRICAL AND/OR IRRIGATIONAL LEGAL DOCUMENTS AND GRAPHICAL EXHIBITS.

USAGE OF THIS DELINEATION MAP BY OTHERS, FOR ANY OTHER PURPOSE, MAY NOT BE APPROPRIATE. IT IS ENTIRELY THE RESPONSIBILITY OF ANY OTHER USER TO DETERMINE ITS SUITABILITY FOR ANY OTHER PURPOSE.

STATEMENT

I, TODD RAKSTAD, A PROFESSIONAL LICENSED SURVEYOR IN THE STATE OF ARIZONA, AFFIRM THAT THIS DELINEATION MAP WAS DEVELOPED UNDER MY DIRECT SUPERVISION.

TODD E. RAKSTAD
REGISTERED LAND SURVEYOR #42847
P.O. BOX 52025
PHOENIX, AZ 85072-2025
602-236-3153

ARS 32-151.
CERTIFY; CERTIFICATION

THE USE OF THE WORD "CERTIFY" OR "CERTIFICATION" BY A PERSON OR FIRM THAT IS REGISTERED OR CERTIFIED BY THE BOARD IS AN EXPRESSION OF PROFESSIONAL OPINION REGARDING FACTS OR FINDINGS THAT ARE THE SUBJECT OF THE CERTIFICATION AND DOES NOT CONSTITUTE AN EXPRESS OR IMPLIED WARRANTY OR GUARANTEE.

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42847
TODD E.
RAKSTAD
ARIZONA U.S.A.
REGISTRATION
EXPIRES: 09-30-08

SERVER • //SURSRV01/SURVEY

REVISION: 0	JOB NUMBER: R&D-970-2007(65)	SCALE: 1"=40'	DRAWING SIZE: 24x36
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CHIEF: D.DEDRERO	FIELD DATE: 04/30/08	FILE: S:\PROJECTS\DELINEATION\R&D-970-200	
SVY TECH: K.COREHAM	COMP. DATE: 07/23/08	FINAL INSPECTION / ISSUE DATE: N/A	

SRP LAND DEPARTMENT SURVEY DIVISION

SW 1/4 SECTION 19
T-2-N, R-2-E
6.1 EAST - 8.1 NORTH

DELINEATION MAP
GRAND CANAL AT INDIAN SCHOOL ROAD

OFFICIAL RECORDS OF
MARICOPA COUNTY RECORDER
HELEN PURCELL
20080646007 07/24/2008 02:50
BOOK 997 PAGE 34
ELECTRONIC RECORDING
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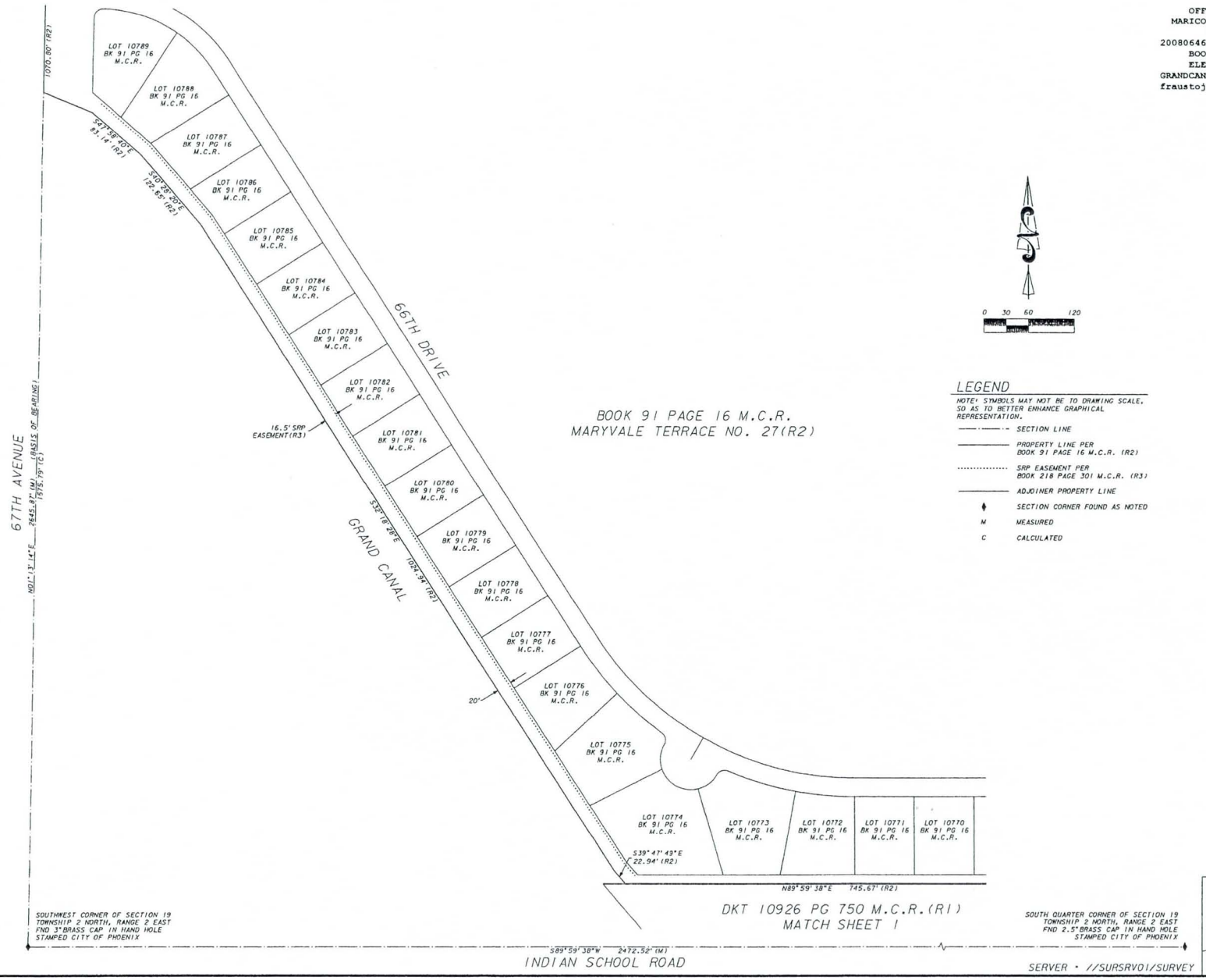
fraustoj



LEGEND

NOTE: SYMBOLS MAY NOT BE TO DRAWING SCALE, SO AS TO BETTER ENHANCE GRAPHICAL REPRESENTATION.

- SECTION LINE
- PROPERTY LINE PER BOOK 91 PAGE 16 M.C.R. (R2)
- SRP EASEMENT PER BOOK 218 PAGE 301 M.C.R. (R3)
- ADJOINER PROPERTY LINE
- SECTION CORNER FOUND AS NOTED
- M MEASURED
- C CALCULATED

REGISTERED LAND SURVEYOR
42847
TODD E. RAKSTADS
REGISTRATION EXPIRES: 09-30-08

SRP SURVEY DIVISION
LAND DEPARTMENT

SW 1/4 SECTION 19
T-2-N, R-2-E
6.1 EAST - 8.1 NORTH

DELINEATION MAP
GRAND CANAL AT INDIAN SCHOOL ROAD

REVISION: 0	JOB NUMBER:	AUD-970-200(65)	SCALE: 1"=60'	DRAWING SIZE: 24x36	
DRAWN BY: HEBERT	SURVEYMAP / LAND	CHK'D BY: TER	SHEET: 2 OF 2		
CRW CHIEF: GUERRERO	FIELD DATE: 04/30/08	FILE: S:/PROJECTS/DELINEATION			
SYT TECH: K.GORGUIM	COMP. DATE: 07/23/08	FINAL INSPECTION / SIGN DATE: N/A			

SERVER • //SURSRV01/SURVEY

Appendix F

Utilities & Pothole Data

TESTHOLE DATA SUMMARY

Preliminary

PREPARED BY:
TBE Group, Inc.
2236 West Shangri-La Rd.
Phoenix, AZ 85029
(602) 749-8550

DATE: October 31, 2007
PROJECT NAME: Bethany Home Outfall Channel - Reach D Design
PROJECT NO: FCD 2006 C027

NOTE: The coordinate and elevation values provided below depict the actual utility location. Adjustments were made, as needed, to the surveyed request location.

All Data is English

TBE Project Number: AZ096-008-00

TH#	Street	Coordinates		Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type, Outside Diameter and Comments	Depth of Cover
		Northing	Easting							
1	Indian School Rd	907771.59	614243.09	Water	09/11/07	1097.86	1093.52	-------	13" Concrete Water Line E-W	4.34
2	Indian School Rd	907778.79	614231.24	TVFO	09/11/07	1097.52	1091.61	1091.16	(1) 1 3/4" (2) 2" Fiber Optic Conduits E-W Laid 6" Wide	5.91
3	Indian School Rd	907841.34	614117.20	Water	09/19/07	1098.56	1081.91	-------	Top of Conc. Water Line E-W	16.65
									Could Not Obtain O.D. Due to Soil Caving In, Pipe Size and Depth	
4	Indian School Rd	907857.82	614091.43	Storm Drain	09/21/07	1098.86	1091.27	-------	18" Concrete Pipe N-S	7.59
5	Indian School Rd	907848.42	614105.61	Gas	09/18/07	1098.39	1093.00	-------	4 1/2" Steel Gas Line E-W	5.39
6	Indian School Rd	907856.63	614090.23	Water	09/18/07	1098.41	1097.94	1094.31	35" Wide X 2.27' Deep Slurry Structure Over 9" Water Line N-S	0.47
									Top Measurement = Top of Slurry Bottom = Bottom of Water line	
7	Indian School Rd	907873.82	614063.06	Telephone	09/11/07	1098.83	1094.10	1090.99	10 (Visible) 4 1/2" Transite Conduits E-W Laid 14" Wide	4.73
7B	Indian School Rd	907873.22	614011.19	Telephone	10/22/07	1098.79	1092.84	1090.43	(14) 4" Transite Conduits E-W Laid 1.3' Wide By 2.41' High	5.95
7C	Indian School Rd	907873.18	614030.21	Telephone	10/22/07	1098.95	1093.61	1091.20	(14) 4" Transite Conduits E-W Laid 1.3' Wide By 2.41' High	5.34
7D	Indian School Rd	907872.71	613972.96	Telephone	03/19/08	1099.09	1092.36	1089.03	2' X 3.33' Concrete Encased Telephone Duct E-W	6.73
8	67th Avenue	909370.00	612799.94	Irrigation	09/11/07	1097.60	1093.03	-------	26" Concrete Irrigation Line N-W	4.57
9	67th Avenue	909372.91	612798.03	Water	09/13/07	1097.75	1094.01	-------	29" Concrete Water Line NE-SW	3.74
10	67th Avenue	909370.32	612793.68	Gas	09/11/07	1097.80	1090.47	-------	2" Wrapped Steel Gas Line NW-SE	7.33
11	67th Avenue	909377.98	612786.21	CATV	09/12/07	1098.32	1096.28	-------	3/4" Direct Buried Cable NW-SE	2.04
12	67th Avenue	909402.25	612774.96	Telephone	09/13/07	1099.18	1097.58	1087.54	(9) Visible 4 1/2" Trans. Conduits N-S Laid 40" Wide & (1) 3/4"	1.60
									Cable -- Opened Tel MH - Shows (24) Total Conduits	
									Top Elevation is top of 3/4" Cable - Bottom = Bottom of Tel Duct	
12A	67th Avenue	909401.61	612772.30	Unk	09/13/07	1099.18	1095.40	-------	Found 28" Concrete Pipe While Digging For TH #12 E-W	3.78
12B	67th Avenue	909391.65	612773.94	Telephone	10/18/07	1099.09	1089.95	1087.54	(24) 4" Transite Conduits N-S Laid 1.6' Wide By 2.41' High	9.14
12C	67th Avenue	909413.81	612774.22	Telephone	10/19/07	1098.91	1090.24	1087.88	(24) 4" Transite Conduits N-S Laid 1.6' Wide By 2.36' High	8.67
13	67th Avenue	909410.42	612766.44	Gas	10/09/07	1098.91	1082.63	-------	6 1/2" Coated Steel Gas Line N-S	16.28
14	67th Avenue	909423.72	612753.23	Gas	09/18/07	1098.92	1094.16	-------	4 1/2" Steel Gas Line N-S	4.76
15	67th Avenue	909445.70	612736.37	Storm Drain	09/19/07	1098.85	1088.01	-------	48"(per plans) Concrete Storm Drain N-S	10.84
									Could Not Expose Entire Pipe Due to Depth and Large Rocks in Soil	
16	67th Avenue	909458.04	612725.01	Water	09/18/07	1098.60	1094.87	-------	9" Concrete Water Line E-W	3.73

TESTHOLE DATA SUMMARY

Preliminary

PREPARED BY:
TBE Group, Inc.
2236 West Shangri-La Rd.
Phoenix, AZ 85029
(602) 749-8550

DATE: October 31, 2007
PROJECT NAME: Bethany Home Outfall Channel - Reach D Design
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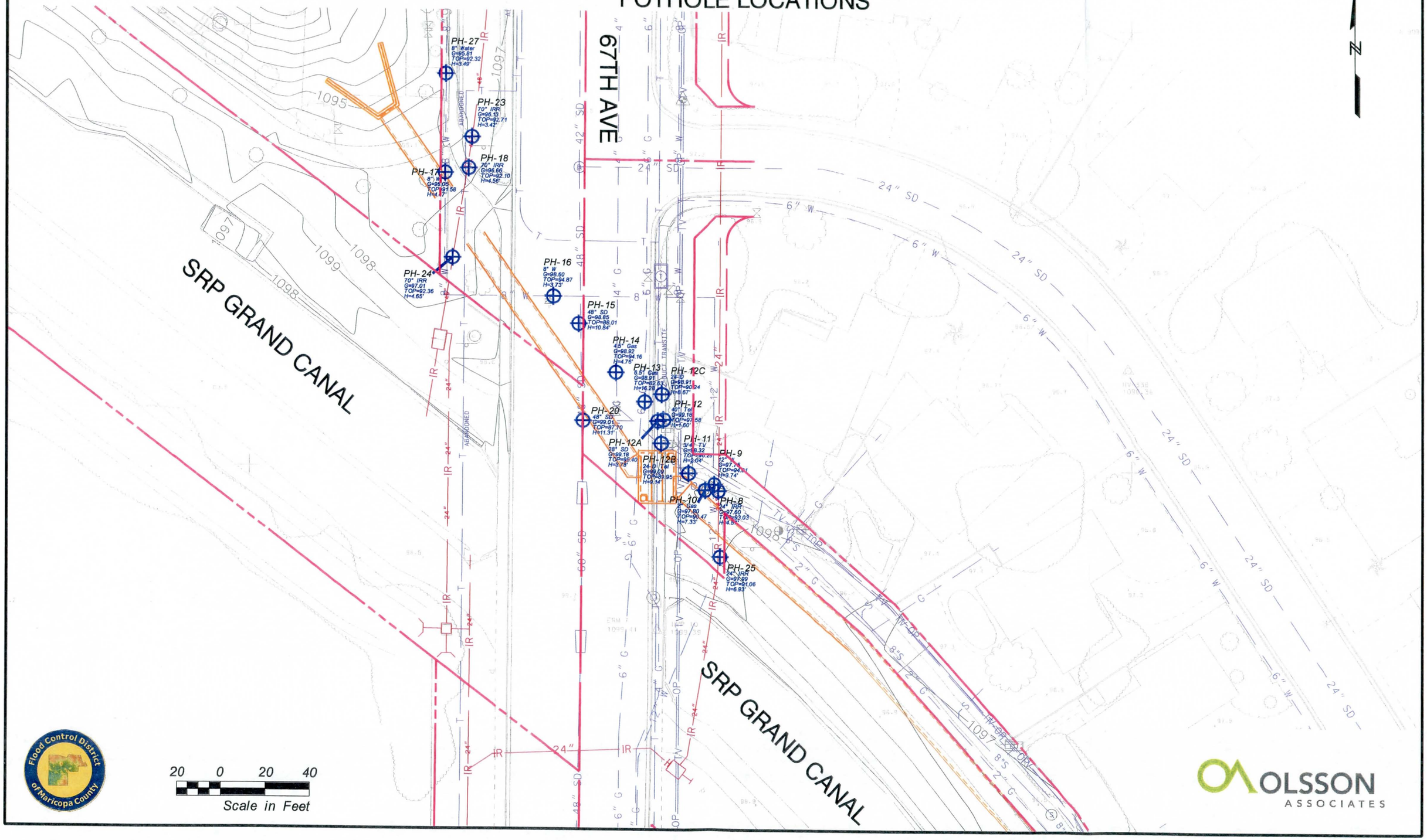
NOTE: The coordinate and elevation values provided below depict the actual utility location. Adjustments were made, as needed, to the surveyed request location.

