FINAL

Design Report

Old Cross Cut Canal Improvements

Arizona Canal to Indian School

FCD Project No. 2008 C013, Assignment #4
COP Project No. ST83110066

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

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1.0 INTRODUCTION

1.1 Purpose

The purpose of the Old Cross Cut Canal Improvements Project is to mitigate flooding for properties within the Arcadia area watershed and to reduce flooding along the upstream side of the Arizona Canal. Currently, there are no drainage facilities to outlet stormwater from the Arcadia drainage area. This project will construct a storm drain system to collect and convey flows from the Arcadia drainage area into the Old Cross Cut Canal (OCCC) north of Indian School Road. The system will provide flood protection in excess of the 10-year level. The existing OCCC earthen ditch will be piped underground and be connected to the existing 2-10'x10' box culvert, which ultimately drains to the Grand Canal.

This project is a joint effort between the Flood Control District of Maricopa County (FCDMC) and the City of Phoenix (COP), with the District taking the lead in the design and the City taking the lead in the construction. SRP is also a Project Stakeholder because of the reconstruction of the OCCC.

Phase 1 of this project includes the undercrossing of the Arizona Canal and the replacement of the OCCC earthen channel with an underground drainage system. Phase 1 is subdivided into Phase 1A, which consists of design and construction of the storm drain system from Indian School Road up to the Arizona Canal, and Phase 1B which includes the design of the undercrossing. The undercrossing may be constructed during the January 2011 dry-up if an agreement with SRP is reached in time. Otherwise, it will be constructed during the 2012 dry-up. Future phases will construct the storm drain portion to the north of the Arizona canal, including the junction structure.

1.2 Location of Project

The Arcadia area watershed is located within the metropolitan Phoenix area, and encompasses Sections 16 through 21 of Township 2N, Range 4E of the Gila and Salt

River Base Line and Meridian, Maricopa County. Phase 1 is located within the southwest quarter of Section 20 and runs from Indian School Road to the Arizona Canal. Figure 1 shows the Project Vicinity Map and Figure 2 is a Project Location Map showing the Phase 1 area.

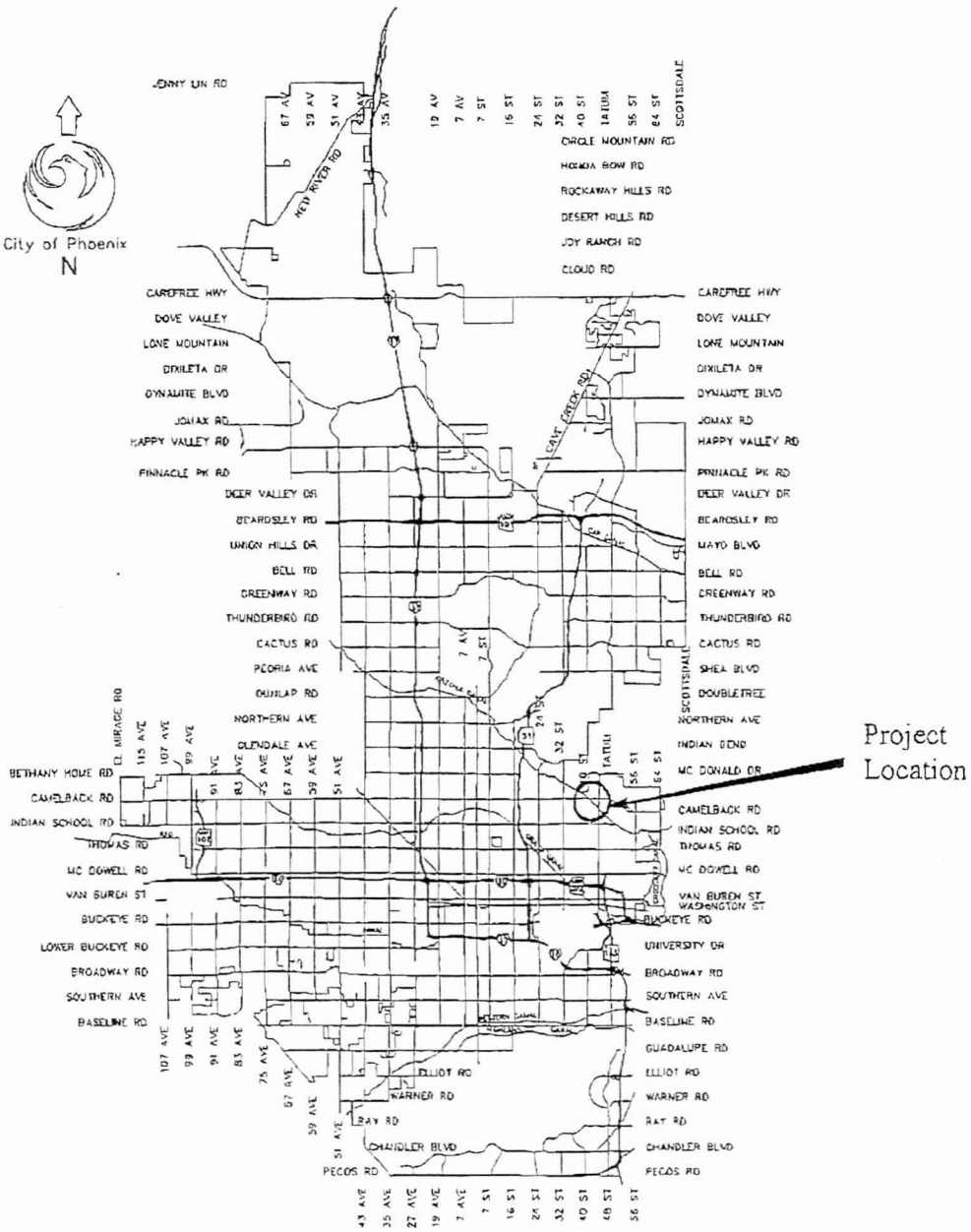


Figure 1: Project Vicinity Map

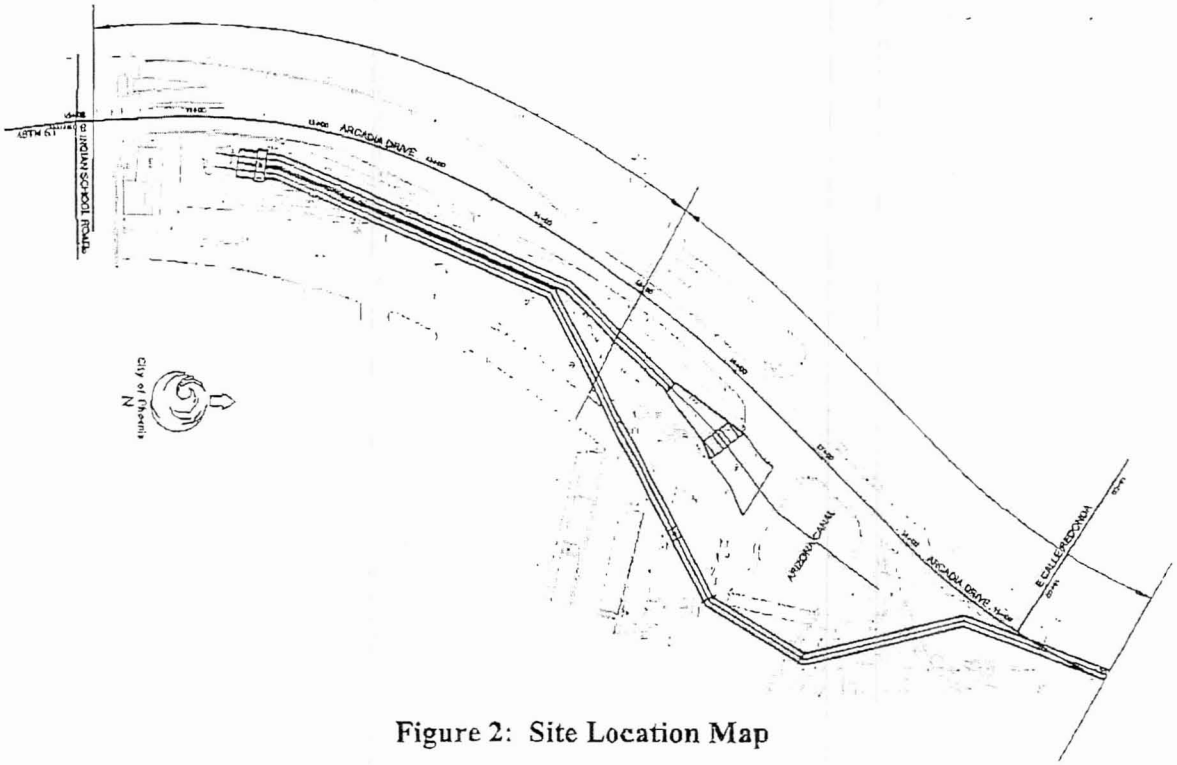
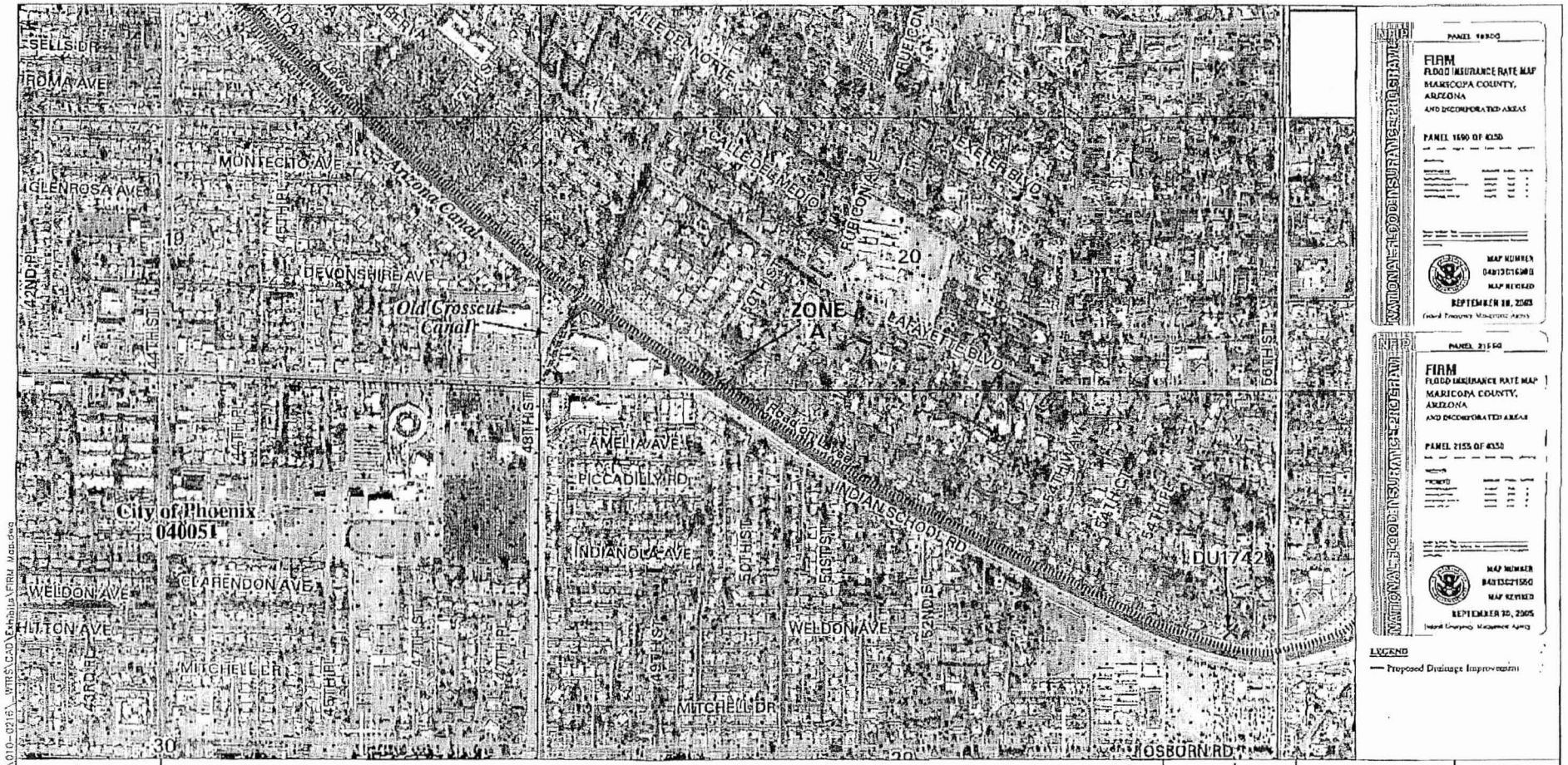


Figure 2: Site Location Map

1.3 Existing Conditions

Stormwater from the Arcadia area drainage watershed sheet flows in a southerly direction, originating from the Camelback Mountains and continuing south until it reaches the Arizona Canal. The canal, being elevated several feet above existing ground, traps water and floods properties along its upstream bank during large storm events. Properties inside this flood area are within FEMA's Zone "A" floodplain designation, which corresponds to the 100-year floodplains that are determined by approximate methods with no base flood elevations or depths. Areas north of the Zone "A" designation are designated shaded Zone "X", which corresponds to areas outside the 100-year floodplains or areas of 100-year sheet flow flooding where average depths are less than 1 foot. A FIRM map showing the existing floodplain of the project area is provided in Figure 3.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD INSURANCE RATE MAP

ARCADIA DR. DRAINAGE IMPROVEMENT PHASE-1: INDIAN SCHOOL RD. TO ARIZONA CANAL

NTS

OLSSON ASSOCIATES

Figure 3

F:\Projects\010-0216_WTRS\CAD\Exhibits\FIRM Map.dwg

1.4 Basis of Design

The basis of design for this project is the *Arcadia Area Drainage Project, Final Recommendation Report* (Huitt-Zollars, 1997). This report evaluated five different storm drain alignments and design alternatives to mitigate flooding problems within the Arcadia drainage area, and recommended the Alternative No. 2 as the preferred alternative.

1.4.1 Basis of Hydrology

The basis of hydrology for this project is the hydrology analysis that was performed in the Huitt-Zollars report. The District selected Alternative 2 as the preferred alternative, which has a total flow of 681 cfs at the concentration point located just north of Arcadia Drive and the Arizona Canal. The City has requested that capacity be provided for some drainage at the Arizona Canal, hence the OCCC design includes 1,000 cfs for the SRP canal discharge and 990 cfs for stormwater flows.

1.5 Design Criteria

The drainage facilities proposed for the Arcadia Area Drainage Improvement Project is located within the City of Phoenix and will be designed to meet the standards and guidelines 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 north of the Arizona Canal will be designed for the 10-year flow.
- The hydraulic grade line (HGL) will be at least 1 foot below the ground or rim elevation for any catch basins and manholes for the 10-yr event.
- The minimum velocity in the storm drain pipe will be 5 ft/sec and the maximum velocity will be 15 ft/sec. Please note that the 102" pipe will have a velocity of 17.45 ft/s at the design discharge of 990 cfs. For the 10-year or less event, the pipe velocity will be less than 15 ft/s. The District has indicated that this condition is acceptable.

2.0 SURVEY

2.1 Scope

A topographic ground survey was performed in the Phase 1 project area, which includes Arcadia Drive from the northerly curb of Indian School Road to approximately 200 feet north of the centerline of the Arizona Canal, and from the edge of sidewalk along the westerly curb of Arcadia Drive to approximately 100 feet east of the easterly curb of Arcadia Drive. Existing surface utilities were located. Control elevations were established in the field areas to create contours or spot elevations, including ground elevations, grade breaks, curbs and/or edge of pavement elevations. Surface features such as structures and trees were identified and located. Topographic surveys from adjacent projects were used to supplement the ground survey performed. Survey data is provided in Appendix F.

2.2 Datum

The ground survey performed for this project was tied into the survey performed by Aztec Engineering for the adjacent projects using the following metadata:

1. Coordinates were taken from GDACS, recorded in Book 734, Page 10, Records of Maricopa County, Arizona and converted from grid to ground using a scale factor of 1.00016.
2. The Basis of Bearing is the South line of the Southeast quarter of Section 19, Township 2 North, Range 4 East of the Gila and Salt River Meridian.
   a. Said line bears N87°51'48"W, as taken from GDACS, recorded in Book 734, Page 10, Records of Maricopa County, Arizona.
3. The Benchmarks used for this project are:

   A) Top of brass cap in hand hole at the intersection of 48th Street and Indian School Road. This marker is designated the Project Benchmark.

   Elevation = 1243.301 (COP datum)

   B) Top of brass cap in hand hole at the intersection of 44th Street and Indian School Road.

   Elevation = 1222.577 (COP datum)

3.0 HYDROLOGY

3.1 Design Flows

The regional hydrology for the Arcadia drainage area was performed as part of the Huitt-Zollars study and is not included in the scope of this project. The results from that report are used as the basis of hydrology for this project. The following design flows are used in the storm drain for this project:

- 681 cfs in a storm drain along Arcadia Drive to the Arizona Canal
- 990 cfs for the Arizona Canal undercrossing
- 1,000 cfs from the Arizona Canal
- 1,990 cfs at the tie-in to the existing 2-10'x10' box culvert

3.2 Existing IGA's along the OCCC

There are several IGA's between the District, City of Phoenix, and SRP that specify the capacity of and flows in the Old Cross Cut Canal. These IGA's are summarized below:

- IGA dated December 8, 1975. This agreement was entered into by the District, City, and SRP for the reconstruction of the Old Cross Cut Canal to a flood control and drainage channel. This agreement indicates the capacity of the gates at the Arizona Canal to be approximately 1,000 cfs. SRP retained the right to the first 1,000 cfs of capacity in the OCCC, and the City had the right to connect storm drain facilities up to 1,000 cfs capacity.

- IGA dated February 26, 1991. IGA FCD-90007 was entered into by the District, City of Phoenix, and SRP for the design and reconstruction of the Old Cross Cut Canal north of McDowell Road to the Arizona Canal. This IGA specified that the OCC "shall be improved to a capacity of approximately 3000 cfs at the Arizona Canal and approximately 4100 cfs at McDowell Road." The IGA repeats the current agreement to assign the first 1000 cfs of capacity to SRP and limits the City to 1000 cfs capacity.

  An amendment to this IGA was made on November 29, 1993 (IGA FCD-90007A). This amendment revised the design assumptions, which states the

capacity of the culvert at Indian School Road to be approximately 2,500 cfs, including the SRP 1,000 cfs discharge from the Arizona Canal. The IGA also specifies the capacity of the conveyance system not to exceed a 10-year storm frequency discharge.

Larger facilities would be needed to accommodate the higher flow values stated in the various IGA's. However, the project team has agreed that the drainage facilities should be upsized to the extent that is economically feasible, using flow values indicated in Section 3.1.

4.0 HYDRAULICS

The hydraulic analysis follows procedures described in Section 3.3 of Flood Control District's *Drainage Design Manual, Volume 2, Hydraulics*.

4.1 Design Considerations

Several design considerations were taken into account in the design of the proposed storm drain system. These factors include:

- Meeting SRP's requirement not to submerge the radial gates at the canal
- Maintaining the historic features in the project area
- Minimizing traffic impacts to 48th Street/Arcadia Drive during construction
- Allowing SRP to maintain service of the canal during construction

4.1.1 SRP Gates

SRP has the right to discharge up to 1,000 cfs from the Arizona Canal through 3 radial gates. The gates currently discharge the canal water under free flow conditions. SRP has expressed concern about the possibility that the proposed drainage system would submerge the gates, which would reduce their performance and potentially impact SRP's ability to discharge up to 1,000 cfs. If the proposed storm drain submerges the gates, SRP has requested that at a minimum, a flow level sensor be installed downstream of the gates to monitor the water surface elevation just downstream of the gates so that submerged gate equations could be used. However, SRP has also indicated that they are concerned about their ability to control any gates in a submerged condition and that any modifications downstream that would create a submerged condition would be a concern. Therefore, the storm drain and inlet structure have been designed to ensure that the gates are not submerged. This is done by maintaining supercritical flow for a distance downstream of the gates.

4.1.2 Historic Features

Several historic features are present within the project area. These include the Arizona Canal, the Old Cross Cut Canal, the Lateral 4.7 canal, and the Lafayette-Arcadia Historical Streetscape District.

The canals are owned by the Bureau of Reclamation, with SRP managing the operation and maintenance of the canals. The project team met with a representative from the BOR to discuss requirements for construction in and near the canal. The BOR representative indicated that the surface features of the Lateral 4.7 canal needs to be preserved. This lateral is located along the east side of Arcadia Drive north of the Arizona Canal within Phase 2 of the project. The final Phase 2 storm drain alignment should be designed to avoid impacting the surface features of the Lateral 4.7 canal.

To maintain the historical streetscape of the area, the project team has agreed to protect the four large eucalyptus trees south of the Arizona Canal. These trees add to the character of the historical streetscape, and residents in the area have expressed a desire to preserve the eucalyptus trees.

An arborist was contracted to evaluate the health of the eucalyptus trees and determine the clear zone requirements needed to keep the trees healthy and safe during construction. The arborist report indicates one tree with a sheared top that will need to be removed for public safety reasons. A critical zone of 12' was indicated for the other 3 eucalyptus trees to remain. The alignment of the proposed storm drain was designed to be outside a 15' radius from the center of the eucalyptus trees. The palm trees that are impacted will be salvaged and replanted at the end of construction. The arborist evaluation is provided in Appendix J.

4.1.3 Constructability

The roadway along Arcadia Drive between Indian School Road and the Arizona Canal is a two-lane local street. At its narrowest section, the roadway width is less than 22 feet. It is the goal of this project to minimize traffic impacts and keep Arcadia Drive open during

construction. To achieve this, the alignment of the storm drain along the OCCC was designed as far east as possible to limit excavation onto the roadway. Shoring will be required for any excavation that extends into the roadway.

SRP has indicated that they may need to release water due to stormwater flows into the canal or delivery cancellations downstream. Therefore, there is the potential for up to 1,000 cfs to be discharged through the OCCC even during construction. The storm drain system was designed to provide for an interim channel above the canal storm drain to convey any canal discharge during construction. The channel will outlet into the new transition structure.

An attempt was made to have the storm drain cross the canal at the shallower location for constructability, as recommended in the Huitt-Zollars report. However, because of the proximity to the existing pedestrian bridge at the shallower location, the project team agreed during the Value Analysis (VA) meeting to move the crossing west to avoid impact to the pedestrian bridge. This location is in a sump that is approximately 6 feet deeper.

The canal crossing will be constructed during the dry-up period. However, SRP has indicated the need to provide up to 70 cfs of flow for service during the dry-up. A temporary bypass pipe will be provided during the canal crossing construction to allow up to 70 cfs of flow in the canal.

4.2 Storm Drain Design

The goal of the storm drain design is to not submerge the gates at the SRP headgate structure for a discharge of 1,000 cfs. To accomplish this, supercritical flow must be maintained for a distance downstream of the gates. Energy must also be dissipated to drop the storm drain approximately 12.8' from the existing outlet elevation at the headgate structure. Several designs were proposed to dissipate the energy, induce a hydraulic jump, and convert the flow to subcritical as the water enters the storm drain. These designs include a flume with roughness elements and a stepped spillway.

Several hydraulic memos were prepared during the design process to obtain feedback from the District. These memos are included in Appendix A. The District was agreeable to the stepped spillway. However, in order to ensure that the energy is dissipated, the District recommended adding a USBR Type III basin with a row of baffle blocks and a concrete sill downstream of the stepped spillway. The proposed inlet structure is a combination stepped spillway with a USBR Type III basin. With this design, normal depth is achieved at the face of the 120" storm drain.

Calculations were performed using procedures and parameters provided by SRP to verify the flow through the three radial gates and to determine the flow condition of the gates. The headwater elevation upstream of the headgate structure was assumed to be 10 feet. These calculations are provided in Appendix B. Hydraulic calculations for the stepped spillway and USBR Type III basin are also included in Appendix B.

Structural design calculations for the inlet structure and transition structure are provided in Appendix C.

The storm drain system was modeled using Bentley's StormCAD program. Curves were used in the storm drains to minimize loss at deflection points. Losses at manholes and junctions were determined using the procedures in the District's *Drainage Design Manual, Hydraulics*. The StormCAD outputs are provided in Appendix D.

4.3 Velocity in Storm Drain

City of Phoenix and FCDMC standards both specify 15 ft/s as the maximum allowable velocity in storm drains. Table 1 below lists the velocity within the storm drains for various pipe sizes and flow values flowing under pressure condition:

Table 1
Pipe Velocities at Various Flow Values

Diameter (inches)	Area (ft^3)	V (Q=990 cfs) (ft/s)	V (Q=1,000 cfs) (ft/s)
96	50.3	19.7	19.9
102	56.7	17.4	17.6
108	63.6	15.6	15.7
120	78.5	12.6	12.7

The hydraulic design has been done to determine the smallest pipes that will work from a hydraulic perspective. Additionally, the velocities above are for pipe full conditions where the downstream HGL dictates flow capacity. It should be noted that the existing sections downstream of the OCCC have velocities that exceed 15 ft/s.

During the VA meeting, the District indicated that an earnest effort should be made to meet the 15 ft/s maximum criterion. Consequently, the storm drain carrying stormwater was upsized to 102" and the profile was flattened to keep the velocity below 15 ft/s for the 10-year or less events. For the design flow of 990 cfs, the 102" would flow under pressure condition and have a velocity of 17.45 ft/s. The District has indicated that because this occurs less frequently, the high velocity for the design flow condition was acceptable.

During the VA meeting, the project team also evaluated and recommended the use of cast-in-place pipe (CIPP) for the canal storm drain segment. CIPP is easier to construct and costs about a third less than pre-cast rubber gasket reinforced concrete pipe (RGRC). However, it does not perform well in pressure flow conditions. The City of Phoenix allows the use of CIPP, while the District is currently developing a policy on CIPP. The District has indicated that CIPP would be acceptable if it does not flow under pressure. To meet this condition, the storm drain carrying canal water was sized so that the HGL would be a minimum of 6 inches below the pipe crown. This results in a 120" CIPP for the storm drain segment for the canal flow.

5.0 GEOTECHNICAL INVESTIGATION

Five soil borings were performed in the Phase 1 project area by Alpha Geotechnical & Materials, Inc. to investigate the subsurface soil conditions and characteristics. A copy of the Geotechnical Report is provided in Appendix H which includes the laboratory results and boring logs.

The borings were drilled to a depth of 25 to 40 feet. No ground water was encountered, although saturated soil was observed in Borings 3 and 4 beginning at 35 feet. The borings indicate that the soil within the project area consists of mostly silty sand with gravel (SM), with densities ranging from loose to very dense. Boring B-5 was a core sample to determine the pavement section in the parking lot area.

Based on the field and laboratory results, the report recommends an excavation slope of 1½ horizontal to 1 vertical or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than 5 feet. Trench boxes and shoring are recommended in the areas near the eucalyptus trees to minimize impacts to the trees. Shoring is also recommended for construction near the existing SRP headgate structure to protect the structure.

6.0 UTILITIES

This section identifies the existing utilities within the project area and the design constraints that impact the design of the proposed storm drain.

Initial identification of utilities within the project area was provided by Bluestake through a design request. The utilities identified within the project area include: water, sewer, storm drain, traffic signals, irrigation, cable TV, telephone, fiber optics, gas, and underground and overhead power. The name and contact for each utility are provided in Table 2 below.

Table 2 – Utility Contact Information

Company	Utility	Number	Contact
AT&T	Fiber Optic	800.241.3624 ext. 0	LSAC Group
City of Phoenix Traffic Signals	Traffic Signals, Junction Boxes, Fiber	602.262.6204	Main Admin Desk
City of Phoenix Water Services Department	Water, Sewer, Reclaimed Water	602.261.8229	Jami Erickson
Cox Communications	Cable TV, Fiber	623.328.4349	John Rowe
Qwest Local	Coaxial, Fiber	602.630.3370	Larry Lasky
SRP	• Irrigation (includes SCADA equipment) • Construction License	602.236.5227	Bob Gooch
	Power Distribution	602. 236-8066	Bob Maldonado
	Power Transmission	602.236.4882	Wayne Darby
Southwest Gas	Gas	480.730.3855	Zach Stevenson
	High Pressure	480.730.3672	Saul Carrasco
Arcadia Water Company	Irrigation	480.945.4621	John Richardson

An initial utility base map was created using as-built maps, quarter section maps, and facility maps obtained from the utility companies. A pothole list is being prepared and potholes will be performed at the storm drain crossings to identify potential conflicts.

Since the proposed storm drain is located off of the roadway, utility impacts will be minimal. The storm drain will cross an existing 8" sewer line north of the canal, but the storm drain is sufficiently deep to provide a minimum 2 feet of clearance. The main utility conflicts will be with SRP facilities.

SRP is a project stakeholder because they manage most of the Project rights-of-way and their existing earthen canal is being replaced. Coordination will be needed at the headwork tie-in location. The existing wing walls will need to be removed and the four 4-inch underdrain pipes will need to be extended through the proposed flume. In the current storm drain layout, the SCADA equipment and conduits need to protected in place during construction. The undercrossing of the canal will need to be done during SRP's dry-up period for an open cut. The City of Phoenix may be able to work out an agreement with SRP for the 2011 dry-up season. This needs to be coordinated with the City's Water Services Department. For an open cut, the minimum clearance required between the bottom canal lining and the top of pipe is 18 inches. For a jack-and-bore, the clearance required is 4 feet. SRP also has power transmission and distribution lines within the project area. The transmission poles are not impacted, but three distribution poles are in conflict and will need to be relocated. SRP's irrigation junction and piping north of the canal are within the excavation limits and should be relocated.

The alignment of the canal crossing was revised from the 40% design to avoid impact to the existing pedestrian bridge, which should be protected in place during construction. Access to and use of the pedestrian bridge should be maintained during construction.

Finally, coordination will be needed with the owners of the medical building and with the Arcadia Estates Homeowner's Association located at the northeast corner of Arcadia Drive and the Arizona Canal. Impacts to these properties should be minimized during construction. A drainage easement and temporary construction easement (TCE) are being acquired from the owners.

A retention basin is located at the northeast corner of Arcadia Drive and the canal, with an existing headwall and a pipe that outlets into the canal. These facilities need to be protected in place during construction. The City does not allow a private drainage facility to be connected to its storm drain system.

Potholes were performed to determine if there were conflicts with any underground utilities. The pothole results indicate there are no conflicts with the proposed storm drains. Pothole results are provided in Appendix G.

7.0 SUMMARY AND RECOMMENDATION

This project will construct a storm drain system to convey stormwater from the Arcadia watershed and canal water from the Arizona Canal to the existing Old Cross Cut Canal 2-10'x10' box culvert north of Indian School Road. The existing Old Cross Cut Canal earthen channel will be replaced with an underground pipe. The project also includes the undercrossing of the Arizona Canal.

The storm drain system will be designed for a capacity of 1,990 cfs, which includes 1,000 cfs from the Arizona Canal and 990 cfs from the Arcadia drainage area. The 10-year flow from the Arcadia drainage area is 681 cfs. The additional 309 cfs of capacity for the stormwater drainage system will increase the level of protection to a 10-plus year system, or provide the capability to handle additional future flows. A collection system will be needed to collect the additional 309 cfs north of the Arizona Canal. The collection system design can be part of the future phase, including the junction structure.

In order to keep the pipe velocity below the 15 ft/s maximum requirement, the storm drain profile needed to be lowered and flattened. This requires the pipe to be dropped a total of 12.8' from the SRP headgate structure, an additional 5.3' from the 40% design. The proposed inlet structure is a combination stepped spillway with a USBR Type III basin containing a row of baffle blocks and a sill to dissipate the energy through the drop. Normal depth is achieved at the entrance of the 120" CIPP storm drain.

A dual storm drain system is recommended, with a 120" diameter CIPP to handle 1,000 cfs from the canal flow and a 102" diameter RGRCP to handle 990 cfs of stormwater from the Arcadia area. The two pipes would run separately on different profiles until they combine at a transition structure at the existing box culvert inlet.

8.0 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. *Metro Phoenix Area Drainage Master Plan,* Engineering and Environmental Consultants, Inc. for Flood Control District of Maricopa County, September 2008.
4. *Storm Water Policies and Standards*, City of Phoenix, March 2004.
5. *Arcadia Area Drainage Project Final Recommendations Report*, Huitt-Zollars for Flood Control District of Maricopa County, FCD No. 94-21, March 1997.

Appendix A

Technical Memos

OLSSON ASSOCIATES

TECHNICAL MEMORANDUM

Date: April 13, 2010

To: Bobbie Ohler, Project Manager

From: Jeff Ford, P.E.

Project: Arcadia Drainage Improvements, Phase 1
Indian School Road to Arizona Canal

Project No: 2008C013, Assignment #4

RE: EVALUATION TO DOWNSIZE BOX CULVERT

Introduction

The basis of design for this project is the preferred alternative (Alternative #2) from the *Arcadia Area Drainage Project, Final Recommendation Report* (Huitt-Zollars, 1997). This report evaluated several alternatives that would construct drainage infrastructure to reduce flooding in the Arcadia area northeast of the Arizona Canal. The recommended alternative was to provide a 10-year storm drain along Arcadia Drive and convey this flow under the Arizona Canal, discharging into the Old Cross Cut (OCC) canal. In addition to the storm drain flows entering the OCC, SRP has IGA's that gives them the right to the first 1,000 cfs of capacity within the OCC.

The basis of design recommended the following:

- A 96-inch pipe to convey flows along Arcadia Drive from Lafayette Boulevard to the OCC. The total flow at the canal undercrossing is 681 cfs.
- A concrete-lined vertical wall channel, 20-ft base and 18 to 20-ft height, to convey 1,990 cfs (1,000 cfs SRP and 990 cfs stormwater) through the OCC and connecting to the existing 2-10'x10' box culverts north of Indian School Road. The scope of the Phase 1 project revised the vertical wall channel to 2-10'x10' box culverts.

The purpose of this memo is to evaluate the feasibility of downsizing the proposed 2-10'x10' box culverts from Indian School Road to the Arizona Canal.

Existing IGA's along the OCC

There are several IGA's between the District, City of Phoenix, and SRP that cover the OCC. These are summarized below:

- IGA dated December 8, 1975. This agreement was entered into by the District, City,

and SRP for the reconstruction of the Old Cross Cut Canal to a flood control and drainage channel. This agreement indicates the capacity of the gates at the Arizona Canal to be approximately 1,000 cfs. SRP retained the right to the first 1,000 cfs of capacity in the OCC, and the City had the right to connect storm drain facilities up to 1,000 cfs capacity.

- IGA dated February 26, 1991. IGA FCD-90007 was entered into by the District, City of Phoenix, and SRP for the design and reconstruction of the Old Cross Cut Canal north of McDowell Road to the Arizona Canal. This IGA specified that the OCC "shall be improved to a capacity of approximately 3000 cfs at the Arizona Canal and approximately 4100 cfs at McDowell Road." The IGA repeats the current agreement to assign the first 1000 cfs of capacity to SRP and limits the City to 1000 cfs capacity.

  An amendment to this IGA was made on November 29, 1993 (IGA FCD-90007A). This amendment revised the design assumptions, which states the capacity of the culvert at Indian School Road to be approximately 2,500 cfs, including the SRP 1,000 cfs discharge from the Arizona Canal. The IGA also specifies the capacity of the conveyance system not to exceed a 10-year storm frequency discharge.

Hydrology

The project team has agreed that since there is not any other major drainage infrastructure that pass flows out of the Arcadia area, this facility should be upsized to the extent that is economically feasible.

The hydrology has been based on the Huitt-Zollars report, which states the capacity of the existing 2-10'x10' box culverts north of Indian School Road to be 1,990 cfs. Therefore, the design flows will be as follows:

- 681 cfs in a storm drain along Arcadia Drive to the Arizona Canal
- 990 cfs for the Arizona Canal undercrossing
- 1,000 cfs from the Arizona Canal
- 1,990 cfs along the OCC canal

Storm Drain Design Consideration

SRP currently has the facilities and the right to discharge up to 1,000 cfs from the Arizona Canal through 3 radial gates under free flow conditions. SRP has expressed concern about the possibility that the proposed drainage system would submerge the gates, which would reduce their performance and potentially impact SRP's ability to discharge 1,000 cfs. If the proposed storm drain submerges the gates, SRP requests that at a minimum, a flow level sensor be installed downstream of the gates to monitor the water surface elevation just downstream of the gates so that submerged gate equations could be used. However, SRP has also indicated that they are concerned about their ability to control any gates in a submerged condition and that any modifications downstream that would create a submerged condition would be a concern. Therefore, the storm drain has been designed to ensure that the gates are not submerged. To ensure this condition is met, supercritical flow needs to be maintained for a distance downstream of the gates.

Storm Drain Design Approach

The goal of the storm drain design is to not change the water surface elevation at the downstream face of SRP's structure for an SRP discharge of 1,000 cfs. The following approach has been used:

1. Determine the existing water surface elevation at the downstream face of SRP's structure for the existing condition. A HEC-RAS model from the gates to the existing 2-10'x10' box culverts was created using GIS topo data. For a flow of 1,000 cfs, the WSE just downstream of the gates was computed to be 1241.39'. Outputs from the RAS model are included in Appendix A.
2. Determine the HGL of the proposed storm drain system downstream of the gates. A StormCAD model was created based on the proposed storm drain layout and design flows. Various scenarios were developed with different pipe sizes and profiles until a preferred alignment was found that resulted in an HGL that matched or was lower than the existing WSE from the RAS model. .
3. Determine hydraulic profile through the hydraulic jump downstream of SRP's structure. A water surface profile was calculated just downstream of SRP's structure to ensure that the jump does not drown SRP's gates. Calculations are included in Appendix B.

Velocity in the Storm Drain

Table 6.9 in Section 6.6 in the Drainage Policies and Standards for Maricopa County identify 15 ft/s as the maximum allowable velocity in storm drains. Table 1 below lists the velocity within the storm drains for various pipe sizes and flow values flowing under pressure condition:

Table 1
Pipe Velocities at Various Flow Values

Diameter (inches)	Area (ft^3)	V (Q=990 cfs) (ft/s)	V (Q=1,000 cfs) (ft/s)
96	50.3	19.7	19.9
102	56.7	17.4	17.6
108	63.6	15.6	15.7
120	78.5	12.6	12.7

The hydraulic design for this submittal has been done to determine the smallest pipes that will work from a hydraulic perspective, but it should be noted that the current design does not meet FCDMC design requirements for maximum velocity within the storm drain. Additionally, the velocities above are for pipe full conditions where the downstream HGL dictates flow capacity. For flows less than the design flow, velocities will be up to 26 ft/s. This should be evaluated during the VA meeting to determine how much pipes could be upsized and slopes revised before adding substantial costs. It should also be noted that the original 20 foot wide concrete channel proposed in the 1997 Huitt-Zollar study would have resulted in velocities similar to the velocities identified in this report. Minimizing these velocities would require a series of drop stuctures as well as significantly increasing the open area of any conduit. Consideration should also include the difficulty in constructing large drops in a channel that has the potential for flow.

Constructability

SRP has indicated that during construction they may need to release water due to stormwater flows into the canal or delivery cancellations downstream. Therefore, there is the potential for up to 1,000 cfs to be discharged through the OCC even during construction. Construction of two separate storm drain systems would allow quicker construction to handle SRP discharges, as well as significantly reduce open trench widths.

40% Design

A dual storm drain system is recommended, with a 102" diameter pipe to handle the canal flow of 1,000 cfs and a 96" diameter pipe to handle the Arcadia flow of 990 cfs. The two pipes would run separately on different profiles until they combine at a junction structure approximately 15 feet upstream of the tie-in point. A 15-foot segment of 2-10'x10' box culvert section downstream of the junction would allow a matching interface at the connection point. This system produces an HGL of 1241.03' just downstream of the SRP gates. Results of the StormCAD model are included in Appendix C.

The dual storm drain concept also allows each system to be constructed separately, which provides a way for the contractor to handle the SRP discharges during construction. While one system is being constructed, the side of the other system could be used to convey the SRP discharge.

OLSSON ASSOCIATES

TECHNICAL MEMORANDUM

Date: June 2, 2010

To: Bobbie Ohler, Project Manager

From: Jeff Ford, P.E.

Project: Arcadia Drainage Improvements, Phase 1
Indian School Road to Arizona Canal

Project No: 2008C013, Assignment #4

RE: OCCC STORM DRAIN HYDRAULIC EVALUATION

Introduction

The purpose of this memo is to summarize the hydraulic evaluation for the Old Cross Cut Canal (OCCC) storm drain and to document the methodology and procedures of its design.

Background

As part of this project, the Old Cross Cut Canal earthen ditch will be replaced with an underground conduit to convey 1,000 cfs from the Arizona Canal to the existing 2-10'x10' box culverts north of Indian School Road. The tie-in elevations at the SRP headgate structure and existing box culvert are 1237.50 and 1223.19, respectively. This results in an average slope of 3.15% for a straight connection of the two inverts.

At the 40% design, a 2:1 spillway was proposed to drop the elevation 7.5 feet to flatten the pipe slope to reduce the pipe velocity. A hydraulic jump was designed at the end of the spillway to transition the flow from supercritical to subcrtical. The proposed 102" diameter pipe was under pressure flow condition with an average pipe velocity of 17.62 ft/s. At flows less than the design Q, the velocity in the pipe could reach up to 26 ft/s.

At the 40% comment resolution meeting, there were several comments regarding the pipe velocity being greater than the maximum 15 ft/s guideline established by the District and City of Phoenix. The District's Engineering Department requested that an effort be made to keep the pipe velocity below the 15 ft/s guideline, especially for the more frequent storm events.

In order to reduce the velocity in the pipe, the slope would have to be flattened. This requires dropping the pipe about 5 feet deeper at the upstream end. The project team brainstormed during the VA meeting and recommended a plunge basin to dissipate the energy created by the approximate 12.5' drop at the SRP headgate structure.

During the VA meeting, the project team also discussed the use of cast-in-place pipe (CIPP). An advantage of CIPP is that it is about a third less expensive than rubber-gasket reinforced concrete pipe (RGRCP. CIPP does not require large equipment to handle and can be installed faster than RGRCP. The trench required for CIPP is narrower, so it would minimize impact on Arcadia Drive. However, CIPP can crack if the pipe is under hydraulic pressure. CIPP can also leak if the joints are not sealed.

The City of Phoenix allows CIPP if it is not under a roadway, and the District is developing a policy on the use of CIPP. The District has indicated that CIPP would be allowed if the pipe will not be under pressure.

CIPP Design

Olsson Associates evaluated the use of CIPP for the OCCC storm drain. StormCAD was used to model the storm drain system. The design parameters for the StormCAD model include:

- Design flow to be 1,000 cfs
- HGL to be a minimum of 6" below crown of pipe
- Tailwater elevation was set at 1230.00. This was based on as-built plans of the OCCC Phase 4 construction. This is a conservative estimate as the design Q for the Phase 4 construction is 3,000 cfs, while the design Q for this project is 1,990 cfs.
- Maximum pipe velocity is 15 ft/s.

It was determined that a 120" CIPP at a slope of 0.0039 ft/ft meets the design criteria described above. Two 300-foot radius curves are also designed to minimize losses through the pipe. The StormCAD outputs are attached.

Inlet Design

Olsson Associates reviewed the plunge basin concept, and due to the uncertainty of the turbulent flows in a plunge basin, recommended a flume with roughness elements as a way to dissipate the energy and reduce the flow velocity. The following describes the hydraulic analysis of the proposed inlet design.

Design Criteria

- The minimum velocity in the storm drain pipe will be 5 ft/sec and the maximum velocity will be 15 ft/sec.
- The proposed storm drain system will not submerge the SRP gates.

Assumptions

- The design flow is 1,000 cfs.
- The headwater depth upstream of the gates is 10 feet.

Inlet Design Methodology

The upstream boundary condition was calculated using the equations and procedure from the M. G. Bos reference, which is attached. The upstream WSEL was set to 10'. The gate opening height was determined to be 2.03' and the water surface elevation downstream of the gate calculated to be 1.44'. The velocity was calculated as 21 fps.

The FHWA circular "Hydraulic Design of Highway Culverts" (HDS-5) was used to develop the entrance geometry of the square throat section and the square-to-round transition. The side-taper inlet design form was used along with the nomographs for side taper inlets.

The inlet geometry and a preliminary chute were modeled using HEC-RAS in a supercritical run using the upstream boundary condition of 1.44' as a known water surface elevation. A combination of Manning's n values and slopes were used to find an alternative that would match the velocity of flow in the pipe. This model showed that a 4:1 slope and an effective Manning's n value of 0.0585 on the chute would slow the flow to 15 fps before entering the square throat section. Outputs from the HEC-RAS model are attached.

The chosen slope and effective Manning's n were used with equations from HEC-14 ("Hydraulic Design of Energy Dissipators for Culverts and Channels") to determine the size, shape, and number of the necessary roughness elements on the chute to create the modeled effective Manning's n. These calculations are provided in the attached documents. The splash freeboard was checked using the equations in HEC-14. The conjugate depths were also checked using the method in the Design of Small Dams.

Proposed Inlet Design

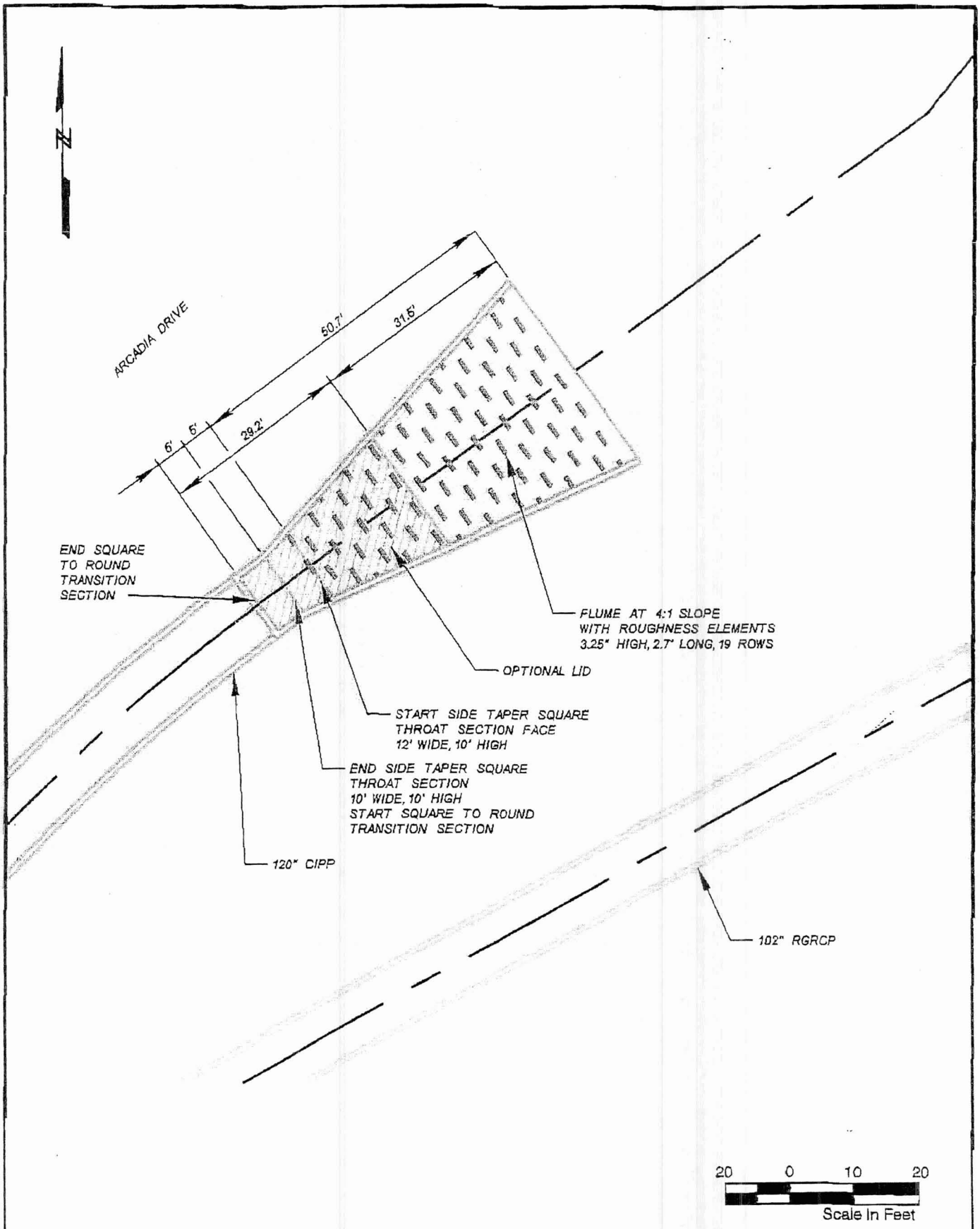
The proposed inlet design downstream of the SRP headgate structure is a flume at a 4 to 1 slope with 19 rows of roughness elements. Each roughness element is 3.25" high, 2.7' long, spaced at 2.7' apart. At the end of the flume, a 12' wide by 10' high side square throat section tapers at a 5-foot length to a 10' wide by 10' high square throat section. A square to round transition occurs in the next 5 feet, which then connects to the 120" cast-in-place pipe (CIPP). The roughness elements reduce the flow velocity from 21 ft/s downstream of the gates to 15 ft/s as the water enters the 120" CIPP. A hydraulic jump occurs within the transition section as the flow transitions from supercritical flow to subcritical flow. The design is also under inlet control, so there is no backwater effect from the storm drain. Therefore, the gates will not be submerged.

References:

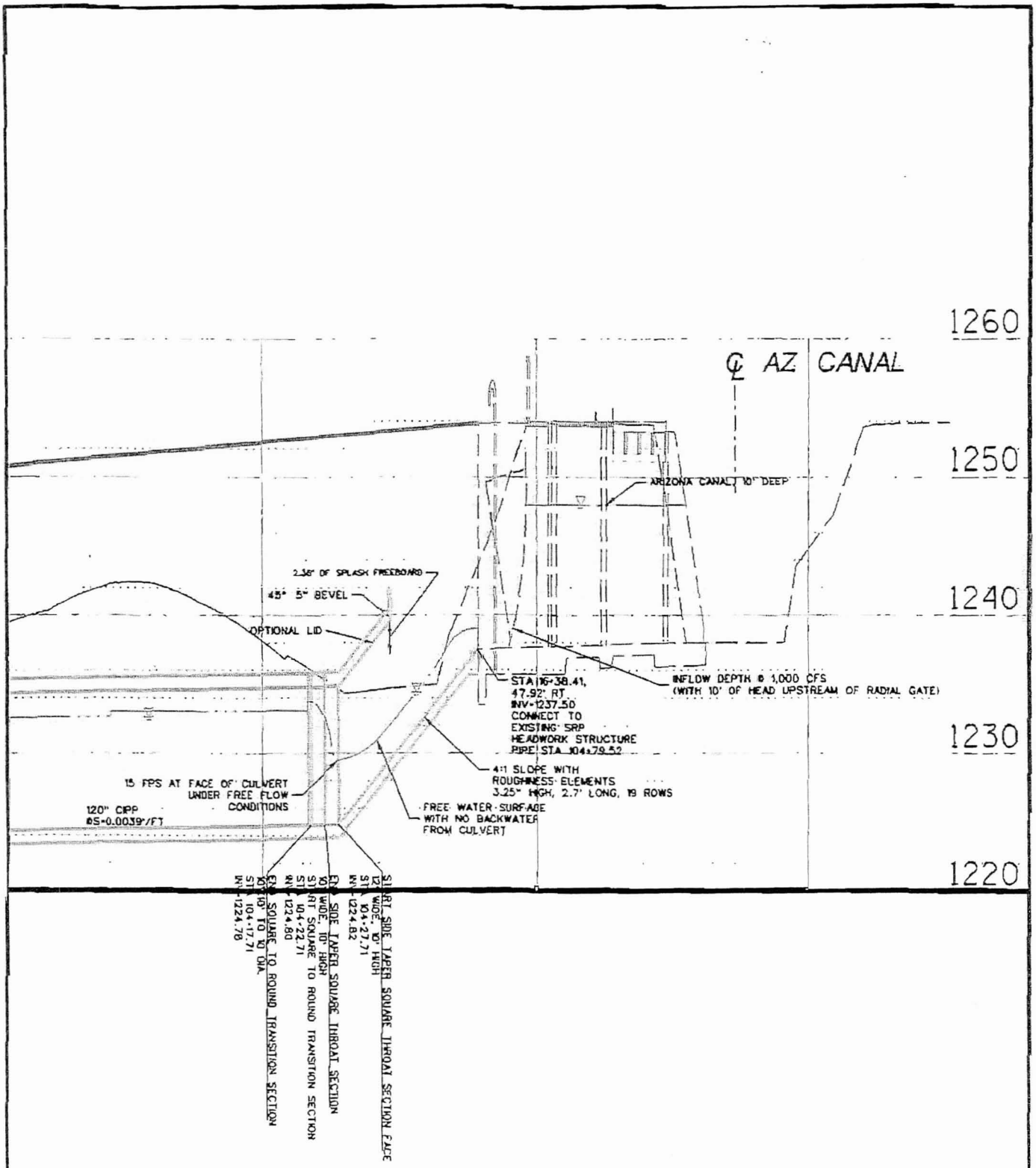
1. M.G. Bos, "Discharge Measurement Structures", December 1989
2. EM 1110-2-2702, Corps of Engineers, Engineering and Design – "Design of Spillway Tainter Gates", January 2000
3. Federal Highway Administration, "Hydraulic Design of Highway Culverts" (HDS-5), September 2001
4. Federal Highway Administration, FHWA-EPD-86-110, HEC-14, "Hydraulic Design of Energy Dissipators for Culverts and Channels", September 1983
5. Bureau of Reclamation, "Design of Small Dams", November 1987

Please feel free to contact me at 602.748.1000 or email me jford@osconsulting.com if you have any questions or concerns.

PROPOSED DESIGN



ARCADIA DRIVE DRAINAGE IMPROVEMENTS PHASE 1	PROPOSED INLET PLAN	OLSSON ASSOCIATES

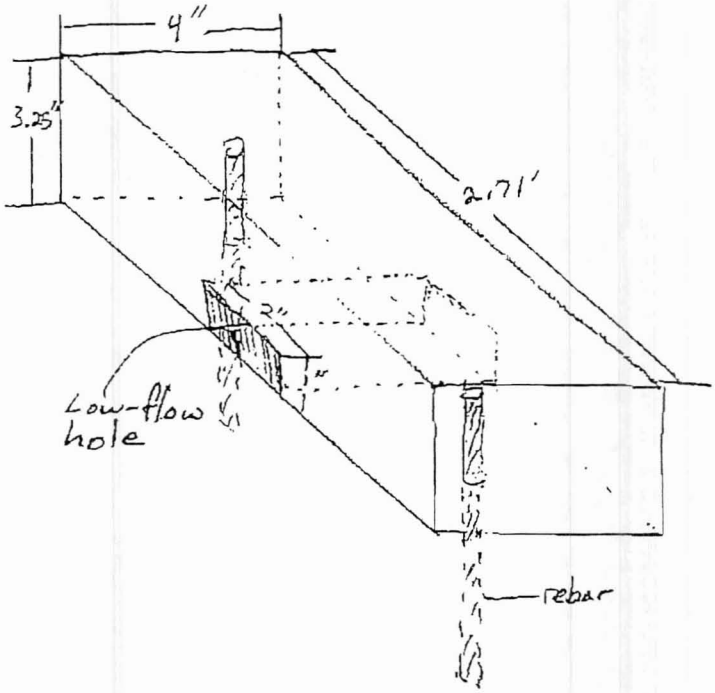


ARCADIA DRIVE
DRAINAGE IMPROVEMENTS
PHASE 1

PROPOSED INLET PROFILE

OLSSON ASSOCIATES

Concrete Roughness elements



HEC-RAS MODEL FOR PROPOSED INLET

HEC-RAS Plan: Side taper • River: 1 Reach: 1

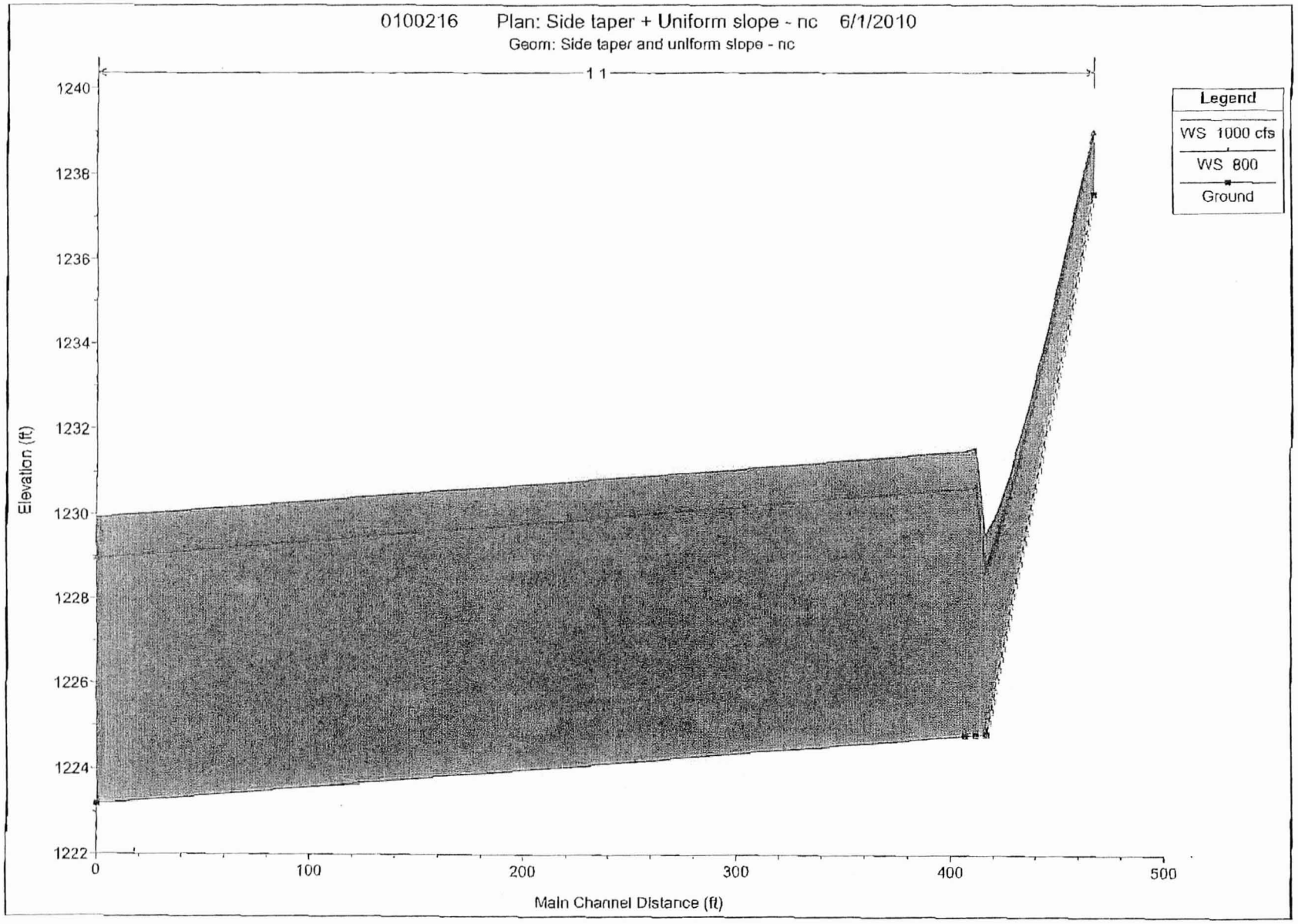
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	10479.29	1000 cfs	1000.00	1237.50	1238.94	1240.56	1245.82	0.471984	21.04	47.52	33.00	3.09
1	10479.29	800	800.00	1237.50	1238.94	1240.12	1243.34	0.302070	16.84	47.52	33.00	2.47
1	10478.5*	1000 cfs	1000.00	1237.25	1238.76	1240.32	1246.26	0.426516	20.48	48.82	32.58	2.95
1	10478.5*	800	800.00	1237.25	1238.73	1239.90	1243.02	0.286429	16.63	48.09	32.58	2.41
1	10477.7*	1000 cfs	1000.00	1237.00	1238.55	1240.10	1244.77	0.390199	20.01	49.97	32.18	2.83
1	10477.7*	800	800.00	1237.00	1238.51	1239.67	1242.72	0.273179	16.46	48.60	32.18	2.36
1	10476.9*	1000 cfs	1000.00	1236.75	1238.36	1239.88	1244.32	0.359604	19.60	51.03	31.76	2.72
1	10476.9*	800	800.00	1236.75	1238.29	1239.44	1242.43	0.262101	16.32	49.01	31.76	2.32
1	10476.1*	1000 cfs	1000.00	1236.51	1238.17	1239.67	1243.91	0.333850	19.23	52.01	31.36	2.63
1	10476.1*	800	800.00	1236.51	1238.09	1239.22	1242.15	0.261686	16.19	49.42	31.36	2.27
1	10475.3*	1000 cfs	1000.00	1236.26	1237.97	1239.44	1243.53	0.312435	18.92	52.85	30.94	2.55
1	10475.3*	800	800.00	1236.26	1237.86	1239.00	1241.90	0.244604	16.12	49.63	30.94	2.24
1	10474.5*	1000 cfs	1000.00	1236.01	1237.77	1239.22	1243.18	0.294941	18.67	53.57	30.52	2.48
1	10474.5*	800	800.00	1236.01	1237.64	1238.78	1241.66	0.239971	16.10	49.70	30.52	2.22
1	10473.8*	1000 cfs	1000.00	1235.76	1237.56	1239.00	1242.85	0.281019	18.47	54.16	30.12	2.43
1	10473.8*	800	800.00	1235.76	1237.41	1238.55	1241.43	0.235656	16.08	49.76	30.12	2.20
1	10473.0*	1000 cfs	1000.00	1235.51	1237.35	1238.78	1242.55	0.268997	18.30	54.65	29.70	2.38
1	10473.0*	800	800.00	1235.51	1237.19	1238.33	1241.16	0.230657	16.04	49.86	29.70	2.18
1	10472.2*	1000 cfs	1000.00	1235.26	1237.14	1238.56	1242.27	0.259301	18.17	55.04	29.30	2.34
1	10472.2*	800	800.00	1235.26	1236.96	1238.10	1240.96	0.227676	16.05	49.84	29.30	2.17
1	10471.4*	1000 cfs	1000.00	1235.01	1236.93	1238.34	1241.99	0.250599	18.08	55.37	28.88	2.30
1	10471.4*	800	800.00	1235.01	1236.73	1237.88	1240.74	0.224937	16.07	49.79	28.88	2.16
1	10470.6*	1000 cfs	1000.00	1234.77	1236.73	1238.13	1241.73	0.242286	17.95	55.72	28.48	2.26
1	10470.6*	800	800.00	1234.77	1236.52	1237.67	1240.53	0.222046	16.07	49.77	28.48	2.14
1	10469.8*	1000 cfs	1000.00	1234.52	1236.51	1237.91	1241.48	0.236192	17.89	55.90	28.06	2.23
1	10469.8*	800	800.00	1234.52	1236.29	1237.46	1240.32	0.219621	16.10	49.70	28.06	2.13
1	10469.0*	1000 cfs	1000.00	1234.27	1236.30	1237.70	1241.25	0.231602	17.86	55.98	27.64	2.21
1	10469.0*	800	800.00	1234.27	1236.07	1237.23	1240.10	0.217522	16.13	49.60	27.64	2.12
1	10468.3*	1000 cfs	1000.00	1234.02	1235.98	1237.48	1241.01	0.226613	17.82	56.11	27.24	2.19
1	10468.3*	800	800.00	1234.02	1235.84	1237.03	1239.90	0.216041	16.17	49.48	27.24	2.11
1	10467.5*	1000 cfs	1000.00	1233.77	1235.87	1237.27	1240.78	0.222181	17.80	56.19	26.82	2.17
1	10467.5*	800	800.00	1233.77	1235.61	1236.78	1239.69	0.214321	16.21	49.38	26.82	2.11
1	10466.7*	1000 cfs	1000.00	1233.52	1235.65	1237.05	1240.57	0.219125	17.80	56.18	26.42	2.16
1	10466.7*	800	800.00	1233.52	1235.39	1236.56	1239.47	0.211462	16.22	49.33	26.42	2.09
1	10465.9*	1000 cfs	1000.00	1233.27	1235.43	1236.84	1240.35	0.215639	17.80	56.18	26.00	2.13
1	10465.9*	800	800.00	1233.27	1235.17	1236.36	1239.26	0.208491	16.23	49.30	26.00	2.08
1	10465.1*	1000 cfs	1000.00	1233.02	1235.22	1236.63	1240.14	0.212778	17.81	56.16	25.58	2.12
1	10465.1*	800	800.00	1233.02	1234.95	1236.13	1239.04	0.205573	16.24	49.27	25.58	2.06
1	10464.3*	1000 cfs	1000.00	1232.78	1235.01	1236.43	1239.93	0.209431	17.80	56.16	25.18	2.10
1	10464.3*	800	800.00	1232.78	1234.73	1235.92	1238.84	0.203650	16.27	49.18	25.18	2.05
1	10463.6*	1000 cfs	1000.00	1232.53	1234.80	1236.22	1239.73	0.207065	17.83	56.10	24.76	2.09
1	10463.6*	800	800.00	1232.53	1234.51	1235.71	1238.64	0.201811	16.31	49.06	24.76	2.04
1	10462.8*	1000 cfs	1000.00	1232.28	1234.58	1236.01	1239.53	0.205315	17.86	55.98	24.36	2.08
1	10462.8*	800	800.00	1232.28	1234.29	1235.49	1238.44	0.200300	16.35	48.94	24.36	2.03
1	10462.0*	1000 cfs	1000.00	1232.03	1234.37	1235.80	1239.34	0.203178	17.89	55.89	23.94	2.06
1	10462.0*	800	800.00	1232.03	1234.07	1235.28	1238.24	0.198529	16.39	48.82	23.94	2.02
1	10461.2*	1000 cfs	1000.00	1231.78	1234.15	1235.60	1239.14	0.201168	17.93	55.79	23.52	2.05
1	10461.2*	800	800.00	1231.78	1233.85	1235.07	1236.04	0.196786	16.43	48.70	23.52	2.01
1	10460.4*	1000 cfs	1000.00	1231.53	1233.94	1235.39	1238.94	0.198473	17.94	55.76	23.12	2.04
1	10460.4*	800	800.00	1231.53	1233.63	1234.86	1237.85	0.195389	16.47	48.56	23.12	2.00
1	10459.6*	1000 cfs	1000.00	1231.28	1233.74	1235.19	1238.74	0.195633	17.94	55.73	22.70	2.02