All Data is English

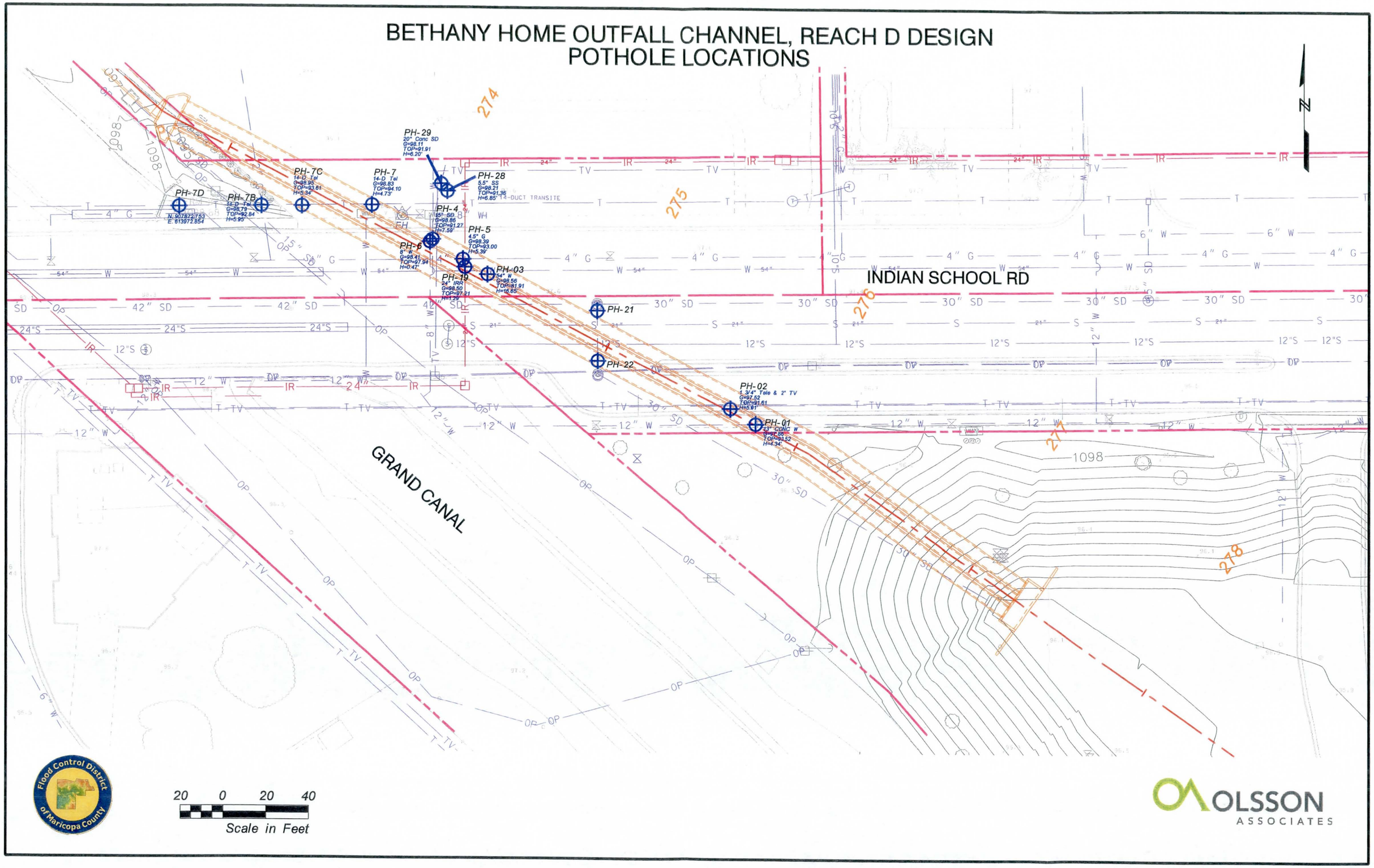
TBE Project Number: AZ096-008-00

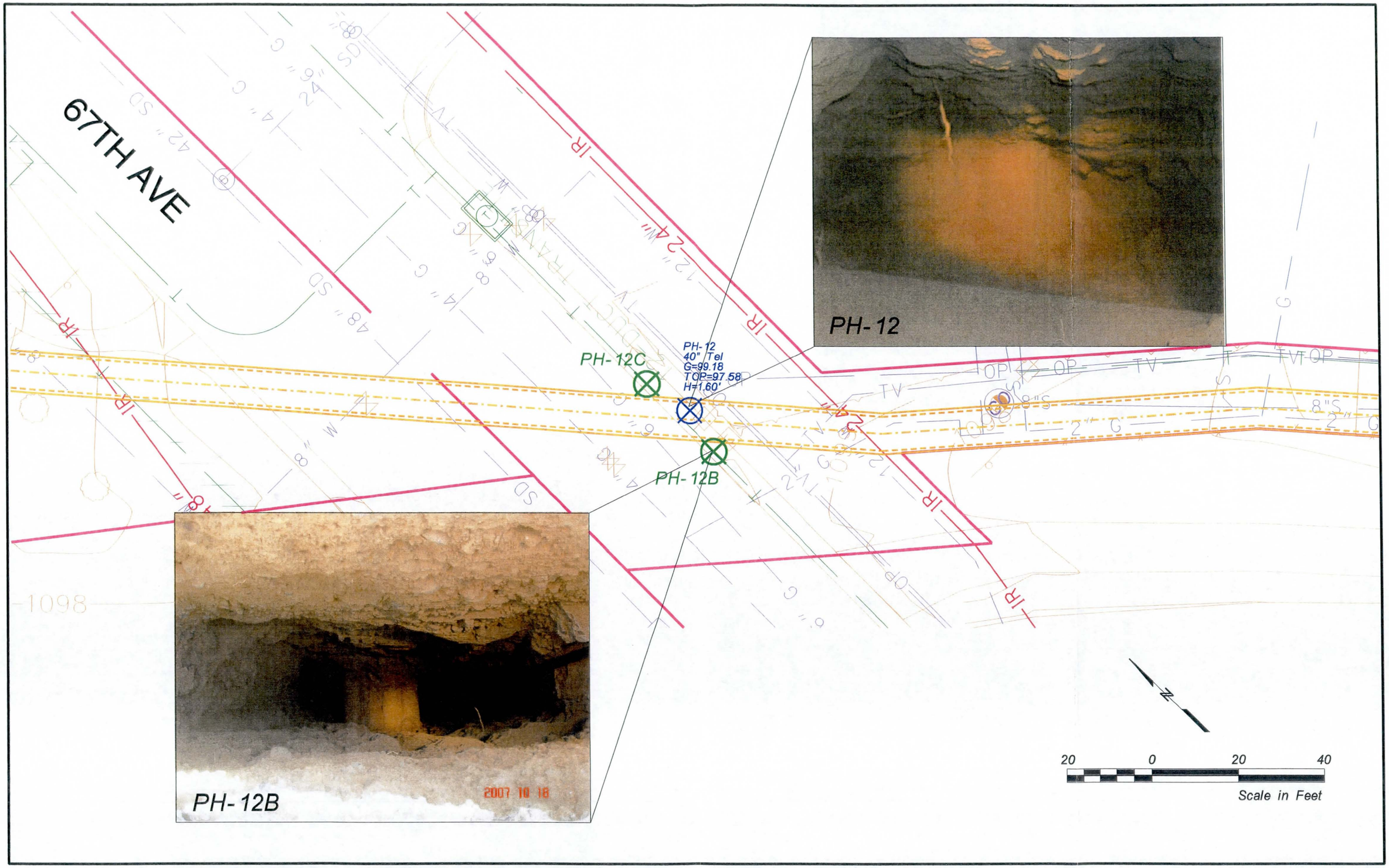
TH#	Street	Coordinates		Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type, Outside Diameter and Comments	Depth of Cover
		Northing	Easting							
17	67th Avenue	909513.84	612676.08	Water	09/12/07	1096.05	1091.58	-------	9" Concrete Water Line N-S	4.47
18	67th Avenue	909515.95	612686.81	Irrigation	10/09/07	1096.66	1092.10	-------	70" Concrete Irrigation N-S	4.56
19	Indian School Rd	907844.71	614106.57	Irrigation	09/20/07	1098.50	1097.21	1093.98	58" Concrete Encasement N-S Lines Up With Old Irrigation Structure on N. Side of Indian School Rd.	1.29
20	Indian School Rd	909401.66	612738.41	Storm Drain	10/23/07	1099.01	1087.70	-------	Exposed half of 48"(per plans) Concrete Storm Drain N-S Couldn't Expose Entire Pipe Due to Depth and Asphalt Chunks in Soil	11.31
21	Indian School Rd	907824.66	614168.71	Storm Drain	05/05/08	1098.28	1097.99	1086.28	South Edge of Manhole Lid	0.29
22	Indian School Rd	907801.20	614168.91	Storm Drain	05/05/08	1097.69	1097.05	1085.25	North Edge of 12" Thick Concrete N. of Manhole	0.64
23	67th Avenue	909530.02	612688.23	Irrigation	09/04/08	1096.13	1092.71	-------	70" Concrete Irrigation & 2" D.B. Cable On Top of Pipe N/S	3.42
24	67th Avenue	909475.22	612679.50	Irrigation	09/03/08	1097.01	1092.36	-------	70" Concrete Irrigation Pipe N/S	4.65
25	67th Avenue	909340.15	612800.83	irrigation	09/03/08	1097.99	1091.06	-------	26" Concrete Irrigation Pipe NW/SE	6.93
26	67th Avenue	909246.01	612782.50			1098.83	1098.83	-------		
27	67th Avenue	909558.69	612676.29	Water	09/04/08	1095.81	1092.32	-------	9" Concrete Water Line N/S	3.49
28	Indian School Rd	907880.52	614098.40	Sewer	09/03/08	1098.21	1091.36	-------	5 1/2" Clay Sewer Pipe N/S	6.85
29	Indian School Rd	907883.98	614095.50	Storm Drain	09/03/08	1098.11	1091.91	-------	20" Concrete Storm Drain NE/SW	6.20

BETHANY HOME OUTFALL CHANNEL, REACH D DESIGN
POTHOLE LOCATIONS



BETHANY HOME OUTFALL CHANNEL, REACH D DESIGN
POTHOLE LOCATIONS

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PH-12C
PH-12
40" Tel
G=99.18
TOP=97.58
H=1.60'
PH-12B
PH-12
PH-12B
2007 10 16
20
0
20
40
Scale in Feet

Appendix G

Structural Calculations

BETHANY HOME OUTFALL CHANNEL REACH-D
STRUCTURAL DESIGN CALCULATIONS
PHOENIX, ARIZONA

OA Project No. 007-1033

Prepared for the Flood Control District of Maricopa County

Prepared by Olsson Associates

September 15, 2008

INDEX OF SHEETS

Sheet	Description
1-2	**Cover Sheet and Design Criteria**
3-21	**Weir Structure Design Calcs**
22-37	**Transition Structure Design Calcs**
38-45	**Inlet Structure Design Calcs**
46-53	**Conflict Structure Calcs**

General Design Criteria

1) Design Code: AASHTO LRFD 4th Edition 2007
2) HS20 Wheel Load of 16 kips
3) One loaded lane with a multiple presence factor of 1.2
4) Concrete Compressive Strength f'_c = 3,000 psi
5) Rebar Yield Strength f_y = 60 ksi
6) At-Rest Equivalent Fluid Pressure EFP = 55 pcf
7) Allowable Bearing Pressure = 3,000 psf
8) Subgrade Modulus = 150 pci
9) Coefficient of Friction = 0.4

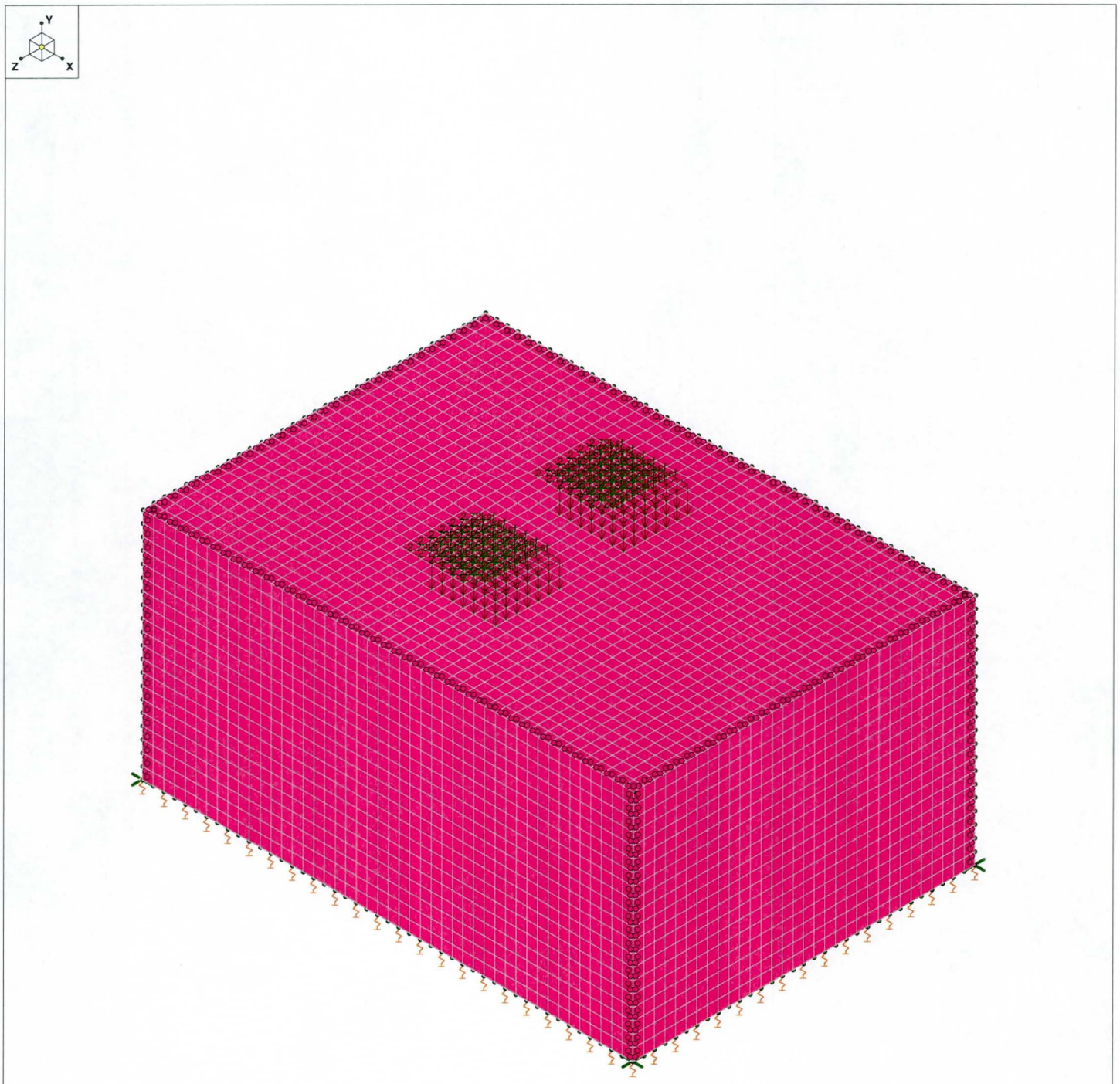
Weir Structure

A 3-dimensional finite element plate model was created in RISA to analyze the weir structure. The top slab, walls and footing were divided into 0.5'x0.5' plates. The loads applied to the structure included self weight, vertical and lateral earth pressure, lateral live load surcharge and vertical vehicular live load. The wheel point loads were applied on the top slab at 6' apart and positioned to create the maximum shear and moment in the slab. The wheel point load was distributed over a 3'x3' area with a multiple presence factor of 1.2 determined according to Art. 4.6.2.10.2. The lane load is not considered for traffic traveling parallel to the span width.

The top slab and wall corners were modeled with simple shear connections, while the wall-to-footing connection was modeled as a rigid moment connection.

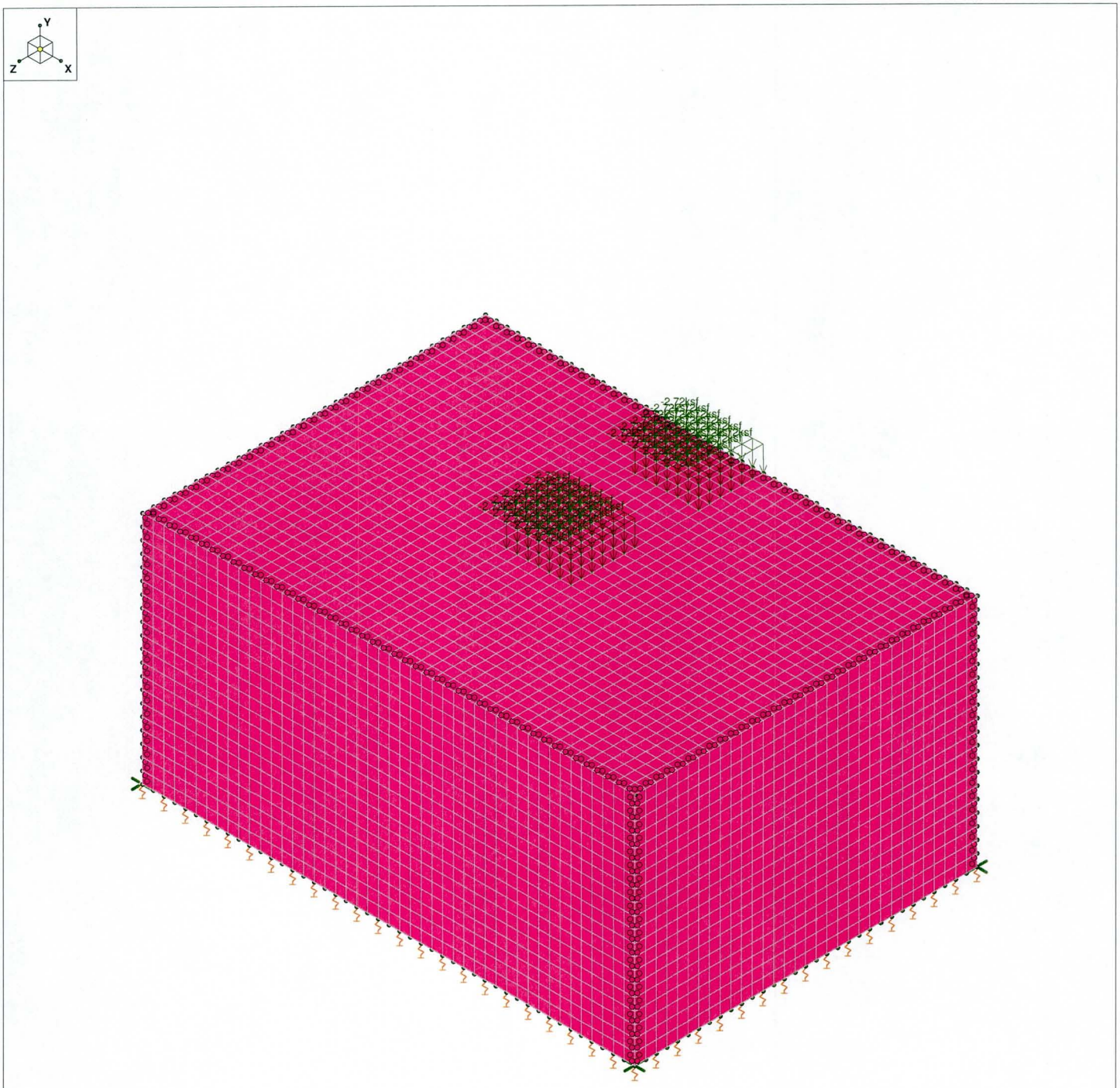
Strength I combination governs for buried structures. For a rigid buried structure, 1.3 was used for vertical earth pressure load factor and 1.35 was used for at-rest horizontal earth pressures load factor. The concrete shear strength for the top slab was modified according to 5.14.5.3. The strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures.