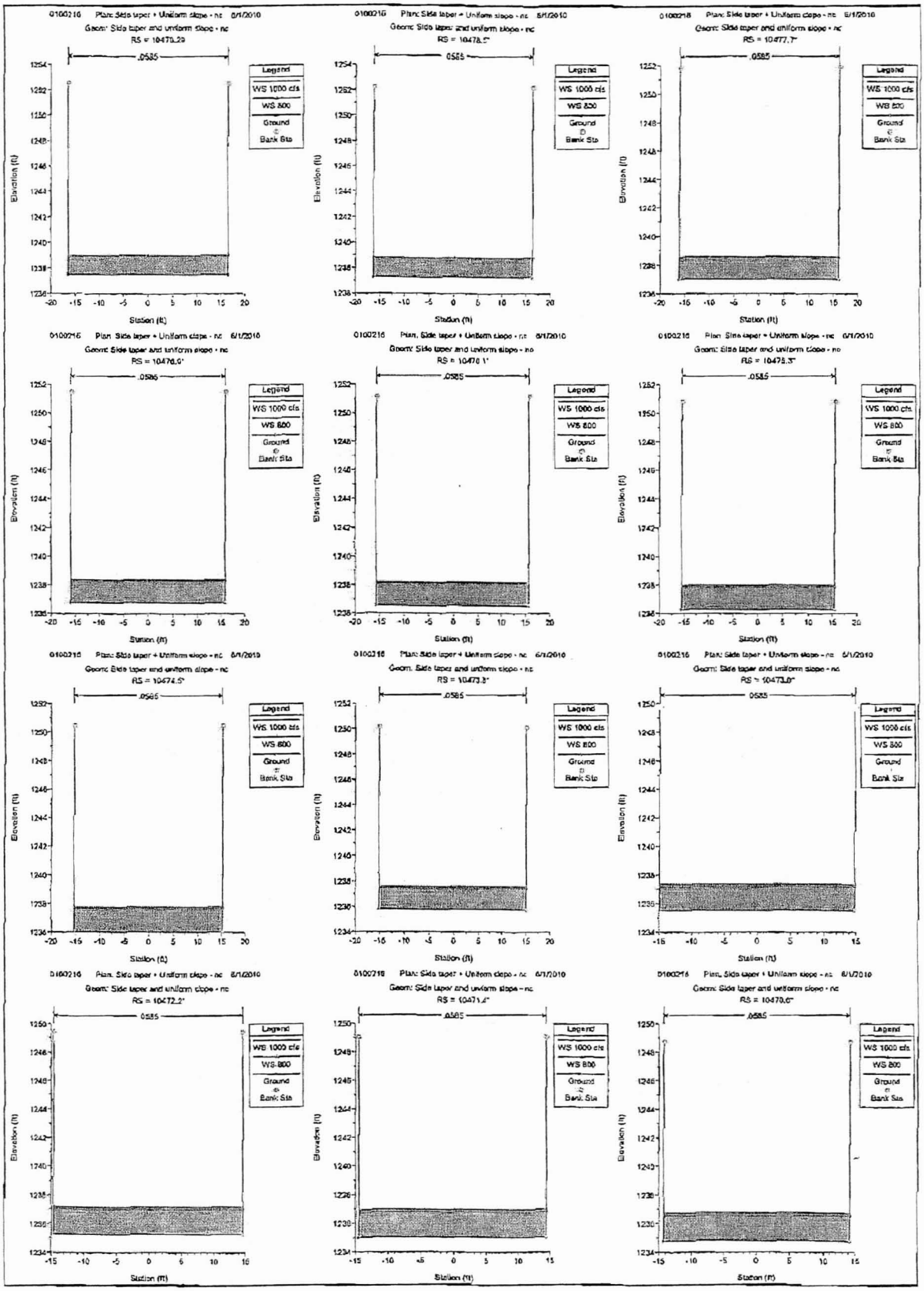
HEC-RAS Plan: Side taper + River: 1 Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	10459.6*	800	800.00	1231.28	1233.41	1234.85	1237.65	0.193692	16.52	48.43	22.70	1.99
1	10458.9*	1000 cfs	1000.00	1231.04	1233.54	1235.00	1238.54	0.192481	17.94	55.75	22.30	2.00
1	10458.9*	800	800.00	1231.04	1233.21	1234.45	1237.45	0.190952	16.53	48.41	22.30	1.98
1	10458.1*	1000 cfs	1000.00	1230.79	1233.34	1234.80	1236.34	0.189781	17.95	55.72	21.88	1.98
1	10458.1*	800	800.00	1230.79	1233.00	1234.24	1237.26	0.189372	16.57	48.27	21.88	1.97
1	10457.3*	1000 cfs	1000.00	1230.54	1233.13	1234.60	1238.16	0.187995	17.96	55.61	21.48	1.97
1	10457.3*	800	800.00	1230.54	1232.78	1234.04	1237.07	0.188113	16.62	48.12	21.48	1.96
1	10456.5*	1000 cfs	1000.00	1230.29	1232.93	1234.40	1237.96	0.185338	17.99	55.58	21.06	1.95
1	10456.5*	800	800.00	1230.29	1232.57	1233.83	1236.88	0.186494	16.67	47.99	21.06	1.95
1	10455.7*	1000 cfs	1000.00	1230.04	1232.73	1234.20	1237.76	0.182713	18.00	55.55	20.64	1.93
1	10455.7*	800	800.00	1230.04	1232.36	1233.63	1236.70	0.184875	16.72	47.86	20.64	1.93
1	10454.9*	1000 cfs	1000.00	1229.79	1232.53	1234.01	1237.58	0.181086	18.04	55.44	20.24	1.92
1	10454.9*	800	800.00	1229.79	1232.15	1233.43	1236.51	0.183575	16.77	47.72	20.24	1.92
1	10454.1*	1000 cfs	1000.00	1229.54	1232.34	1233.82	1237.39	0.178516	18.05	55.41	19.82	1.90
1	10454.1*	800	800.00	1229.54	1231.94	1233.23	1236.33	0.181919	16.81	47.59	19.82	1.91
1	10453.4*	1000 cfs	1000.00	1229.30	1232.15	1233.64	1237.22	0.176716	18.08	55.32	19.42	1.89
1	10453.4*	800	800.00	1229.30	1231.76	1233.04	1236.14	0.179264	16.82	47.56	19.42	1.89
1	10452.6*	1000 cfs	1000.00	1229.05	1231.96	1233.45	1237.04	0.174247	18.09	55.29	19.00	1.87
1	10452.6*	800	800.00	1229.05	1231.55	1232.84	1235.96	0.177646	16.86	47.44	19.00	1.88
1	10451.8*	1000 cfs	1000.00	1228.80	1231.77	1233.27	1236.85	0.171826	18.10	55.26	18.58	1.85
1	10451.8*	800	800.00	1228.80	1231.35	1232.65	1235.79	0.175984	16.91	47.32	18.58	1.87
1	10451.0*	1000 cfs	1000.00	1228.55	1231.58	1233.08	1236.69	0.170261	18.13	55.16	18.18	1.83
1	10451.0*	800	800.00	1228.55	1231.15	1232.45	1235.61	0.174624	16.96	47.18	18.18	1.85
1	10450.2*	1000 cfs	1000.00	1228.30	1231.41	1232.90	1236.51	0.167910	18.14	55.14	17.76	1.81
1	10450.2*	800	800.00	1228.30	1230.95	1232.27	1235.44	0.172863	16.99	47.08	17.76	1.84
1	10449.4*	1000 cfs	1000.00	1228.05	1231.22	1232.72	1236.34	0.165779	18.15	55.11	17.36	1.79
1	10449.4*	800	800.00	1228.05	1230.76	1232.08	1235.26	0.171423	17.04	46.95	17.36	1.83
1	10448.7*	1000 cfs	1000.00	1227.80	1231.05	1232.55	1236.18	0.164370	18.19	54.99	16.94	1.76
1	10448.7*	800	800.00	1227.80	1230.57	1231.89	1235.09	0.169552	17.07	46.86	16.94	1.81
1	10447.9*	1000 cfs	1000.00	1227.55	1230.87	1232.38	1236.03	0.162730	18.21	54.90	16.52	1.76
1	10447.9*	800	800.00	1227.55	1230.39	1231.71	1234.92	0.167052	17.08	46.83	16.52	1.79
1	10447.1*	1000 cfs	1000.00	1227.31	1230.72	1232.22	1235.87	0.160390	18.21	54.92	16.12	1.74
1	10447.1*	800	800.00	1227.31	1230.22	1231.54	1234.74	0.163946	17.06	46.88	16.12	1.76
1	10446.3*	1000 cfs	1000.00	1227.06	1230.56	1232.05	1235.71	0.158317	18.21	54.90	15.70	1.72
1	10446.3*	800	800.00	1227.06	1230.04	1231.37	1234.57	0.161598	17.07	46.85	15.70	1.74
1	10445.5*	1000 cfs	1000.00	1226.81	1230.40	1231.89	1235.55	0.156191	18.21	54.92	15.30	1.69
1	10445.5*	800	800.00	1226.81	1229.87	1231.19	1234.40	0.159443	17.08	46.83	15.30	1.72
1	10444.7*	1000 cfs	1000.00	1226.56	1230.25	1231.74	1235.40	0.153915	18.20	54.95	14.88	1.67
1	10444.7*	800	800.00	1226.56	1229.70	1231.02	1234.25	0.156031	17.12	46.72	14.88	1.70
1	10444.*	1000 cfs	1000.00	1226.31	1230.11	1231.58	1235.25	0.151824	18.19	54.97	14.48	1.65
1	10444.*	800	800.00	1226.31	1229.53	1230.86	1234.10	0.156679	17.16	46.61	14.48	1.69
1	10443.2*	1000 cfs	1000.00	1226.06	1229.98	1231.44	1235.10	0.149487	18.16	55.06	14.06	1.62
1	10443.2*	800	800.00	1226.06	1229.37	1230.69	1233.95	0.154884	17.17	46.58	14.06	1.66
1	10442.4*	1000 cfs	1000.00	1225.81	1229.86	1231.30	1234.95	0.146347	18.10	55.26	13.64	1.58
1	10442.4*	800	800.00	1225.81	1229.23	1230.54	1233.80	0.152459	17.16	46.61	13.64	1.64
1	10441.6*	1000 cfs	1000.00	1225.57	1229.77	1231.17	1234.80	0.142716	18.00	55.57	13.24	1.55
1	10441.6*	800	800.00	1225.57	1229.10	1230.39	1233.68	0.149791	17.13	46.69	13.24	1.61
1	10440.8*	1000 cfs	1000.00	1225.32	1229.69	1231.05	1234.64	0.138691	17.87	55.95	12.82	1.51
1	10440.8*	800	800.00	1225.32	1228.97	1230.25	1233.51	0.147194	17.10	46.77	12.82	1.58
1	10440.0*	1000 cfs	1000.00	1225.07	1229.62	1230.91	1234.49	0.134393	17.72	56.45	12.42	1.46
1	10440.0*	800	800.00	1225.07	1228.84	1230.10	1233.37	0.144863	17.07	46.86	12.42	1.55

HEC-RAS Plan: Side taper * River: 1 Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	10439.29	1000 cfs	1000.00	1224.82	1229.47	1230.81	1234.46	0.006813	17.93	55.78	12.00	1.47
1	10439.29	800	800.00	1224.82	1228.67	1229.98	1233.33	0.007392	17.34	46.14	12.00	1.56
1	10416.29	1000 cfs	1000.00	1224.80	1231.55	1231.55	1234.96	0.004113	14.81	67.51	10.00	1.00
1	10416.29	800	800.00	1224.80	1230.62	1230.62	1233.65	0.003870	13.75	58.18	10.00	1.00
1	10414.04	1000 cfs	1000.00	1224.78	1231.47	1231.53	1234.94	0.004211	14.95	66.89	10.00	1.02
1	10414.04	800	800.00	1224.78	1230.60	1230.60	1233.63	0.003870	13.75	58.18	10.00	1.00
1	9989.04	1000 cfs	1000.00	1223.19	1229.94	1229.94	1233.35	0.004112	14.81	67.52	10.00	1.00
1	9989.04	800	800.00	1223.19	1228.97	1229.01	1231.95	0.003947	13.85	57.75	10.00	1.02


0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
1 1
Legend
WS 1000 cfs
WS 800
Ground
Elevation (ft)
1240
1238
1236
1234
1232
1230
1228
1226
1224
1222
0
100
200
300
400
500
Main Channel Distance (ft)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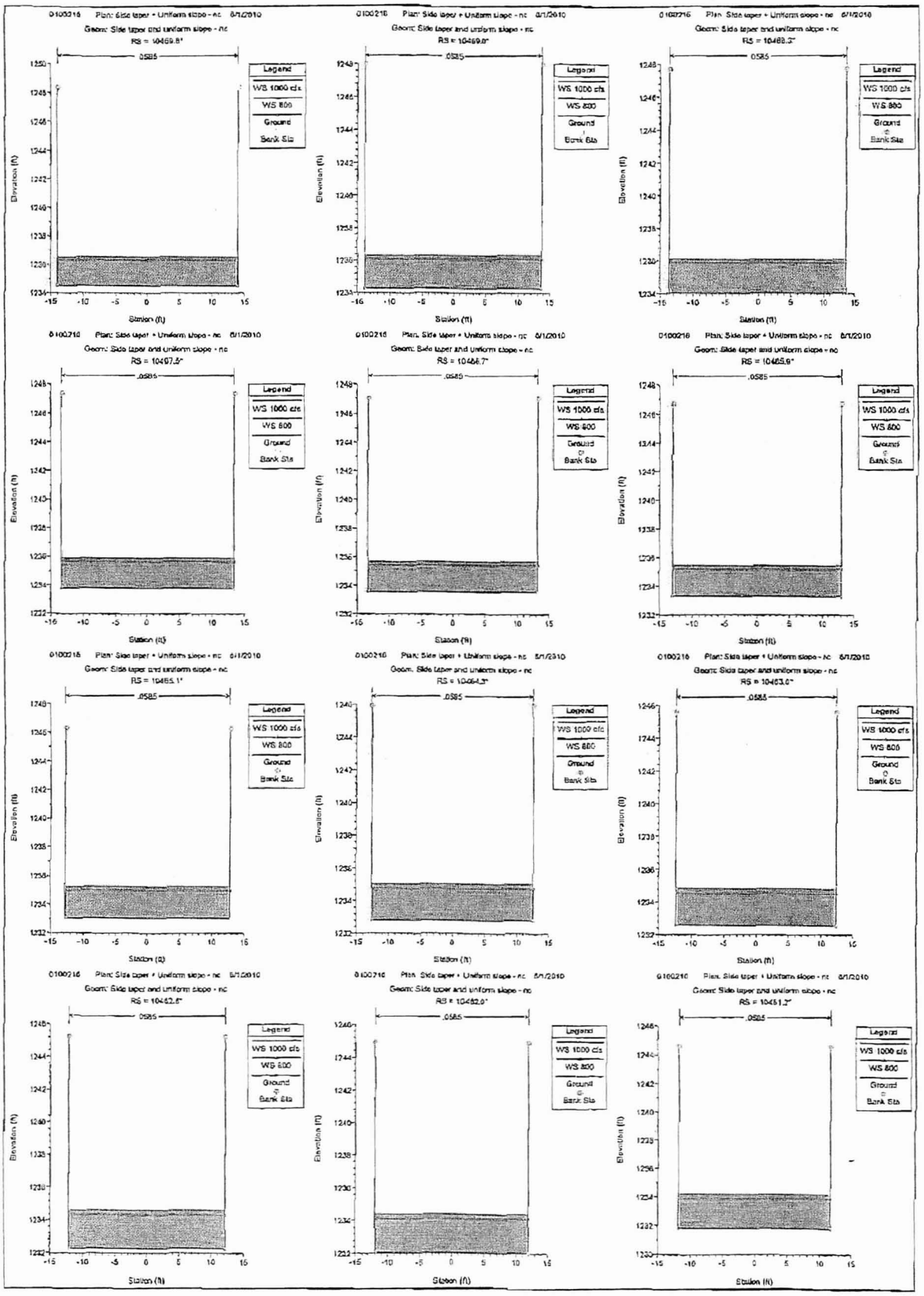
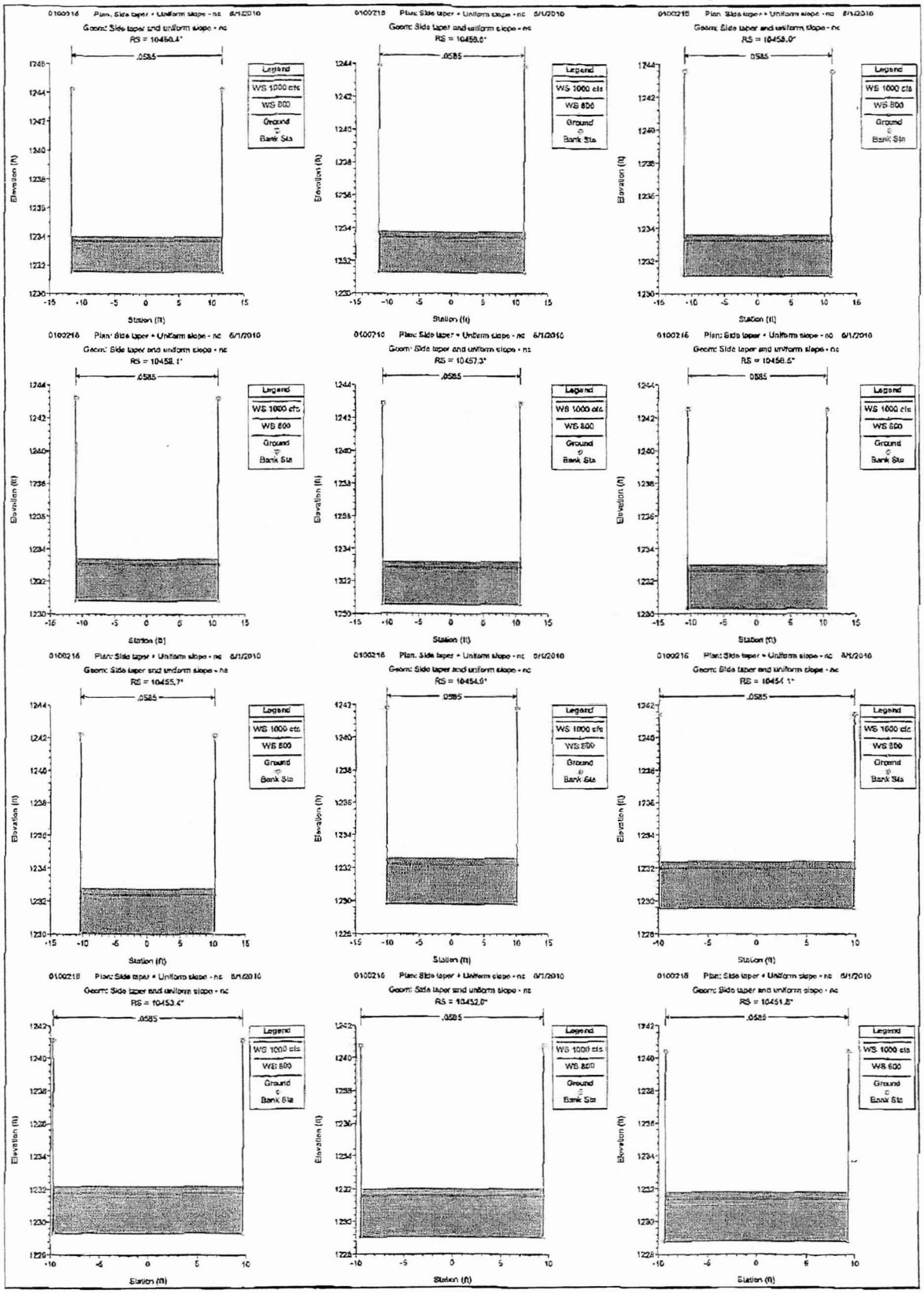
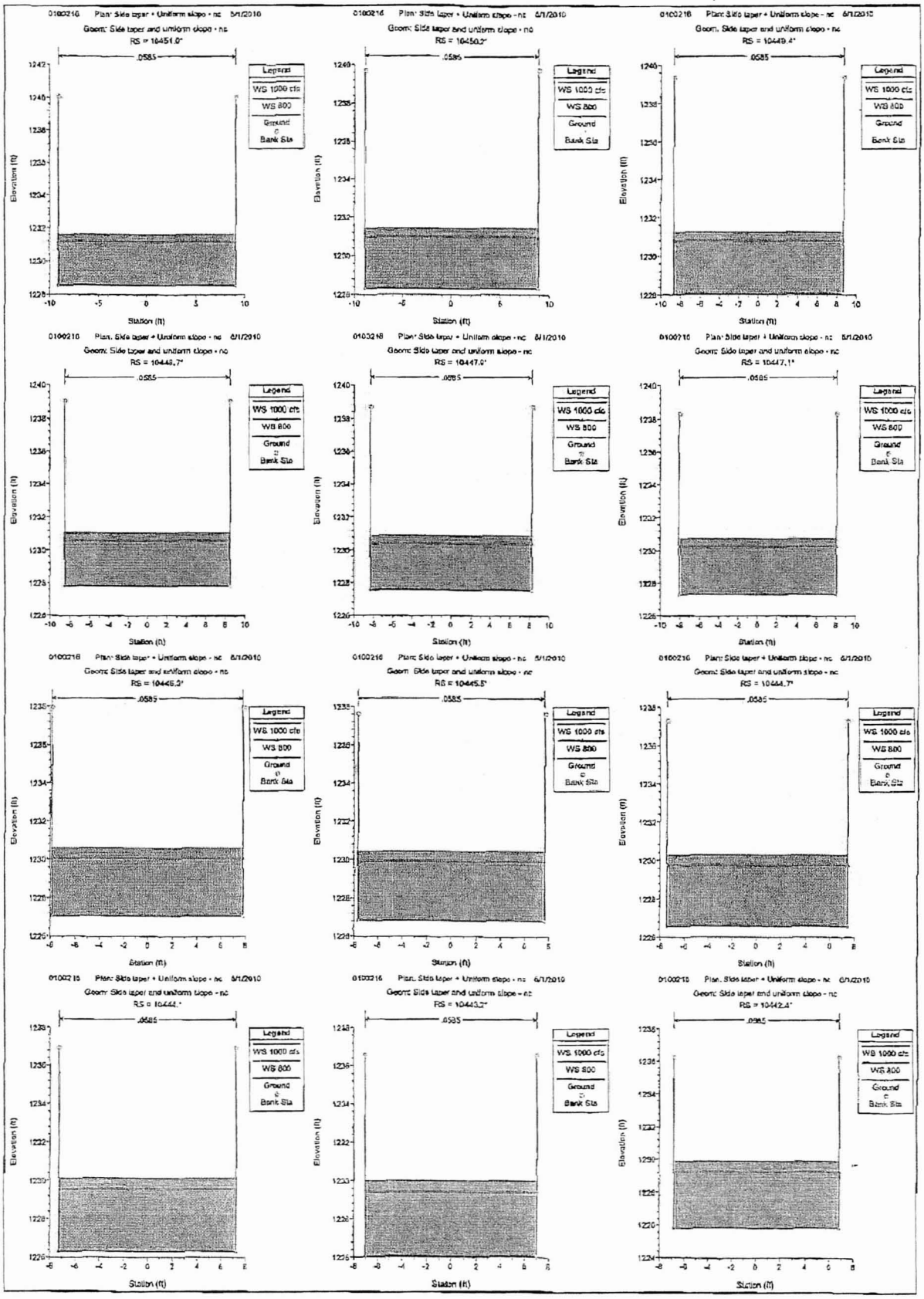
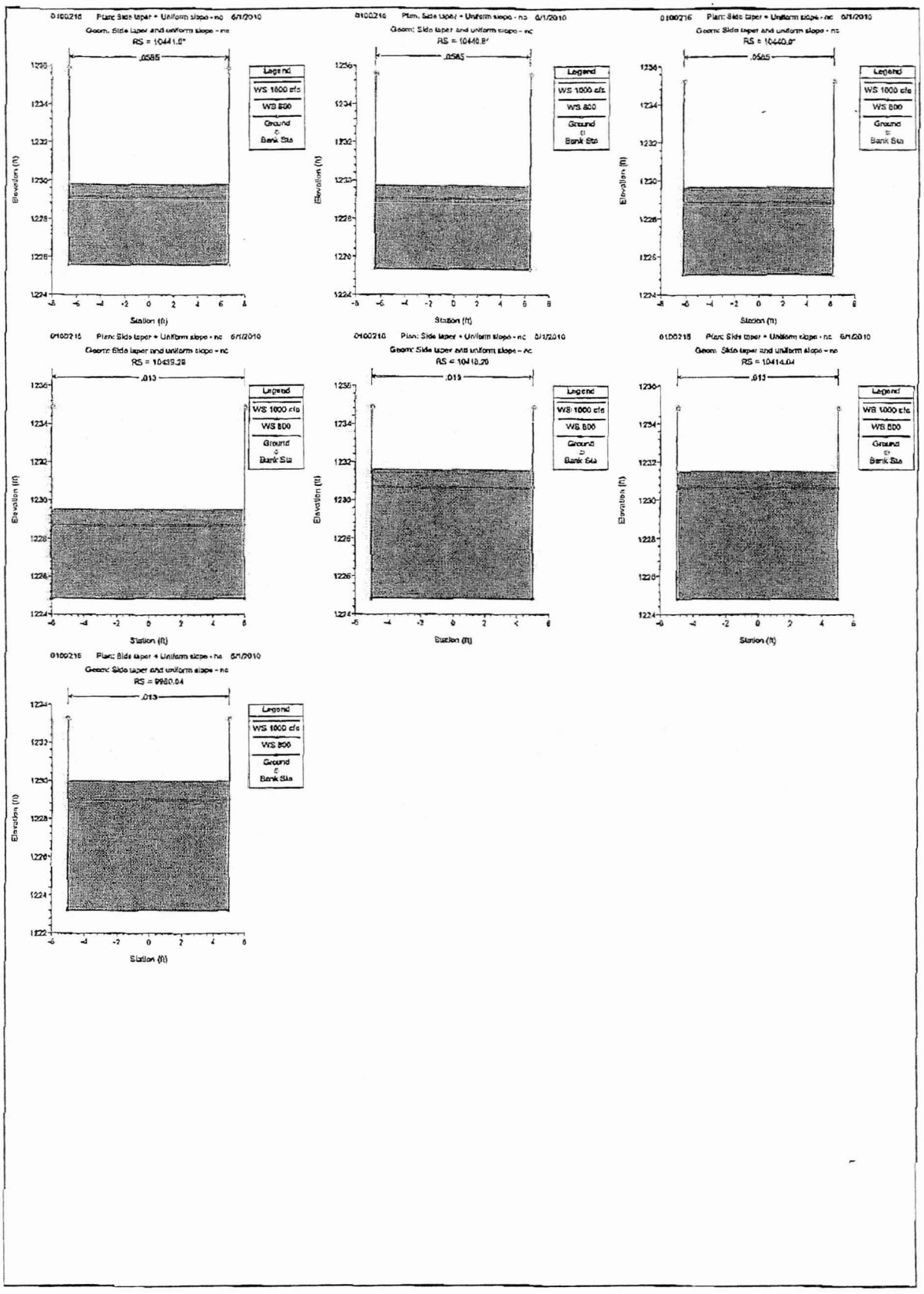
Geom: Side taper and uniform slope - nc
RS = 10479.29
RS = 10478.5*
RS = 10477.7*
RS = 10476.9*
RS = 10476.1*
RS = 10475.3*
RS = 10474.5*
RS = 10473.8*
RS = 10473.0*
RS = 10472.2*
RS = 10471.4*
RS = 10470.6*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)


0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10469.8*
RS = 10469.0*
RS = 10468.3*
RS = 10467.5*
RS = 10466.7*
RS = 10465.9*
RS = 10465.1*
RS = 10464.3*
RS = 10463.6*
RS = 10462.6*
RS = 10462.0*
RS = 10461.2*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)


0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10460.4*
RS = 10459.0*
RS = 10458.0*
RS = 10458.1*
RS = 10457.3*
RS = 10456.5*
RS = 10455.7*
RS = 10454.0*
RS = 10454.1*
RS = 10453.4*
RS = 10452.0*
RS = 10451.5*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)


0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10451.0*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10450.2*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10449.4*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10448.7*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10447.9*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10447.1*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10446.3*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10445.5*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10444.7*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10444.*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10443.2*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10442.4*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)


0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10441.0*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10440.8*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10440.0*
.0585
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10439.28
.013
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10418.20
.013
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 10414.04
.013
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)
0100216 Plan: Side taper + Uniform slope - nc 6/1/2010
Geom: Side taper and uniform slope - nc
RS = 9980.04
.013
Legend
WS 1000 cfs
WS 800
Ground
Bank Sta
Elevation (ft)
Station (ft)

Gate Openings - U/S Boundary Condition 10-0216

Changed U/S WSEL to 10'

KAR
5-6-10

$w/r = 0.1353$

$w = 2.030'$

$C_o = 0.662$

$$C_o = \frac{\delta}{\sqrt{1 + \frac{\delta w}{y_1}}}$$

$\delta = 0.70773$

$y = \delta w = 1.44'$

Use y as upstream condition (Elev = 1238.94)

$Q = VA \qquad V = 21$ fps

PROJECT: 10-0216
Side-taper

STATION:

SHEET: 1 OF 1

TAPERED INLET DESIGN FORM

DESIGNER / DATE: KAR / 5/27/10

REVIEWER / DATE: / /

DESIGN DATA:

Q = 1000 cfs ; EL_{hi} = 1239.61 ft

EL. THROAT INVERT 1224.86 ft

EL. STREAM BED AT FACE 1224.86 ft

FALL ____ ft TAPER 6 : 1 (4:1 TO 6:1) try 6

STREAM SLOPE, S_p = ____ ft/ft n/a

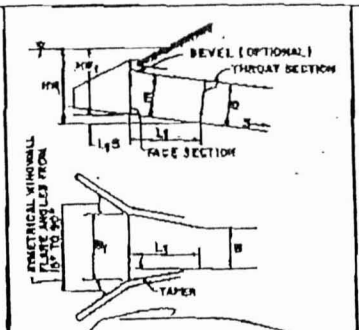
SLOPE OF BARREL, S = 0.0039 ft/ft

S_f ____ : 1 (2:1 TO 3:1) n/a

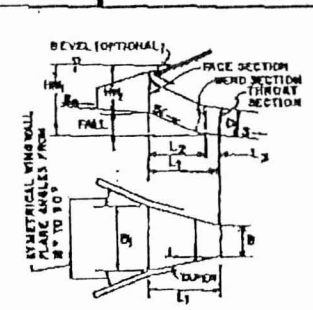
BARREL SHAPE AND MATERIAL: conc., circ

N = 1 barrel ; B = 10' ; D = 10'

INLET EDGE DESCRIPTION ____



SIDE-TAPERED



SLOPE-TAPERED

COMMENTS

Chart 58

Q (cfs)	EL_{hi}	EL. THROAT INVERT	EL. FACE INVERT (1)	HW_f (2)	HW_f / E (3)	Q / B_f (4)	MIN. B_f (5)	SELECTED B_f	SLOPE-TAPERED ONLY: MIN. L_3 (6)	L_2 (7)	CHECK L_2 (8)	ADJ. L_3 (9)	ADJ. TAPER (10)	L_1 (11)	SIDE-TAPERED W/ FALL: EL. CREST INV.	HW_c (12)	MIN. W (13)
1000		1224.86	1224.86	14.75	14.75/10 = 1.5	120	8.3	12'									

(1) SIDE-TAPERED: EL. FACE INVERT = EL. THROAT INVERT + 1 ft (APPROX.)
SLOPE-TAPERED: EL. FACE INVERT = EL. STREAM BED AT FACE

(2) HW_f = EL_{hi} - EL. FACE INVERT

(3) 1.1 D ≥ E ≥ D

(4) FROM DESIGN CHARTS

(5) MIN. B_f = Q/(Q/B_f) 8.3

(6) MIN. L_3 = 0.5 NB ≃ 5

(7) L_2 = (EL. FACE INVERT - EL. THROAT INVERT) S_f

(8) CHECK $L_2 = \left[\frac{B_f - NB}{2}\right]$ · TAPER - L_3

(9) IF (8)>(7), ADJ. $L_3 = \left[\frac{B_f - NB}{2}\right]$ · TAPER - L_2

(10) IF (7)>(8), ADJ. TAPER = $(L_2 + L_3) \Big/ \left[\frac{B_f - NB}{2}\right]$

(11) SIDE-TAPERED: $L = \left[\frac{B_f - NB}{2}\right]$ · TAPER $\left(\frac{11-10}{2}\right)6 = 3'$

SLOPE-TAPERED: $L_1 = L_2 + L_3$

(12) HW_c = EL_{hi} - EL. CREST INVERT

(13) MIN. W = $0.35\,Q / HW_c^{1.5}$

SELECTED DESIGN

B_f ____

L_1 ____

L_2 ____

L_3 ____

BEVELS ANGLE ____°

b = ____ in ; d = ____ in

TAPER ____ : 1

S_f = ____ : 1

Baffle Sizing

Job Number: 10-0216
Engineer: KAR
Date: 5/28/2010

Cells in green require input

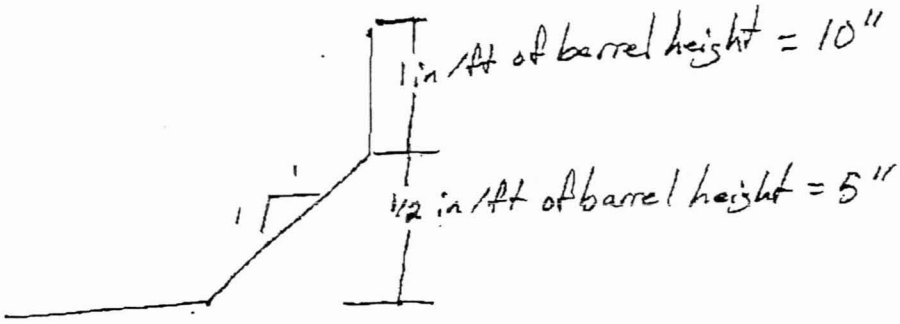
Variables:

Manning's n of culvert without elements:	0.013		
B (width of chute)	25.36 ft		
D (wetted depth)	1.44 ft		
L/h (length of element divided by height)	10.00		
Lr/P	0.50		
n_r/n (from Figure VII-C-8)	4.50		
n_r	0.0585	$= (n_r/n)/n$	Use L/h=10
So (slope of chute)	0.25		
C	12.74		
h (height of elements)	0.27 ft		
y_i (guess y_i so that $Q = Q_{design}$)	2.71 ft	guess y_i so that Q = Qdesign	
A_i	68.66 ft^2		
R_i	1.22 ft		
Q	1000 cfs		$C=1.49S_o^{1/2}/n_r$
V_i	14.56 fps		
γ	62.4		
yn (normal depth)	1.44 ft		
p	1.94		$A_i=By_i$
C_D	1.9		$R_i=A_i/2(B+Y_i)$
A_f	6.87 ft^2		
V_n (normal velocity)	21 fps		$Q=[(1.49/n_r)S_o^{1/2}]A_iR_i^{2/3}$
V_w (avg velocity divided by 3)	5.93 fps	$= (V_n+V_i)/6$	$V=Q/A_i$
N (required number of rows of elements)	19 (minimum 51)		
Length of chute	50.7 ft		
Spacing of elements	2.7 ft	= Length of chute/N	
Length of element	2.71 ft	= (L/h)*h	o =1.94

C_D=1.9
A_f=wetted frontal area of
=B(h) for bottom roughne

10-0216 | 5/27/10 | KAR

Bevel



From HEC-14, p VII-A-5,

$$FB = h + y_1 + \frac{0.5\,(V_A \sin\phi)^2}{32.2}$$

$$FB = 2.71 + 1.44 + \frac{0.5\,(21 \sin 45)^2}{32.2} = 7.6'$$

Partial Pipe Capacity

Calculated:

Diameter=	120	inches	Capacity=	1032.7	cfs
Slope=	0.0039	ft/ft	Depth of Flow=	10.00	ft
'n'=	0.013	unitless	Radius=	5	ft

Depth of Flow ft	Flow Area ft^2	Wetted Perimeter ft	Capacity cfs	Velocity fps	Froude Number unitless
0.25	0.52	3.18	1.1	2.15	0.76
0.38	0.96	3.90	2.7	2.80	0.81
0.56	1.75	4.79	6.4	3.65	0.86
0.84	3.18	5.89	15.1	4.73	0.91
1.27	5.77	7.27	35.3	6.12	0.96
1.90	10.38	9.02	81.4	7.84	1.00
2.85	18.43	11.26	182.8	9.92	1.04
4.27	32.01	14.25	392.0	12.25	1.04
6.41	53.15	18.56	765.2	14.40	1.00
7.90	66.55	21.90	996.8	14.98	0.94
10.00	78.54	31.42	1032.7	13.15	0.73

OLSSON ASSOCIATES

TECHNICAL MEMORANDUM

Date: July 10, 2010

To: Bobbie Ohler, Project Manager

From: Jeff Ford, P.E.

Project: Old Cross Cut Canal Improvements,
Arizona Canal to Indian School Road

Project No: 2008C013, Assignment #4 (OA Project 010-0216)

RE: STUBOUT EVALUATION

Introduction

The purpose of this memo is to evaluate constructing a stubout as part of this project for future collection of stormwater.

Background

As part of this project, the existing irrigation junction and associated pipes are being relocated by SRP because they are within the construction limits of the proposed storm drain. Several comments were received to provide a stubout underneath the 24" irrigation pipe to the north to eliminate the need to support or relocate the irrigation pipe during the future phase of the storm drain construction. The stubout would provide additional capacity to capture stormwater, possibility using the existing retention basin as a collection system. The stormwater system south of the canal is designed to collect the 10-year flow of 681 cfs and an additional capacity of 309 cfs for a total of 990 cfs across the canal. The stubout would provide the additional 309 cfs capacity.

Stubout Evaluation

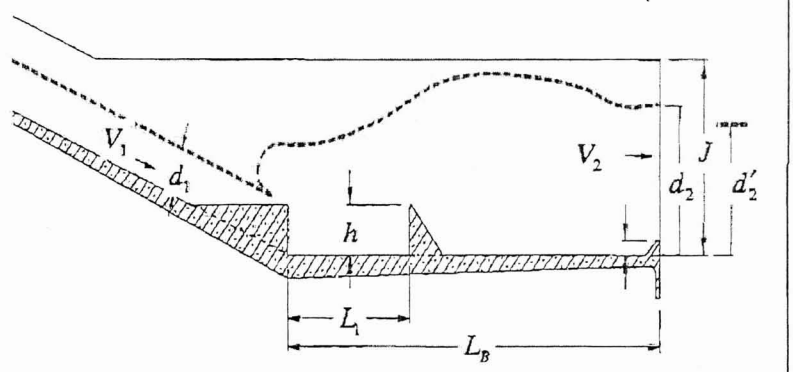
Three stubout configurations were evaluated, as shown in the attached exhibit. The size of the stubout was assumed to be 60", based on an assumed design flow of 309 cfs and slope of 1.5%. The layout of each configuration was based on physical constraints, such as the historical eucalyptus trees nearby that need to be protected in place.

The following table summarizes the advantages and disadvantages of each stubout configuration.

HYDRAULIC JUMP TYPE BASIN	Project: Arcadia, AZ	Proj. #: 010-0216
	Comment: USBR basin calculations to match County calculations	
D. Hurtz 1/2007	By: Eric Dove	Date: 7/11/2010

From Hydraulic Analysis:

Chute Width, ft =	12.00
Discharge, cfs =	1,000
Unit q, cfs/ft =	83.33
Entrance depth d_1,ft =	2.15
V_1,ft/sec =	38.76
Basin Floor Elevation:	1224.67



Froude No. - F_1

USACE BuREC: $F_1 = \frac{V_1}{\sqrt{g d_1}}$ = 4.66

NRCS: $F_1 = \frac{V_1^2}{g d_1}$ = 21.73

Sequent Depth - d_2,ft.

USACE BuREC: $d_2 = \frac{d_1}{2}\left(-1+\sqrt{8F_1^2+1}\right)$ 13.14

NRCS: $d_2 = \frac{d_1}{2}\left(-1+\sqrt{8F_1+1}\right)$ 13.14

Minimum Tailwater - d'_2,ft.

USACE BuREC: $d_2' = 0.85 d_2$ = 11.17 Elev. 1235.84

NRCS: $d_2' = 1.4 d_1 F_1^{0.45}$ = 12.03 Elev. 1236.70

Available Tailwater: Elev. 1233.00

INADEQUATE TAILWATER per USACE, BuREC

INADEQUATE TAILWATER per NRCS

Baffle Pier Location - L_1,ft.

USACE: $F_1 \le 4.6$ $L_1 = 1.5 d_2$ = NA

$F_1 > 4.6$ $L_1 = (1.04 + 0.10 F_1) d_2$ = 19.79

BuREC $L_1 = 0.80 d_2$ = 10.51

NRCS $L_1 = L_B/3$ = 6.12

Baffle Pier Height - h,ft.

USACE: $F_1 \le 4.6$ $h = d_2/6$ = 2.19

$F_1 > 4.6$ $h = (0.387 + 0.135 F_1) d_1$ = 13.3523

BuREC $h = (0.59 + 0.17 F_1) d_1$ = 2.97

NRCS $h = d_1$ = 2.15

Sidewall Height - J,ft.

USACE BuREC: J = Max. tailwater = 8.33

NRCS: $J = \frac{d_2}{3} + d_2'$ = 15.55

Endsill Height - S,ft.

USACE: $S = h/2$ = 6.68

S = smaller $d_1/2, d_2/12$ 1.08

BuREC $S = (0.992 + 0.056 F_1) d_1$ 2.69

NRCS $S = 0.07 d_2$ = 0.92

Sidewall Divergence - Z,ft/ft

NRCS $Z \ge 3\sqrt{F_1}$ ≥ 13.98

Basin Length - L_B,ft. Guidance from the indicated sources.

			L_B		Selected Values:
EM 1110-2-1602	Basins w/baffle piers & endsill	(3 < F_1 < 12)			
	$L_B = 3.0 d_2$	(recommended)	39.42		
	$L_B = 3.5 d_2$ to $4.0 d_2$	(for highly erodible outlet channel)	45.98	52.55	
	$L_B = 2.5 d_2$	(for stable "rock" outlet channel)	32.85		
	Basins w/o baffle piers & endsill				
	$L_B = 4.0 d_2$ to $5.0 d_2$		52.55	65.69	
EM 1110-2-1603	$L_B = K d_1 F_1^{1.5}$	(2 < F_1 < 20)			
	K = 1.4 (F_1 < 8)	(1 or 2 rows of baffle piers and endsill)	30.29		
	K = 1.7	(endsill only)	36.78		
	$K \approx 3.5$ (F_1 < 5)	(flat basin w/o baffle piers & endsill)	75.73		
	$K \approx 8.0 d_1 F_1$ (F_1 > 5)	(flat basin w/o baffle piers & endsill)	80.17		
	K = 2.0	low head broad-crested spillway with 1 or 2 rows of baffle piers and endsill	43.27		
NRCS	$L_B = \frac{4.5 d_2}{F_1^{0.38}}$		18.35		
BuREC	L_B is a function of F_1 & d_2 — Type II	(chute blocks & endsill - no baffle piers)	49.79		
	Type III	chute blocks, baffle piers & endsill; V_1<50 to 60 ft/s; Unit q<200 cfs/ft.	29.41		

References: EM 1110-2-1602, Hydraulic Design of Reservoir Outlet Works, USACE
EM 1110-2-1603, Hydraulic Design of Spillways, USACE
Design of Small Dams, Third Edition, 1987, BuREC
Engineering Monograph No. 25, Hydraulic Design of Stilling Basins and Energy Dissipators, BuREC
Engineering Handbood Section 14, Chute Spillways, NRCS

VERTICAL CURVE PROFILE	Project:	Arcadia, AZ	Proj #:	010-0216
	Comment:			
D. Hurtz 10/07	By:	D. Hurtz, OA	Date:	7/3/2010

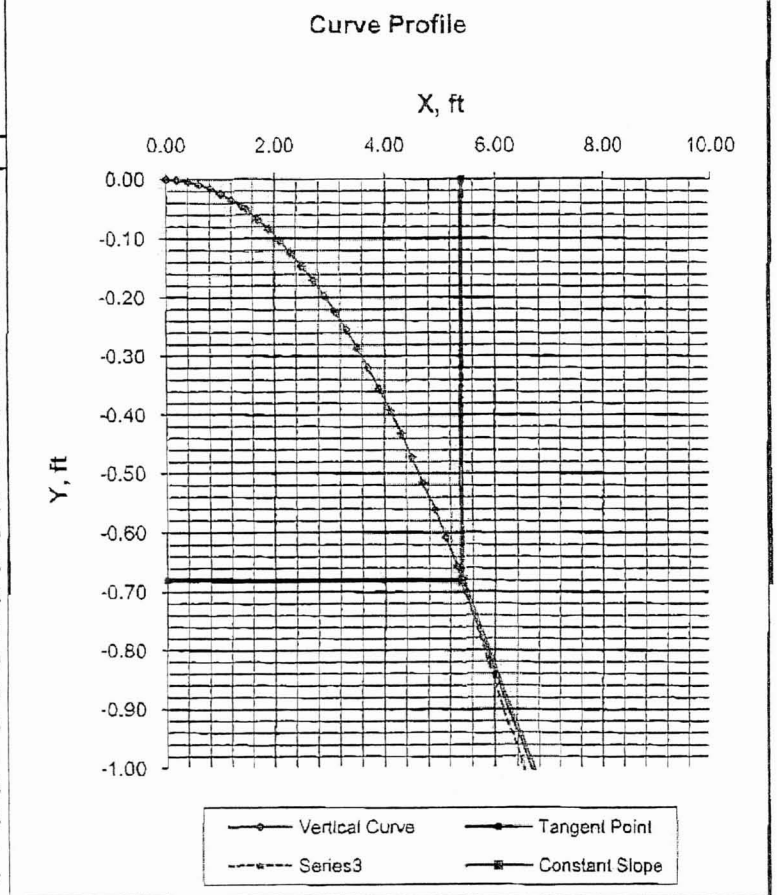
HYDRAULIC PARAMETERS	
Entrance Invert Elevation =	1237.50
Entrance Slope,ft/ft =	0.000
Discharge,cfs =	1,000
Flow Depth,ft =	
Flow Width,ft =	33.00
Flow Velocity,ft/sec =	21.00
Unit Discharge,cfs/ft =	30.30

	X:Y	ft/ft
Max. Allowable Chute Slope =	4.00 : 1	0.2500
	User	Default
Increment for "x" in table and chart, ft =	0.20	1.00
Note: Increment must be ≥ 0.1		
Coordinates for tangent point at which Max. Allowable Slope is attained	X, ft	Y, ft
	5.40	-0.68

Equation for Free Trajectory:

$$y = -x\tan\theta - \frac{gx^2}{2*(1.25V_{sm})^2\cos^2\theta}$$

x	y	Δy	Elev
0	0.0	0.000	1237.50
0.20	-0.0009	-0.001	1237.50
0.40	-0.0037	-0.003	1237.50
0.60	-0.0084	-0.005	1237.49
0.80	-0.0149	-0.007	1237.49
1.00	-0.0233	-0.008	1237.48
1.20	-0.0336	-0.010	1237.47
1.40	-0.0457	-0.012	1237.45
1.50	-0.0525	-0.007	1237.45
1.70	-0.0674	-0.015	1237.43
1.90	-0.0842	-0.017	1237.42
2.10	-0.1029	-0.019	1237.40
2.30	-0.1234	-0.021	1237.38
2.50	-0.1459	-0.022	1237.35
2.70	-0.1701	-0.024	1237.33
2.90	-0.1963	-0.026	1237.30
3.10	-0.2243	-0.028	1237.28
3.30	-0.2541	-0.030	1237.25
3.50	-0.2859	-0.032	1237.21
3.70	-0.3195	-0.034	1237.18
3.90	-0.3549	-0.035	1237.15
4.10	-0.3923	-0.037	1237.11
4.30	-0.4315	-0.039	1237.07
4.50	-0.4726	-0.041	1237.03
4.70	-0.5155	-0.043	1236.98
4.90	-0.5603	-0.045	1236.94
5.10	-0.6070	-0.047	1236.89
5.30	-0.6555	-0.049	1236.84
5.40	-0.6805	-0.025	1236.82
	0.6695		1238.17



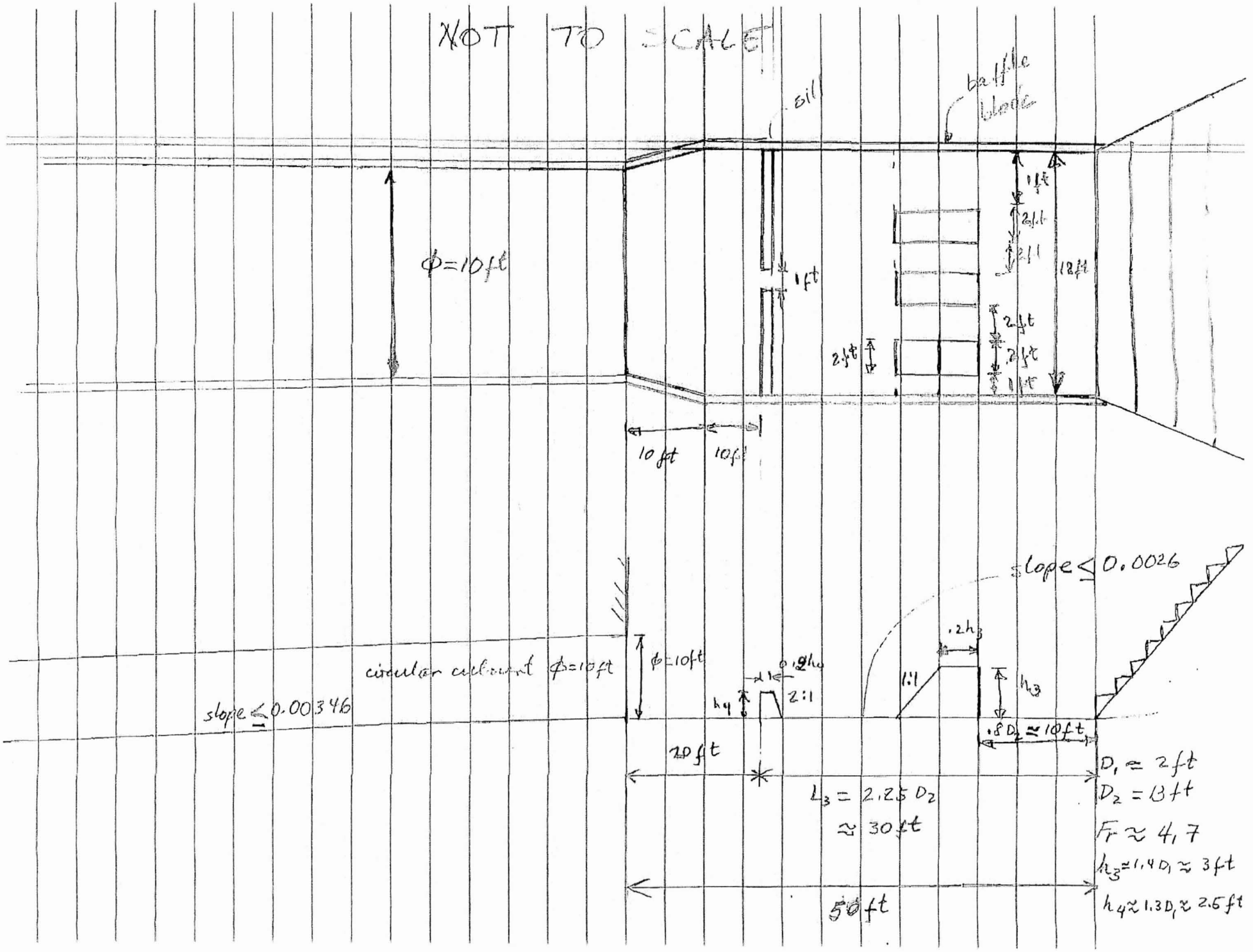
Note: The velocity has been increased by 25% ($1.25V_{sm}$) in the trajectory equation to insure against flow separation from the floor.

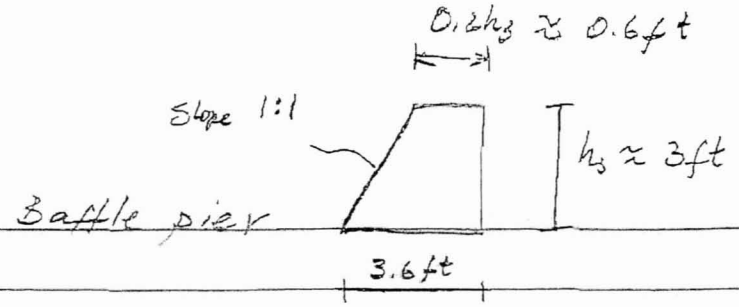
Reference:

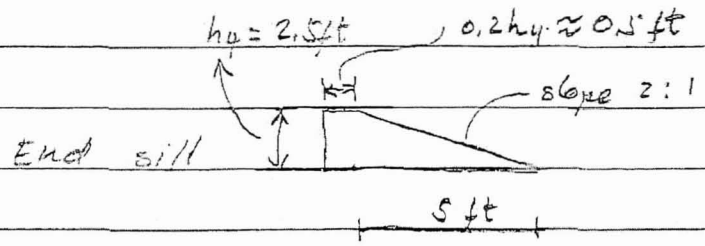
EM 1110-2-1602, Hydraulic Design of Reservoir Outlet Works, USACE (Pg. 5-4, F-4)

EM 1110-2-1603, Hydraulic Design of Spillways, USACE (Pg. 4-5 , E-6)

NOT TO SCALE


sill
baffle block
$\phi = 10$ ft
1 ft
1 ft
2 ft
2 ft
2 ft
2 ft
1 ft
18 ft
10 ft
10 ft
slope ≤ 0.0026
circular culvert $\phi = 10$ ft
$\phi = 10$ ft
slope ≤ 0.00346
$.2h_3$
$0.2h_4$
h_4
2:1
1:1
h_3
$.8D_2 \approx 10$ ft
20 ft
$L_3 = 2.25\,D_2$
≈ 30 ft
50 ft
$D_1 \approx 2$ ft
$D_2 = 13$ ft
$F_r \approx 4.7$
$h_3 \approx 1.4D_1 \approx 3$ ft
$h_4 \approx 1.3D_1 \approx 2.6$ ft


0.2h3 ≈ 0.6ft
Slope 1:1
h3 ≈ 3ft
Baffle pier
3.6ft


h4 = 2.5ft
0.2h4 ≈ 0.5ft
Slope 2:1
End sill
5ft

Total discharge	Q_w	1000	ft	cos θ	0.970296				
Spillway width	w	33	ft	sin θ	0.219847				
Spillway slope	θ	14		q_w	30.30303				
Dam height	H_d	12.7	ft	F_r	11.91632				
Step height	h	1	ft	k	0.970296				
Step length	l	4	ft	L	57.76752				
Critical depth	d_c	3.055194	ft						
	H_d/d_c	[illegible]							
	d_c/h	[illegible]							
	1.2-0.325 tan θ	[illegible]							
Is skimming flow?	TRUE								
Maximum height of step	$h < 15 d_c \cos\theta$	44.46661							
RHS	$0.1193 \cos\theta (\sin\theta)^{0.258} (L/(h \cos\theta))^{0.835}$	3.569214							
Inception point	$L_i = 9.719 (\sin\theta)^{0.0798} F_r^{0.713} k$	[illegible]	ft						
Depth at inception	$d_i = (0.4034 F_r^{0.592} k)/((\sin\theta)^{0.04})$	[illegible]	ft						
Length to attainment	$L_u = 8.6 q_w^{0.71}/[h^{0.07} (\cos\theta)^{0.07} (\sin\theta)^{0.28}]$	[illegible]	ft						
Criteria	$d_c/h < RHS^{-1}$	FALSE							
				D_H	1.398154				
1.-	$d = d_c [f_e/(8 \sin\theta)]^{1/3}$	1.363345		$1/f_m$	6.389551				
2.-		1.186686		f_m	0.156506				
3.-		1.180172		C	0.252588				
Uniform flow	$d_w = 0.215 d_c (\sin\theta)^{-1/3}$	1.088355	1.-	f_e	0.166	$C = 8/f_e^{1/2}$	20.236	$n = 1.486 R^{1/6}/C$	0.077
			2.-	f_e	0.103		24.919		0.061
			3.-	f_e	0.200		17.889		0.089
				$f_e = 8 g d_w^3 \sin\theta / q_w^2$	0.079507		28.372		0.053
	$u_w = q_w/d$	22.23	ft/s	Fr^*	3.354669				
		25.54	ft/s		4.130991				
		20.47	ft/s		2.985446				
		27.84	ft/s		4.703296				
	$y_{90} = d/(1-C)$	1.82	ft	$BL = 0.4 * y_{90}$	0.73	$h_w \approx 1.4 * y_{90}$	2.55		
		1.59	ft		0.64		2.22		
		1.98	ft		0.79		2.77		
		1.46	ft		0.58		2.04		
Sequent depth	$d_2 = 0.5 d (-1+(8Fr^{*2}+1)^{0.5})$	5.82	ft	Basin length $= 4 d_2$	23.29	ft			
		9.36			25.46	ft			
		5.51			22.05	ft			
		6.72			26.88	ft			

Total discharge	Q_w	1000	ft	cos θ	0.970296				
Spillway width	w	12	ft	sin θ	0.219847				
Spillway slope	θ	14		q_w	83.33333				
Dam height	H_d	12.7	ft	F_r	32.76987				
Step height	h	1	ft	k	0.970296				
Step length	l	4	ft	L	57.76752				
Critical depth	d_c	5.996906	ft						
	H_c/d_c	[illegible]							
	d_c/h	[illegible]							
	1.2-0.325 tan θ	[illegible]							
Is skimming flow?	TRUE								
Maximum height of step	$h<15d_c \cos\theta$	87.28157							
RHS	$0.1193 \cos\theta (\sin\theta)^{0.259} (L/[h \cos\theta])^{0.835}$	3.569214							
Inception point	$L_i = 9.719 (\sin\theta)^{0.0798} F_r^{0.713} k$	[illegible]	ft						
Depth at inception	$d_i = (0.4034 F_r^{0.582} k)/((\sin\theta)^{0.04})$	[illegible]	ft						
Length to attainment	$L_u = 8.6 q_w^{0.71}/[h^{0.07} (\cos\theta)^{0.07} (\sin\theta)^{0.28}]$	[illegible]	ft						
Criteria	$d_c/h < RHS^{-1}$	[illegible]							
				D_H	1.999312				
1.-	$d = d_c[f_e/(8 \sin\theta)]^{1/3}$	2.611799		$1/f_m$	6.882561				
2.-		2.395294		f_m	0.145295				
3.-		2.905364		C	0.166013				
Uniform flow	$d_w = 0.215 d_c (\sin\theta)^{-1/3}$	2.136284	1.-	f_e	0.145	$C=8/f_e^{1/2}$	20.988	$n=1.486R^{1/6}/C$	0.083
			2.-	f_e	0.112		23.897		0.072
			3.-	f_e	0.200		17.889		0.099
				$f_e = 8 g d_w^3 \sin\theta/q_w^2$	0.079507		28.372		0.059
	$u_w = q_w/d$	31.91	ft/s	Fr^*	3.479215				
		34.79	ft/s		3.961435				
		28.68	ft/s		2.965446				
		39.01	ft/s		4.703296				
	$y_{90} = d/(1-C)$	3.13	ft	$BL = 0.4^* y_{90}$	1.25	$h_w = 1.4^* y_{90}$	4.38		
		2.87	ft		1.15		4.02		
		3.48	ft		1.39		4.88		
		2.56	ft		1.02		3.59		
Sequent depth	$d_2 = 0.5 d (-1+(8Fr^{*2}+1)^{0.5})$	11.61	ft	Basin length $= 4 d_2$	46.45	ft			
		12.27			49.10	ft			
		10.82			43.27	ft			
		13.18			52.73	ft			

Worksheet for 102" Pipe Free Flow

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.0050	ft/ft
Diameter	102.00	in
Discharge	800.00	ft^3/s

Results

Normal Depth	7.49	ft
Flow Area	52.97	ft^2
Wetted Perimeter	20.73	ft
Top Width	5.49	ft
Critical Depth	7.05	ft
Percent Full	88.2	%
Critical Slope	0.00546	ft/ft
Velocity	15.10	ft/s
Velocity Head	3.55	ft
Specific Energy	11.04	ft
Froude Number	0.86	
Maximum Discharge	815.45	ft^3/s
Discharge Full	758.06	ft^3/s
Slope Full	0.00557	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

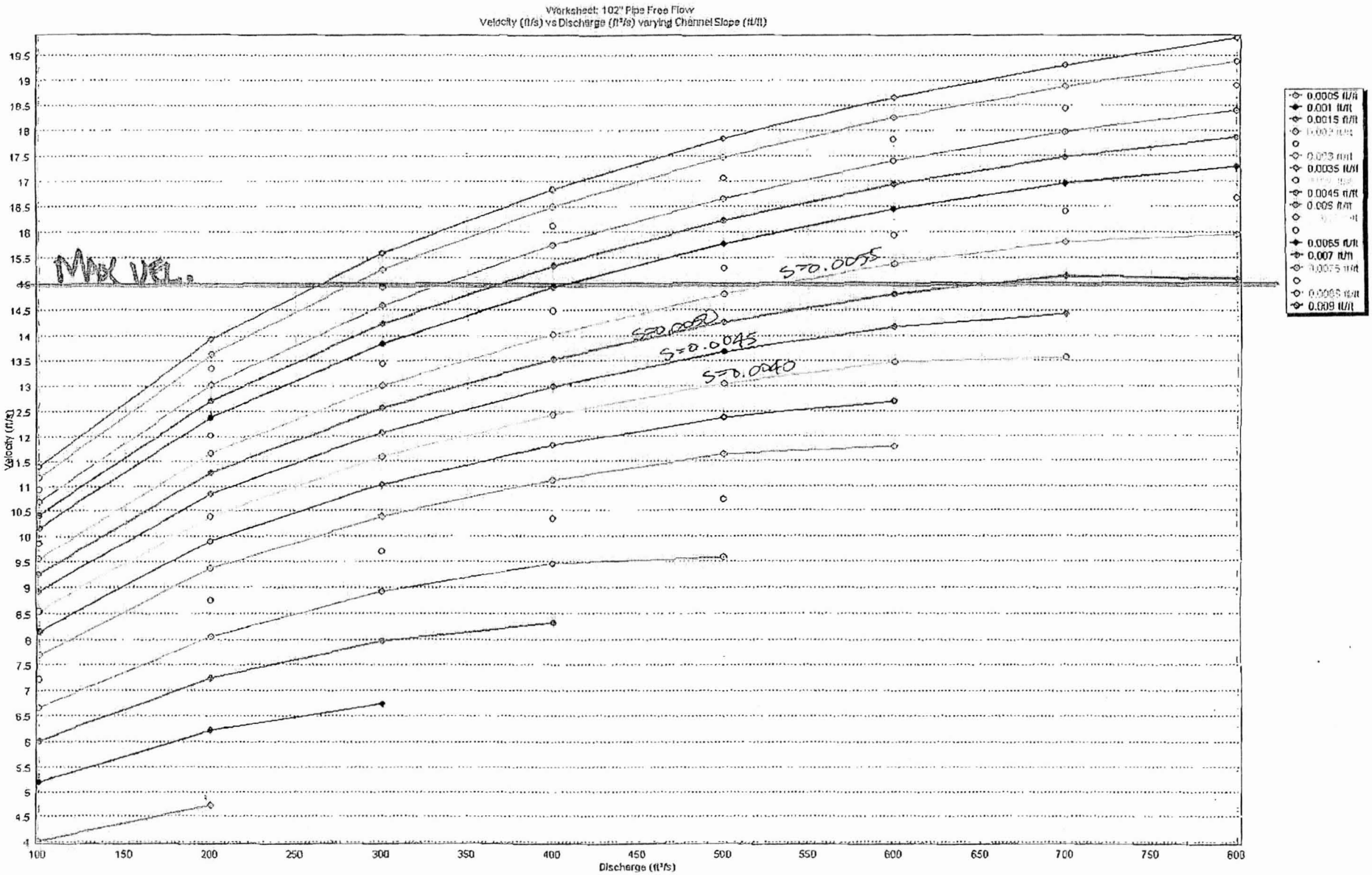
GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	88.17	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for 102" Pipe Free Flow

GVF Output Data

Normal Depth	7.49	ft
Critical Depth	7.05	ft
Channel Slope	0.0050	ft/ft
Critical Slope	0.00546	ft/ft


Worksheet: 102" Pipe Free Flow
Velocity (ft/s) vs Discharge (ft³/s) varying Channel Slope (ft/ft)
Velocity (ft/s)
Discharge (ft³/s)
MAX VEL.
S=0.0055
S=0.0045
S=0.0040
0.0005 ft/ft
0.001 ft/ft
0.0015 ft/ft
0.0035 ft/ft
0.0045 ft/ft
0.005 ft/ft
0.0065 ft/ft
0.007 ft/ft
0.009 ft/ft

Worksheet for 120" Pipe Free Flow

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.0039	ft/ft
Diameter	120.00	in
Discharge	1000.00	ft^3/s

Results

Normal Depth	7.93	ft
Flow Area	66.75	ft^2
Wetted Perimeter	21.96	ft
Top Width	8.11	ft
Critical Depth	7.62	ft
Percent Full	79.3	%
Critical Slope	0.00424	ft/ft
Velocity	14.98	ft/s
Velocity Head	3.49	ft
Specific Energy	11.41	ft
Froude Number	0.92	
Maximum Discharge	1110.86	ft^3/s
Discharge Full	1032.68	ft^3/s
Slope Full	0.00366	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

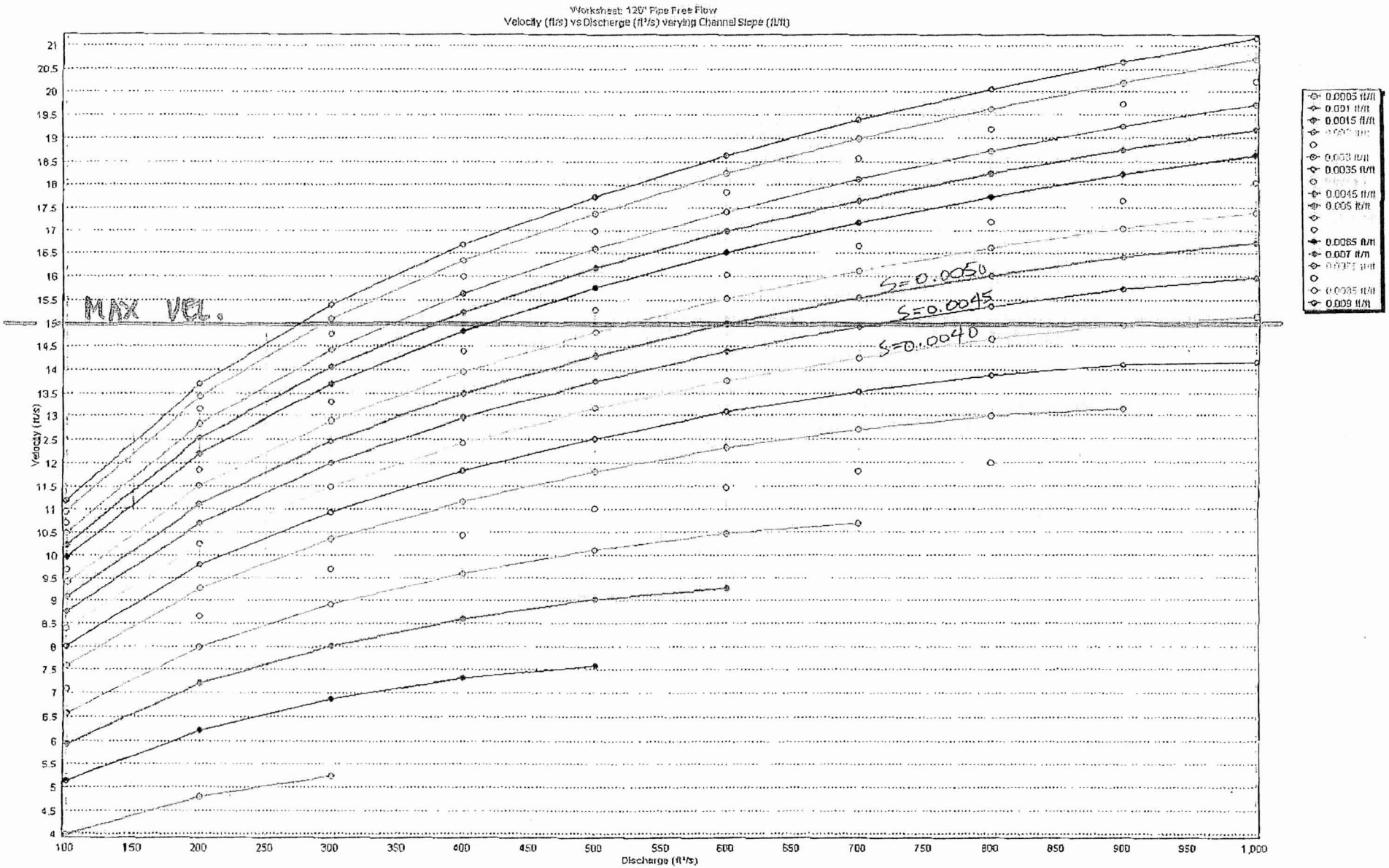
GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	79.25	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for 120" Pipe Free Flow