The same flexural reinforcing in the bottom of the top slab was used in each direction using the maximum moment from either direction. The maximum shear was conservatively taken at the support.



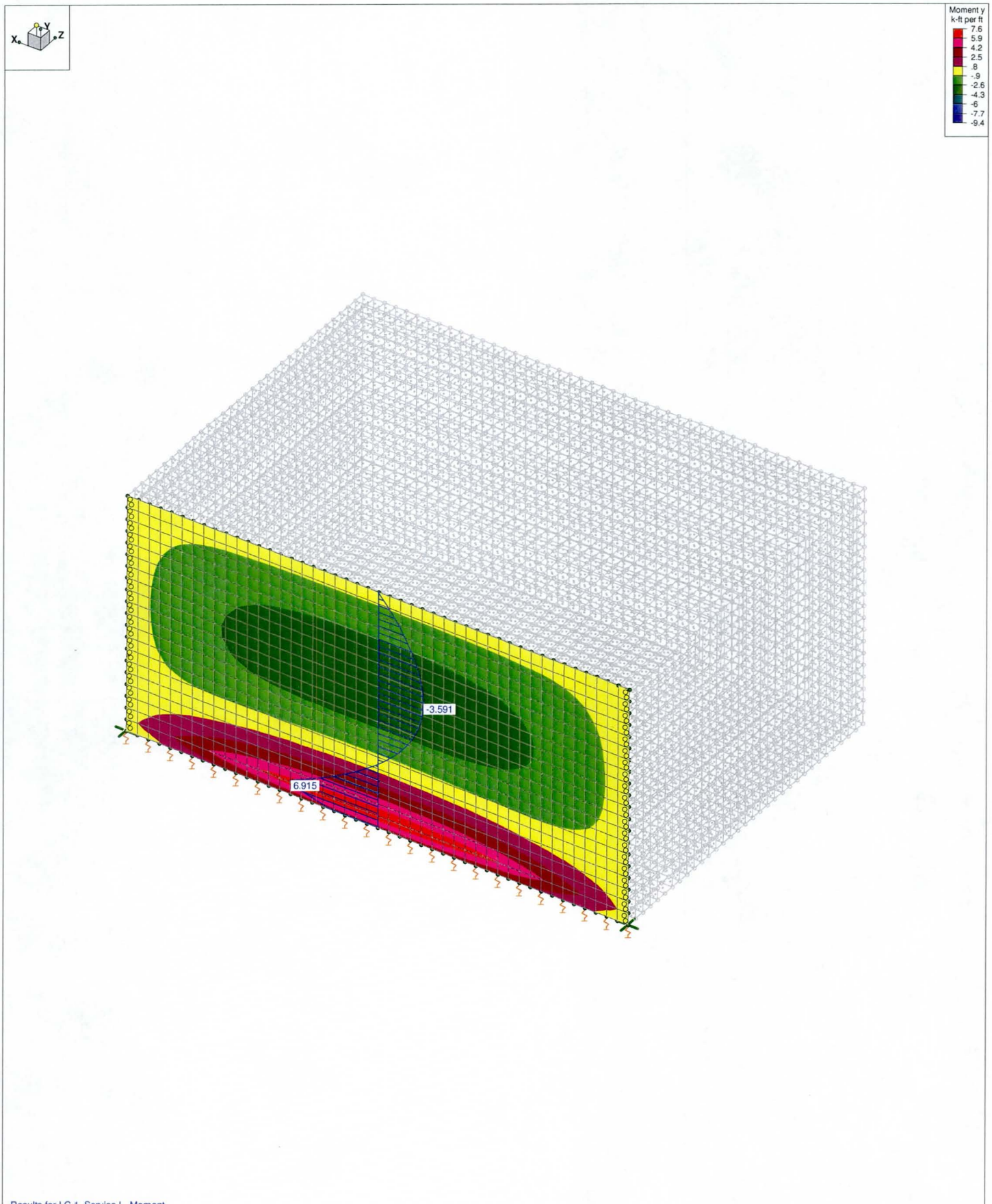
Loads: BLC 5, LL -Vehicular - Moment
Results for LC 1, Service I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 3:00 PM
007-1033	Load Case 1	Weir Box - Plates2.r3d



Loads: BLC 6, LL - Vehicular - Shear
Results for LC 1, Service I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 3:01 PM
007-1033	Load Case 2	Weir Box - Plates2.r3d

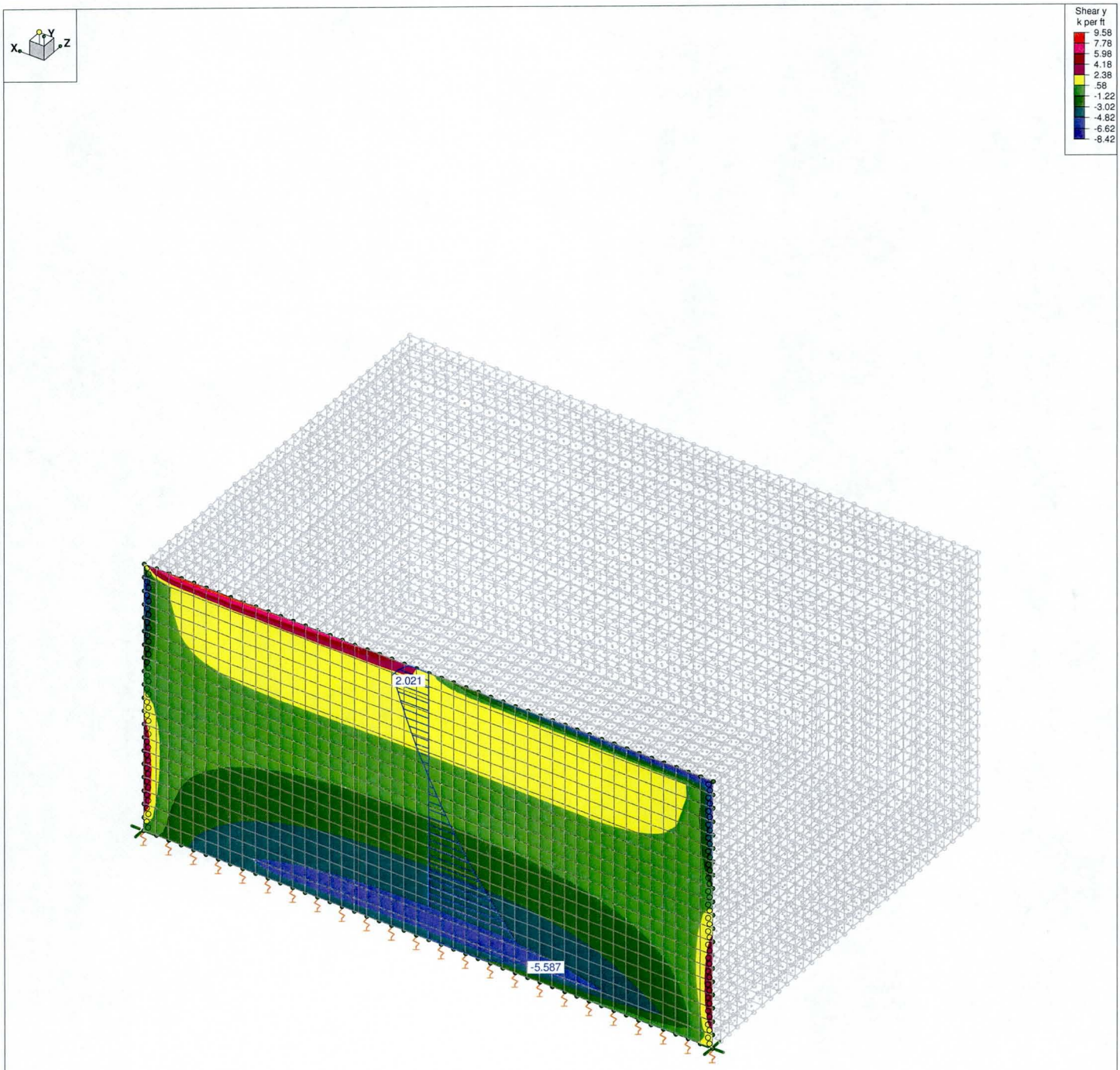


Results for LC 1, Service I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:54 PM
007-1033	Wall	Weir Box - Plates2.r3d

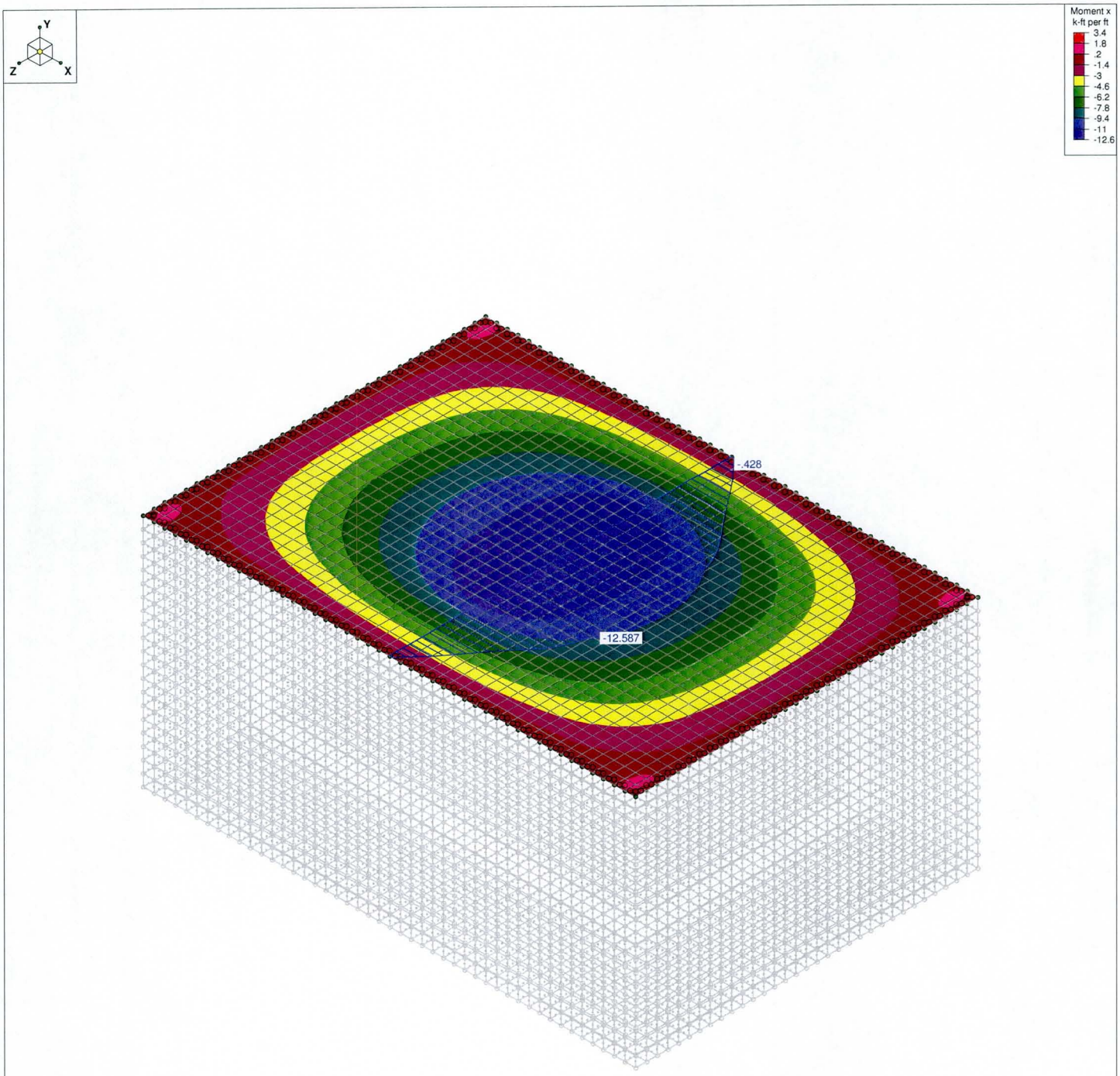
Results for LC 3, Strength I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:53 PM
007-1033	Wall	Weir Box - Plates2.r3d



Results for LC 4, Strength I - Shear

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:55 PM
007-1033	Wall	Weir Box - Plates2.r3d



Results for LC 1, Service I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:45 PM
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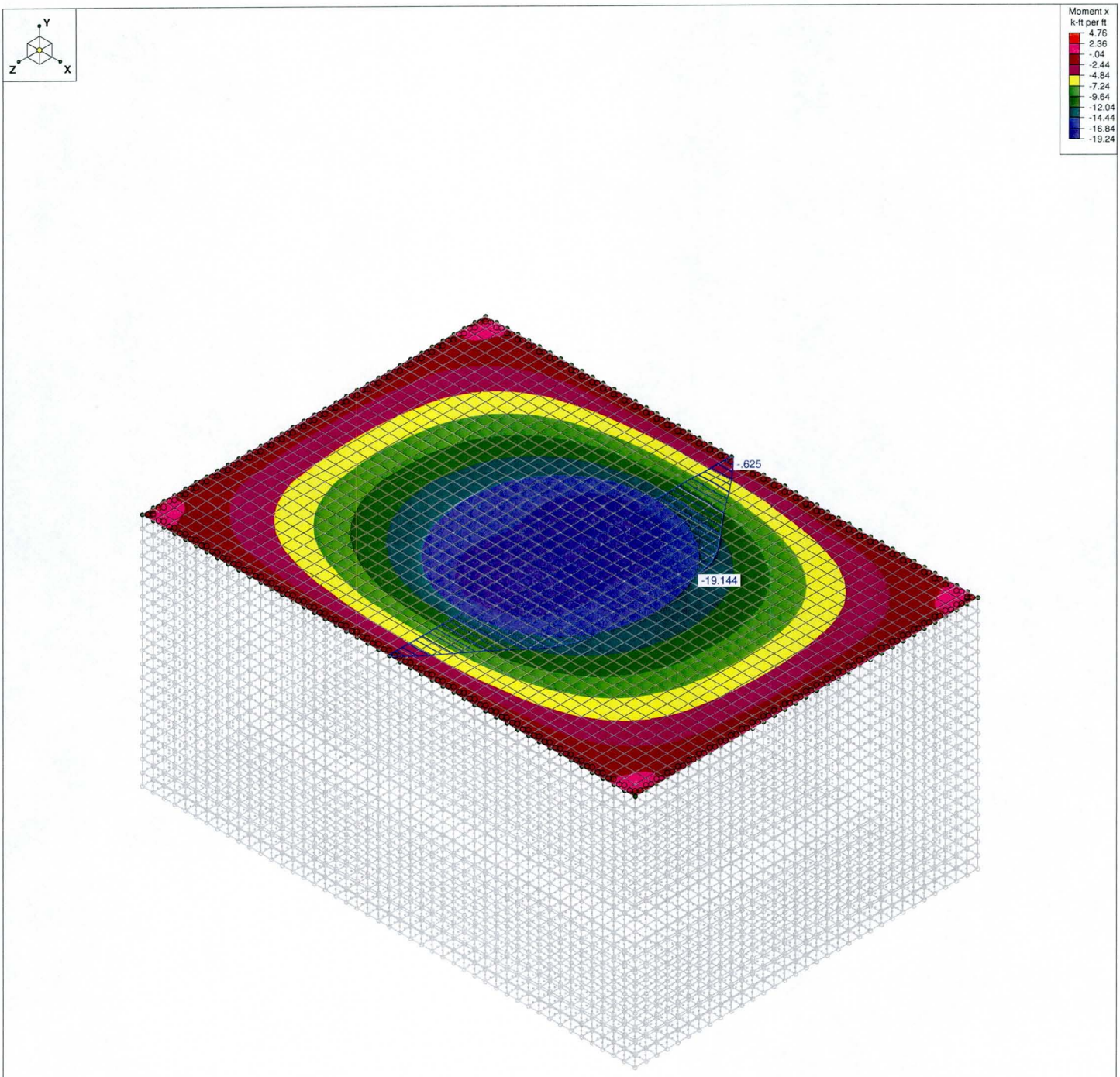
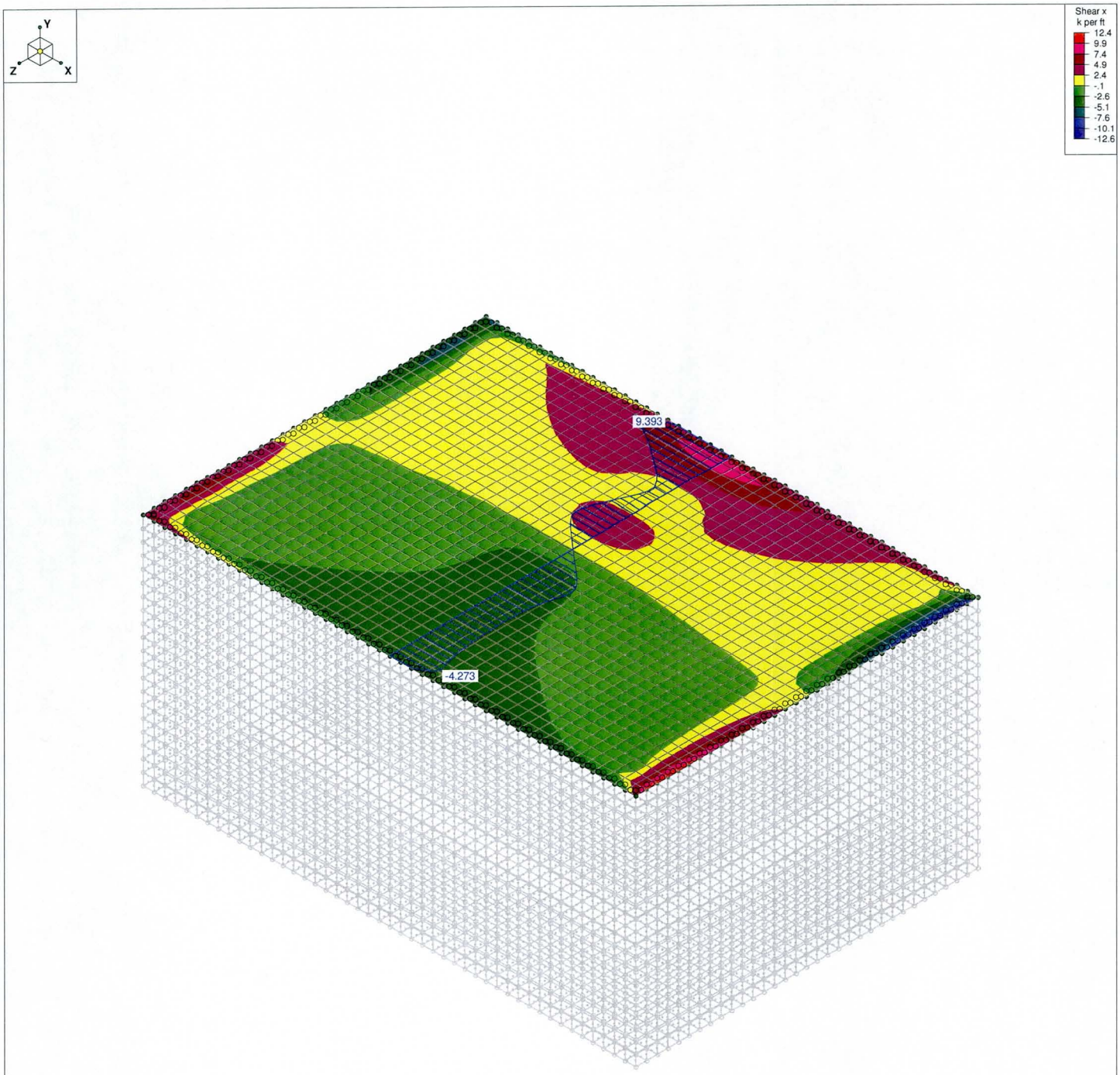


Results for LC 3, Strength I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:44 PM
007-1033	Top Slab	Weir Box - Plates2.r3d

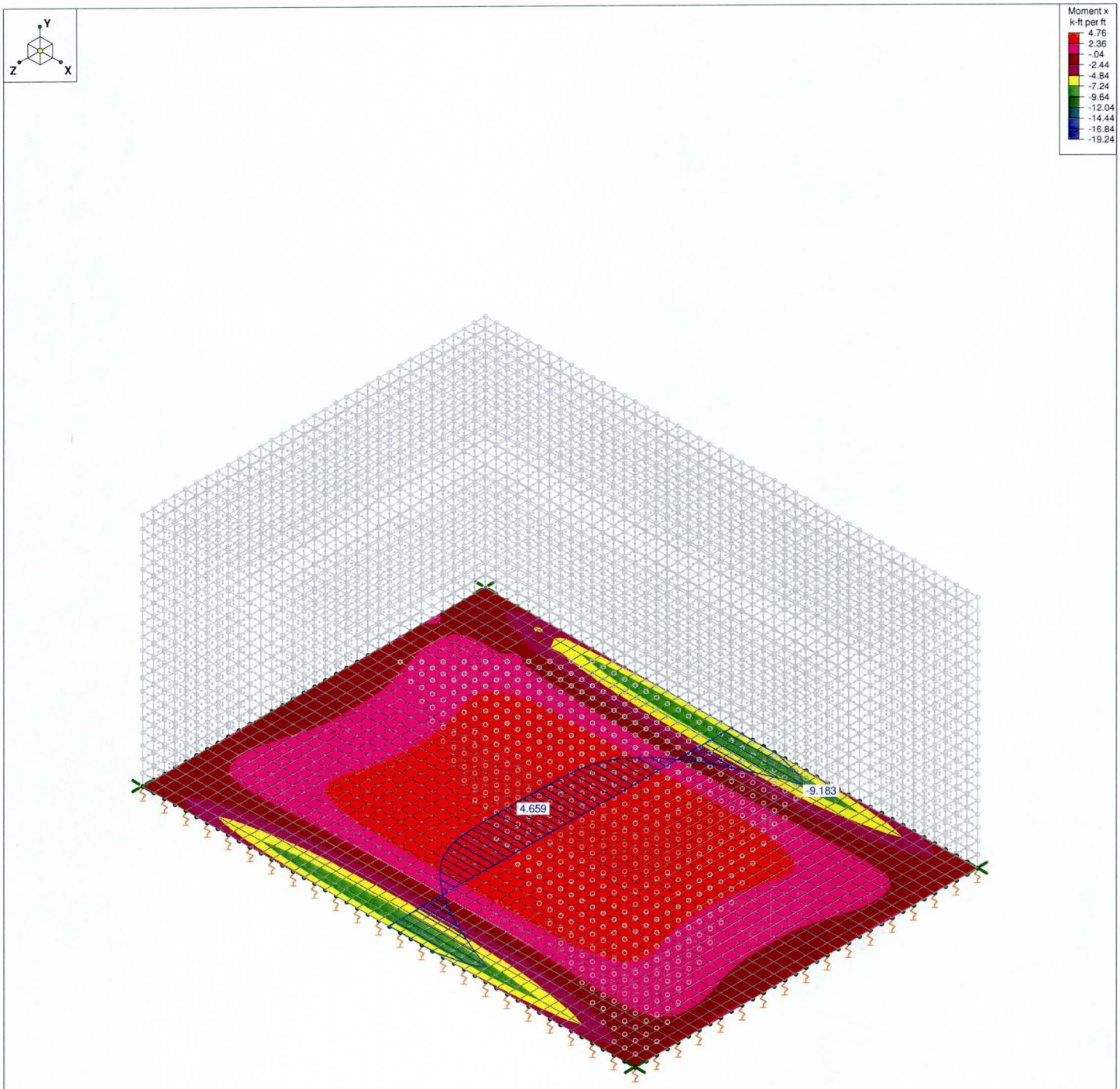


Results for LC 4, Strength I - Shear

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:44 PM
007-1033	Top Slab	Weir Box - Plates2.r3d

Results for LC 1, Service I - Moment

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:58 PM
007-1033	Footing	Weir Box - Plates2.r3d



Results for LC 3, Strength I - Moment

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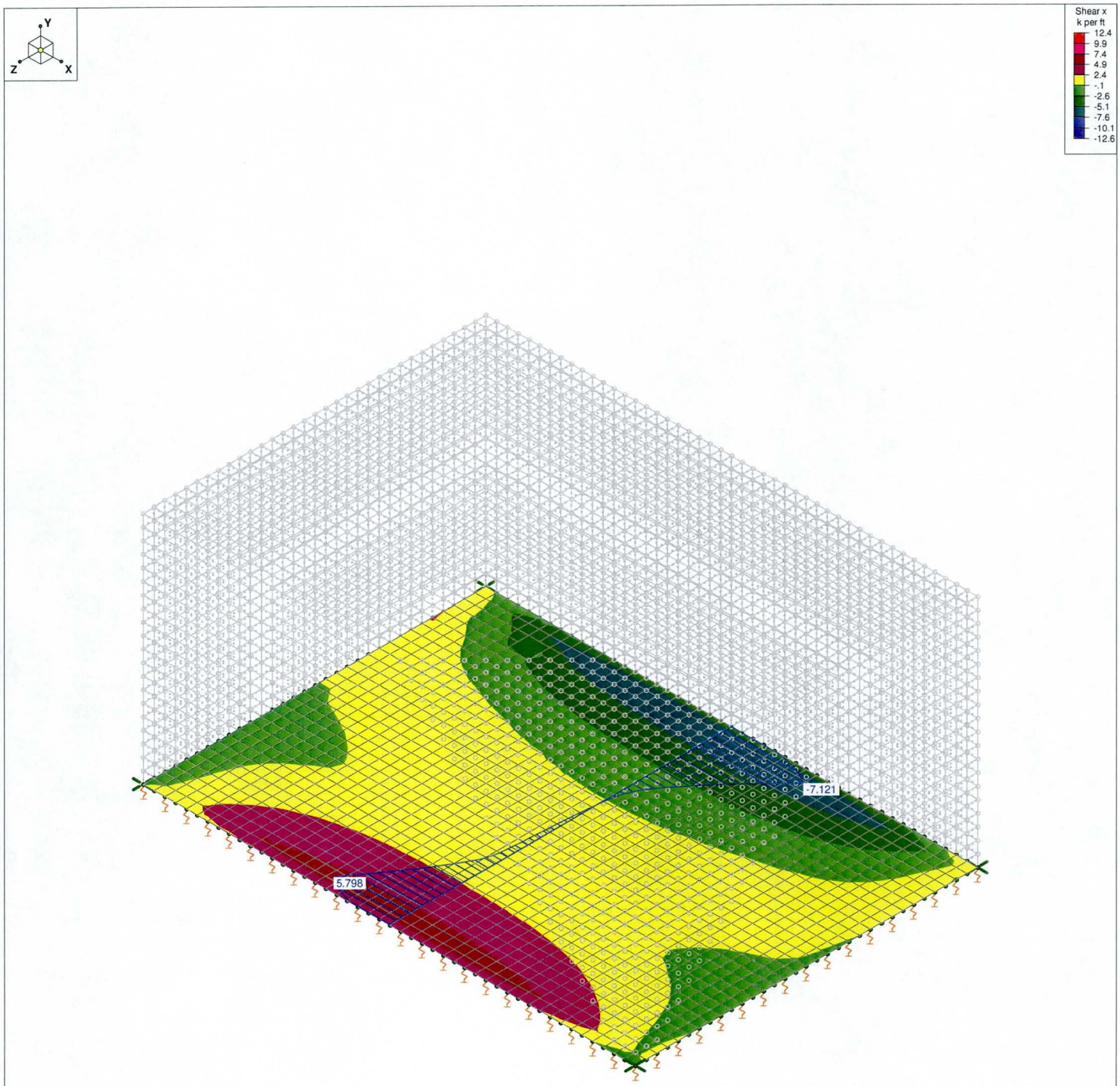
NJS		June 23, 2008 at 2:57 PM
007-1033	Footing	Weir Box - Plates2.r3d



Results for LC 4, Strength I - Shear

OA	Weir Junction Box	
NJS		June 23, 2008 at 2:57 PM
007-1033	Footing	Weir Box - Plates2.r3d

Weir Junction Box Design

R.C. concrete sections are designed according to AASHTO LRFD 2005. Design is based on a per foot of length basis. Fill height is measured from grade to the bottom of the top slab of the box.

Materials

Concrete Strength	f'_c	4.0	ksi
Conc. Mod. of Elast.	E_c	3,834	ksi
Stress Block Coeff.	β_1	0.85	
Rebar Strength	f_y	60	ksi
Steel Mod. of Elast.	E_s	29,000	ksi
Modular Ratio	n	7.6	

Box Dimensions

Top Slab Thickness	TT	14.0	in
Wall Thickness	TW	12.0	in
Bot. Slab Thickness	TB	14.0	in
Total Height	H	11.83	ft

Parameters

Length	L	22.00	ft
Width	W	15.00	ft
Rise	R	9.50	ft
Fill	h_f	2.50	ft
Footing Offset	d	0.33	ft

Soil Data

At-Rest - Drained - Cohesive Soil

Soil Wt.	γ_s	120	pcf
Eq. Fluid Density	γ_{eq}	55	pcf

Dead Loads

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k)
Top Slab	1	1.167	24.000	17.000		150	71.4
Long Walls	2	9.500	23.000	1.000		150	65.6
Short Walls	2	9.500	16.000	1.000		150	45.6
Bottom Slab	1	1.167	24.667	17.667		150	76.3
Earth Fill	1	1.333	24.000	17.000		120	65.3
Earth Fill	1	10.667			27.778	120	35.6
Water Fill	1	4.000	22.000	15.000		62.4	82.4
Concrete Fill	1	5.500	22.000	5.000		150	90.8
Additional Wt.							0.0
Total							**532.8**

Live Loads

The equivalent strip width for fill > 2' is calculated according to Art. 3.6.1.2.6 and for fill < 2' Art. 4.6.2.10 is used. The tire contact width of 20" is also taken into account in calculating the distributed live load. For box culvert loading parallel to the main span, only one loaded lane is considered, however the multiple presence factor of 1.2 still applies.

Wheel Load - Traffic Parallel to Span

Total Span Length	L	24.00	ft
Actual Fill Height	h_{fa}	1.33	ft

Fill Height < L - Must Include Live Load

Wheel Load (HS20)	P	16.0	k
Impact Factor	IM	28	%
Distribution Length	E_{span}	3.00	ft
Distributed Load	w_{LL+IM}	2.720	ksf

Surcharge - Horz. Loads Only

Soil Height	h_s	2.0	ft
Horz. Pressure	p_{LS}	110	psf

Stability

For the live load bearing pressure, the wheel load applied to the top slab is distributed over the bearing area without an increase due to impact. Forces resisting buoyancy include the box self weight and soil weight above the box. The groundwater is assumed to be at the surface and the weight of water inside the box is ignored.

Bearing Capacity (Service Loads)

Bearing Area	A_q	435.78	ft^2
DL Bearing Pressure	q_{DL}	1,223	psf
LL Bearing Pressure	q_{LL}	106	psf
Bearing Pressure	q	1,328	psf
All. Bearing Pressue	q_{all}	3,000	psf
Factor of Safety	**FS**	2.26	**OK**

Buoyancy

Depth to Bot. Slab	z	11.83	ft
Groundwater Depth	z_w	0.00	ft
Buoyant Force	P_b	311.1	k
Self Weight	P_w	450.4	k
Factor of Safety	**FS**	1.45	**OK > 1.1**

Top Slab Design

Designed as a simple span slab with the clear span length used to calculate forces. Strength I combination governs for buried structures. For a rigid buried structure, 1.3 is used for vertical earth pressure. Concrete shear strength is modified according to 5.14.5.3. Strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures. The maximum shear force is taken at the support.

Parameters

Slab Thickness	TT	14.00	in

Loads

Self Weight	w_{DC}	0.175	ksf
Soil Load	w_{EV}	0.160	ksf
Wheel Live Load	w_{LL+IM}	2.720	k/ft

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	11.56	in
Conc. Shear Strength	V_c	22.9	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	9.4	k/ft
Reduced Nom. Cap.	ΦV_c	19.5	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.48	**OK**

Flexure (Short Bottom Bars) Use #7 @ 8 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	14.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 7	
Spacing		8.0	in
Bar Diameter	d_b	0.88	in
Area of Steel	A_s	0.90	in^2/ft
Steel Depth	d	11.56	in
Eq. Stress Depth	a	1.32	in
Neutral Axis Depth	c	1.56	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	7.13	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	23	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0193	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	29.0	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	25.5	k·ft/ft
Min. Moment Capacity	M_{min}	25.5	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	12.6	k·ft/ft
Service Stress in Reinf.	f_{ss}	14.7	ksi
Concrete Cover	d_c	2.44	
Clear Cover Factor	β_s	1.30	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	19.2	k·ft/ft
Reduced Nom. Cap.	ΦM_n	44.1	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.43	**OK**

Wall Design

Designed with a simple connection to the top slab and a rigid connection to the footin. Strength I combination governs for buried structures. For a rigid buried structure, 1.35 is used for at-rest horizontal earth pressure. Maximum shear is taken at the face of the bottom slab. Axial load is not taken into consideration.

Parameters

Outer Wall Thickness	TW	12.00	in

Loads

Earth Press. @ Top	p_{EH}	0.138	k/ft
Earth Press. @ Bot.	p_{EH}	0.660	k/ft
LL Surcharge	p_{LS}	0.110	k/ft

Shear

Concrete - Art. 5.8.3.4.1

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	9.63	in
Conc. Shear Strength	V_c	14.6	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	5.6	k/ft
Reduced Nom. Cap.	ΦV_c	12.4	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.45	**OK**

Flexure (Inside Face)

Use #4 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 4	
Spacing		12.0	in
Bar Diameter	d_b	0.50	in
Area of Steel	A_s	0.20	in^2/ft
Steel Depth	d	9.75	in
Eq. Stress Depth	a	0.29	in
Neutral Axis Depth	c	0.35	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.50	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	8	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0815	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	21.3	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	7.0	k·ft/ft
Min. Moment Capacity	M_{min}	7.0	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	3.6	k·ft/ft
Service Stress in Reinf.	f_{ss}	22.3	ksi
Concrete Cover	d_c	2.25	
Clear Cover Factor	β_s	1.33	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	5.3	k·ft/ft
Reduced Nom. Cap.	ΦM_n	8.6	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.61	**OK**

Flexure (Corner Bars) — Use #6 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 6	
Spacing		12.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.44	in^2/ft
Steel Depth	d	9.63	in
Eq. Stress Depth	a	0.65	in
Neutral Axis Depth	c	0.76	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.25	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	17	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0349	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	21.3	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	12.6	k·ft/ft
Min. Moment Capacity	M_{min}	12.6	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	6.9	k·ft/ft
Service Stress in Reinf.	f_{ss}	19.8	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	9.5	k·ft/ft
Reduced Nom. Cap.	ΦM_n	18.4	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.52	**OK**

Footing Design

Designed with rigid connections to the walls. The maximum moment and shear are taken from the RISA analysis. Loads are applied to the top slab and transfered into the footing. The subgrade modulus is taken as 150 pci.