GVF Output Data

Normal Depth	7.93	ft
Critical Depth	7.62	ft
Channel Slope	0.0039	ft/ft
Critical Slope	0.00424	ft/ft


Worksheet 120" Pipe Free Flow
Velocity (ft/s) vs Discharge (ft³/s) varying Channel Slope (ft/ft)
Velocity (ft/s)
Discharge (ft³/s)
MAX VEL.
S=0.0050
S=0.0045
S=0.0040
0.0005 ft/ft
0.001 ft/ft
0.0015 ft/ft
0.0035 ft/ft
0.0045 ft/ft
0.0065 ft/ft
0.007 ft/ft
0.009 ft/ft

Worksheet for Exist Flow Condition DS of Gates

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00700	ft/ft
Bottom Width	33.00	ft
Discharge	1000.00	ft^3/s

Results

Normal Depth	2.29	ft
Flow Area	75.67	ft^2
Wetted Perimeter	37.59	ft
Top Width	33.00	ft
Critical Depth	3.06	ft
Critical Slope	0.00283	ft/ft
Velocity	13.22	ft/s
Velocity Head	2.71	ft
Specific Energy	5.01	ft
Froude Number	1.54	
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	2.29	ft
Critical Depth	3.06	ft
Channel Slope	0.00700	ft/ft
Critical Slope	0.00283	ft/ft

Culvert Calculator Report
Interim Pipe

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	1,247.00	ft	Headwater Depth/Height	1.00	
Computed Headwater Elev	1,247.00	ft	Discharge	73.12	cfs
Inlet Control HW Elev.	1,246.87	ft	Tailwater Elevation	1,245.00	ft
Outlet Control HW Elev.	1,247.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	1,244.00	ft	Downstream Invert	1,238.50	ft
Length	100.00	ft	Constructed Slope	0.055000	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileS1S2		Depth, Downstream	6.50	ft
Slope Type	N/A		Normal Depth	0.99	ft
Flow Regime	N/A		Critical Depth	1.97	ft
Velocity Downstream	5.17	ft/s	Critical Slope	0.005126	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

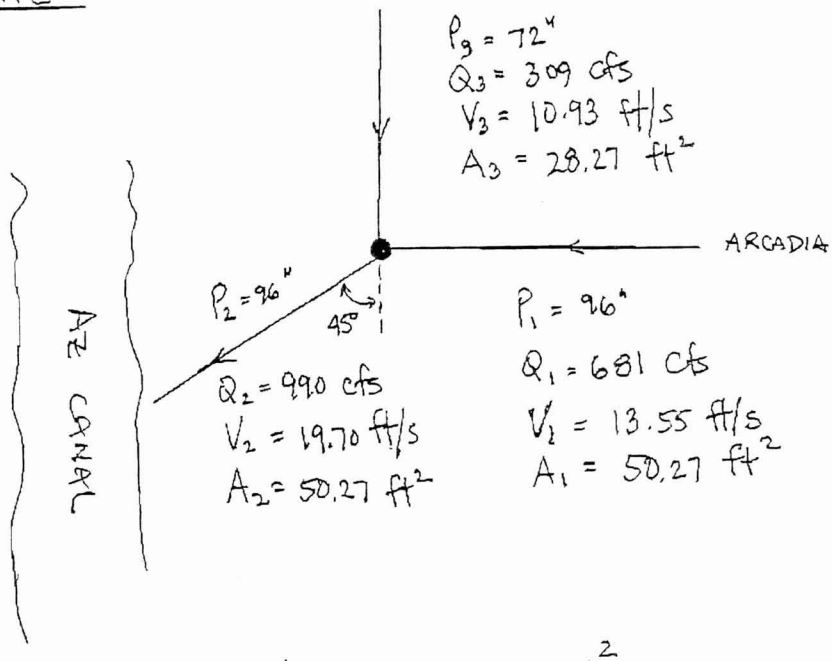
Outlet Control Properties					
Outlet Control HW Elev.	1,247.00	ft	Upstream Velocity Head	0.86	ft
Ke	0.20		Entrance Loss	0.17	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,246.87	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	14.1	ft^2
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

2-36" PIPES TO DISCHARGE 73 cfs
DURING CANAL DRY UP

OLSSON ASSOCIATES

JUNCTION @ CANAL



$$h_j = \frac{2(Q_2V_2 - Q_1V_1 - Q_3V_3\cos\theta^\circ)}{(A_1 + A_2)\,g} + \frac{V_1^2}{2g} - \frac{V_2^2}{2g}$$

$$= \frac{2\left[(990)(19.7) - (681)(13.55) - (309)(10.93)\cos 90^\circ\right]}{(50.27 + 50.27)(32.2)} + \frac{(13.55)^2}{2(32.2)} - \frac{(19.70)^2}{2(32.2)}$$

$$= 3.17 \text{ ft}^2$$

Bend Loss @ Junction: $h_b = K_b \dfrac{V^2}{2g}$

From Fig. 4.7 DDM, $K_b \doteq 0.4$ for 45° BEND

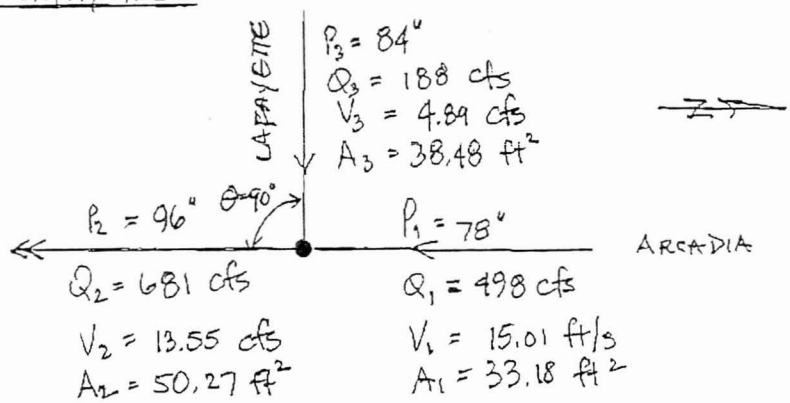
$$h_b = \frac{0.4(13.55)^2}{2(32.2)} = 1.14 \text{ ft}$$

Total Loss @ Junction = 3.17 + 1.14 = <u>4.31 ft</u>

project:			
subject			
drawn by:	date:	project no.:	sheet of

OLSSON ASSOCIATES

JUNCTION @ LAFAYETTE



Eqn 4.10b: $$h_j = \frac{2(Q_2V_2 - Q_1V_1 - Q_3V_3\cos\theta°)}{(A_1 + A_2)\,g} + \frac{V_1^2}{2g} - \frac{V_2^2}{2g}$$

$$h_j = \frac{2\left[(681)(13.55) - (498)(15.01) - (188)(4.89)\cos 90\right]}{(50.27 + 33.18)(32.2)} + \frac{(15.01)^2}{2(32.2)} - \frac{(13.55)^2}{2(32.2)}$$

$$h_j = \underline{\underline{1.95 \text{ ft}}}$$

project: ARCADIA DRAINAGE IMPROVEMENTS - PHASE 1				
subject HEAD LOSS CALCULATIONS				
drawn by: DVD	date: 3/18/10	project no.: 10-0216	sheet	of

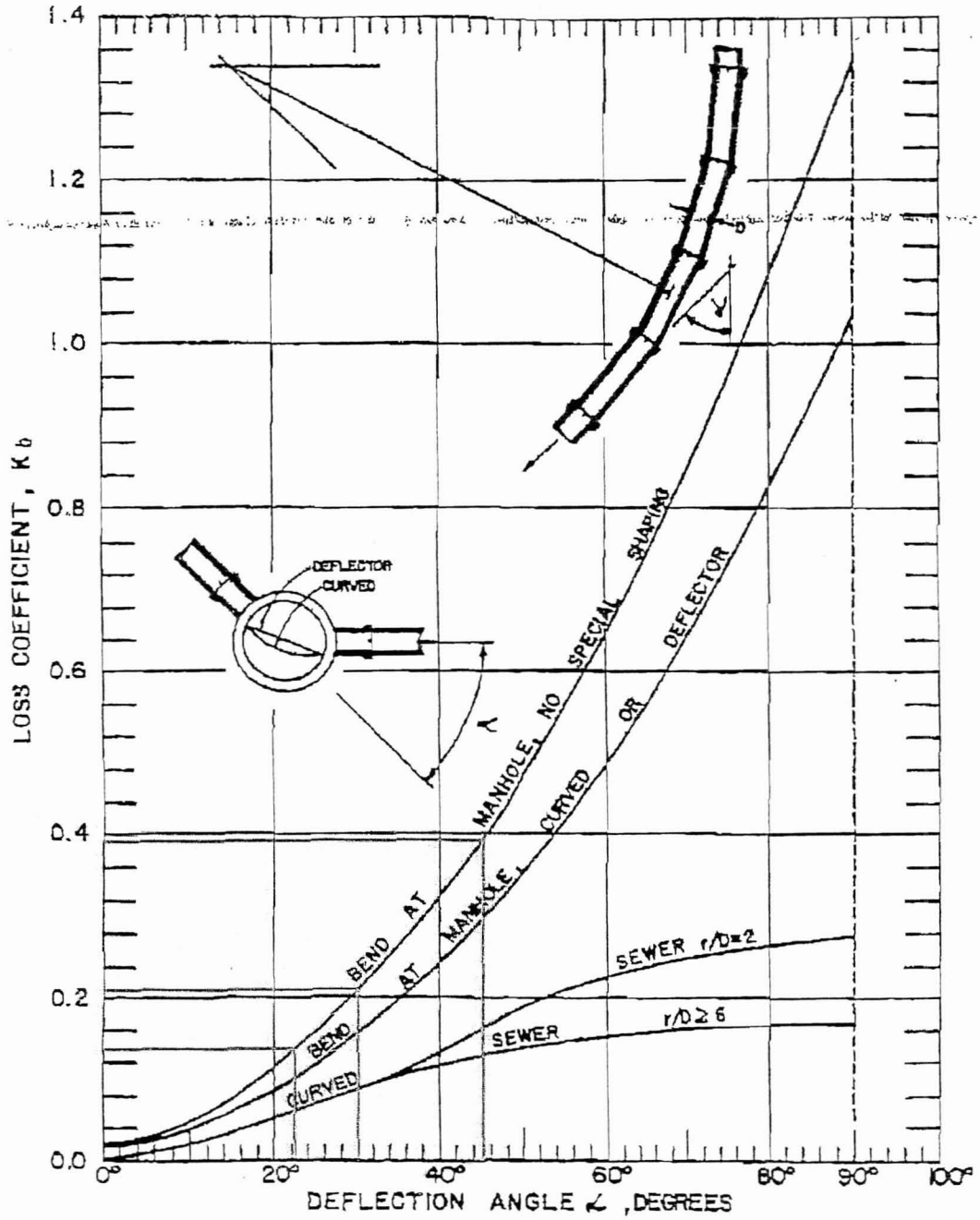


Figure 4.7
Bend Loss Coefficient
(University of Missouri, 1958)

Appendix C

Structural Calculations

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
STRUCTURAL DESIGN CALCULATIONS
PHOENIX, ARIZONA

OA Project No. 010-0216

Prepared for the Flood Control District of Maricopa County

Prepared by Olsson Associates

August 1, 2010

INDEX OF SHEETS

Sheet	Description
1-2	**Cover Sheet and Design Criteria**
3-15	**Transition Structure Design Calculations**
16-47	**Inlet Structure Design Calculations**

General Design Criteria

1) Design Code: AASHTO LRFD Bridge Design Specifications 4th Edition 2007
2) HL-93 Design Truck Wheel Load of 16 kips
3) One loaded lane with a multiple presence factor of 1.2
4) Concrete Compressive Strength f'_c = 3,500 psi
5) Rebar Yield Strength f_y = 60 ksi
6) At-Rest Equivalent Fluid Pressure EFP = 51 pcf
7) Allowable Bearing Pressure = 3,000 psf
8) Subgrade Modulus = 150 pci
9) Coefficient of Friction = 0.4

Transition Structure

The transition structure was designed as a one-way slab since the span ratio is greater than 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 11.22' 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, 1.35 was used for the at-rest horizontal earth pressures load factor, and 1.75 was used for the live load factor. The concrete shear strength for the top slab was modified according to Art. 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.

TRANSITION STRUCTURE DESIGN

010-0216
rb

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

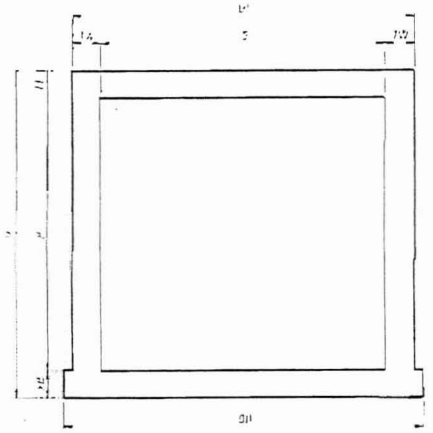
Concrete Strength	f'_c	3.5	ksi
Conc. Mod. of Elast.	E_c	3,587	ksi
Stress Block Coeff.	β_1	0.85	
Rebar Strength	f_y	60	ksi
Steel Mod. of Elast.	E_s	29,000	ksi
Modular Ratio	n	8.1	

BOX DIMENSIONS

Wall Thickness	TW	12.0	in
Top Slab Thickness	TT	12.0	in
Top Slab Width	BT	12.00	ft
Bot. Slab Thickness	TB	12.0	in
Bot. Slab Width	BB	12.67	ft
Total Height	H	14.00	ft

PARAMETERS

Design Span	S	10.00	ft
Rise	R	12.00	ft
Fill	h_f	10.55	ft
Footing Offset	d	0.33	ft



SOIL DATA

At-Rest - Drained - Cohesive Soil

Soil Wt.	γ_s	115	pcf
Eq. Fluid Density	γ_{eq}	51	pcf

DEAD LOADS

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k/ft)
Top Slab	1	1.000	12.000	1.000		150	1.800
Walls	2	1.000	12.000	1.000		150	3.600
Bottom Slab	1	1.000	12.667	1.000		150	1.900
Earth Fill	1			1.000	129.633	115	14.908
Water Fill	1	4.000	10.000	1.000		62.4	2.496
Concrete Fill	1	5.500	10.000	1.000		150.0	8.250
Additional Wt.							0.000
Total							32.954

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	12.00	ft
Actual Fill Height	h_{fa}	9.55	ft
<u>Fill Height < L - Must Include Live Load</u>			
Axle Load	P	16.0	k
Impact Factor	IM	0	%
Distribution Width	E_{span}	11.22	ft
Wheel Load	w	0.153	ksf

Surcharge - Horz. Loads Only

Soil Height	h_s	2.0	ft
Horz. Pressure	p	102	psf

STABILITY

010-0216
rb

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. Based on the preliminary geotechnical report, dated March 30th, 2010, completed by Alpha Geotechnical and Materials, Inc., no groundwater was considered as part of the design. Stability calculations are based on a one foot strip width.

BEARING CAPACITY (SERVICE LOADS)

Bearing Area	A_o	12.67	ft^2
DL Bearing Pressure	q_{DL}	2,602	psf
LL Bearing Pressure	q_{LL}	135	psf
Bearing Pressure	q	2,736	psf
All. Bearing Pressue	q_{all}	3,000	psf
Utilization Ratio	q/q_{all}	0.91	**OK**

BUOYANT FORCES

Depth to Bot. Slab	z	23.55	ft	
Groundwater Depth	z_w	0.00	ft	
Buoyant Force	P_b	10.5	k	
Self Weight	P_w	22.2	k	
Factor of Safety	**FS**	2.12	**OK**	> 1.1

TOP SLAB DESIGN

010-0216

rb

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 (Service)

Self Weight	w_{DC}	0.150	ksf
Soil Load	w_{EV}	1.098	ksf
Distr. Live Load	w_{LL}	0.153	ksf

SHEAR *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	17.6	k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	9.5	k/ft
Reduced Nom. Cap.	ΦV_c	15.0	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.63	**OK**

FLEXURE (BOTTOM 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	1.11	in
Neutral Axis Depth	c	1.30	in

Spacing Limit - Art 5.10.3

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	18	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0191	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	19.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	31.7	k·ft/ft
Min. Moment Capacity	M_{min}	19.9	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	17.8	k·ft/ft
Service Stress in Reinf.	f_{ss}	34.8	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	10.1	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	23.8	k·ft/ft
Reduced Nom. Cap.	ΦM_n	26.9	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.88	**OK**

WALL DESIGN

010-0216

rb

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	12.00	ft
Point of Contraflexure	x	2.54	ft

LOADS (Service)

Earth Press. @ Top	p_{SH}	0.538	k/ft
Earth Press. @ Bot.	p_{SH}	1.150	k/ft
LL Surcharge	p_{LS}	0.102	k/ft

SHEAR *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	13.7	k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	10.6	k/ft
Reduced Nom. Cap.	ΦV_c	11.6	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.91	OK

FLEXURE (INSIDE FACE) **Use #6 @ 10 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		10.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.53	in^2/ft
Steel Depth	d	9.63	in
Eq. Stress Depth	a	0.89	in
Neutral Axis Depth	c	1.04	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	9.25	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	18	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0247	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	19.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	18.5	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	9.8	k·ft/ft
Service Stress in Reinf.	f_{ss}	23.6	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	17.2	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	13.9	k·ft/ft
Reduced Nom. Cap.	ΦM_n	21.8	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.64	OK

FLEXURE (CORNER BARS) Use #6 @ 10 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		10.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.53	in^2/ft
Steel Depth	d	9.63	in
Eq. Stress Depth	a	0.89	in
Neutral Axis Depth	c	1.04	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	9.25	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	18	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0247	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	19.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	23.1	k·ft/ft
Min. Moment Capacity	M_{min}	19.9	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	12.7	k·ft/ft
Service Stress in Reinf.	f_{ss}	30.7	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	12.1	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	17.4	k·ft/ft
Reduced Nom. Cap.	ΦM_n	21.8	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	**0.80**	**OK**

FOOTING DESIGN

010-0216

rb

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

Art. 5.14.5.3

Reduction Factor	Φ	0.85
Width for Shear	b_v	12.00 in
Steel Depth for Shear	d_v	9.69 in
Conc. Shear Strength	V_c	13.7 k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	10.0 k/ft
Reduced Nom. Cap.	ΦV_c	11.7 k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.86 OK

FLEXURE (TOP BARS)

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	2.00 in
Bar Size		# 5
Spacing		12.0 in
Bar Diameter	d_b	0.63 in
Area of Steel	A_s	0.31 in^2/ft
Steel Depth	d	9.69 in
Eq. Stress Depth	a	0.52 in
Neutral Axis Depth	c	0.61 in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50 in
Actual Clear Spacing	S_{clr}	11.38 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	13 in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0444

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	19.9 k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	12.8 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	7.7 k·ft/ft
Service Stress in Reinf.	f_{ss}	31.2 ksi
Concrete Cover	d_c	2.31
Clear Cover Factor	β_s	1.34
Exposure Factor	γ_e	1.00
Max. Spacing	S_{max}	12.1 in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	9.6 k·ft/ft
Reduced Nom. Cap.	ΦM_n	13.2 k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.73 OK

FLEXURE (CORNER BARS) Use #6 @ 10 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		10.0	in
Bar Diameter	d_b	0.75	in
Area of Steel	A_s	0.53	in^2/ft
Steel Depth	d	9.63	in
Eq. Stress Depth	a	0.89	in
Neutral Axis Depth	c	1.04	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{mkl}	1.50	in
Actual Clear Spacing	S_{clr}	9.25	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	18	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0247	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	19.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	23.1	k·ft/ft
Min. Moment Capacity	M_{min}	19.9	k·ft/ft

Temp & Shrink - Art 5.10.8

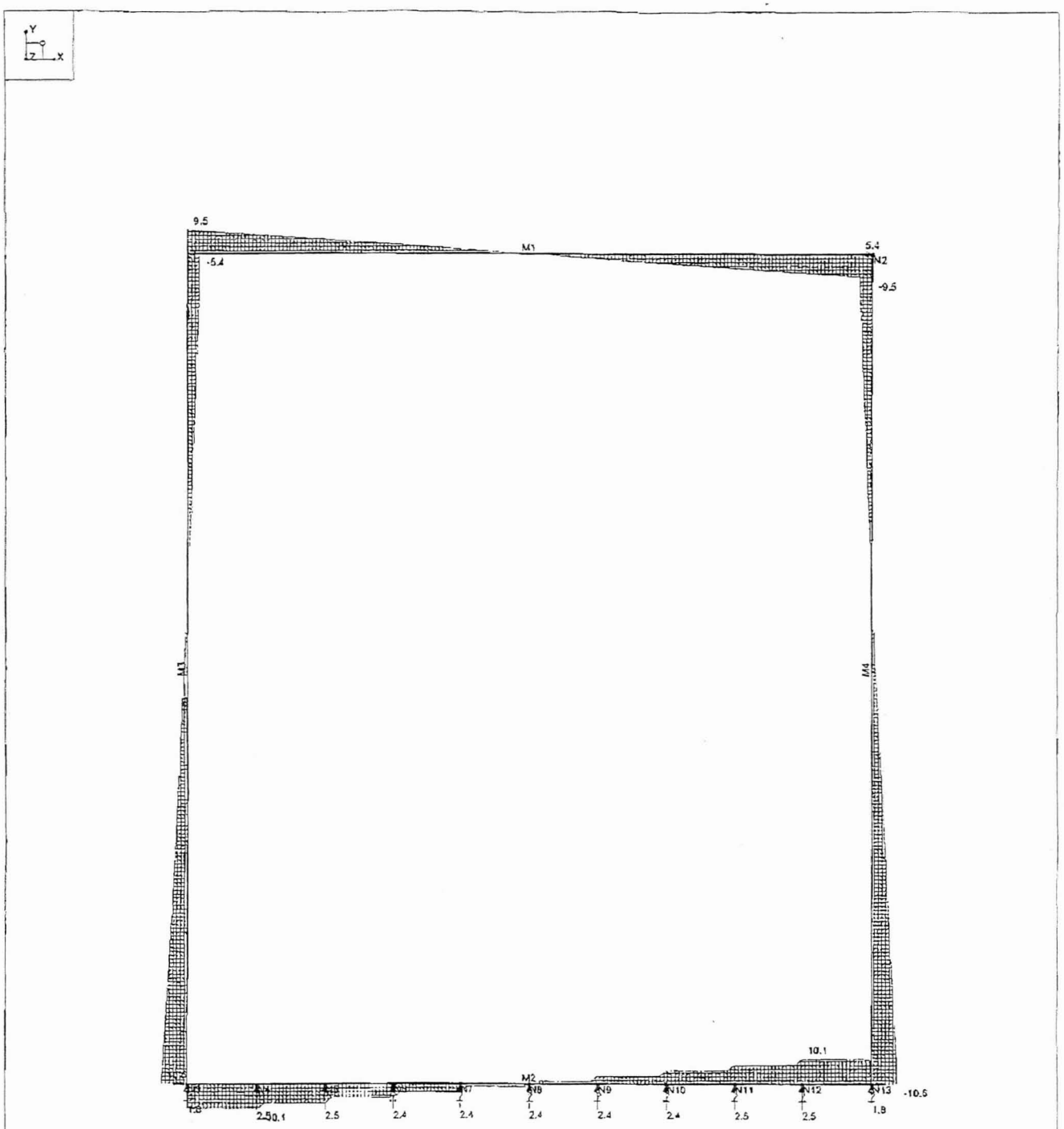
Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	12.7	k·ft/ft
Service Stress in Reinf.	f_{ss}	30.7	ksi
Concrete Cover	d_c	2.38	
Clear Cover Factor	β_s	1.35	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	12.1	in

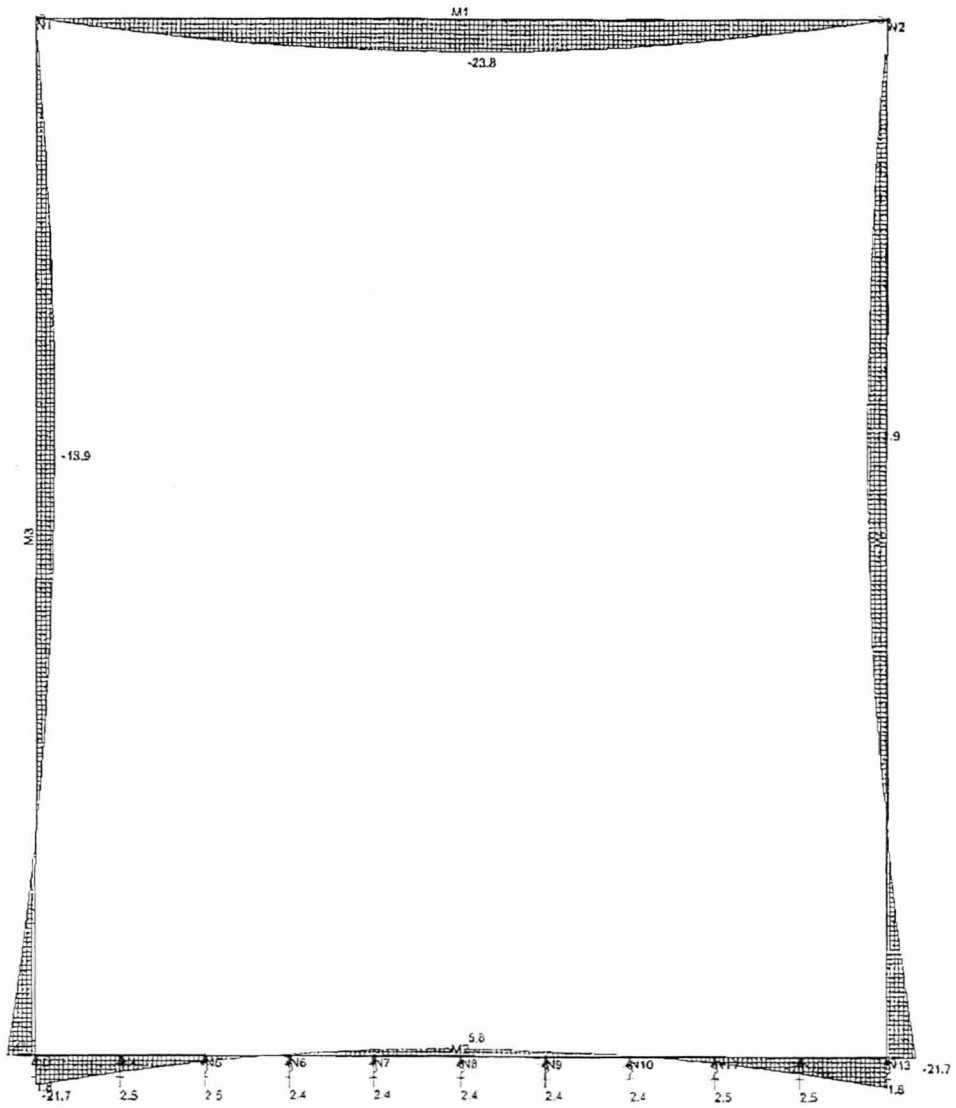
Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	17.4	k·ft/ft
Reduced Nom. Cap.	ΦM_n	21.8	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.80	OK



Results for LC 3, Strength I - Case 1
Member y Shear Forces (k)
Reaction units are k and k-ft

Olsson Associates		
rb	Transition Structure	July 7, 2010 at 10:45 AM
010-0216	Strength 1 - Shear	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		
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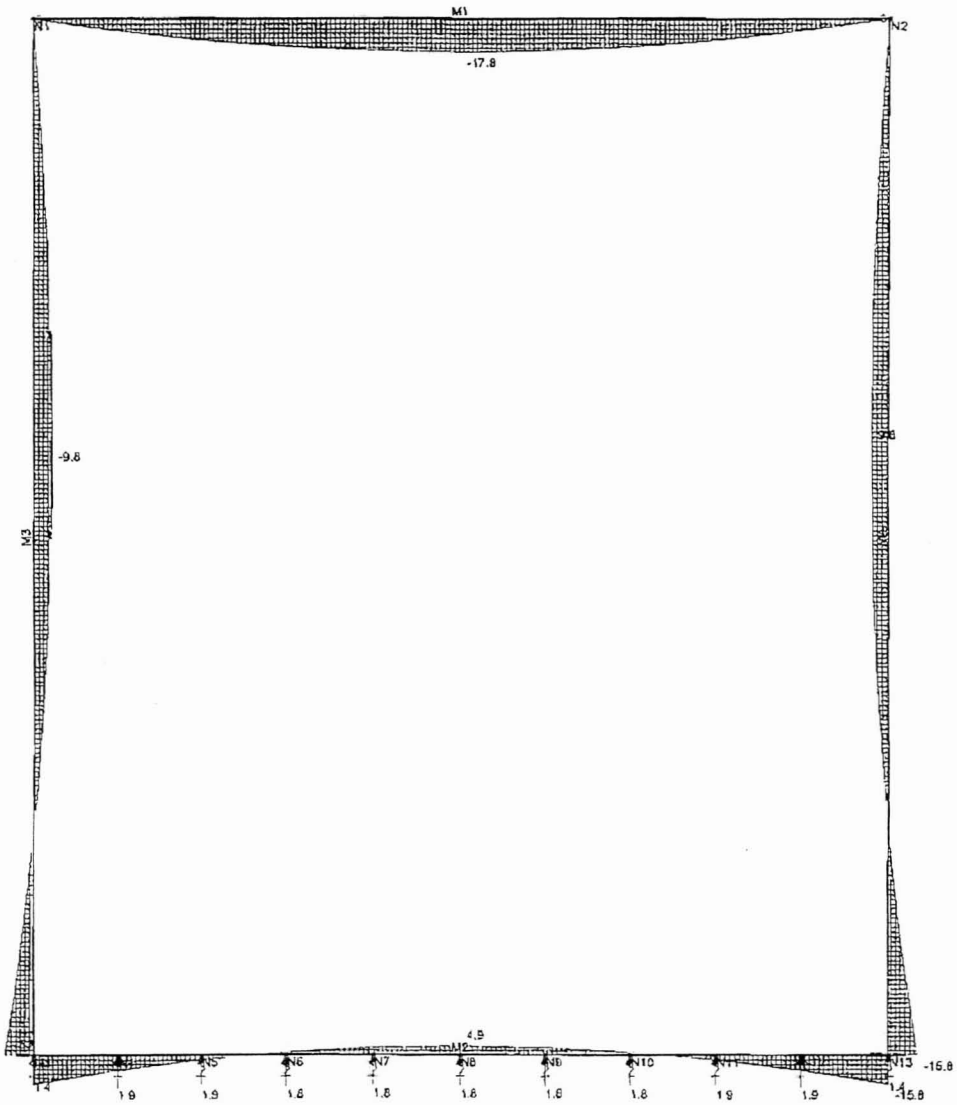
010-0216	Strength 1 - Bending Moments	Transition Box.r3d



Results for LC 1, Service I - Case 1
Member z Bending Moments (k-ft)
Reaction units are k and k-ft

Olsson Associates		
rb	Transition Structure	July 7, 2010 at 10:43 AM
010-0216	Service Bending Moments	Transition Box.r3d

Project Name:	Arcadia
Project Number:	010-0216
Analyst:	RB
Date:	8/1/2010

Transition Struct. Quantities

Summary

	Concrete	48.5 yd^3
	Reinforcing	8,173.8 lb

Concrete

	Total						48.5 yd^3
Location/Description	*Amount*	*Height*	*Length*	*Width*	*Area*	*Volume*	
Top Slab	1	1.00'	28'	12.00'		336 ft^3	12.4 yd^3
	-1	1.00'			12.57 ft^2	0 ft^3	0.0 yd^3
Walls	2	12.00'	28'	1.00'		672 ft^3	24.9 yd^3
	2	12.00'	10'	1.00'		240 ft^3	8.9 yd^3
Minus 120 "Pipe	-1		1'		113.10 ft^2	-113 ft^3	-4.2 yd^3
Minus 102 "Pipe	-1		1'		82.52 ft^2	-83 ft^3	-3.1 yd^3
Minus 10x10 Box	-1		1'		253.00 ft^2	-253 ft^3	-9.4 yd^3
Footing	1	1.00'	28.667'	12.667'		363 ft^3	13.4 yd^3
fillet	2		28.667'		2.33 ft^2	134 ft^3	5.0 yd^3
MH Base	1		1.000'		15.71 ft^2	16 ft^3	0.6 yd^3

Reinforcing

Total	8,173.8 lb

Location/Description	Mark	Amount	Length ft.	Length in.	Weight
Top Slab					
Longs.-Top	4	13	27'	8.00"	240.26 lb
Longs-Bot.	4	13	27'	8.00"	240.26 lb
Trans.-Top	4	28	11'	8.00"	218.21 lb
Trans.-Bot.	6	46	11'	8.00"	806.07 lb
Dowels	4	96	4'	0.00"	256.51 lb
at MH-Dowels	4	16	2'	4.00"	24.94 lb
at MH-Stirrup	4	1	15'	8.50"	10.49 lb
at MH-Bars	6	16	6'	0.00"	144.19 lb
Walls					
Short Walls					
Horz.	4	48	11'	8.00"	374.08 lb
I.F. Verts	6	29	11'	10.00"	515.44 lb
O.F. Verts	4	29	11'	10.00"	229.24 lb
I.F. Dowels	6	29	5'	7.00"	243.20 lb
O.F. Dowels	6	29	7'	7.00"	330.31 lb
18" pipe trim	5	8	5'	6.00"	45.89 lb
Long Walls					
Horz.-box side	8	2	27'	8.00"	147.74 lb
I.F. Verts-box side	6	34	1'	6.00"	76.60 lb
O.F. Verts-box side	4	34	1'	6.00"	34.07 lb
Box dowels	4	28	1'	6.00"	28.06 lb
Horz.-pipe side	8	2	27'	8.00"	147.74 lb
Horz.-pipe side	4	22	20'	0.00"	293.92 lb
I.F. Verts-pipe side	6	32	12'	10.00"	616.82 lb
O.F. Verts-pipe side	4	32	12'	10.00"	274.33 lb
Corner Bars	4	48	4'	0.00"	128.26 lb
Trim Bars	6	16	8'	0.00"	192.26 lb
I.F. Dowels	6	8	5'	7.00"	67.09 lb
O.F. Dowels	6	8	7'	7.00"	91.12 lb
Footing					
Longs.-Top	5	13	28'	4.00"	384.17 lb
Longs-Bot.	5	13	28'	4.00"	384.17 lb
Trans.-Top	7	58	9'	8.00"	1,146.00 lb
Trans.-Bot.	4	29	9'	8.00"	187.26 lb
Deep footing Trans.	5	29	5'	7.50"	170.14 lb
Deep footing Longs.	4	6	27'	8.00"	110.89 lb
Box Dowels	4	14	1'	6.00"	14.03 lb

Inlet Structure

The inlet structure sidewalls were modeled as a cantilevered retaining wall. The maximum retained height for each section was used for design; 26'-3" for 'Wall Type 1,' and 25' for 'Wall Type 2.' For stability, the bearing pressure, buoyant forces and overturning forces were checked. The walls are considered restrained from sliding due to the continuous footing between the two walls. The stem, heel, and toe reinforcing were designed on a per foot basis according to AASHTO LRFD Specifications.