Parameters

Footing Thickness	TB	14.00	in

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	11.63	in
Conc. Shear Strength	V_c	17.6	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	7.2	k/ft
Reduced Nom. Cap.	ΦV_c	15.0	k/ft
Utilization Ratio	V_u / ΦV_c	0.48	**OK**

Flexure (Top Bars) — Use #6 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	14.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 6	
Spacing		12.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.44	in^2/ft
Steel Depth	d	11.63	in
Eq. Stress Depth	a	0.65	in
Neutral Axis Depth	c	0.76	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.25	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	17	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0428	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	29.0	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	6.8	k·ft/ft
Min. Moment Capacity	M_{min}	6.8	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	3.7	k·ft/ft
Service Stress in Reinf.	f_{ss}	8.7	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.29	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	5.1	k·ft/ft
Reduced Nom. Cap.	ΦM_n	22.4	k·ft/ft
Utilization Ratio	M_u / ΦM_n	0.23	**OK**

Flexure (Corner Bars) — Use #6 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	14.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 6	
Spacing		12.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.44	in^2/ft
Steel Depth	d	11.63	in
Eq. Stress Depth	a	0.65	in
Neutral Axis Depth	c	0.76	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.25	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	17	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0428	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	29.0	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	12.5	k·ft/ft
Min. Moment Capacity	M_{min}	12.5	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	6.7	k·ft/ft
Service Stress in Reinf.	f_{ss}	15.9	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.29	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	9.4	k·ft/ft
Reduced Nom. Cap.	ΦM_n	22.4	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.42	**OK**

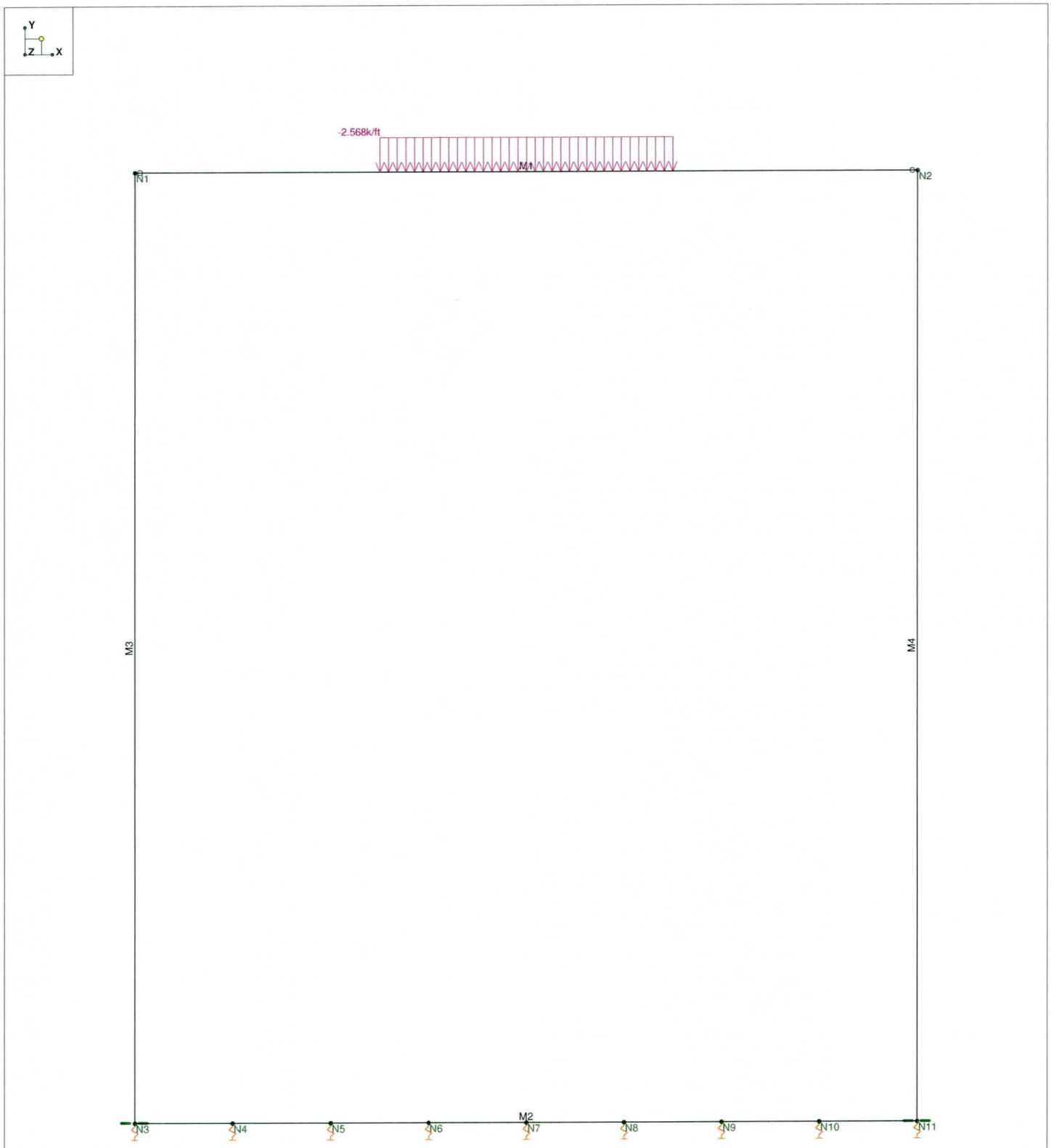
Transition Structure

The transition structure was designed as a one-way slab since the span ratios > 2. A two-dimensional stick model was created in RISA to analyze the structure. The loads applied to the structure included self weight, vertical and lateral earth pressure, lateral live load surcharge and vertical vehicular live load. The wheel point load was applied on the top slab and positioned to create the maximum shear and moment in the slab. The wheel point load was distributed over a 3.08' width with a multiple presence factor of 1.2 determined according to Art. 4.6.2.10.2. The lane load is not considered for traffic traveling parallel to the span width.

The top slab and wall corners were modeled with simple shear connections, while the wall-to-footing connection was modeled as a rigid moment connection.

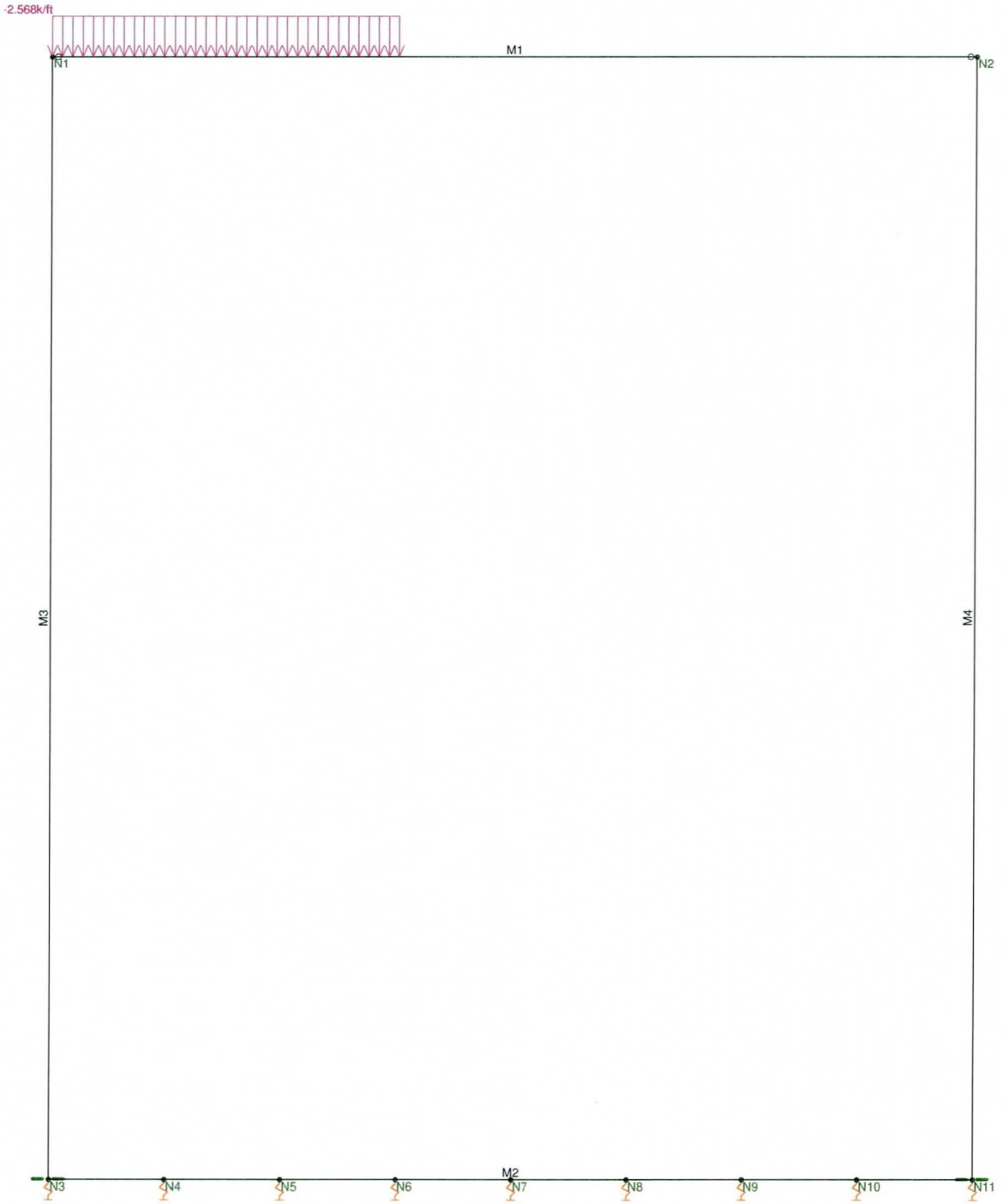
Strength I combination governs for buried structures. For a rigid buried structure, 1.3 was used for the vertical earth pressure load factor and 1.35 was used for the at-rest horizontal earth pressures load factor. The concrete shear strength for the top slab was modified according to 5.14.5.3. The strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures.

The same flexural reinforcing in the bottom of the top slab was used in each direction using the maximum moment from either direction. The maximum shear was conservatively taken at the support.



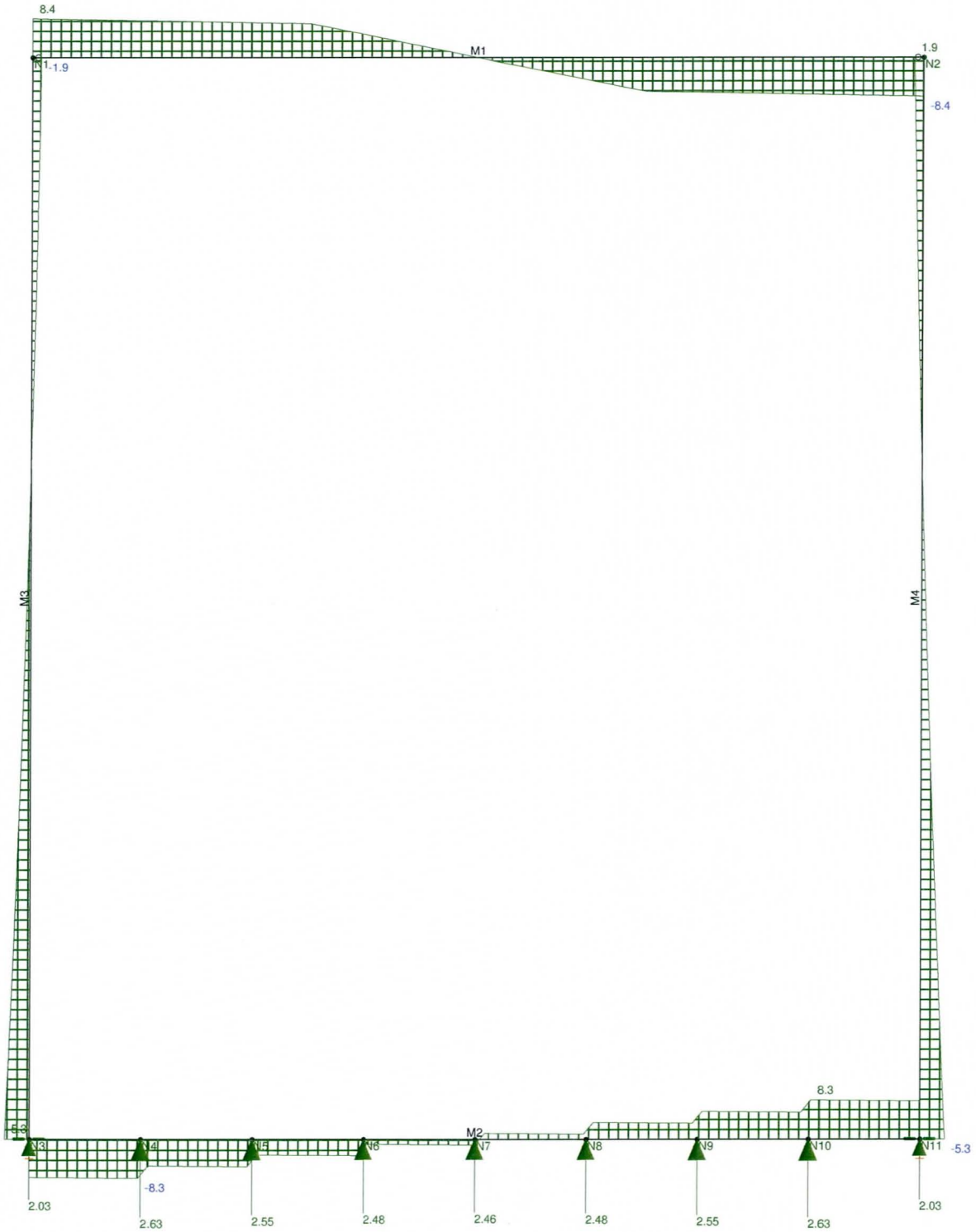
Loads: BLC 5, LL+IM - Case 1
Results for LC 2, Strength I

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:19 PM
007-1033	LL Case 1	Transition Box.r3d



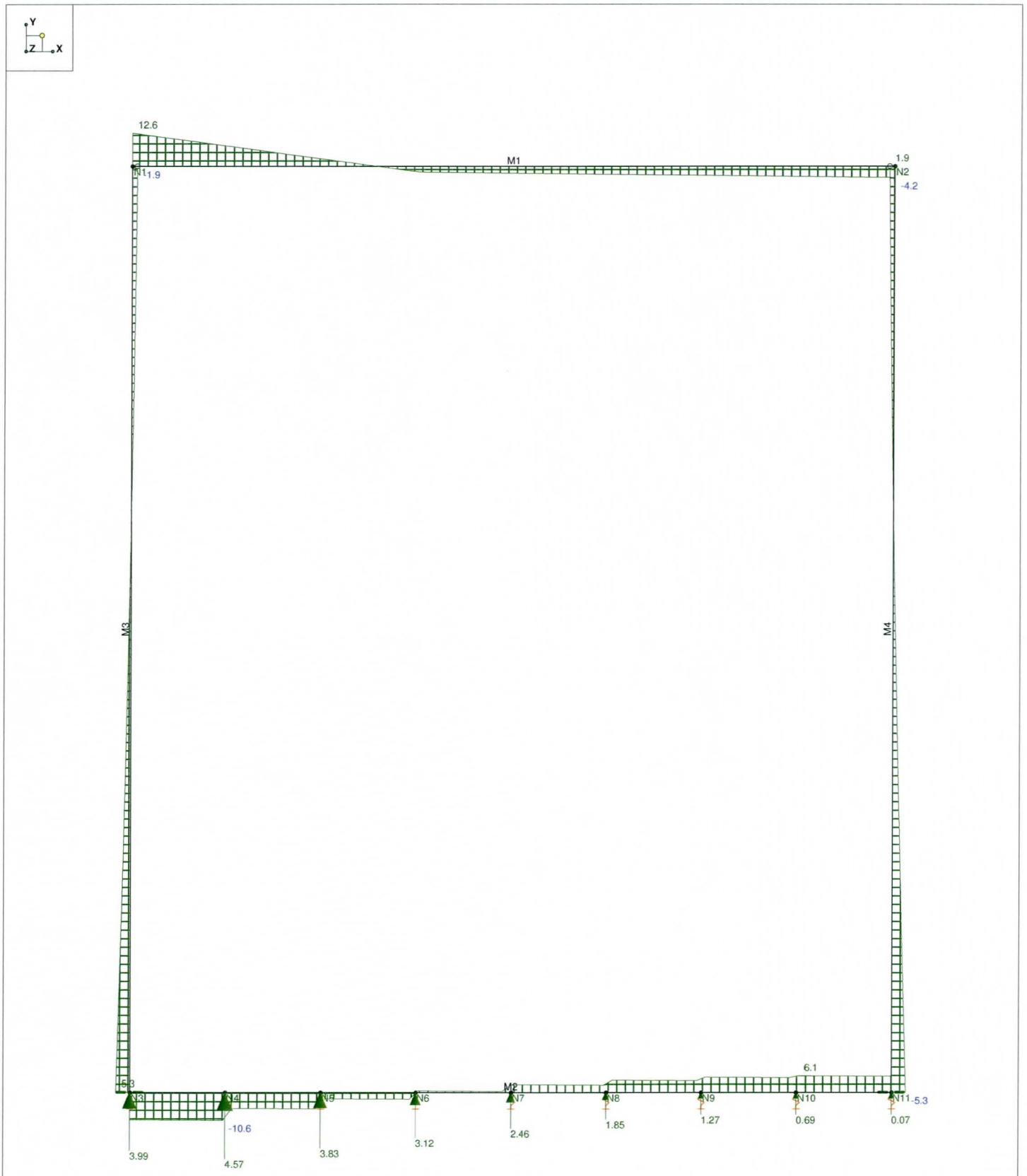
Loads: BLC 6, LL + IM - Case 2
Results for LC 2, Strength I

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:22 PM
007-1033	Load Case 2	Transition Box.r3d



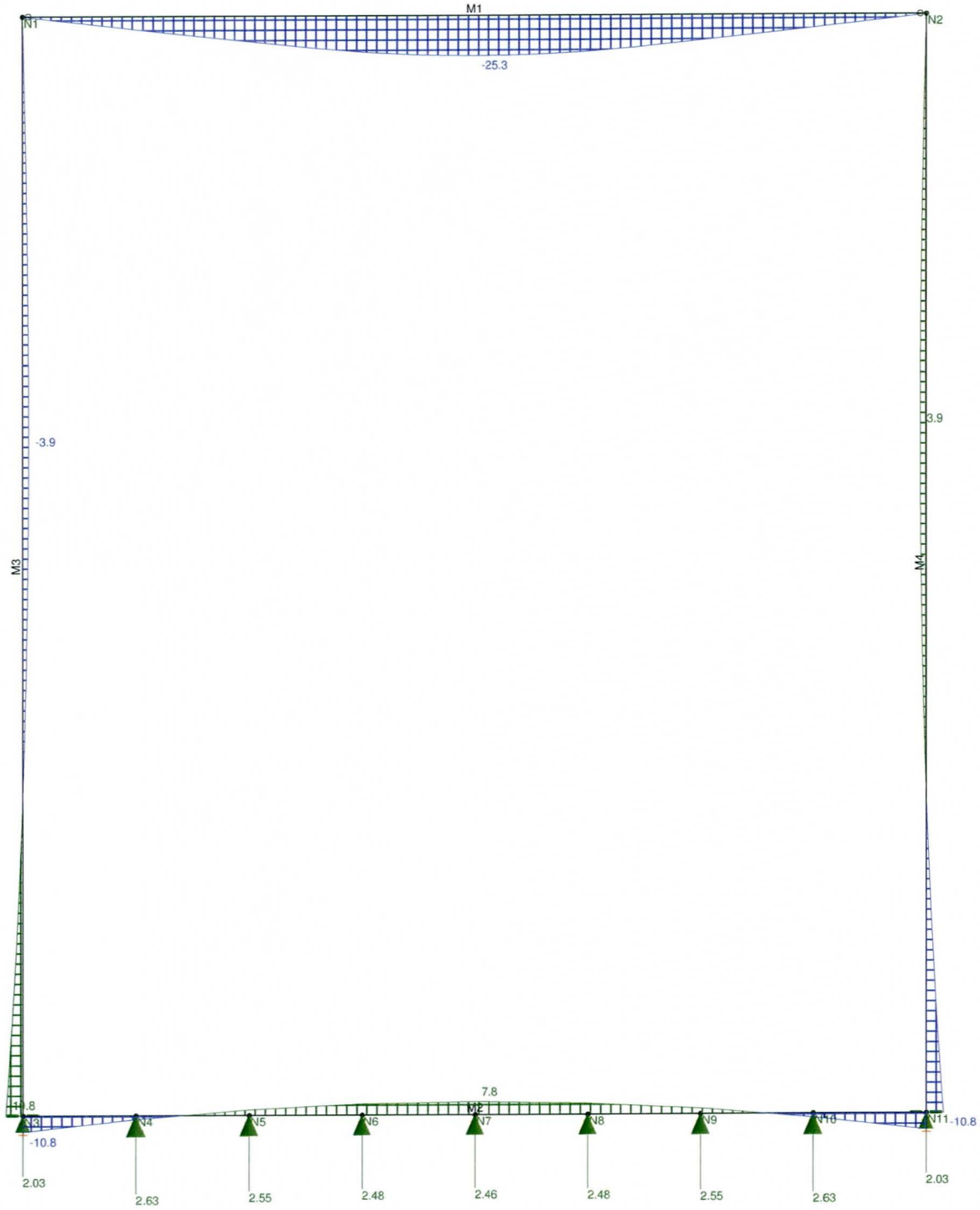
Results for LC 3, Strength I - Case 1
Member y Shear Forces (k)
Reaction units are k and k-ft

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:27 PM
007-1033		Transition Box.r3d



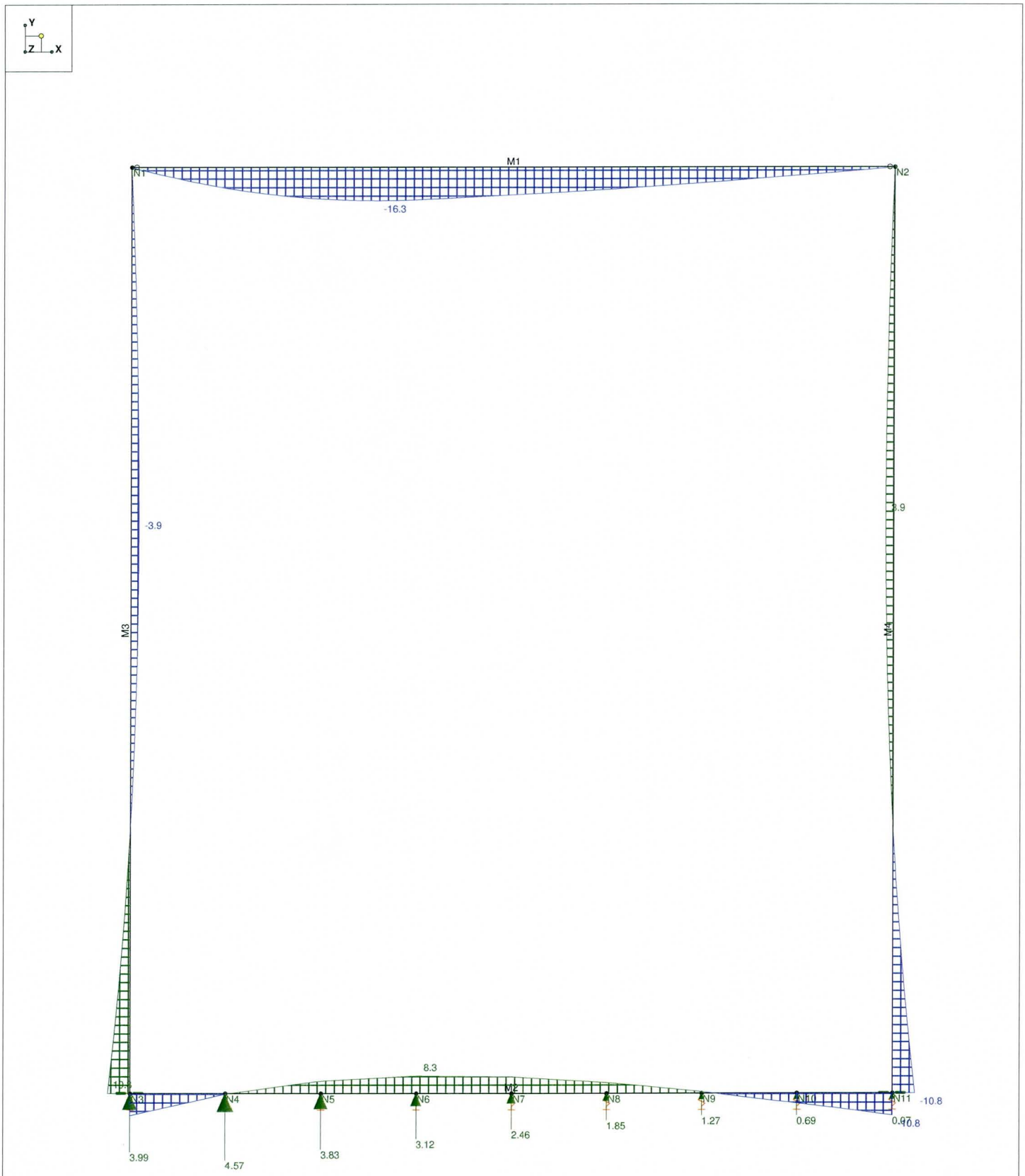
Results for LC 4, Strength I - Case 2
Member y Shear Forces (k)
Reaction units are k and k-ft

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:27 PM
007-1033		Transition Box.r3d



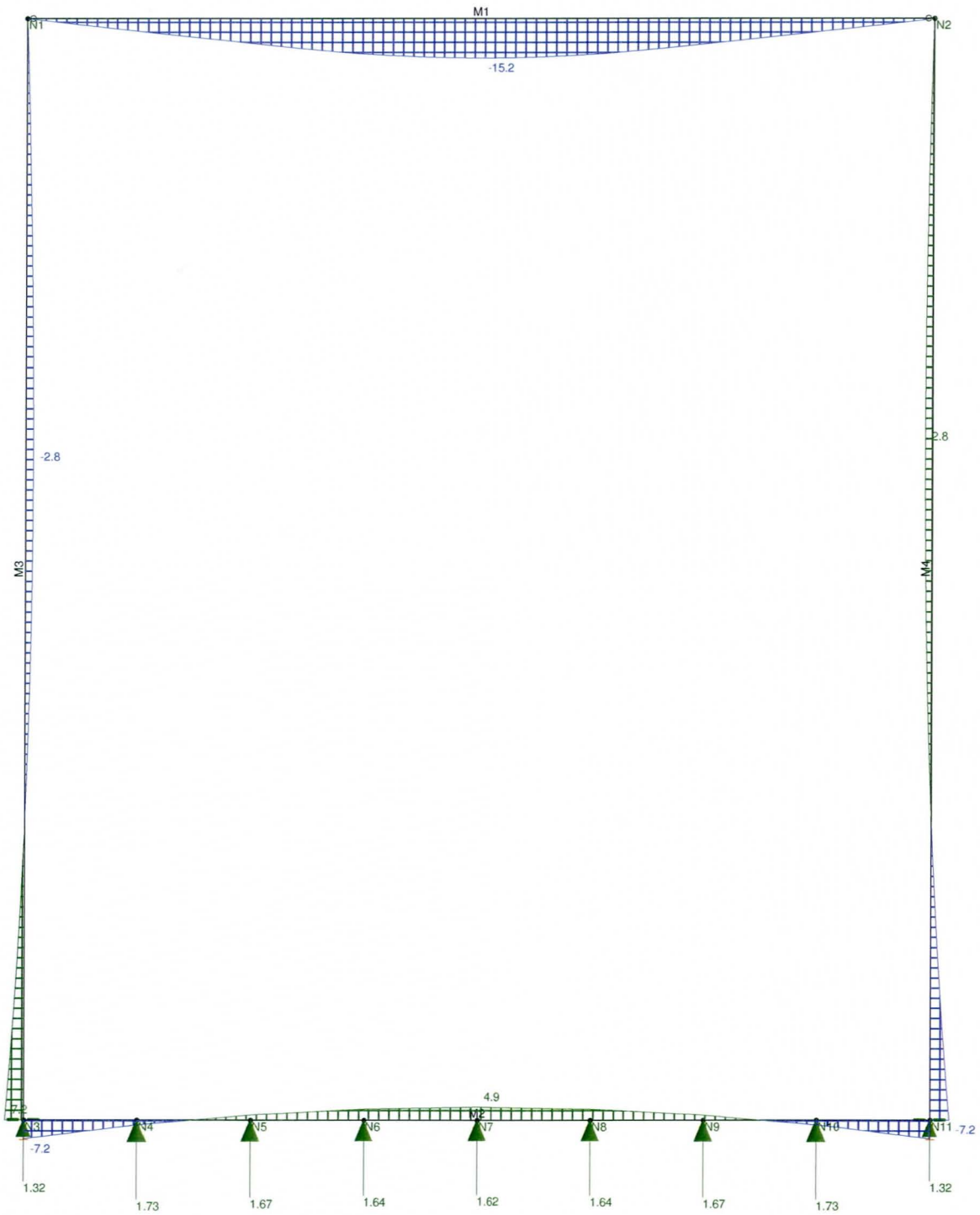
Results for LC 3, Strength I - Case 1
Member z Bending Moments (k-ft)
Reaction units are k and k-ft

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:26 PM
007-1033		Transition Box.r3d



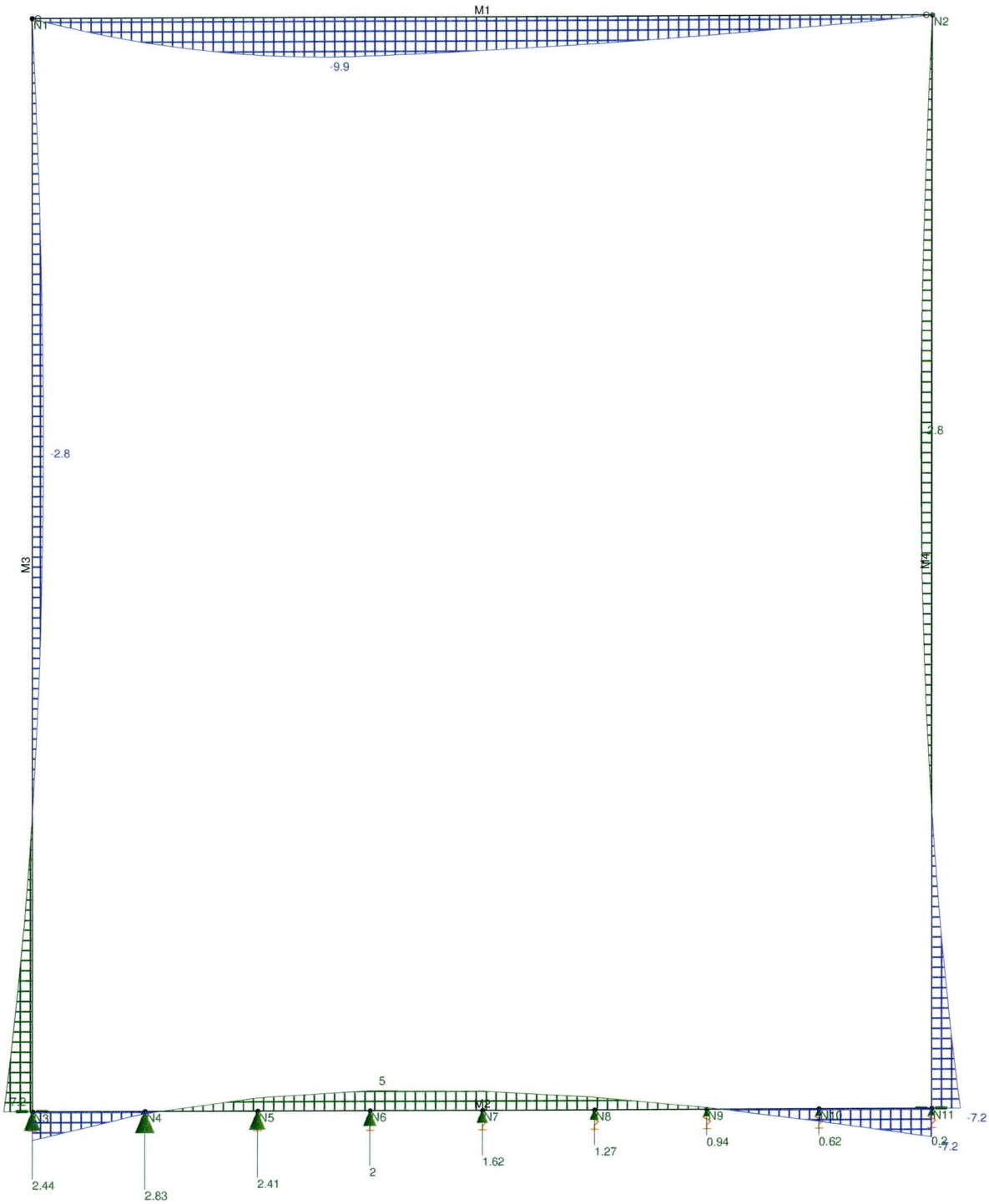
Results for LC 4, Strength I - Case 2
Member z Bending Moments (k-ft)
Reaction units are k and k-ft

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:26 PM
007-1033		Transition Box.r3d



Results for LC 1, Service I - Case 1
Member z Bending Moments (k-ft)
Reaction units are k and k-ft

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:25 PM
007-1033		Transition Box.r3d



Results for LC 2, Service I - Case 2
Member z Bending Moments (k-ft)
Reaction units are k and k-ft

Olsson Associates	Transition Structure	
NJS		June 23, 2008 at 4:25 PM
007-1033		Transition Box.r3d

Transition Structure Design

R.C. concrete sections are designed according to AASHTO LRFD 2005. Design is based on a per foot of length basis. Fill height is measured from grade to the bottom of the top slab of the box.

Materials

Concrete Strength	f'_c	3.0	ksi
Conc. Mod. of Elast.	E_c	3,321	ksi
Stress Block Coeff.	β_1	0.85	
Rebar Strength	f_y	60	ksi
Steel Mod. of Elast.	E_s	29,000	ksi
Modular Ratio	n	8.7	

Soil Data

At-Rest - Drained - Cohesive Soil

Soil Wt.	γ_s	120	pcf
Eq. Fluid Density	γ_{eq}	55	pcf

Parameters

Span	S	8.00	ft
Rise	R	9.75	ft
Fill	h_f	2.50	ft
Footing Offset	d	0.33	ft

Box Dimensions

Wall Thickness	TW	10.0	in
Top Slab Thickness	TT	12.0	in
Top Slab Width	BT	9.67	ft
Bot. Slab Thickness	TB	12.0	in
Bot. Slab Width	BB	10.33	ft
Total Height	H	11.75	ft

Dead Loads

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k/ft)
Top Slab	1	1.000	9.667	1.000		150	1.450
Walls	2	0.833	9.750	1.000		150	2.438
Bottom Slab	1	1.000	10.333	1.000		150	1.550
Earth Fill	1			1.000	22.667	120	2.720
Water Fill	1	4.000	8.000	1.000		62.4	1.997
Concrete Fill	1	5.500	8.000	1.000		150.0	6.600
Additional Wt.							0.000
Total							**16.754**

Live Loads

The equivalent strip width for fill > 2' is calculated according to Art. 3.6.1.2.6 and for fill < 2' Art. 4.6.2.10 is used. The tire contact width of 20" is also taken into account in calculating the distributed live load. For box culvert loading, only one loaded lane is considered, however the multiple presence factor of 1.2 still applies.

Wheel Load - Traffic Parallel to Span

Total Span Length	L	9.67	ft
Actual Fill Height	h_{fa}	1.50	ft

Fill Height < L - Must Include Live Load

Axle Load (HS20)	P	16.0	k
Impact Factor	IM	27	%
Distribution Length	E_{span}	3.17	ft
Wheel Load	w	2.428	ksf

Surcharge - Horz. Loads Only

Soil Height	h_s	2.0	ft
Horz. Pressure	p	110	psf

Stability

For the live load bearing pressure, the wheel load applied to the top slab is distributed over the bearing area without an increase due to impact. Forces resisting buoyancy include the box self weight and soil weight above the box. The groundwater is

Bearing Capacity (Service Loads)

Bearing Area	A_q	10.33	ft^2
DL Bearing Pressure	q_{DL}	1,621	psf
LL Bearing Pressure	q_{LL}	538	psf
Bearing Pressure	q	2,160	psf
All. Bearing Pressue	q_{all}	3,000	psf
Factor of Safety	**FS**	**1.39**	**OK**

Buoyancy

Depth to Bot. Slab	z	13.25	ft
Groundwater Depth	z_w	0.00	ft
Buoyant Force	P_b	7.1	k
Self Weight	P_w	8.2	k
Factor of Safety	**FS**	**1.15**	**OK > 1.1**

Top Slab Design

Designed as a simple span slab with the clear span length used to calculate forces. Strength I combination governs for buried structures. For a rigid buried structure, 1.3 is used for vertical earth pressure. Concrete shear strength is modified according to 5.14.5.3. Strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures.

Parameters

Slab Thickness	TT	12.00	in

Loads

Self Weight	w_{DC}	0.150	ksf
Soil Load	w_{EV}	0.180	ksf
Distr. Live Load	w_{LL}	2.428	ksf

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	9.63	in
Conc. Shear Strength	V_c	16.6	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	12.6	k/ft
Reduced Nom. Cap.	ΦV_c	14.1	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.90	**OK**

Flexure (Bot. Bars)

Use #6 @ 8 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 6	
Spacing		8.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.66	in^2/ft
Steel Depth	d	9.63	in
Eq. Stress Depth	a	1.29	in
Neutral Axis Depth	c	1.52	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	7.25	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	20	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0160	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	33.6	k·ft/ft
Min. Moment Capacity	M_{min}	18.5	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	15.2	k·ft/ft
Service Stress in Reinf.	f_{ss}	29.7	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	11.9	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	25.3	k·ft/ft
Reduced Nom. Cap.	ΦM_n	26.7	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.95	**OK**

Wall Design

Designed with a simple connection to the top slab and a rigid connection to the bottom slab. Clear span length is used to calculate forces. Strength I combination governs for buried structures. For a rigid buried structure, 1.35 is used for at-rest horizontal earth pressure. Maximum shear is taken at the face of the bottom slab. Axial load is not taken into consideration.