Reinforcing for the footing slab for 'Wall Type 1' was based on a RISA analysis to determine the bending moment in the slab, based on a 12' distance between the stems. A similar method was used to determine the maximum bending moment for 'Wall Type 2,' with a 16.5' distance between the stems.

The inlet box at the transition between 'Wall Type 1' and the 120" CIPP, was designed as a one-way slab. A two dimensional model was created in RISA to analyze the structure. The loads applied to the structure include 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 the entire top slab 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. The maximum shear was conservatively taken at the support.

Strength 1 combination governs for buried structures. For a rigid buried structure, 1.3 was used for the vertical earth pressure load factor, 1.35 was used for the at-rest horizontal earth pressure load factor, and 1.75 was used for the live load factor. The concrete shear strength for the top slab was modified according to Art. 5.14.5.3. The strength reduction factor for shear is taken as 0.85 for buried CIP concrete structures.

To divert loads away from the 120" CIPP, a beam was added and supported on columns in the corners of the walls. Similarly, a beam was created at the front face of the top slab to carry the additional vertical load from the parapet.

The parapet was designed as a two-way slab; a plate fixed at the bottom, as well as each side, and free at the top.

INLET STRUCTURE DESIGN - WALL TYPE 1

010-0216
rb

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 top of the apron slab.

MATERIALS

Concrete Strength	f'_c	3.5	ksi
Conc. Mod. of Elast.	E_c	3,602	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	8.1	

SOIL DATA

At-Rest - Drained - Cohesive Soil			
Soil Wt.	γ_s	115	pcf
Eq. Fluid Density	γ_{eq}	51	pcf

PROJECT DIMENSIONS

Wall Dimensions

Design Wall Height	H	26.25	ft
Stem Thick @ Top		24	in.
Stem Thick. @ Bottom		39.00	in.

Footing Dimensions

Dist. from Wall to Wall	S	12.00	ft
Heel Length	d	5.00	ft
Bot. Slab Thickness	TB	42.0	in
Bot. Slab Width	BB	28.50	ft

DEAD LOADS

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k/ft)
Walls	2	26.250	2.625	1.000		150	20.672
Bottom Slab	1	3.500	28.500	1.000		150	14.963
Earth Fill	2	26.250	5.000	1.000		115	30.188
Water Fill	1	4.000	12.000	1.000		62.4	2.995
Concrete Fill	1	0.000	12.000	1.000		150.0	0.000
Additional Wt.							0.000
Total							**68.817**

LIVE LOADS

Live Load to be considered includes surcharge on horizontal pressure equal to a quantity of additional fill. A Live Load pressure is considered to act on the apron slab.

Surcharge - Horz. Loads Only

Soil Height	h_s	3.0	ft
Horz. Pressure	p	153	psf

Surcharge -Vertical on Apron Only

Vertical Pressure	p	300	psf

STABILITY

010-0216
rb

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

BEARING CAPACITY (SERVICE LOADS)

Bearing Area	A_q	28.50	ft^2
DL Bearing Pressure	q_{DL}	2,415	psf
LL Bearing Pressure	q_{LL}	126	psf
Bearing Pressure	q	2,541	psf
All. Bearing Pressue	q_{all}	3,000	psf
Factor of Safety	FS	1.18	OK

BUOYANT FORCES

Depth to Bot. Slab	z	29.75	ft
Groundwater Depth	z_w	0.00	ft
Buoyant Force	P_b	29.7	k
Self Weight	P_w	65.8	k
Factor of Safety	FS	2.22	OK > 1.1

WALL DESIGN

010-0216

rb

Cantileverd wall designed with a rigid connection to the apron slab. Strength I combination governs. The load factor for at-rest lateral earth pressure is 1.5 and for active lateral earth pressure is 1.35. COE recommends an additional load factor of 1.3 for all loads on hydraulic structures. Maximum shear is taken at the face of the support.

PARAMETERS				LOADS (Service)			
Stem Height	H	26.25	ft	Earth Press. @ Bot.	p_{EH}	1.339	k/ft
Top of Stem Thickness	TW	24.00	in	LL Surcharge	p_{LS}	0.153	k/ft
Stem Batter		~~0.5~~ ~~:12~~					
Stem Thick. @ Bottom		39.00	in.				

SHEAR	*Art. 5.8.3.4.1*				*Art 5.8.3.3*		
Reduction Factor	Φ	0.85		Factored Ultimate Load	V_u	30.8	k/ft
Width for Shear	b_v	12.00	in	Reduced Nom. Cap.	ΦV_c	44.0	k/ft
Steel Depth for Shear	d_v	36.37	in	**Utilization Ratio**	$V_u / \Phi V_c$	0.70	OK
Conc. Shear Strength	V_c	51.8	k/ft				

FLEXURE		Use #10 @ 6 in. Spa.					
Parameters				**Strain Calculation**			
Reduction Factor	Φ	0.90		Extr. Tensile Strain	ε_t	0.0189	
Width	b	12.00	in	**Min. Reinforcement - Art 5.7.3.3.2**			
Height	h	39.00	in	1.2 x Cracking Moment	$1.2M_{cr}$	211.5	k·ft/ft
Clear Cover	c_c	2.00	in	1.33 x Ult. Moment	$1.33M_u$	398.7	k·ft/ft
Bar Size		# 10		Min. Moment Capacity	M_{min}	211.5	k·ft/ft
Spacing		6.0	in	**Temp & Shrink - Art 5.10.8**			
Bar Diameter	d_b	1.27	in	Min. Area of Steel	$A_{s,min}$	0.11	in^2/ft/face
Area of Steel	A_s	2.54	in^2/ft	**Crack Control - Art 5.7.3.4**			
Steel Depth	d	36.37	in	Service Moment	M_s	206.5	k·ft/ft
Eq. Stress Depth	a	4.23	in	Service Stress in Reinf.	f_{ss}	27.6	ksi
Neutral Axis Depth	c	4.98	in	Concrete Cover	d_c	2.64	
Spacing Limit - Art 5.10.3				Clear Cover Factor	β_s	1.10	
Min. Clear Spacing	S_{min}	1.91	in	Exposure Factor	γ_e	1.00	
Actual Clear Spacing	S_{clr}	4.73	in	Max. Spacing	S_{max}	17.7	in
Max. Spacing	S_{max}	12.0	in	**Moment Capacity - Art 5.7.3.2.1**			
Development Length - Art 5.11.2.1				Factored Ultimate Load	M_u	299.8	k·ft/ft
Epoxy Modifier	Ψ_e	1.0		Reduced Nom. Cap.	ΦM_n	391.5	k·ft/ft
Top Bar Modifier	Ψ_t	1.0		**Utilization Ratio**	$M_u / \Phi M_n$	0.77	OK
Development Length	L_d	51	in				

DEFLECTION							
Nuetral Axis Depth	c	9.89	in	Deflection	Δ	0.33	in
Gross Inertia	I_g	48,090	in^4	Deflection Limit	0.002H	0.58	in
Cracked Inertia	I_{cr}	45,205	in^4	**At-Rest Lateral Earth Pressure**			
Cracked Moment	M_{cr}	105.4	k-in				
Effective Inertia	I_e	48,090	in^4				

FOOTING DESIGN

010-0216

rb

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

Dist. from Wall to Wall		12.00	ft
Footing Thickness	TB	42.00	in
Heel Length	d	5.00	ft
Bot. Slab Width	BB	28.50	ft

LOADS (Service)

Loads on Heel

Vertical Earth Pressure	p_{EV}	3.019	k/ft

Loads in Apron *(Non-concurrent)*

Fluid Load	p_{FL}	0.250	k/ft
Live Load Pressure	p_{LL}	0.300	k/ft

SHEAR *Art. 5.14.5.3*

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	39.44	in
Conc. Shear Strength	V_c	56.2	k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	23.9	k/ft
Reduced Nom. Cap.	ΦV_c	47.8	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.50	OK

FLEXURE (Top Bar) Use #9 @ 6 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	42.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 9	
Spacing		6.0	in
Bar Diameter	d_b	1.13	in
Area of Steel	A_s	2.00	in^2/ft
Steel Depth	d	39.44	in
Eq. Stress Depth	a	3.33	in
Neutral Axis Depth	c	3.92	in

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.69	in
Actual Clear Spacing	S_{clr}	4.87	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	40	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0272	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	245.3	k-ft/ft
1.33 x Ult. Moment	$1.33M_u$	363.1	k-ft/ft
Min. Moment Capacity	M_{min}	245.3	k-ft/ft

Temp & Shrink - Art 5.10.8

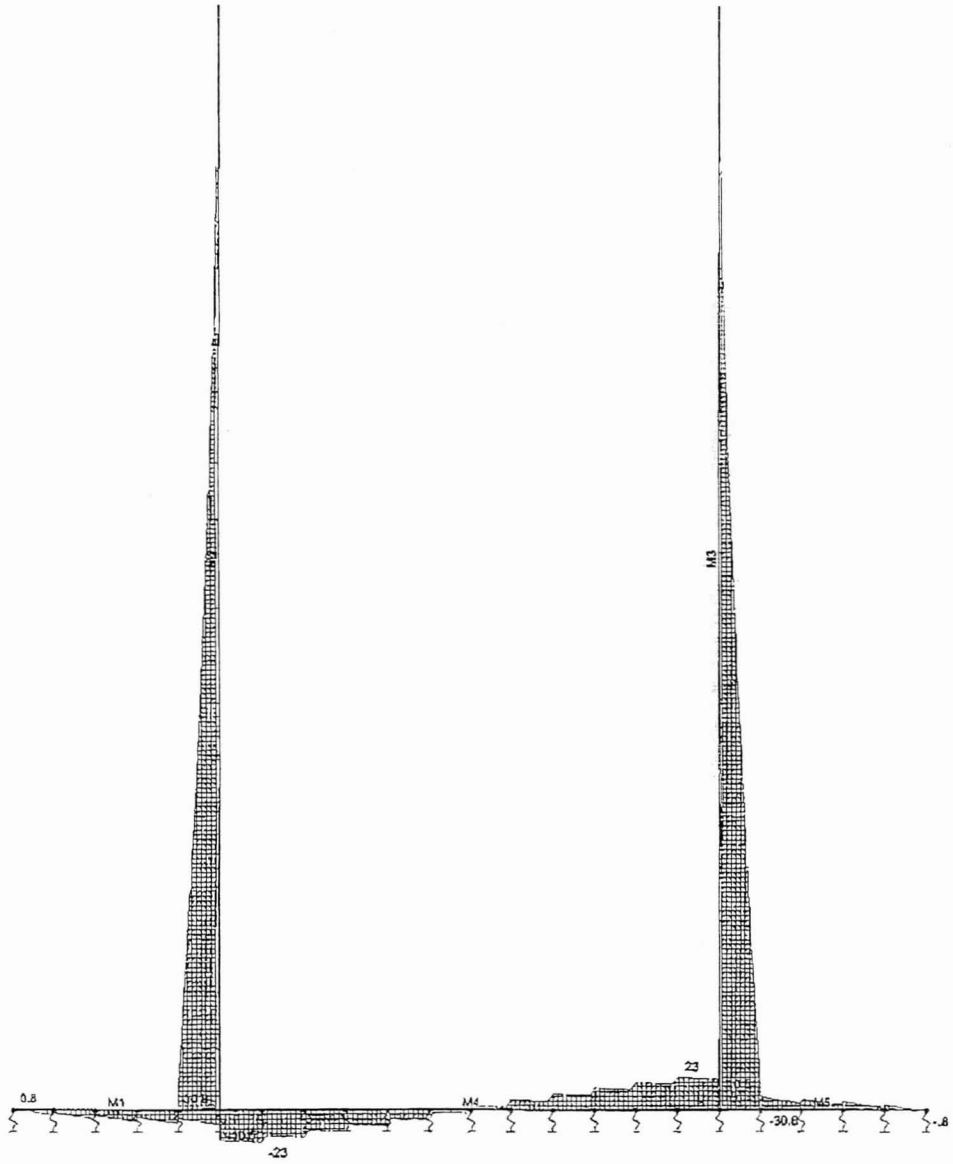
Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	186.1	k-ft/ft
Service Stress in Reinf.	f_{ss}	28.9	ksi
Concrete Cover	d_c	2.56	
Clear Cover Factor	β_s	1.09	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	17.0	in

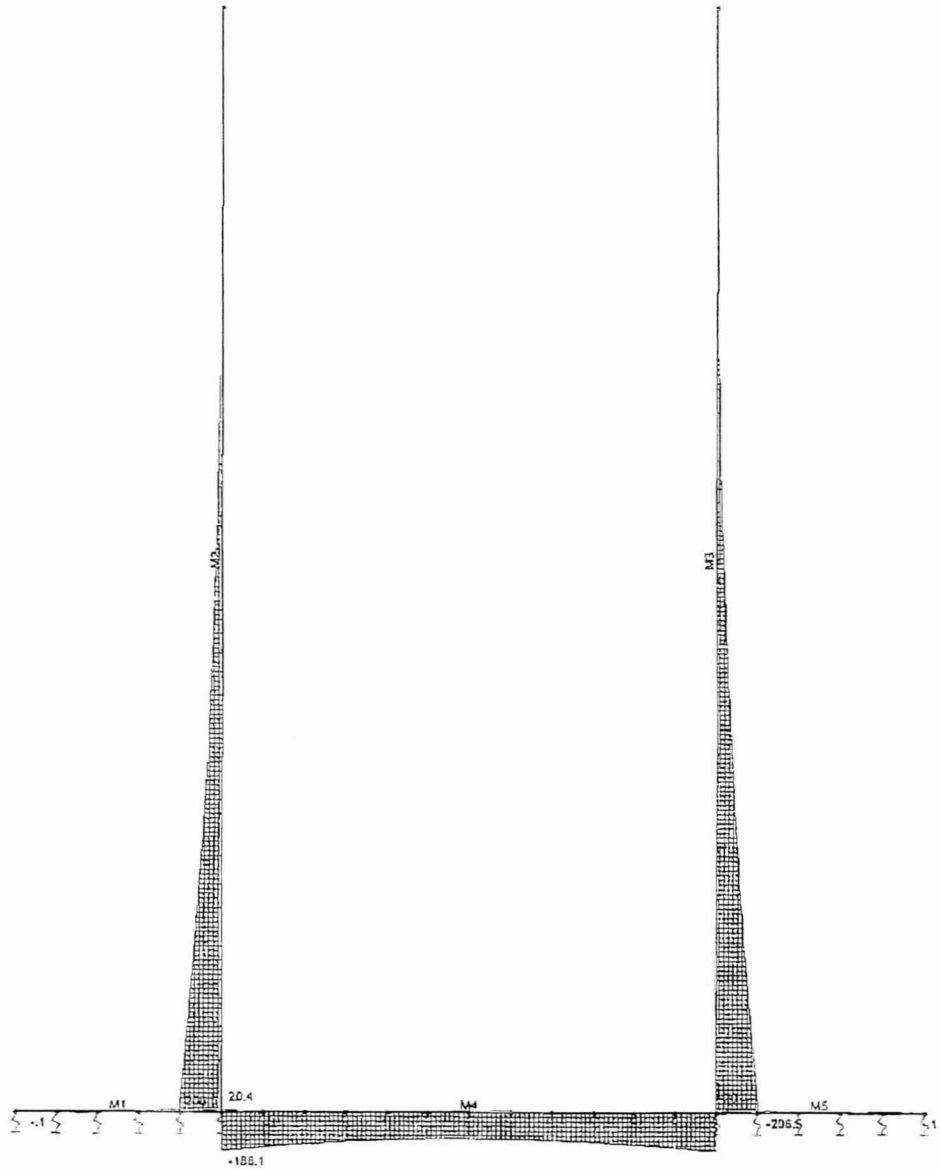
Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	273.0	k-ft/ft
Reduced Nom. Cap.	ΦM_n	339.9	k-ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.80	OK



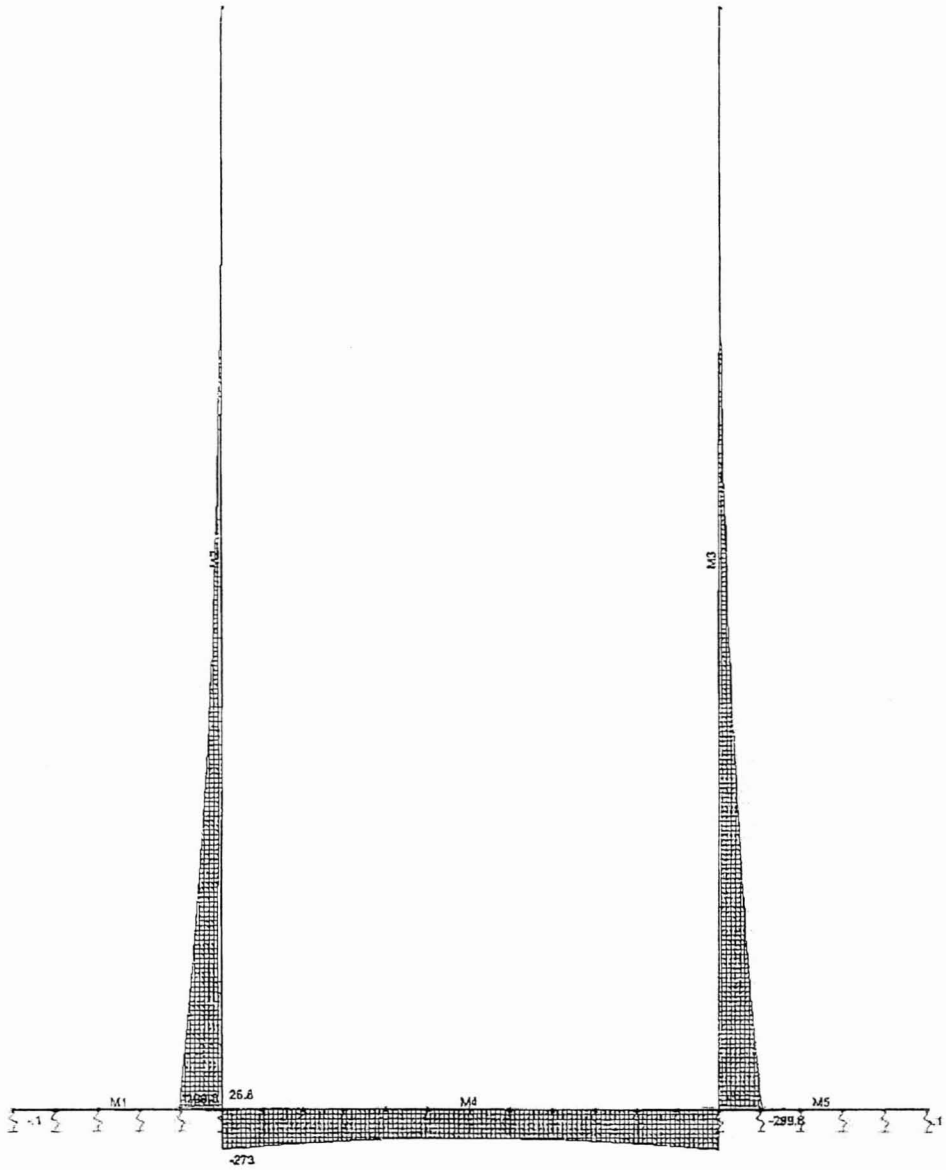
Results for LC 4, Strength 1 w/ LL
Member y Shear Forces (k)

Olsson Associates		
rb	Inlet Structure - Wall Type 1	July 29, 2010 at 5:33 PM
010-0216	Strength 1 - Shear	Inlet - WALL TYPE 1.r3d



Results for LC 1, Service w/o LL
Member z Bending Moments (k-ft)

Olsson Associates		
rb	Inlet Structure - Wall Type 1	July 29, 2010 at 5:35 PM
010-0216	Service - Bending Moments	Inlet - WALL TYPE 1.r3d



Results for LC 4, Strength 1 w/ LL
Member z Bending Moments (k-ft)

Olsson Associates		
rb	Inlet Structure - Wall Type 1	July 29, 2010 at 5:35 PM
010-0216	Strength 1 - Bending Moments	Inlet - WALL TYPE 1.r3d

INLET STRUCTURE DESIGN - WALL TYPE 2

010-0216
rb

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 top of the apron slab.

MATERIALS

Concrete Strength	f'_c	3.5	ksi
Conc. Mod. of Elast.	E_c	3,587	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	8.1	

SOIL DATA

At-Rest - Drained - Cohesive Soil

Soil Wt.	γ_s	115	pcf
Eq. Fluid Density	γ_{eq}	51	pcf

PROJECT DIMENSIONS

Wall Dimensions

Wall Height	H	25.000	ft
Stem Thick @ Top		24	in.
Stem Thick. @ Bottom		39	in.
Stem Batter		0.6	:12

Footing Dimensions

Dist. from Wall to Wall	S	17.00	ft
Heel Length	d	3.00	ft
Bot. Slab Thickness	TB	36.0	in
Bot. Slab Width	BB	29.50	ft

DEAD LOADS

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k/ft)
Walls	2	25.000	2.625	1.000		150	19.688
Bottom Slab	1	3.000	29.500	1.000		150	13.275
Earth Fill	2	25.000	3.000	1.000		115	17.250
Water Fill	1	4.000	17.000	1.000		62.4	4.243
Concrete Fill	1	0.000	17.000	1.000		150.0	0.000
Additional Wt.							0.000
Total							54.456

LIVE LOADS

Live Load to be considered includes surcharge on horizontal pressure equal to a quantity of additional fill. A Live Load pressure is considered to act on the apron slab.

Surcharge - Horz. Loads Only

Soil Height	h_s	3.0	ft
Horz. Pressure	p	153	psf

Surcharge -Vertical on Apron Only

Vertical Pressure	p	300	psf

STABILITY

010-0216
rb

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

BEARING CAPACITY (SERVICE LOADS)

Bearing Area	A_q	29.50	ft^2
DL Bearing Pressure	q_{DL}	1,846	psf
LL Bearing Pressure	q_{LL}	173	psf
Bearing Pressure	q	2,019	psf
All. Bearing Pressue	q_{all}	3,000	psf
Factor of Safety	FS	1.49	OK

BUOYANT FORCES

Depth to Bot. Slab	z	28.00	ft
Groundwater Depth	z_w	0.00	ft
Buoyant Force	P_b	36.7	k
Self Weight	P_w	50.2	k
Factor of Safety	FS	1.37	OK > 1.1

WALL DESIGN

010-0216

rb

Cantileverd wall designed with a rigid connection to the apron slab. Strength 1 combination governs. The load factor for at-rest lateral earth pressure is 1.5 and for active lateral earth pressure is 1.35. COE recommends an additional load factor of 1.3 for all loads on hydraulic structures. Maximum shear is taken at the face of the support.

PARAMETERS

Stem Height	H	25.00 ft
Top of Stem Thickness	TW	24.00 in
Stem Batter		0.60 :12
Stem Thick. @ Bottom		39.00 in.

LOADS (Service)

Earth Press. @ Bot.	p_{EH}	1.275 k/ft
LL Surcharge	p_{LS}	0.153 k/ft

SHEAR

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	36.44 in
Conc. Shear Strength	V_c	51.7 k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	28.2 k/ft
Reduced Nom. Cap.	ΦV_c	43.9 k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.64 OK

FLEXURE

Use #9 @ 6 in. Spa.

Parameters

Reduction Factor	Φ	0.90
Width	b	12.00 in
Height	h	39.00 in
Clear Cover	c_c	2.00 in
Bar Size		# 9
Spacing		6.0 in
Bar Diameter	d_b	1.13 in
Area of Steel	A_s	2.00 in^2/ft
Steel Depth	d	36.44 in
Eq. Stress Depth	a	3.36 in
Neutral Axis Depth	c	3.95 in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.69 in
Actual Clear Spacing	S_{clr}	4.67 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	41 in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0246

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	210.6 k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	349.8 k·ft/ft
Min. Moment Capacity	M_{min}	210.6 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	180.6 k·ft/ft
Service Stress in Reinf.	f_{ss}	30.5 ksi
Concrete Cover	d_c	2.56
Clear Cover Factor	β_s	1.10
Exposure Factor	γ_e	1.00
Max. Spacing	S_{max}	15.8 in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	263.0 k·ft/ft
Reduced Nom. Cap.	ΦM_n	312.8 k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.84 OK

DEFLECTION

Nuetral Axis Depth	c	8.95 in
Gross Inertia	I_g	48,372 in^4
Cracked Inertia	I_{cr}	42,859 in^4
Cracked Moment	M_{cr}	105.4 k-in
Effective Inertia	I_e	48,372 in^4

Deflection	Δ	0.26 in
Deflection Limit	0.002H	0.58 in

At-Rest Lateral Earth Pressure

FOOTING DESIGN

010-0216

rb

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

Dist. from Wall to Wall		17.00 ft
Footing Thickness	TB	36.00 in
Heel Length	d	3.00 ft
Bot. Slab Width	BB	29.50 ft

LOADS

Loads on Heel

Vertical Earth Pressure	p_{EV}	2.875 k/ft

Loads in Apron *(Optional)*

Fluid Load	p_{FL}	0.250 k/ft
Live Load Pressure	p_{LL}	0.300 k/ft

SHEAR *Art. 5.14.5.3*

Reduction Factor	Φ	0.85
Width for Shear	b_v	12.00 in
Steel Depth for Shear	d_v	33.44 in
Conc. Shear Strength	V_c	47.4 k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	21.8 k/ft
Reduced Nom. Cap.	ΦV_c	40.3 k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.54 OK

FLEXURE (Top Bar) **Use #9 @ 6 in. Spa.**

Parameters

Reduction Factor	Φ	0.90
Width	b	12.00 in
Height	h	36.00 in
Clear Cover	c_c	2.00 in
Bar Size		# 9
Spacing		6.0 in
Bar Diameter	d_b	1.13 in
Area of Steel	A_s	2.00 in^2/ft
Steel Depth	d	33.44 in
Eq. Stress Depth	a	3.36 in
Neutral Axis Depth	c	3.95 in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.69 in
Actual Clear Spacing	S_{clr}	4.87 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	41 in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0224

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	179.4 k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	324.3 k·ft/ft
Min. Moment Capacity	M_{min}	179.4 k·ft/ft

Temp & Shrink - Art 5.10.8

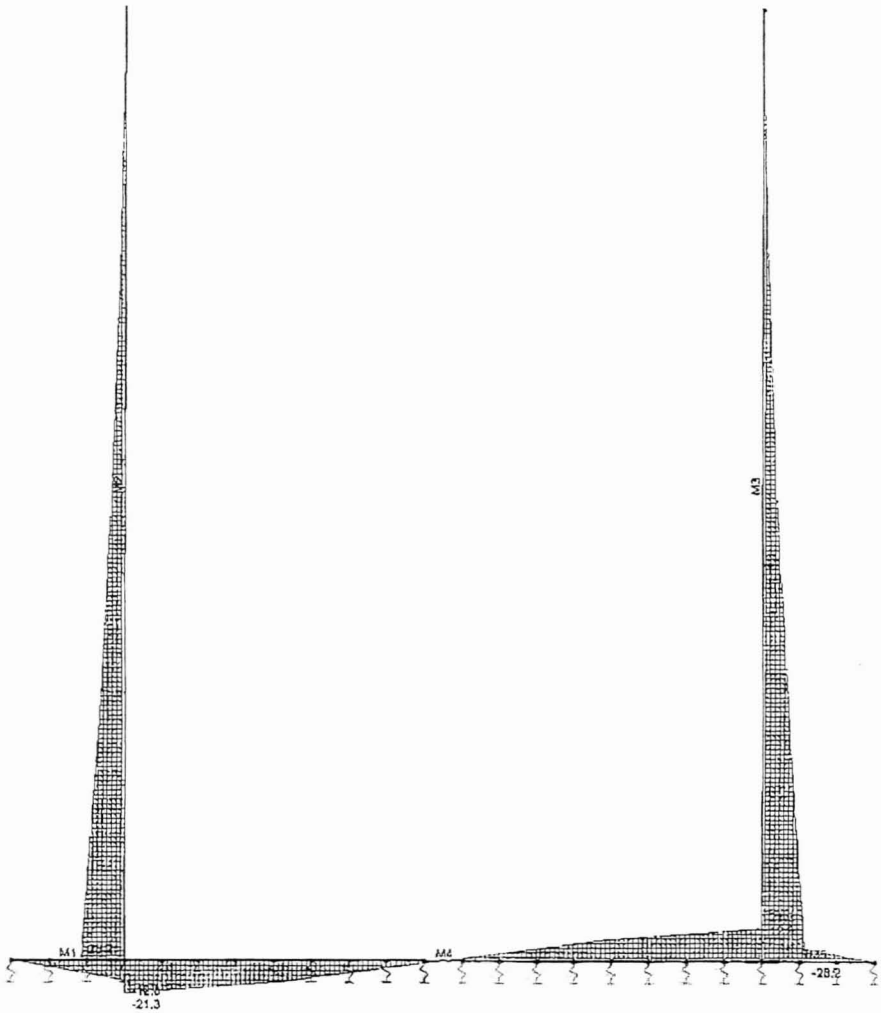
Min. Area of Steel	$A_{s,min}$	0.11 $in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	166.1 k·ft/ft
Service Stress in Reinf.	f_{ss}	30.6 ksi
Concrete Cover	d_c	2.56
Clear Cover Factor	β_s	1.11
Exposure Factor	γ_e	1.00
Max. Spacing	S_{max}	15.5 in

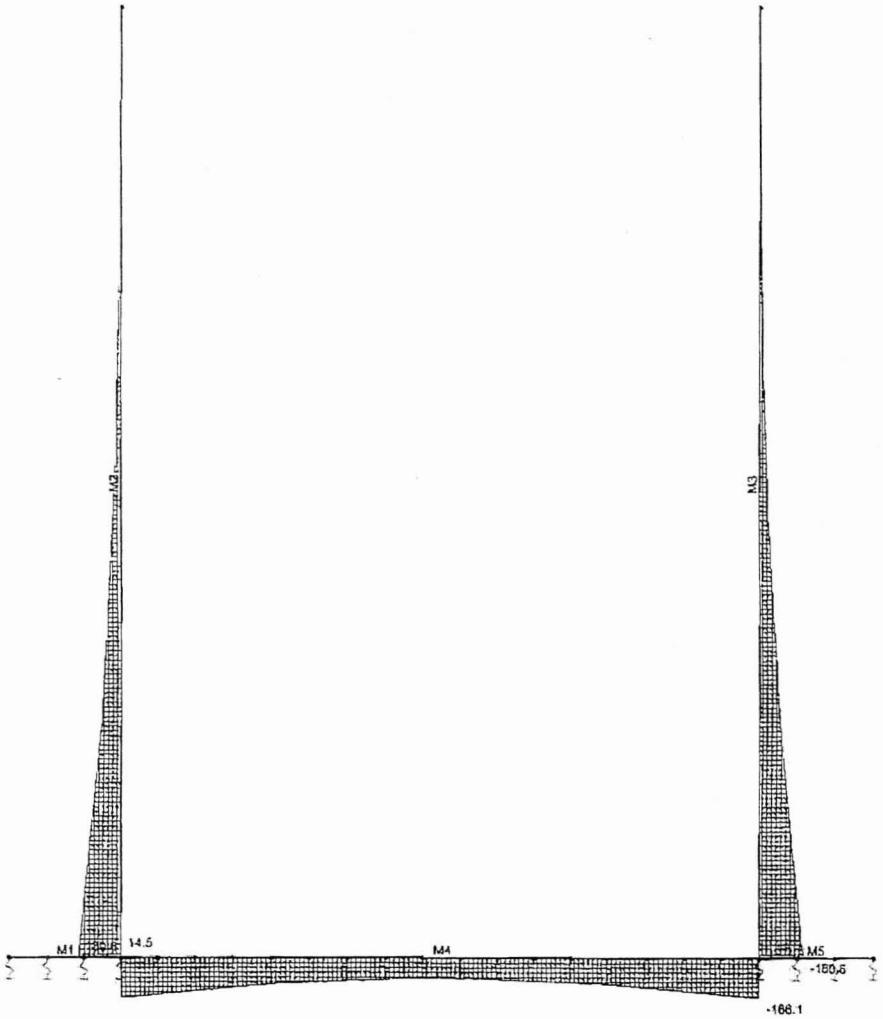
Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	243.8 k·ft/ft
Reduced Nom. Cap.	ΦM_n	285.8 k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.85 OK