Parameters

Outer Wall Thickness	TW	10.00	in
Span Length	L	9.75	ft
Point of Contraflexure	x	2.06	ft

Loads

Earth Press. @ Top	p_{EH}	0.138	k/ft
Earth Press. @ Bot.	p_{EH}	0.674	k/ft
LL Surcharge	p_{LS}	0.110	k/ft

Shear

Concrete - Art. 5.8.3.4.1

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	7.56	in
Conc. Shear Strength	V_c	9.9	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	5.3	k/ft
Reduced Nom. Cap.	ΦV_c	8.4	k/ft
Utilization Ratio	V_u / ΦV_c	0.63	OK

Flexure (Inside Face)

Use #4 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	10.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 4	
Spacing		12.0	in
Bar Diameter	d_b	0.50	in
Area of Steel	A_s	0.20	in^2/ft
Steel Depth	d	7.75	in
Eq. Stress Depth	a	0.39	in
Neutral Axis Depth	c	0.46	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.50	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	9	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0474	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	12.8	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	4.9	k·ft/ft
Min. Moment Capacity	M_{min}	4.9	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	2.7	k·ft/ft
Service Stress in Reinf.	f_{ss}	21.1	ksi
Concrete Cover	d_c	2.25	
Clear Cover Factor	β_s	1.41	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	3.7	k·ft/ft
Reduced Nom. Cap.	ΦM_n	6.8	k·ft/ft
Utilization Ratio	M_u / ΦM_n	0.54	OK

Flexure (Corner Bars)

Use #7 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	10.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 7	
Spacing		12.0	in
Bar Diameter	d_b	0.88	in
Area of Steel	A_s	0.60	in^2/ft
Steel Depth	d	7.56	in
Eq. Stress Depth	a	1.18	in
Neutral Axis Depth	c	1.38	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.13	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	26	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0134	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	12.8	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	14.9	k·ft/ft
Min. Moment Capacity	M_{min}	12.8	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	7.4	k·ft/ft
Service Stress in Reinf.	f_{ss}	20.1	ksi
Concrete Cover	d_c	2.44	
Clear Cover Factor	β_s	1.46	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	11.2	k·ft/ft
Reduced Nom. Cap.	ΦM_n	18.8	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.60	**OK**

Footing Design

Designed with rigid connections to the walls for flexure in the corners. The maximum moment and shear are taken from the RISA analysis. Loads are applied to the top slab and transfered into the footing. The subgrade modulus is taken as 150 pci.

Parameters

Footing Thickness	TB	12.00	in

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	9.63	in
Conc. Shear Strength	V_c	12.6	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	10.6	k/ft
Reduced Nom. Cap.	ΦV_c	10.7	k/ft
Utilization Ratio	V_u / ΦV_c	0.99	**OK**

Flexure (Top Bars) — Use #6 @ 8 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 6	
Spacing		8.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.66	in^2/ft
Steel Depth	d	9.63	in
Eq. Stress Depth	a	1.29	in
Neutral Axis Depth	c	1.52	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	7.25	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	20	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0160	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	11.4	k·ft/ft
Min. Moment Capacity	M_{min}	11.4	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	5.3	k·ft/ft
Service Stress in Reinf.	f_{ss}	10.1	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	8.5	k·ft/ft
Reduced Nom. Cap.	ΦM_n	26.7	k·ft/ft
Utilization Ratio	M_u / ΦM_n	0.32	**OK**

Flexure (Corner Bars)

Use #7 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 7	
Spacing		12.0	in
Bar Diameter	d_b	0.88	in
Area of Steel	A_s	0.60	in^2/ft
Steel Depth	d	9.56	in
Eq. Stress Depth	a	1.18	in
Neutral Axis Depth	c	1.38	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.13	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	26	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0177	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	14.9	k·ft/ft
Min. Moment Capacity	M_{min}	14.9	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	7.4	k·ft/ft
Service Stress in Reinf.	f_{ss}	15.7	ksi
Concrete Cover	d_c	2.44	
Clear Cover Factor	β_s	1.36	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	11.2	k·ft/ft
Reduced Nom. Cap.	ΦM_n	24.2	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.46	**OK**

Inlet Structure

The inlet structure sidewalls and wing walls were modeled as a cantilevered retaining wall. The maximum retained height of 7.5' was used for the design. For stability, the bearing pressure and overturning were checked. The wall is considered restrained against sliding due to the apron. The stem, heel and toe reinforcing were designed on a per foot basis according to AASTHO LRFD Specifications.

Reinforcing for the apron was designed to meet the minimum steel required for temperature and shrinkage. Reinforcing for the headwall has determined to be #5 bars at 12" centers, each face, each way. This reinforcing was based on typical headwall reinforcing on past projects.

Retaining Wall

Design is for a cantilevered reinforced concrete retaining wall supported on a shallow foundation. Design is based on a per foot length of wall. Reinforced concrete sections are designed according to AASTHO LRFD Specifications.

Parameters

Retained Height	h_f	7.50	ft
Burial Depth	d_b	1.00	ft
Height of Groundwater	h_w	0.00	ft

Dimensions

Top of Stem Thick.	t_t	12.00	in
Toeside Taper	t_{ts}	0.00	in
Heelside Taper	t_{hs}	0.00	in
Bot. of Stem Thick.	t_b	12.00	in
Toe Length	L_t	0.50	ft
Heel Length	L_h	3.00	ft
Footing Thickness	t_f	1.00	ft
Stem Height	h_s	7.50	ft
Wall Height	H	8.50	ft
Footing Width	B	4.50	ft
Toe Cover	h_c	0.00	ft

Materials

Concrete Strength	f'_c	4.0	ksi
Concrete Weight	w_c	150	pcf
Conc. Mod. of Elast.	E_c	3,834	ksi
Stress Block Coeff.	β_1	0.85	
Rebar Strength	f_y	60	ksi
Steel Mod. of Elast.	E_s	29,000	ksi
Modular Ratio	n	7.6	

Soil Data

All. Bearing Pressure	q_{all}	3,000	psf
Active (1) or At-Rest (2)		2	
Coeff. of Friction		0.40	
Overburden Depth	d_{ob}	1.00	ft

Drained

Dry Soil Wt.	w_s	120	pcf
EFP - Active	w_a	35	pcf
EFP - At Rest	w_o	55	pcf
EFP - Passive	w_p	300	pcf

Undrained

Saturated Soil Wt.	w_{sat}	140	pcf
Sat. EFP - Active	$w_{a,sat}$	85	pcf
Sat. EFP - At Rest	$w_{o,sat}$	90	pcf
Sat. EFP - Passive	$w_{p,sat}$	210	pcf

Assumption	Value
Neglect Vertical Soil Pressure for Toe Design	TRUE
Neglet Bearing Pressure for Heel Design	TRUE
Neglet Passive Pressure for Stem Design	TRUE
Neglect Live Load Surcharge for Toe Design	TRUE

Recommended Dimensions

Footing Width B (ft)

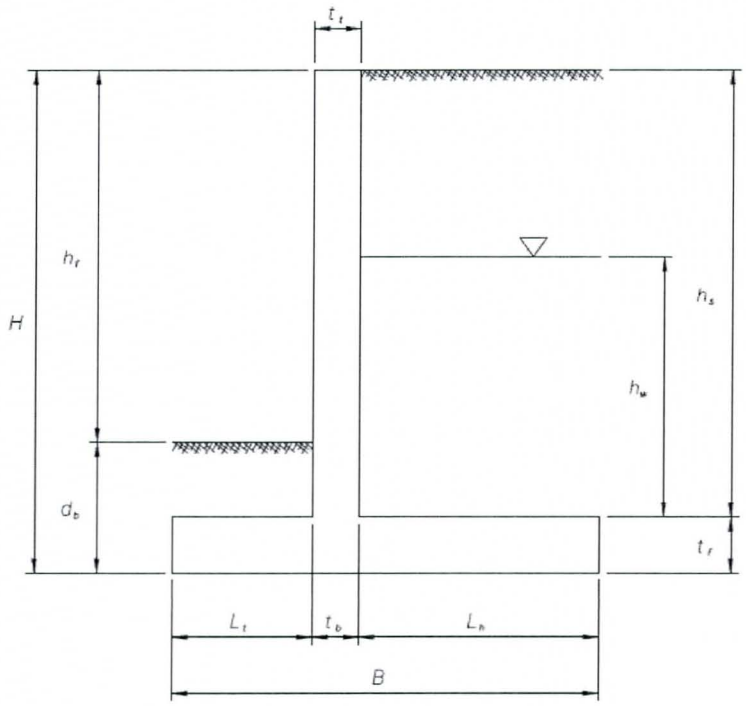
Max 0.7H	Actual	Min 0.4H
5.95	4.50	3.40

Toe Length L_t (in)

B/3	Actual
1.50	0.50

Stem Thickness t_b (in)

Max H/10	Actual	Min H/12
10.2	12.0	8.5



Loads

Load factors specified according to AASTHO LRFD 2005.

Importance Factor	IMP	1.00
Load Factors		Strength 1
Self Weight	DC	1.25
Vertical Earth	EV	1.35
Horz. Earth - Active	EH	1.50
Horz. Earth - At Rest	EH	1.35
Earth Surcharge	ES	1.50
Live Load Surcharge	LS	1.75
Live Load	LL	1.75
Factors of Safety		
Bearing		1.00
Overturning		1.50
Sliding		1.50
Buoyancy		1.50
Live Load Surcharge		
Vert. Surcharge Load	w_{LS}	100 psf
Horz. Surcharge Load	p_{LS}	46 psf
Deflection Limit		
Min Defl. Limit	L/Δ	180

Stability

Retaining wall is checked for bearing pressure overturning and sliding. For most efficient design, resultant should be within the middle third of the footing.

Resultant Location

Resultant Force	F_r	4.80	k
Resultant Moment	M_r	4.4	k-ft
Distance to Resultant	d_r	0.91	ft
Outside Middle Third (Toeside)			

Bearing Pressure

Toe	q_t	2,975	psf
Stem (Toeside)	q_{st}	2,551	psf
Stem (Heelside)	q_{sh}	1,703	psf
Heel	q_h	-842	psf
Allowable	q_{all}	3,000	psf
Max	q_u	2,975	psf
Factor of Safety	**FS**	**1.01**	**≥ 1 OK**

Overturning

Resisting Moment	RM	11.6	k-ft
Overturning Moment	OTM	7.3	k-ft
Factor of Safety	**FS**	**1.60**	**≥ 1.5 OK**

Sliding

Backfill	1.99	k
Surcharge	0.39	k
Sliding Forces	**2.38**	**k**
Passive Pressure	0.00	k
Friction	1.92	k
Resisting Forces	**1.92**	**k**

Factor of Safety	**FS**	**0.81**	**< 1.5 NG**

Restrained Against Sliding OK

Lateral Forces

	F (k)	h (ft)	M (k-ft)
Soil	1.99	2.833	5.6
Water	0.00	0.000	0.0
Passive	0.00	0.000	0.0
Live Load Surcharge	0.39	4.250	1.7
Total	**2.38**		**7.3**

Vertical Forces

	F (k)	d (ft)	M (k-ft)
Self Weight - DC			
Footing	0.68	2.250	1.5
Stem	1.13	1.000	1.1
Toeside Taper	0.00	0.500	0.0
Heelside Taper	0.00	1.500	0.0
Soil - EV			
Heelside	2.70	3.000	8.1
Heelside Taper	0.00	1.500	0.0
Toeside	0.00	0.250	0.0
Toeside Taper	0.00	0.500	0.0
LL Surcharge - LS	0.30	3.000	0.9
Total	**4.80**		**11.6**

Modified Bearing Pressure Load Factor

DC Percentage	38	%
EV Percentage	56	%
LL Percentage	6	%
Modified Load Factor	1.34	

Stem

The reatining wall stem is designed as a cantileverd wall. The passive soil pressure above the footing is assumed to be in a drained condition. The passive soil pressure may also be neglected.

Parameters

Stem Height	h_s	7.50	ft
Top of Stem Thick.	t_t	12.0	in
Toeside Taper	t_{ts}	0.0	in
Heelside Taper	t_{hs}	0.0	in
Bot. of Stem Thick.	t_b	12.0	in
Section for Analysis	x	7.50	ft

Lateral Forces

Reduction Factor		1.00	
Backfill Pressure	p_{EH}	0.413	k/ft
Addl. Hydrostatic	p_w	0.000	k/ft
Toeside Pressure	p_{EH}	0.000	k/ft
Live Load Surcharge	p_{LS}	0.046	k/ft

☑ Neglet Passive Pressure for Stem Design (Conservative)

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.90	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	9.44	in
Conc. Shear Strength	V_c	14.3	k/ft

Shear Strength - Art 5.8.3.3

Reduced Nom. Cap.	ΦV_c	12.9	k/ft
Factored Ultimate Load	V_u	2.7	k/ft
Factor of Safety	$\Phi V_c / V_u$	4.79	**OK**

Flexure

Reinforcing	**Dowels**	**Vert. Bars**
Bar Size	# 5	# 4
Bar Spacing (in)	12.0	12.0
Length (ft)	2.00	7.50
Area of Steel (in^2/ft)	0.31	0.00
Dev. Length (in)	14	9

☑ Equal Dowel and Vertical Bar Spacing

Parameters

Clear Cover	c_c	2.00	in
Lap Length		2.00	ft
Reduction Factor	Φ	0.90	
Width	b	12.00	in
Thickness	t	12.00	in
Bar Diameter	d_b	1.13	in
Area of Steel	A_s	0.31	in^2/ft
Steel Depth	d	9.44	in
Eq. Stress Depth	a	0.46	in
Neutral Axis Depth	c	0.54	in
Actual Clear Spacing	S_{clr}	10.87	in
Min. Clear Spacing	S_{min}	1.69	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.2	
Top Bar Modifier	Ψ_t	1.0	

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.12	in^2/ft/face

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0498	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	21.3	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	9.9	k·ft/ft
Min. Moment Capacity	M_{min}	9.9	k·ft/ft

Crack Control - Art 5.7.3.4

Service Moment	M_s	5.2	k·ft/ft
Service Stress in Reinf.	f_{ss}	21.3	ksi
Concrete Cover	d_c	2.56	
Clear Cover Factor	β_s	1.39	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	17.4	in

Moment Capacity - Art 5.7.3.2.1

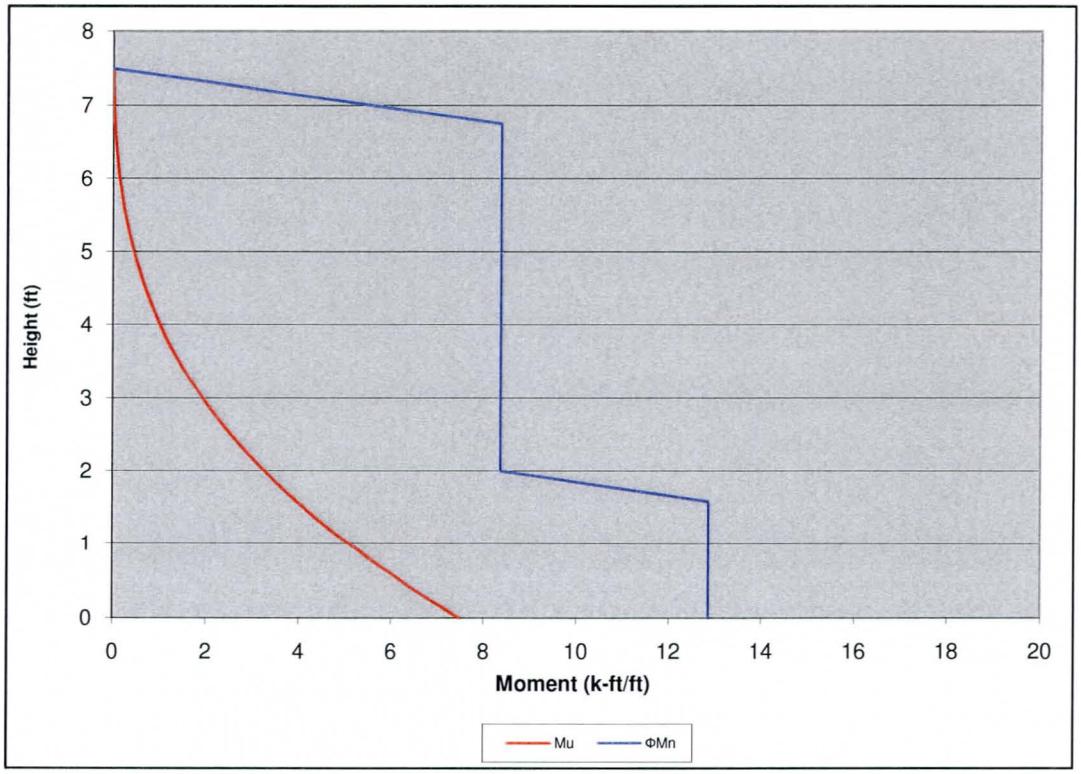
Reduced Nom. Cap.	ΦM_n	12.8	k·ft/ft
Factored Ultimate Load	M_u	7.5	k·ft/ft
Factor of Safety	$\Phi M_n / M_u$	1.72	**OK**

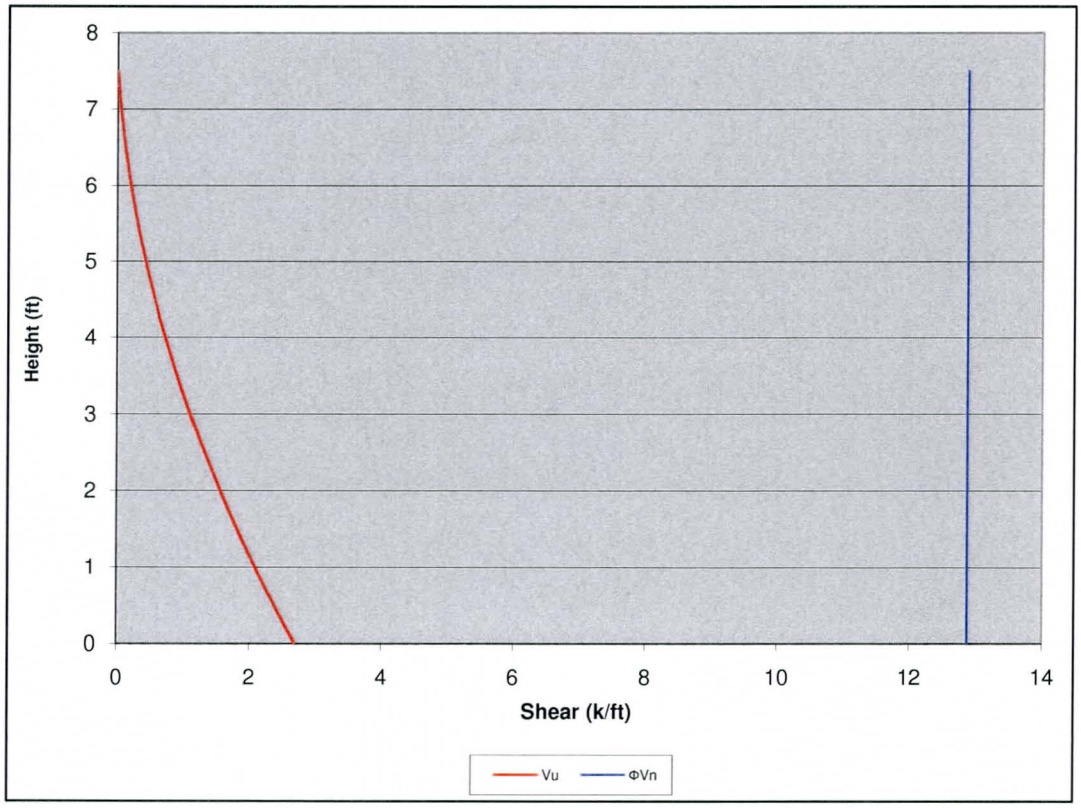
Deflection

Nuetral Axis Depth	c	1.73	in
Gross Inertia	I_g	1,728	in^4
Cracked Inertia	I_{cr}	160	in^4
Cracked Moment	M_{cr}	11.5	k·ft/ft
Effective Inertia	I_e	1,728	in^4

Deflection	Δ	0.02	in
Defl. Ratio	L/Δ	5,599	**> 180 OK**
Active Pressure Limit	0.002H	0.18	in

At-Rest Lateral Earth Pressure


Height (ft)
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16
18
20
Moment (k-ft/ft)
Mu
ΦMn


Height (ft)
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
Shear (k/ft)
Vu
ΦVn

Heel Reinforcing

Loads due to vertical soil pressure, self weight and live load surcharge produce tension in the top of the footing along the heel. Bearing pressure acts against these forces but can be conservatively ignored.

Parameters

Footing Thickness	t_{foot}	12.00	in
Heel Length	L_h	3.00	ft

☑ Neglet Bearing Pressure for Heel Design (Conservative)

Loads

Self Weight	w_{DC}	0.150	k/ft
Soil Pressure	w_{EV}	0.900	k/ft
LL Surcharge	w_{LS}	0.100	k/ft
BP @ Heel	q_h	0.000	k/ft
BP @ Stem (Heelside)	q_{sh}	0.000	k/ft

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.90	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	8.50	in
Conc. Shear Strength	V_c	12.9	k/ft

Shear Strength - Art 5.8.3.3

Reduced Nom. Cap.	ΦV_c	11.6	k/ft
Factored Ultimate Load	V_u	4.7	k/ft
Factor of Safety	$\Phi V_c / V_u$	2.45	**OK**

Positive Flexure — Use #5 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	3.00	in
Bar Size		# 5	
Spacing		12.0	in
Bar Diameter	d_b	1.00	in
Area of Steel	A_s	0.31	in^2/ft
Steel Depth	d	8.50	in
Eq. Stress Depth	a	0.46	in
Neutral Axis Depth	c	0.54	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.00	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.2	
Top Bar Modifier	Ψ_t	1.4	
Development Length	L_d	20	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0445	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	21.3	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	9.4	k·ft/ft
Min. Moment Capacity	M_{min}	9.4	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	5.2	k·ft/ft
Service Stress in Reinf.	f_{ss}	23.8	ksi
Concrete Cover	d_c	3.50	
Clear Cover Factor	β_s	1.59	
Exposure Factor	γ_e	1.0	
Max. Spacing	S_{max}	11.2	in

Moment Capacity - Art 5.7.3.2.1

Reduced Nom. Cap.	ΦM_n	11.5	k·ft/ft
Factored Ultimate Load	M_u	7.1	k·ft/ft
Factor of Safety	$\Phi M_n / M_u$	1.63	**OK**

Toe Reinforcing

Loads due to bearing pressure produce tension in the bottom of the footing along the toe. Vertical soil pressure and live load surcharge act against bearing pressure but can be conservatively ignored.

Parameters

Footing Thickness	t_{foot}	12.00 in
Toe Length	L_t	0.50 ft

☑ Neglet Vertical Soil Weight for Toe Reinforcing (Conservative)

☑ Neglet Live Load Surcharge Toe Reinforcing (Conservative)

Loads

Self Weight	w_{DC}	0.150 k/ft
Soil Pressure	w_{EV}	0.000 k/ft
LL Surcharge	w_{LS}	0.000 k/ft
BP @ Toe	q_t	2.975 k/ft
BP @ Stem (Toeside)	q_{st}	2.551 k/ft

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.90
Width for Shear	b_v	12.00 in
Steel Depth for Shear	d_v	8.50 in
Conc. Shear Strength	V_c	12.9 k/ft

Shear Strength - Art 5.8.3.3

Reduced Nom. Cap.	ΦV_c	11.6	k/ft
Factored Ultimate Load	V_u	1.8	k/ft
Factor of Safety	$\Phi V_c / V_u$	6.61	**OK**

Positive Flexure — Use #4 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	3.00	in
Bar Size		# 4	
Spacing		12.0	in
Bar Diameter	d_b	1.00	in
Area of Steel	A_s	0.20	in^2/ft
Steel Depth	d	8.50	in
Eq. Stress Depth	a	0.29	in
Neutral Axis Depth	c	0.35	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.00	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.2	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	9	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0707	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	21.3	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	0.6	k·ft/ft
Min. Moment Capacity	M_{min}	0.6	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	0.3	k·ft/ft
Service Stress in Reinf.	f_{ss}	2.4	ksi
Concrete Cover	d_c	3.50	
Clear Cover Factor	β_s	1.59	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Reduced Nom. Cap.	ΦM_n	7.5	k·ft/ft
Factored Ultimate Load	M_u	0.5	k·ft/ft
Factor of Safety	$\Phi M_n / M_u$	16.69	**OK**

Conflict Structure

The conflict structure was designed as a one-way slab since the span ratios > 2. A two-dimensional stick model was created in RISA to analyze the structure. The loads applied to the structure included self weight, vertical and lateral earth pressure, lateral live load surcharge and vertical vehicular live load. The wheel point load was applied on the top slab and positioned to create the maximum shear and moment in the slab. The wheel point load was distributed over a 3.08' width with a multiple presence factor of 1.2 determined according to Art. 4.6.2.10.2. The lane load is not considered for traffic traveling parallel to the span width.

The top slab and wall corners were modeled with simple shear connections, while the wall-to-footing connection was modeled as a rigid moment connection.

Strength I combination governs for buried structures. For a rigid buried structure, 1.3 was used for the vertical earth pressure load factor and 1.35 was used for the at-rest horizontal earth pressures load factor. The concrete shear strength for the top slab was modified according to 5.14.5.3. The strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures.

The same flexural reinforcing in the bottom of the top slab was used in each direction using the maximum moment from either direction. The maximum shear was conservatively taken at the support.

Box Culvert Design

Design is for a single span reinforced concrete box culvert. R.C. concrete sections are designed according to AASHTO LRFD 2005. Design is based on a per foot of length basis. Fill height, h_f, is measured from grade to the bottom of the top slab of the box.

Materials

Concrete Strength	f'_c	3.0	ksi
Conc. Mod. of Elast.	E_c	3,321	ksi
Stress Block Coeff.	β_1	0.85	
Rebar Strength	f_y	60	ksi
Steel Mod. of Elast.	E_s	29,000	ksi
Modular Ratio	n	8.7	

Soil Data

At-Rest - Drained - Cohesive Soil			
Soil Wt.	γ_s	120	pcf
Eq. Fluid Density	γ_{eq}	55	pcf
Embankment Installation			
Soil-Interaction Factor	F_e	1.01	

Parameters

Span	S	13.00	ft
Rise	R	10.50	ft
Fill	h_f	2.00	ft
Footing Offset	d	0.33	ft

Box Dimensions

Wall Thickness	TW	12.0	in
Top Slab Thickness	TT	12.0	in
Top Slab Width	BT	15.00	ft
Bot. Slab Thickness	TB	12.0	in
Bot. Slab Width	BB	15.67	ft
Total Height	H	12.50	ft

Dead Loads

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k/ft)
Top Slab	1	1.000	15.000	1.000		150	2.250
Walls	2	1.000	10.500	1.000		150	3.150
Bottom Slab	1	1.000	15.667	1.000		150	2.350
Earth Fill	1			1.000	23.333	120	2.800
Water Fill	1			1.000		62.4	0.000
Additional Wt.							0.500
Total							**11.050**

Live Loads

The equivalent strip width for fill > 2' is calculated according to Art. 3.6.1.2.6 and for fill < 2' Art. 4.6.2.10 is used. The tire contact width of 20" is also taken into account in calculating the distributed live load. For box culvert loading, only one loaded lane is considered, however the multiple presence factor of 1.2 still applies. The lane load is distributed over a 10' lane width.

Total Span Length	L	15.00	ft
Actual Fill Height	h_a	1.00	ft

Fill Height < L - Must Include Live Load

Surcharge - Horz. Loads Only

Soil Height	h_s	2.0	ft
Horz. Pressure	p	110	psf

Wheel Load - Traffic Parallel to Span

Wheel Load (H20)	P	16.0	k
Impact Factor	IM	29	%
Distribution Length	E_{span}	2.67	ft
Distribution Width	E/2	4.78	ft
Distributed Load	w	1.941	ksf

Lane Load - Traffic Parallel to Span

Lane Load	w	0.064	ksf
Distribution Length	E_{span}	12.00	ft
Distributed Load	w	0.053	ksf

Stability

For the live load bearing pressure, the wheel load applied to the top slab is distributed over the bearing area without an increase due to impact. Forces resisting buoyancy include the box self weight and soil weight above the box.

Bearing Capacity (Service Loads)

Bearing Area	A_q	15.67	ft^2
DL Bearing Pressure	q_{DL}	705	psf
LL Bearing Pressure	q_{LL}	267	psf
Bearing Pressure	q	972	psf
All. Bearing Pressue	q_{all}	1,500	psf
Factor of Safety	**FS**	**1.54**	**OK**

Buoyancy

Depth to Bot. Slab	z	13.50	ft	
Groundwater Depth	z_w	0.00	ft	
Buoyant Force	P_b	11.7	k	
Self Weight	P_w	10.6	k	
Factor of Safety	**FS**	**0.90**		**NG < 1.1**

Top Slab Design

Designed as a simple span slab with the clear span length used to calculate forces. Strength I combination governs for buried structures. For a rigid buried structure, 1.3 is used for vertical earth pressure. The soil-structure interaction is also taken into consideration (Art 12.11.2.2). Concrete shear strength is modified according to 5.14.5.3. Strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures. Maximum shear is assumed to be caused by the point live load and is taken at d from the face of the support.

Parameters

Slab Thickness	TT	12.00	in
Max. Span Length	L	15.000	ft
Distribution Length	b	2.667	ft
	a	6.167	ft

Loads

Self Weight	w_{DC}	0.150	k/ft
Soil Load	w_{EV}	0.120	k/ft
Distr. Live Load	w_{LL}	1.995	k/ft
Point Live Load	p_{LL}	5.177	k/ft

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	9.50	in
Conc. Shear Strength	V_c	18.8	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	11.4	k/ft
Reduced Nom. Cap.	ΦV_c	16.0	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.71	OK

Flexure (Bot. Bars)

Use #8 @ 8 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 8	
Spacing	s	8.0	in
Bar Diameter	d_b	1.00	in
Area of Steel	A_s	1.19	in^2/ft
Steel Depth	d	9.50	in
Eq. Stress Depth	a	2.32	in
Neutral Axis Depth	c	2.73	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	7.00	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	35	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0074	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	58.1	k·ft/ft
Min. Moment Capacity	M_{min}	18.5	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	27.1	k·ft/ft
Service Stress in Reinf.	f_{ss}	30.8	ksi
Concrete Cover	d_c	2.50	
Clear Cover Factor	β_s	1.38	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	10.5	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	43.7	k·ft/ft
Reduced Nom. Cap.	ΦM_n	44.5	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.98	OK

Wall Design

Designed with a simple connection to the top slab and a rigid connection to the bottom slab. Clear span length is used to calculate forces. Strength I combination governs for buried structures. For a rigid buried structure, 1.35 is used for at-rest horizontal earth pressure. Maximum shear is taken at the face of the bottom slab. Axial load is not taken into consideration.

Parameters

Outer Wall Thickness	TW	12.00	in
Span Length	L	10.50	ft
Point of Contraflexure	x	2.22	ft

Loads

Earth Press. @ Top	p_{EH}	0.165	k/ft
Earth Press. @ Bot.	p_{EH}	0.743	k/ft
LL Surcharge	p_{LS}	0.110	k/ft

Shear

Concrete - Art. 5.8.3.4.1

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	9.50	in
Conc. Shear Strength	V_c	12.5	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	6.0	k/ft
Reduced Nom. Cap.	ΦV_c	10.6	k/ft
Utilization Ratio	V_u / ΦV_c	0.57	**OK**

Flexure (Inside Face)

Use #4 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 4	
Spacing	s	12.0	in
Bar Diameter	d_b	0.50	in
Area of Steel	A_s	0.20	in^2/ft
Steel Depth	d	9.75	in
Eq. Stress Depth	a	0.39	in
Neutral Axis Depth	c	0.46	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.50	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	9	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0604	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	7.5	k·ft/ft
Min. Moment Capacity	M_{min}	7.5	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	3.9	k·ft/ft
Service Stress in Reinf.	f_{ss}	24.4	ksi
Concrete Cover	d_c	2.25	
Clear Cover Factor	β_s	1.33	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	16.5	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	5.7	k·ft/ft
Reduced Nom. Cap.	ΦM_n	8.6	k·ft/ft
Utilization Ratio	M_u / ΦM_n	0.66	**OK**

Flexure (Corner Bars)

Use #8 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 8	
Spacing	s	12.0	in
Bar Diameter	d_b	1.00	in
Area of Steel	A_s	0.79	in^2/ft
Steel Depth	d	9.50	in
Eq. Stress Depth	a	1.55	in
Neutral Axis Depth	c	1.82	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.00	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	35	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0126	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	15.2	k·ft/ft
Min. Moment Capacity	M_{min}	15.2	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	8.0	k·ft/ft
Service Stress in Reinf.	f_{ss}	13.1	ksi
Concrete Cover	d_c	2.50	
Clear Cover Factor	β_s	1.38	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	11.5	k·ft/ft
Reduced Nom. Cap.	ΦM_n	31.0	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.37	**OK**

Bottom Slab Design

Designed as a simple slab for flexure in the top of the slab and rigid connections to the walls for flexure in the corners. Clear span length is used to calculate forces. Strength I combination governs for buried structures. For a rigid buried structure, 1.3 is used for vertical earth pressure. The soil-structure interaction is also taken into consideration (Art 12.11.2.2). Strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures. Maximum shear is taken at d from the face of the support.

Parameters

Footing Thickness	TB	12.00	in
Max. Span Length	L	15.00	ft
Point of Contraflexure	x	3.17	ft

Loads

Self Weight	q_{DC}	0.527	k/ft
Soil Load	q_{EV}	0.179	k/ft
Live Load	q_{LL}	0.267	k/ft

Shear

Concrete - Art. 5.14.5.3

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	12.50	in
Conc. Shear Strength	V_c	16.4	k/ft

Shear Strength - Art 5.8.3.3

Factored Ultimate Load	V_u	8.8	k/ft
Reduced Nom. Cap.	ΦV_c	14.0	k/ft
Utilization Ratio	V_u / ΦV_c	0.63	**OK**

Flexure (Top Bars)

Use #8 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 8	
Spacing	s	12.0	in
Bar Diameter	d_b	1.00	in
Area of Steel	A_s	0.79	in^2/ft
Steel Depth	d	9.50	in
Eq. Stress Depth	a	1.55	in
Neutral Axis Depth	c	1.82	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.00	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	35	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0126	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	19.6	k·ft/ft
Min. Moment Capacity	M_{min}	18.5	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	9.1	k·ft/ft
Service Stress in Reinf.	f_{ss}	14.9	ksi
Concrete Cover	d_c	2.50	
Clear Cover Factor	β_s	1.38	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	14.7	k·ft/ft
Reduced Nom. Cap.	ΦM_n	31.0	k·ft/ft
Utilization Ratio	M_u / ΦM_n	0.48	**OK**

Flexure (Corner Bars)

Use #8 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	12.00	in
Clear Cover	c_c	3.00	in
Bar Size		# 8	
Spacing	s	12.0	in
Bar Diameter	d_b	1.00	in
Area of Steel	A_s	0.79	in^2/ft
Steel Depth	d	8.50	in
Eq. Stress Depth	a	1.55	in
Neutral Axis Depth	c	1.82	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.00	in
Max. Spacing	S_{max}	12.0	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0	
Top Bar Modifier	Ψ_t	1.0	
Development Length	L_d	35	in

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0110	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	18.5	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	15.2	k·ft/ft
Min. Moment Capacity	M_{min}	15.2	k·ft/ft

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	8.0	k·ft/ft
Service Stress in Reinf.	f_{ss}	14.7	ksi
Concrete Cover	d_c	3.50	
Clear Cover Factor	β_s	1.59	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	11.5	k·ft/ft
Reduced Nom. Cap.	ΦM_n	27.5	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.42	**OK**