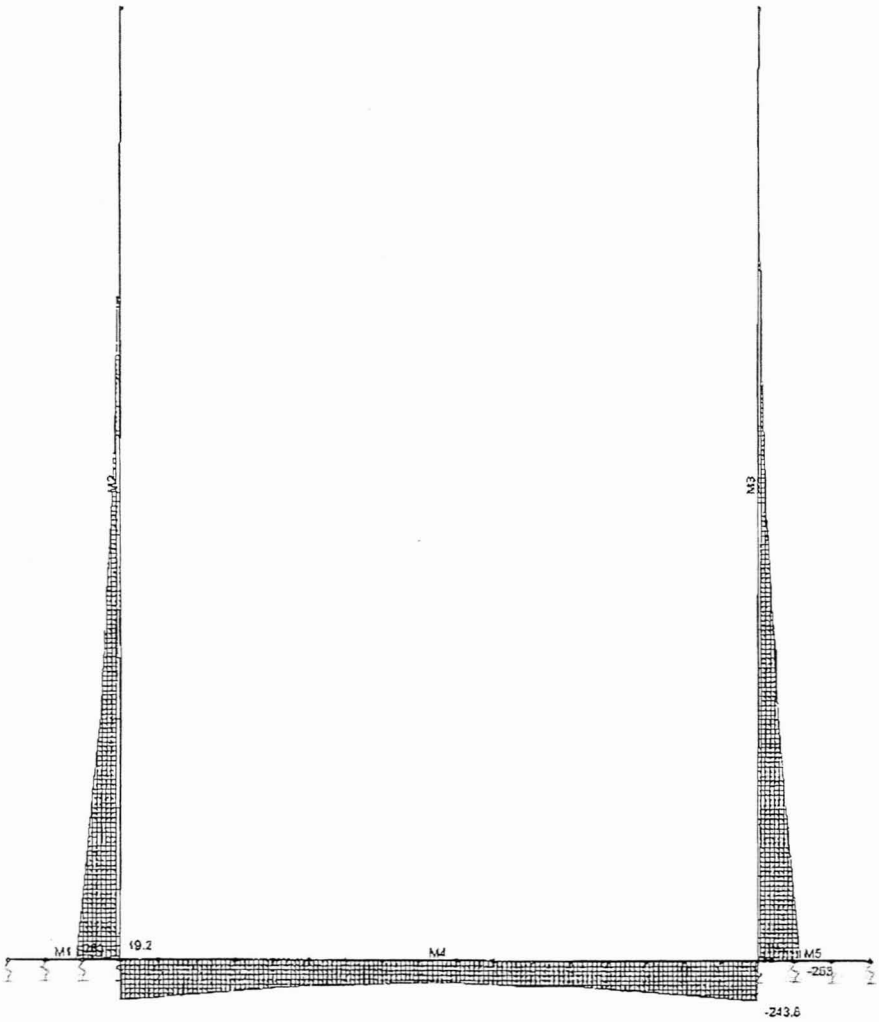
Results for LC 3, Strength 1 w/o LL
Member y Shear Forces (k)

Olsson Associates		
rb	Inlet Structure - WALL TYPE 2	July 29, 2010 at 5:39 PM
010-0216	Strength 1 - Shear	Inlet - WALL TYPE 2.r3d



Results for LC 2, Service w/ LL
Member z Bending Moments (k-ft)

Olsson Associates		
rb	Inlet Structure - WALL TYPE 2	July 29, 2010 at 5:43 PM
010-0216	Service - Bending Moments	Inlet - WALL TYPE 2.r3d



Results for LC 4, Strength 1 w/ LL
Member z Bending Moments (k-ft)

Olsson Associates		
rb	Inlet Structure - WALL TYPE 2	July 29, 2010 at 5:39 PM
010-0216	Strength 1 - Bending Moments	Inlet - WALL TYPE 2.r3d

INLET BOX DESIGN

010-0216
rb

Design of inlet transition box between 'Wall Type 1' and 120"CIPP. 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

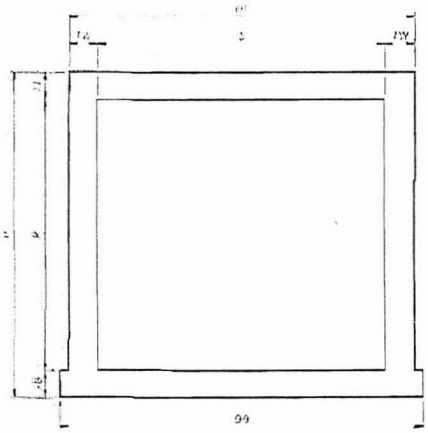
Concrete Strength	f'_c	3.5	ksi
Conc. Mod. of Elast.	E_c	3,587	ksi
Stress Block Coeff.	β_1	0.85	
Rebar Strength	f_y	60	ksi
Steel Mod. of Elast.	E_s	29,000	ksi
Modular Ratio	n	8.1	

BOX DIMENSIONS

Wall Thickness	TW	14.0	in
Top Slab Thickness	TT	18.0	in
Top Slab Width	BT	14.33	ft
Bot. Slab Thickness	TB	18.0	in
Bot. Slab Width	BB	15.00	ft
Total Height	H	15.00	ft

PARAMETERS

Design Span	S	12.00	ft
Rise	R	12.00	ft
Fill	h_f	12.75	ft
Footing Offset	d	0.33	ft



SOIL DATA

At-Rest - Drained - Cohesive Soil

Soil Wt.	γ_s	115	pcf
Eq. Fluid Density	γ_{eq}	51	pcf

DEAD LOADS

Component	No.	Height (ft)	Length (ft)	Width (ft)	Area (ft^2)	Wt (pcf)	Wt (k/ft)
Top Slab	1	1.500	14.333	1.000		150	3.225
Walls	2	1.167	12.000	1.000		150	4.200
Bottom Slab	1	1.500	15.000	1.000		150	3.375
Earth Fill	1			1.000	177.750	115	20.441
Water Fill	1	12.000	12.000	1.000		62.4	8.986
Concrete Fill	1	0.000	12.000	1.000		150.0	0.000
Additional Wt.							0.000
Total							40.227

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	14.33	ft
Actual Fill Height	h_{fa}	11.25	ft
<u>Fill Height < L - Must Include Live Load</u>			
Axle Load	P	16.0	k
Impact Factor	IM	0	%
Distribution Width	E_{span}	12.92	ft
Wheel Load	w	0.115	ksf

Surcharge - Horz. Loads Only

Soil Height	h_s	2.0	ft
Horz. Pressure	p	102	psf

STABILITY

010-0216
rb

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. Based on the preliminary geotechnical report, dated March 30th, 2010, completed by Alpha Geotechnical and Materials, Inc., no groundwater was considered as part of the design. Stability calculations are based on a one foot strip width.

BEARING CAPACITY (SERVICE LOADS)

Bearing Area	A_q	15.00	ft^2
DL Bearing Pressure	q_{DL}	2,682	psf
LL Bearing Pressure	q_{LL}	102	psf
Bearing Pressure	q	2,784	psf
All. Bearing Pressue	q_{all}	3,000	psf
Utilization Ratio	q/q_{all}	0.93	**OK**

BUOYANT FORCES

Depth to Bot. Slab	z	26.25	ft
Groundwater Depth	z_w	0.00	ft
Buoyant Force	P_b	13.4	k
Self Weight	P_w	31.2	k
Factor of Safety	**FS**	2.33	**OK** > 1.1

TOP SLAB DESIGN

010-0216

rb

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	18.00 in

LOADS (Service)

Self Weight	w_{DC}	0.225	ksf
Soil Load	w_{EV}	1.294	ksf
Distr. Live Load	w_{LL}	0.115	ksf

SHEAR *Art. 5.14.5.3*

Reduction Factor	Φ	0.85	
Width for Shear	b_v	12.00	in
Steel Depth for Shear	d_v	15.56	in
Conc. Shear Strength	V_c	26.9	k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	13.1	k/ft
Reduced Nom. Cap.	ΦV_c	22.9	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.57	OK

FLEXURE (BOTTOM BARS) **Use #7 @ 10 in. Spa.**

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	18.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 7	
Spacing		10.0	in
Bar Diameter	d_b	0.88	in
Area of Steel	A_s	0.72	in^2/ft
Steel Depth	d	15.56	in
Eq. Stress Depth	a	1.21	in
Neutral Axis Depth	c	1.42	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	9.13	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	25	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0298	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	44.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	52.1	k·ft/ft
Min. Moment Capacity	M_{min}	44.9	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	29.6	k·ft/ft
Service Stress in Reinf.	f_{ss}	32.4	ksi
Concrete Cover	d_c	2.44	
Clear Cover Factor	β_s	1.22	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	12.8	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	39.2	k·ft/ft
Reduced Nom. Cap.	ΦM_n	48.5	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.81	OK

WALL DESIGN

010-0216

rb

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	14.00	in
Span Length	L	12.00	ft
Point of Contraflexure	x	2.54	ft

LOADS (Service)

Earth Press. @ Top	p_{EH}	0.650	k/ft
Earth Press. @ Bot.	p_{EH}	1.262	k/ft
LL Surcharge	p_{LS}	0.102	k/ft

SHEAR *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	11.56	in
Conc. Shear Strength	V_c	16.4	k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	11.9	k/ft
Reduced Nom. Cap.	ΦV_c	13.9	k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.85	OK

FLEXURE (INSIDE FACE) **Use #5 @ 10 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		# 5	
Spacing		10.0	in
Bar Diameter	d_b	0.63	in
Area of Steel	A_s	0.37	in^2/ft
Steel Depth	d	11.69	in
Eq. Stress Depth	a	0.63	in
Neutral Axis Depth	c	0.74	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	9.38	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	13	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0447	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	27.1	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	18.5	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	9.8	k·ft/ft
Service Stress In Reinf.	f_{ss}	27.4	ksi
Concrete Cover	d_c	2.31	
Clear Cover Factor	β_s	1.28	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	15.3	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	13.9	k·ft/ft
Reduced Nom. Cap.	ΦM_n	19.0	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.73	OK

FLEXURE (CORNER BARS) **Use #7 @ 10 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		10.0	in
Bar Diameter	d_b	0.88	in
Area of Steel	A_s	0.72	in^2/ft
Steel Depth	d	11.56	in
Eq. Stress Depth	a	1.21	in
Neutral Axis Depth	c	1.42	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	9.13	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	25	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0214	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	27.1	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	36.8	k·ft/ft
Min. Moment Capacity	M_{min}	27.1	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	20.4	k·ft/ft
Service Stress in Reinf.	f_{ss}	30.2	ksi
Concrete Cover	d_c	2.44	
Clear Cover Factor	β_s	1.30	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	12.9	in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	27.7	k·ft/ft
Reduced Nom. Cap.	ΦM_n	35.5	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.78	OK

FOOTING DESIGN

010-0216

rb

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	18.00 in

SHEAR

Art. 5.14.5.3

Reduction Factor	Φ	0.85
Width for Shear	b_v	12.00 in
Steel Depth for Shear	d_v	15.69 in
Conc. Shear Strength	V_c	22.3 k/ft

Art 5.8.3.3

Factored Ultimate Load	V_u	13.6 k/ft
Reduced Nom. Cap.	ΦV_c	18.9 k/ft
Utilization Ratio	$V_u / \Phi V_c$	0.72 OK

FLEXURE (TOP BARS)

Use #5 @ 12 in. Spa.

Parameters

Reduction Factor	Φ	0.90
Width	b	12.00 in
Height	h	18.00 in
Clear Cover	c_c	2.00 in
Bar Size		# 5
Spacing		12.0 in
Bar Diameter	d_b	0.63 in
Area of Steel	A_s	0.31 in^2/ft
Steel Depth	d	15.69 in
Eq. Stress Depth	a	0.52 in
Neutral Axis Depth	c	0.61 in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50 in
Actual Clear Spacing	S_{clr}	11.38 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	13 in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0738

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	44.9 k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	20.9 k·ft/ft
Min. Moment Capacity	M_{min}	20.9 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	12.6 k·ft/ft
Service Stress in Reinf.	f_{ss}	31.4 ksi
Concrete Cover	d_c	2.31
Clear Cover Factor	β_s	1.21
Exposure Factor	γ_e	1.00
Max. Spacing	S_{max}	13.8 in

Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	15.7 k·ft/ft
Reduced Nom. Cap.	ΦM_n	21.5 k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.73 OK

FLEXURE (CORNER BARS) Use #7 @ 10 in. Spa.

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Height	h	18.00	in
Clear Cover	c_c	2.00	in
Bar Size		# 7	
Spacing		10.0	in
Bar Diameter	d_b	0.88	in
Area of Steel	A_s	0.72	in^2/ft
Steel Depth	d	15.56	in
Eq. Stress Depth	a	1.21	in
Neutral Axis Depth	c	1.42	in

Spacing Limit - Art 5.10.3

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	9.13	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	25	in

Strain Calculation

Extr. Tensile Strain	ε_t	0.0298	

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	44.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	36.8	k·ft/ft
Min. Moment Capacity	M_{min}	36.8	k·ft/ft

Temp & Shrink - Art 5.10.8

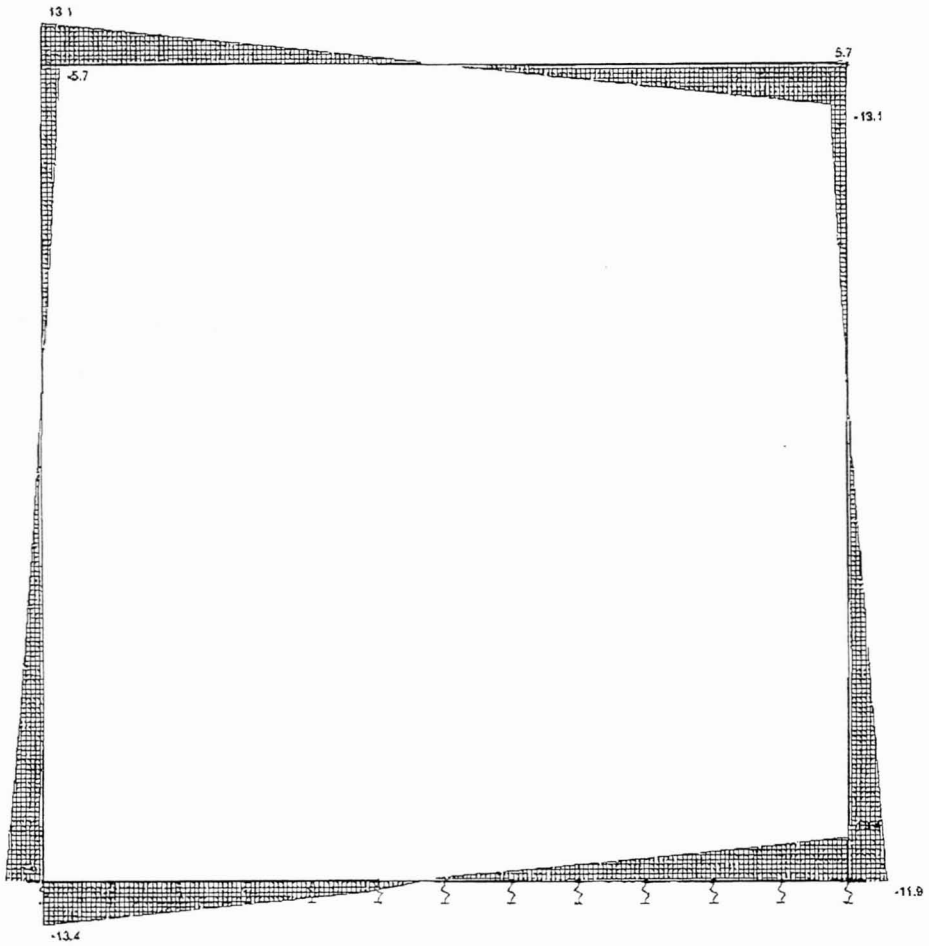
Min. Area of Steel	$A_{s,min}$	0.11	$in^2/ft/face$

Crack Control - Art 5.7.3.4

Service Moment	M_s	20.4	k·ft/ft
Service Stress in Reinf.	f_{ss}	22.2	ksi
Concrete Cover	d_c	2.44	
Clear Cover Factor	β_s	1.22	
Exposure Factor	γ_e	1.00	
Max. Spacing	S_{max}	18.0	in

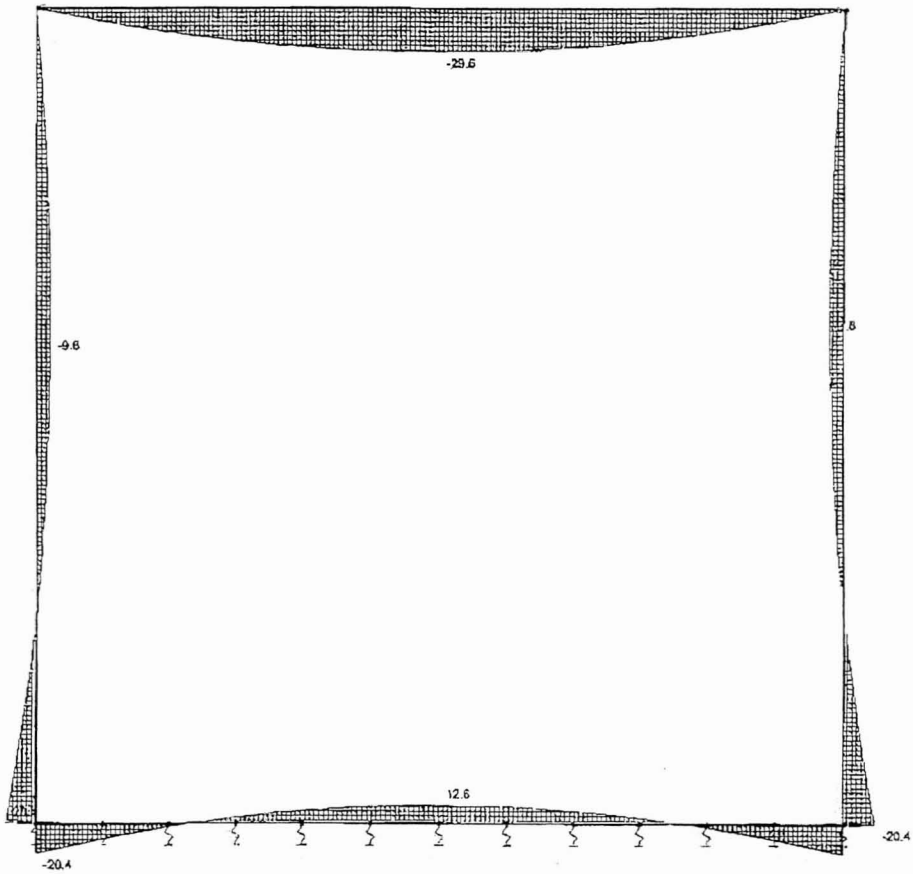
Moment Capacity - Art 5.7.3.2.1

Factored Ultimate Load	M_u	27.7	k·ft/ft
Reduced Nom. Cap.	ΦM_n	48.5	k·ft/ft
Utilization Ratio	$M_u / \Phi M_n$	0.57	OK



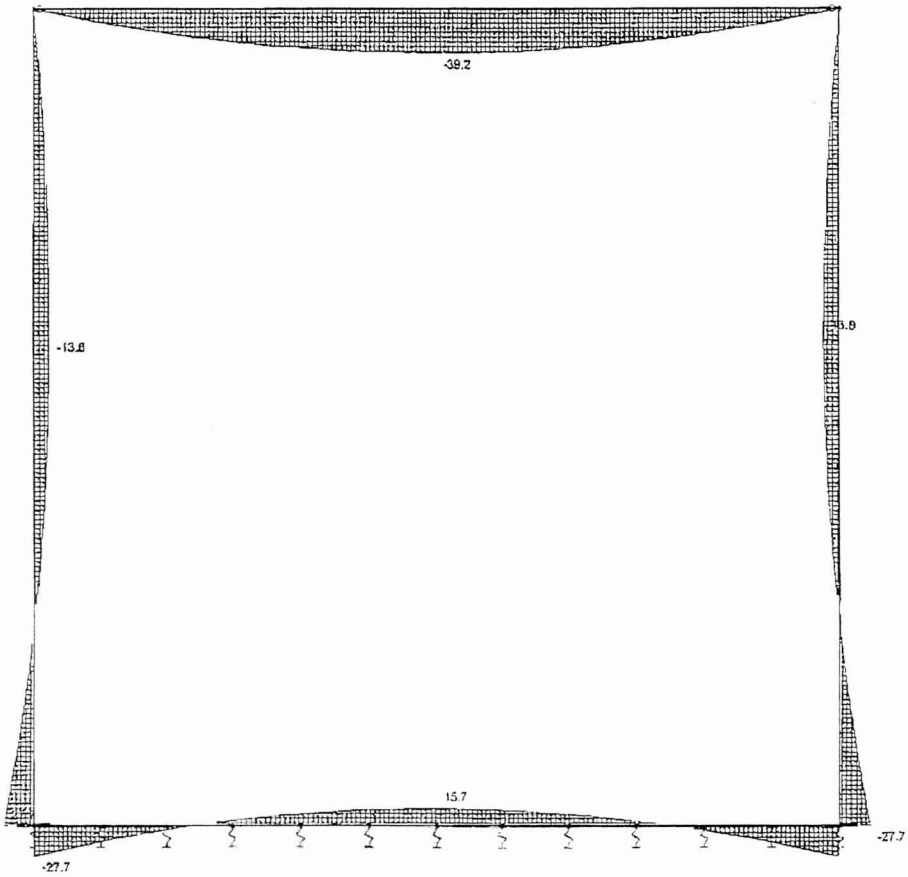
Results for LC 2, Strength I - Case 1
Member y Shear Forces (k)

Olsson Associates		
rb	Inlet Box	July 29, 2010 at 5:50 PM
010-0216	Strength 1 - Shear	Inlet Box.r3d



Results for LC 1, Service I - Case 1
Member z Bending Moments (k-ft)

Olsson Associates		
rb	Inlet Box	July 29, 2010 at 5:48 PM
010-0216	Service - Bending Moments	Inlet Box.r3d



Results for LC 2, Strength I - Case 1
Member z Bending Moments (k-ft)

Olsson Associates		
rb	Inlet Box	July 29, 2010 at 5:51 PM
010-0216	Strength 1 - Bending Moments	Inlet Box.r3d

PARAPET WALL

010-0216
rb

Designed as a plate with a free connection on the top, and either hinged or fixed on all other sides. Strength I combination governs. The load factor for at-rest lateral earth pressure is 1.5 and for active lateral earth pressure is 1.35. Maximum shear is taken at the face of the support.

MATERIALS			PARAMETERS		
Concrete Strength	f'_c	3.5 ksi	Wall Height	b	12.75 ft
Conc. Mod. of Elast.	E_c	3,587 ksi	Top of Wall Thick.	t_1	18.00 in
Stress Block Coeff.	β_1	0.85	Bottom of Wall Thick.	t_2	18.00 in
Rebar Strength	f_y	60 ksi	Top of Wall Elevation		1250.82
Steel Mod. of Elast.	E_s	29,000 ksi	Ground Water Elevation		
Modular Ratio	n	8.1	Height of Water		0.00 ft
			Span Length	S	12.00 ft
SOIL DATA			a/b		0.47
Description: Drained Cohesive Soil					
Moist Soil Wt.	w_s	115 pcf	**LOADS (Service)**		
EFP	w_{eq}	51 pcf	Lateral Earth Load Factor		1.35
Saturated Soil Wt.	w_s	135 pcf	Factored Lateral Earth Pr	p_E	1.141 k/ft²
Saturated EFP	w_{eq}	75 pcf	Factored Surcharge (2' A	p_Q	0.299 k/ft²
At-Rest Lateral Earth Pressure			Pore Pressure Load	p_S	0.00 k/ft²

CASE 1 - PLATE FIXED ALONG THREE EDGES AND FREE ALONG THE FOURTH EDGE.

Mx for Wall Slab at Supports — **Max Moment, M_X** 7.79 k-ft

		Moment Coefficients Values of pb^2			Moments (k-ft)			Total Moments (k-ft)
		185.5	48.6	0.0				
x/a	y/b	p_E	p_Q	p_S	M_E	M_Q	M_S	
0	1.0	0.0131	0.0764	0	2.43	3.71	0.00	6.14
0	0.8	0.0193	0.0727	0	3.57	3.53	0.00	7.11
0	0.6	0.0250	0.0648	0	4.64	3.15	0.00	7.79
0	0.4	0.0261	0.0506	0	4.84	2.46	0.00	7.30
0	0.2	0.0156	0.0241	0	2.90	1.17	0.00	4.07
0	0	0.0000	0.0000	0	0.00	0.00	0.00	0.00
0.2	0	0.0013	0.0017	0	0.23	0.08	0.00	0.32
0.4	0	0.0030	0.0045	0	0.56	0.22	0.00	0.77
0.6	0	0.0045	0.0071	0	0.84	0.35	0.00	1.19
0.8	0	0.0056	0.0089	0	1.03	0.43	0.00	1.46
1.0	0	0.0059	0.0095	0	1.10	0.46	0.00	1.56

My for Wall Slab at Supports — **Max Moment, M_Y** 7.80 k-ft

		Moment Coefficients Values of pb^2			Moments (k-ft)			Total Moments (k-ft)
		185.5	48.6	0.0				
x/a	y/b	p_E	p_Q	p_S	M_E	M_Q	M_S	
0	1.0	0.0000	0.0000	0	0.00	0.00	0.00	0.00
0	0.8	0.0038	0.0145	0	0.71	0.70	0.00	1.42
0	0.6	0.0050	0.0129	0	0.93	0.63	0.00	1.56
0	0.4	0.0052	0.0101	0	0.96	0.49	0.00	1.46
0	0.2	0.0031	0.0048	0	0.58	0.23	0.00	0.81
0	0	0.0000	0.0000	0	0.00	0.00	0.00	0.00
0.2	0	0.0061	0.0084	0	1.13	0.41	0.00	1.54
0.4	0	0.0151	0.0224	0	2.80	1.09	0.00	3.89
0.6	0	0.0228	0.0356	0	4.24	1.73	0.00	5.97
0.8	0	0.0279	0.0445	0	5.18	2.16	0.00	7.34
1.0	0	0.0296	0.0476	0	5.48	2.31	0.00	7.80

FLEXURE

At Top Slab Interaction

Reinforcing

Bar Spacing	s	12.0	in
Clear Cover	c_c	2.00	in
Lap Length		10.00	ft

	Dowels	Vert. Bars
Bar Size	# 5	# 4
Length (ft)	6.50	17.00
Area of Steel (in^2/ft)	0.31	0.00
Dev. Length (in)	13	9

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Thickness	t	18.00	in
Bar Diameter	d_b	0.63	in
Area of Steel	A_s	0.31	in^2/ft
Steel Depth	d	15.69	in
Eq. Stress Depth	a	0.52	in
Neutral Axis Depth	c	0.61	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0
Top Bar Modifier	Ψ_t	1.0

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.38	in
Max. Spacing	S_{max}	12.0	in

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.17	$in^2/ft/face$

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0738

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	44.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	10.4	k·ft/ft
Min. Moment Capacity	M_{min}	10.4	k·ft/ft

Crack Control - Art 5.7.3.4

Service Moment	M_s	6.0	k·ft/ft
Service Stress in Reinf.	f_{ss}	14.9	ksi
Concrete Cover	d_c	2.31	
Clear Cover Factor	β_s	1.21	
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	21.5	k·ft/ft
Factored Ultimate Load	M_u	7.8	k·ft/ft
Factor of Safety	$\Phi M_n / M_u$	2.76	OK

At Wall Interaction

Reinforcing

Bar Spacing	s	12.0	in
Clear Cover	c_c	2.00	in
Lap Length		18.10	ft

	Dowels	Vert. Bars
Bar Size	# 5	# 4
Length (ft)	6.50	18.90
Area of Steel (in^2/ft)	0.31	0.00
Dev. Length (in)	13	9

Parameters

Reduction Factor	Φ	0.90	
Width	b	12.00	in
Thickness	t	18.00	in
Bar Diameter	d_b	0.63	in
Area of Steel	A_s	0.31	in^2/ft
Steel Depth	d	15.69	in
Eq. Stress Depth	a	0.52	in
Neutral Axis Depth	c	0.61	in

Development Length - Art 5.11.2.1

Epoxy Modifier	Ψ_e	1.0
Top Bar Modifier	Ψ_t	1.0

Spacing Limit - Art 5.10.3.1.1

Min. Clear Spacing	S_{min}	1.50	in
Actual Clear Spacing	S_{clr}	11.38	in
Max. Spacing	S_{max}	12.0	in

Temp & Shrink - Art 5.10.8

Min. Area of Steel	$A_{s,min}$	0.17	$in^2/ft/face$

Max. Reinforcement - Art 5.7.3.3.1

Extr. Tensile Strain	ε_t	0.0738

Min. Reinforcement - Art 5.7.3.3.2

1.2 x Cracking Moment	$1.2M_{cr}$	44.9	k·ft/ft
1.33 x Ult. Moment	$1.33M_u$	10.4	k·ft/ft
Min. Moment Capacity	M_{min}	10.4	k·ft/ft

Crack Control - Art 5.7.3.4

Service Moment	M_s	6.0	k·ft/ft
Service Stress in Reinf.	f_{ss}	14.9	ksi
Concrete Cover	d_c	2.31	
Clear Cover Factor	β_s	1.21	
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	21.5	k·ft/ft
Factored Ultimate Load	M_u	7.8	k·ft/ft
Factor of Safety	$\Phi M_n / M_u$	2.76	OK

SHEAR

Reactions for Wall Slab at Supports

Max Shear, R 9.55 k

		Shear Coefficients Values of pb			Shear (k)			Total Shear (k)
		14.6	3.8	0.0				
x/a	y/b	p_E	p_Q	p_S	R_E	R_Q	R_S	
0	1.0	0.0294	0.1145	0	0.43	0.44	0.00	0.86
0	0.8	0.1214	0.1067	0	1.77	0.41	0.00	2.17
0	0.6	0.1871	0.0930	0	2.72	0.35	0.00	3.08
0	0.4	0.2347	0.0833	0	3.42	0.32	0.00	3.73
0	0.2	0.1627	0.1111	0	2.37	0.42	0.00	2.79
0	0	-0.0010	0.1479	0	-0.02	0.56	0.00	0.55
0.2	0	0.0680	0.2230	0	0.99	0.85	0.00	1.84
0.4	0	0.1835	0.2946	0	2.67	1.12	0.00	3.79
0.6	0	0.2571	0.3305	0	3.74	1.26	0.00	5.00
0.8	0	0.2971	1.2228	0	4.32	4.66	0.00	8.98
1.0	0	0.3097	1.3242	0	4.51	5.05	0.00	9.55

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	15.69	in
Conc. Shear Strength	V_c	22.3	k/ft

Shear Strength - Art 5.8.3.3

Reduced Nom. Cap.	ΦV_c	20.0	k/ft
Factored Ultimate Load	V_u	9.6	k/ft
Factor of Safety	$\Phi V_c / V_u$	2.10	OK

Project Name:	Arcadia
Project Number:	010-0216
Analyst:	RB
Date:	8/1/2010

Inlet Struct. Quantities

Summary

	Concrete	864.7 yd^3
	Reinforcing	112,411.0 lb

Concrete

	Total		864.7 yd^3				
Location/Description	*Amount*	*Height*	*Length*	*Width*	*Area*	*Volume*	
INLET BOX							
Top Slab	1	1.50'	11.167'	14.33'		240 ft^3	8.9 yd^3
Side Walls	2	12.00'	11.167'	1.17'		313 ft^3	11.6 yd^3
	1	12.00'	12.000'	1.17'		168 ft^3	6.2 yd^3
Minus Pipe Penetration	-1		1.167'		113.10 ft^2	-132 ft^3	-4.9 yd^3
Footing	1	1.50'	12.000'	15.00'		270 ft^3	10.0 yd^3
Foot Fillet	1			15.00'	7.13 ft^2	107 ft^3	4.0 yd^3
Parapet Wall	1	12.75'	14.333'	1.50'		274 ft^3	10.2 yd^3
Fillet	1		14.333'		0.63 ft^2	9 ft^3	0.3 yd^3
INLET WALL TYPE 1							
Stem	2	26.25'	48.021'	2.63'		6,618 ft^3	245.1 yd^3
Footing	1	3.50'	37.271'	28.50'		3,718 ft^3	137.7 yd^3
	1	3.50'	10.750'	30.73'		1,156 ft^3	42.8 yd^3
Box connection foot	1	2.00'	2.500'	18.50'		93 ft^3	3.4 yd^3
Type 2 connection foot	1	2.17'	2.000'	33.50'		145 ft^3	5.4 yd^3
Stair Stop Box	1	3.00'	15.620'	4.00'		187 ft^3	6.9 yd^3
Chute Blocks	3	2.00'	4.000'	2.00'		48 ft^3	1.8 yd^3
Baffles	3			2.00'	6.31 ft^2	38 ft^3	1.4 yd^3
Sills	2			5.50'	7.38 ft^2	81 ft^3	3.0 yd^3
INLET WALL TYPE 2							
Stem	2	21.51'	40.833'	2.63'		4,611 ft^3	170.8 yd^3
Footing	1	3.00'			1361.25 ft^2	4,084 ft^3	151.3 yd^3
Stairs	1	1.33'			989.00 ft^2	1,319 ft^3	48.8 yd^3

Reinforcing

Total	91,162.4 lb

Location/Description	Mark	Amount	Length ft.	Length in.	Weight
INLET BOX					
Footing					
Long. - Top	7	15	11'	2.00"	342.37 lb
Long.-Bot.	5	15	11'	8.00"	182.53 lb
Trans. - Top	5	13	14'	0.00"	189.83 lb
Trans. - Bot.	5	14	14'	0.00"	204.43 lb
Deep Footing-Trans	5	6	14'	0.00"	87.61 lb
Deep Footing-Long	5	15	9'	0.00"	140.81 lb
Sidewalls					
IF Dowels	5	24	4'	0.00"	100.13 lb
OF Dowels	7	24	8'	6.00"	416.98 lb
IF Verts	5	24	11'	10.00"	296.21 lb
OF Verts	4	24	11'	10.00"	189.71 lb
Horz	4	48	10'	10.00"	347.36 lb
Headwall					
Footing Dowels	4	8	4'	2.00"	22.27 lb
Trim Bars	6	16	12'	5.00"	298.40 lb
column' bar	6	8	16'	2.00"	194.26 lb
Stirrups	3	18	3'	4.00"	22.56 lb
beam' bars	8	2	14'	0.00"	74.76 lb
beam bent bars	5	4	4'	0.00"	16.69 lb
Top Slab					
Headwall Dowels	4	24	5'	8.00"	90.85 lb
Sidewall Dowels	4	48	3'	2.00"	101.54 lb
Trans.-bot	7	11	14'	0.00"	314.78 lb
Trans-top	5	13	14'	0.00"	189.83 lb
longs-bot	6	15	10'	10.00"	244.08 lb
longs-top	5	15	10'	10.00"	169.49 lb
beam' bars	9	4	15'	0.00"	204.00 lb
Beam Stirrups	4	14	5'	6.00"	51.44 lb
Parapet					
Fillet Dowel	4	14	5'	8.00"	52.99 lb
Mild Dowel	5	14	4'	4.00"	63.28 lb
Main Dowel	5	14	6'	1.00"	88.83 lb
IF Verts	5	14	12'	6.00"	182.53 lb
OF Verts	4	14	12'	6.00"	116.90 lb
tie	4	14	3'	2.00"	29.61 lb
Horz	4	26	14'	0.00"	243.15 lb
Corners	5	52	5'	0.00"	271.18 lb
WALL TYPE 1					
Footing					
Trans.-Bot	9	75	28'	2.00"	7,182.50 lb
	9	22	32'	8.00"	2,443.47 lb
Trans.-Top	9	75	28'	2.00"	7,182.50 lb

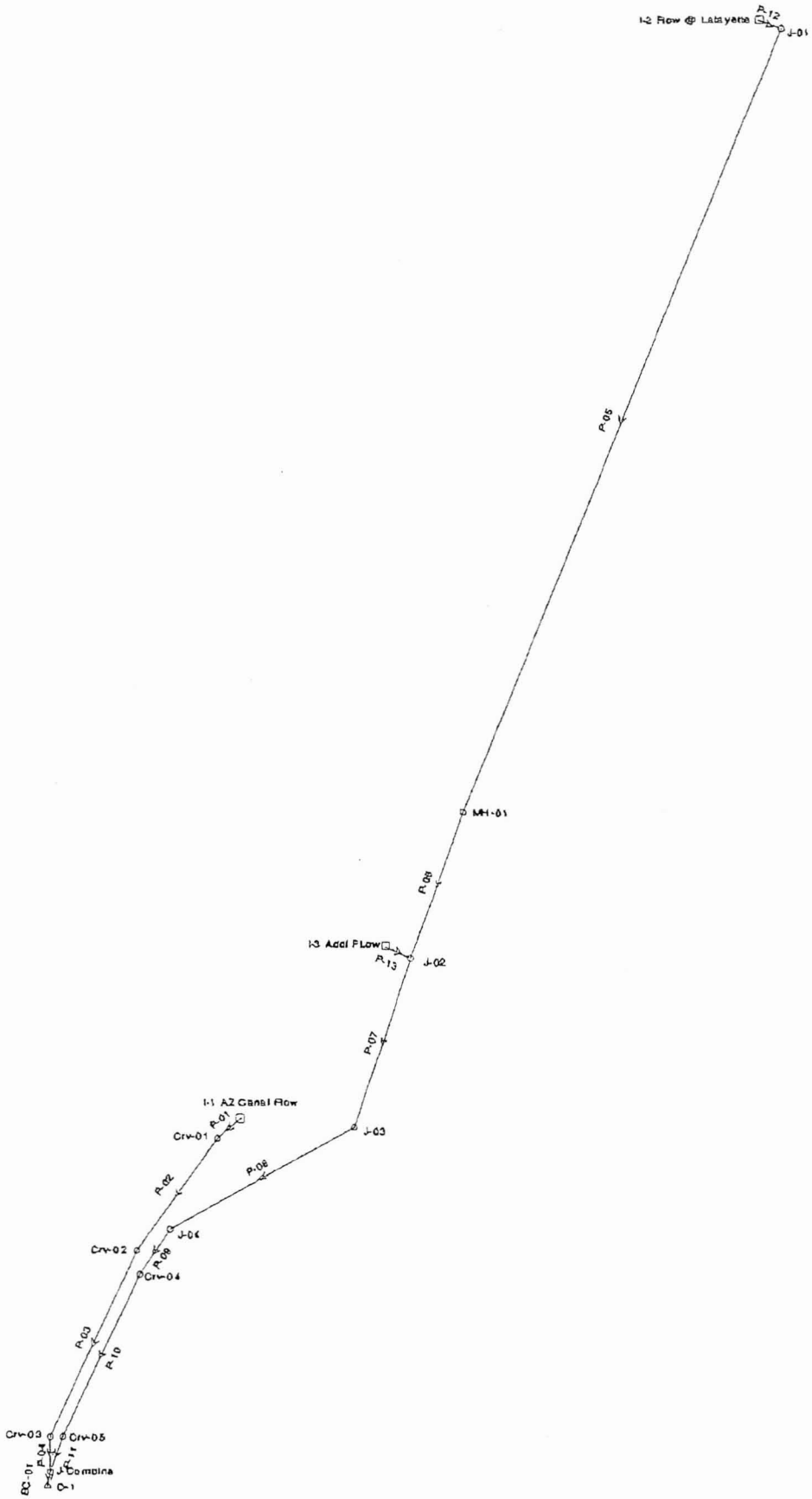
		9	22	32'	8.00"	2,443.47 lb
	Long-Bot.	5	43	50'	0.00"	2,242.45 lb
	Long-Top	5	43	50'	0.00"	2,242.45 lb
Stem						
	Mild Dowel	5	130	6'	7.00"	892.63 lb
	Dowel	10	130	17'	6.00"	9,789.33 lb
	IF verts	5	130	26'	0.00"	3,525.34 lb
	OF verts	6	130	26'	1.00"	5,093.03 lb
	Ties	4	130	4'	8.00"	405.25 lb
Inlet box foot						
	ties	5	19	9'	8.00"	191.56 lb
	trans	4	8	18'	2.00"	97.08 lb
	ties	4	13	3'	2.00"	27.50 lb
at Inlet 2 foot						
	ties	5	25	10'	4.00"	269.44 lb
	trans	4	5	25'	0.00"	83.50 lb
	ties	4	34	6'	0.00"	136.27 lb
stair stop-block						
	dowel	5	16	2'	6.00"	41.72 lb
	Bottom	4	16	3'	8.00"	39.19 lb
	trans	5	16	6'	5.00"	107.08 lb
	longs	4	13	18'	0.00"	156.31 lb
chute blocks						
	dowel	4	24	2'	0.00"	32.06 lb
	horz	4	21	3'	8.00"	51.44 lb
	trans	4	15	5'	2.00"	51.77 lb
sill						
	dowel	4	6	5'	10.00"	23.38 lb
	dowel	4	6	4'	1.00"	16.37 lb
	trans	4	21	1'	8.00"	23.38 lb
baffle						
	dowel	4	14	4'	2.00"	38.97 lb
	dowel	4	14	4'	6.00"	42.08 lb
	trans	4	6	5'	2.00"	20.71 lb
WALL TYPE 2						
Footing						
	Trans.-Bot	6	80	25'	2.00"	3,024.03 lb
	Trans.-Top	9	80	41'	8.00"	11,333.33 lb
	Long-Bot.	5	34	41'	3.00"	1,462.81 lb
	Long-Top	5	34	41'	3.00"	1,462.81 lb
Stem						
	Mild Dowel	5	170	4'	1.00"	724.02 lb
	Dowel	9	170	15'	6.00"	8,959.00 lb
	IF verts	5	170	21'	3.92"	3,781.51 lb
	OF verts	6	170	21'	3.92"	5,445.55 lb
	Ties	4	170	4'	8.00"	529.95 lb
Stairs Typ.						
	Long-bot.	4	25	41'	0.00"	684.70 lb

Stirrups	4	270	7'	0.00"	1,262.52 lb
Trans.	4	90	24'	6.00"	1,472.94 lb
bent at bottom	5	20	5'	3.00"	109.52 lb
Add. Trans at bottom	4	2	16'	3.00"	21.71 lb
tie	4	11	5'	0.00"	36.74 lb
Top stirrups	5	40	3'	5.00"	142.54 lb
longs	4	4	32'	6.00"	86.84 lb
dowels	4	33	2'	0.00"	44.09 lb
Stem Dowels					
	6	48	2'	0.00"	144.19 lb

Appendix D

StormCAD Output

Scenario: Scenario 3B - 120" CIPP at OCC & 102" Arcadia SD S. of Canal



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Olsson Associates
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Project Engineer: Duc
StormCAD v5.5 [5.5003]
Page 1 of 1

Calculation Results Summary

==========
Scenario: Scenario 3B - 120" CIPP at OCC & 102" Arcadia SD S. of Canal

>>>> 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)
I-2 Flow @ Lafayette	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00
I-3 Addl FLow	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00
I-1 AZ Canal Flow	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00

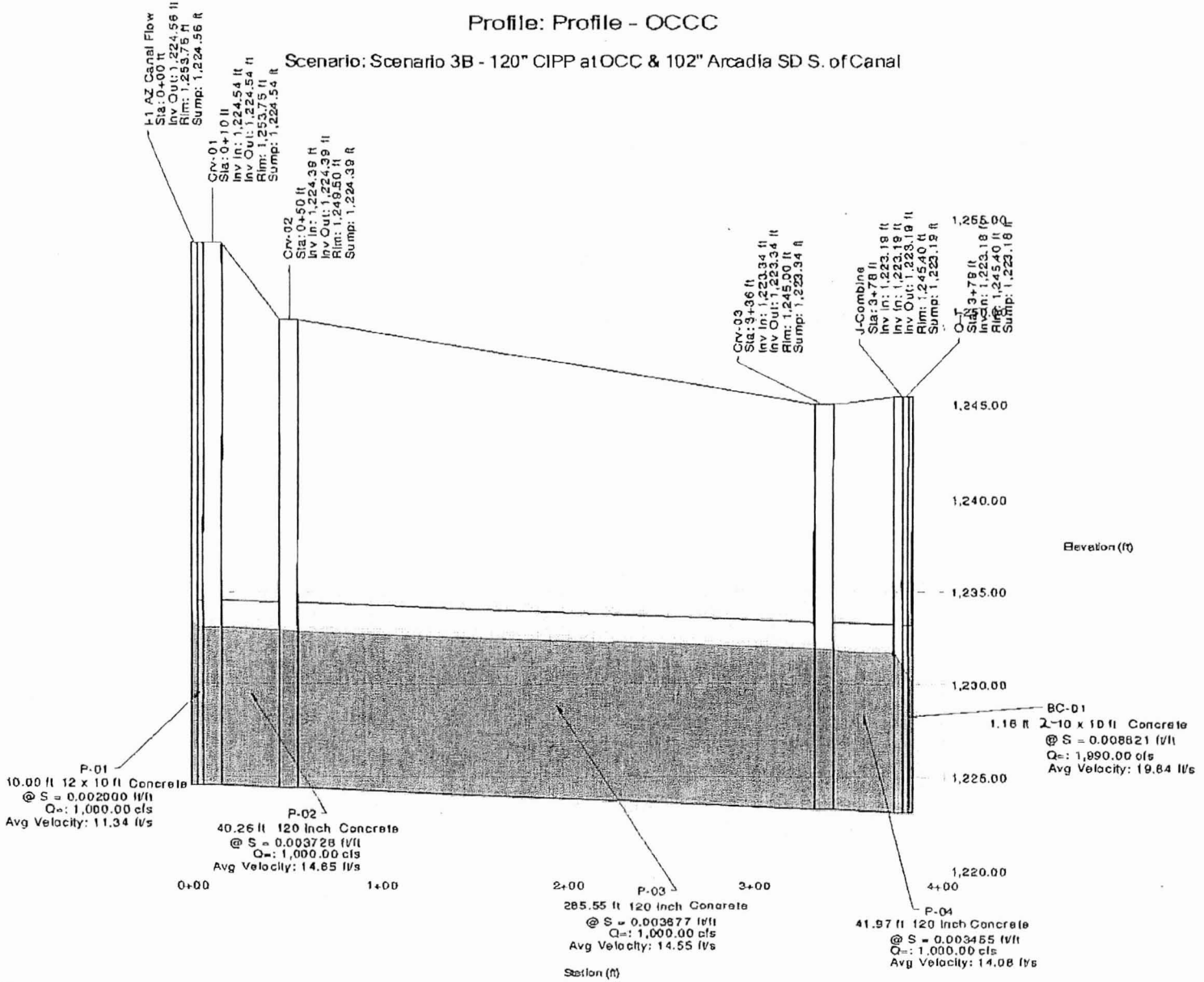
CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1

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)
BC-01	2	10 x 10 ft	Box	1.16	1,990.00	19.64	1,229.94	1,230.00
P-11	1	102 inch	Circular	44.84	990.00	17.45	1,232.02	1,231.63
P-04	1	120 inch	Circular	41.97	1,000.00	14.08	1,231.78	1,231.63
P-10	1	102 inch	Circular	181.50	990.00	17.45	1,233.75	1,232.20
P-03	1	120 inch	Circular	285.55	1,000.00	14.55	1,232.79	1,231.90
P-09	1	102 inch	Circular	41.32	990.00	17.45	1,234.25	1,233.89
P-02	1	120 inch	Circular	40.26	1,000.00	14.65	1,233.03	1,232.91
P-08	1	102 inch	Circular	207.32	990.00	17.45	1,236.72	1,234.96
P-01	1	12 x 10 ft	Box	10.00	1,000.00	11.34	1,233.04	1,233.03
P-07	1	102 inch	Circular	197.08	990.00	17.45	1,240.30	1,238.62
P-13	1	60 inch	Circular	1.00	309.00	15.74	1,245.04	1,245.03
P-06	1	96 inch	Circular	490.01	681.00	13.55	1,247.76	1,245.03
P-05	1	96 inch	Circular	484.84	681.00	13.55	1,253.31	1,250.61
P-12	1	96 inch	Circular	1.00	681.00	13.55	1,255.32	1,255.31

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1	1,990.00	1,245.40	1,230.00	1,230.00
J-Combine	1,990.00	1,245.40	1,231.63	1,229.94
Crv-05	990.00	1,245.80	1,232.20	1,232.02
Crv-03	1,000.00	1,245.00	1,231.90	1,231.78
Crv-04	990.00	1,248.10	1,233.89	1,233.75
Crv-02	1,000.00	1,249.50	1,232.91	1,232.79
J-04	990.00	1,248.80	1,234.96	1,234.25
Crv-01	1,000.00	1,253.75	1,233.03	1,233.03
J-03	990.00	1,252.70	1,238.62	1,236.72
I-1 AZ Canal Flow	1,000.00	1,253.75	1,233.34	1,233.04
J-02	990.00	1,253.90	1,245.03	1,240.30
I-3 Addl FLow	309.00	1,254.00	1,245.04	1,245.04
MH-01	681.00	1,258.70	1,250.61	1,247.76
J-01	681.00	1,265.50	1,255.31	1,253.31
I-2 Flow @ Lafayette	681.00	1,265.50	1,255.32	1,255.32

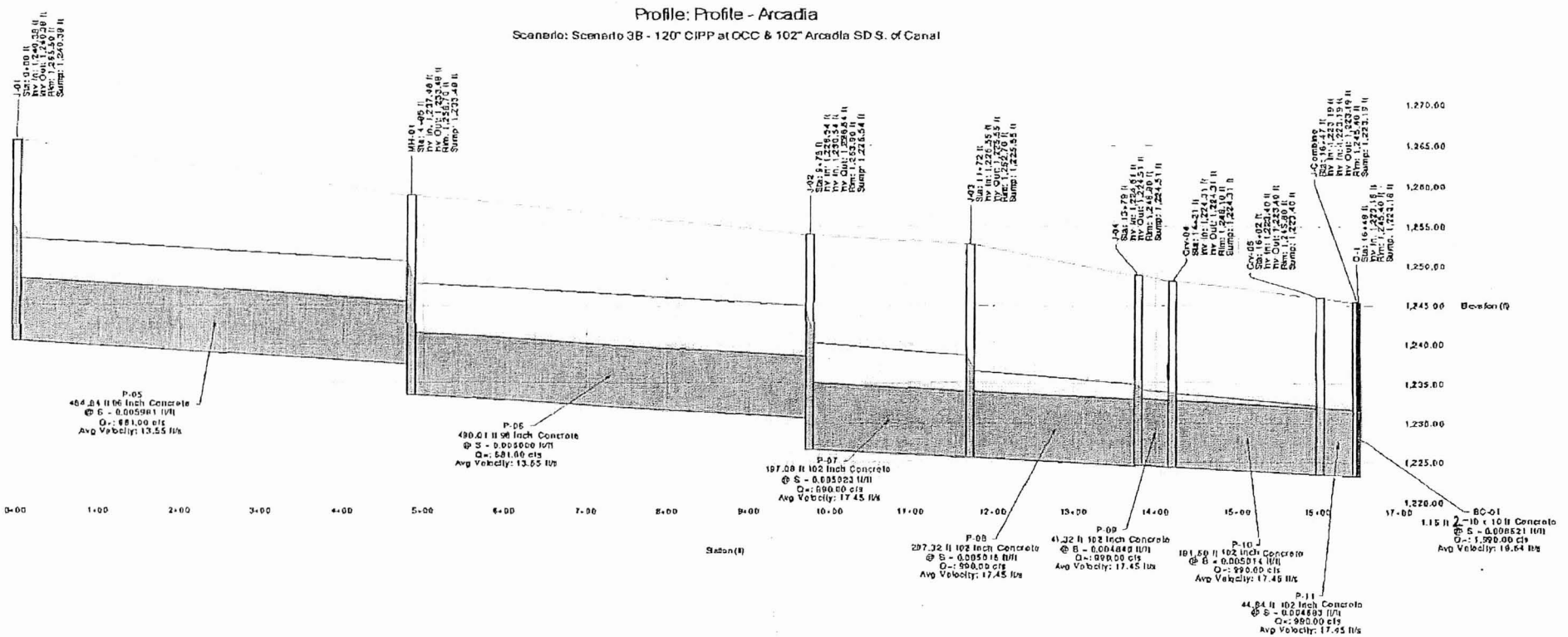
Profile

Scenario: Scenario 3B - 120" CIPP at OCC & 102" Arcadia SD S. of Canal



Profile

Scenario: Scenario 3B - 120" CIPP at OCC & 102" Arcadia SD S. of Canal



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Project Engineer: Dua
StormCAD v5.5 (5.5000)
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Appendix E

Reference Documents

8.4 Radial or tainter gate

8.4.1 Description

The radial or tainter gate is a movable control; it is commonly used in a rectangular canal section. It has the structural advantage of not requiring a complicated groove arrangement to transmit the hydraulic thrust to the side walls, because this thrust is concentrated at the hinges. In fact, the radial gate does not require grooves at all, but has rubber seals in direct contact with the undisturbed sides of the rectangular canal section.

Figure 8.9 shows two methods by which the radial gate can be installed, either with the gate sill at stream bed elevation or with its sill raised.

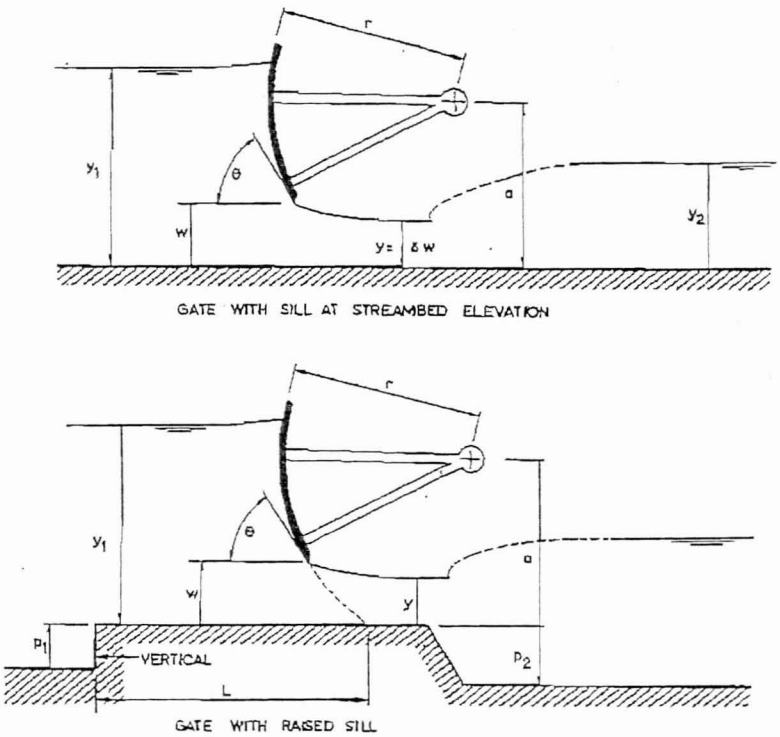


Figure 8.9 Flow below a radial or tainter gate

Reference: "Discharge Measurement Structures", edited by M.G. Bos

8.4.2 Evaluation of discharge

Free flow through a partially open radial gate is commonly computed with the following equation:

$$Q = C_o C_1 w b_c \sqrt{2gy_1} \tag{8-15}$$

The coefficient, C_o, depends on the contraction of the jet below the gate and may be expressed as a function of the gate opening w, gate radius r, trunnion height a, and upstream water depth y_1, for a gate sill at streambed elevation. Figure 8.10 gives C_o-values for a/r ratios of 0.1, 0.5, and 0.9. Coefficient values for other a/r-values may be obtained by linear interpolation between the values presented.

The coefficient C_1 is a correction to C_o for gate sills above streambed elevation and depends upon sill height p_1 and the distance between the step and the gate seat L, as shown in Figure 8.11. Insufficient information is available to determine the effects, if any, of the parameter p_1/r.

It should be noted that the velocity $\sqrt{2gy_1}$ in Equation 8-15 does not occur anywhere in the flow system, but simply serves as a convenient reference velocity.

The experiments on which Figure 8.10 is based showed that the contraction coefficient, δ, of the jet below the gate is mainly determined by the angle θ and to a much lesser extent by the ratio y_1/w. For preliminary design purposes, Henderson (1966) proposed Equation 8-16 to evaluate δ-values.

$$\delta = 1 - 0.75\,(\theta/90°) + 0.36\,(\theta/90°)^2 \tag{8-16}$$

where θ equals the angle of inclination in degrees.

Equation 8-16 was obtained by fitting a parabola as closely as possible to Toch's results (1952, 1955) and data obtained by Von Mises (1917) for non-gravity, two-dimensional flow through an orifice with inclined side walls. Values of δ given by Equation 8-16 and shown in Figure 8.12 can be expected to have an error of less than 5%, provided that $\theta < 90°$.

If the discharge coefficient C_o in Equation 8-15 is to be evaluated from the contraction coefficient, we may write, according to continuity and Bernoulli:

$$C_o = \frac{\delta}{\sqrt{1 + \delta w/y_1}} \tag{8-17}$$

The discharge coefficient, C_o, given in Figure 8.10 and Equation 8-17 for free flow below a radial gate can be expected to have errors of less than 5% and between 5 and 10% respectively. The error in the correction coefficient C_1, given in Figure 8.11 can be expected to have an error of less than 5%. The method by which these errors have to be combined with other sources of error is shown in Annex 2.

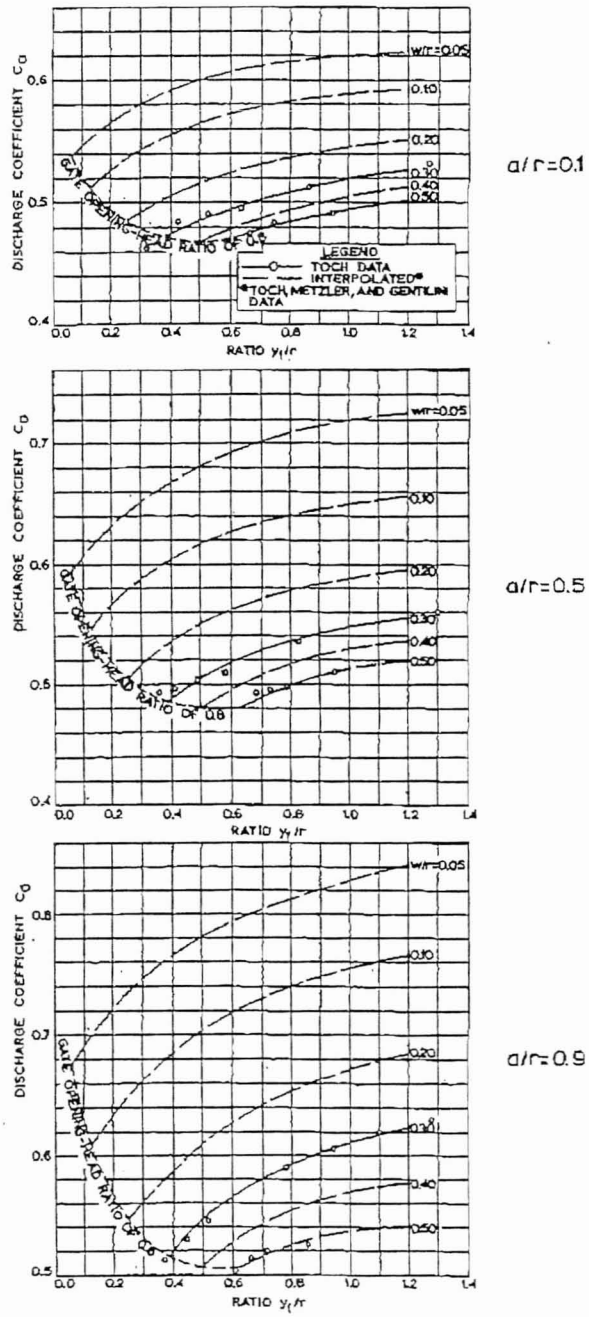


Figure 8.10 C_D-values as a function of a/r, y_1/r and w/r (from U.S. Army Engineer Waterways Experiment Station 1960)

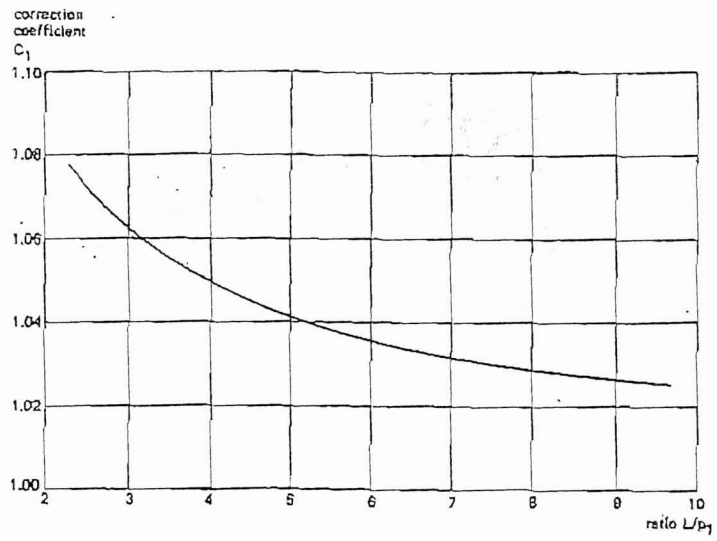


Figure 8.11 C_1-values for radial gates with raised sill (from U.S. Army Engineer Waterways Experiment Station)

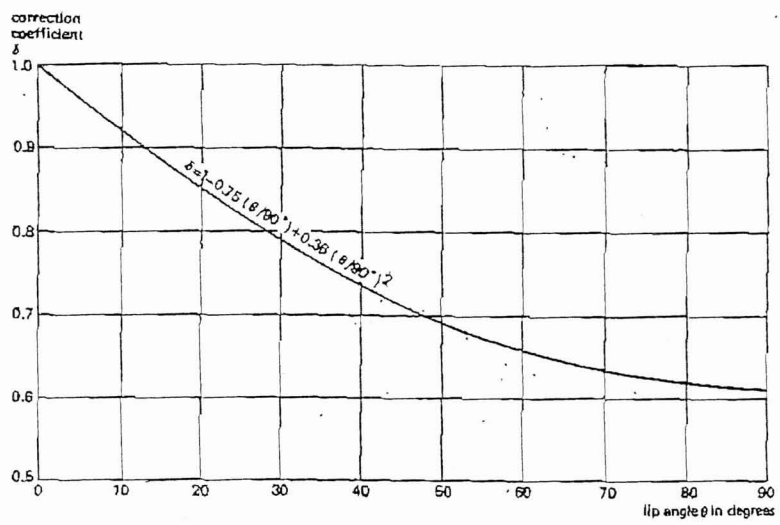


Figure 8.12 Effect of lip angle on contraction coefficient

8.4.3 Modular limit

Modular flow below a radial gate occurs as long as the roller of the hydraulic jump does not submerge the section of minimum depth of the jet (vena contracta). To pre-

vent such submergence, the water depth, y_2, downstream of the hydraulic jump should not exceed the alternate depth to $y = \delta w$ or according to the equation

$$\frac{y_2}{w} < \frac{\delta}{2}\left[\sqrt{1 + 16\left(\frac{H}{\delta w} - 1\right)} - 1\right] \tag{8-18}$$

For each radial gate the modular limit may be obtained by combining Equation 8-16 (or Figure 8.12) and Equation 8-18.

If flow below the gate is submerged, Equation 1-73 as derived in Section 1.12 may be used as a head-discharge relationship. It reads

$$Q = C_e\, b_e w \sqrt{2g(y_1 - y_2)} \tag{8-19}$$

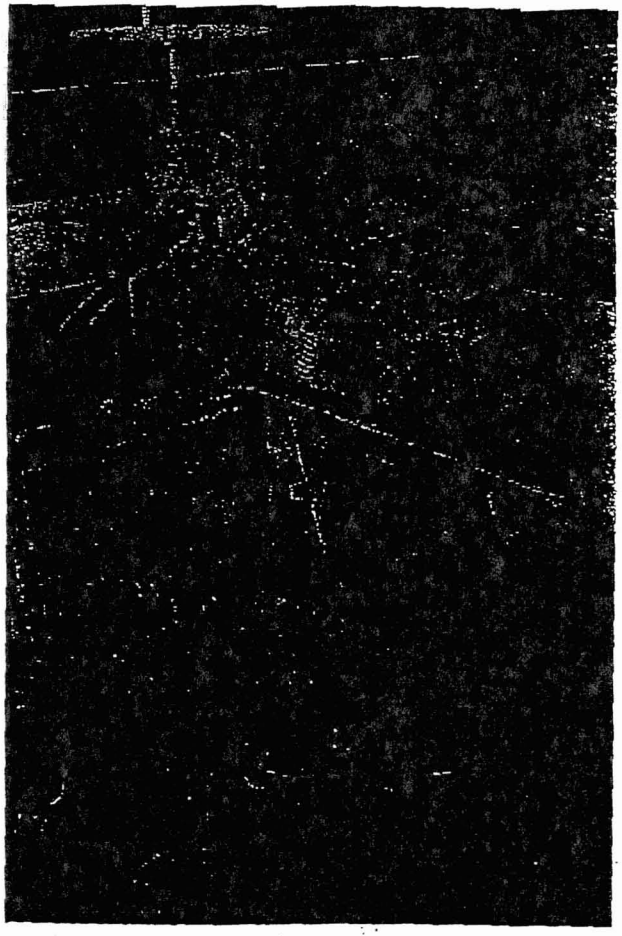


Photo 1 Radial gates are suitable flow control structures

Insufficient experimental data are available to present reasonably accurate C_c-values. For design purposes, however, the coefficient C_c may be evaluated from the contraction coefficient δ for free flow conditions (Figure 8.12).

A combination of the Bernoulli and the continuity equations gives for C_c

$$C_c = \frac{\delta}{\sqrt{1-\left(\frac{\delta w}{y_1}\right)^2}} \tag{8-20}$$

It should be noted that the assumption that the contraction coefficient is the same for free flow as for submerged flow is not completely correct.

8.4.4 Limits of application

The limits of application of the radial or tainter gate are:

a. The bottom edge of the gate should be sharp and horizontal from end to end;
b. The upstream head should be measured in a rectangular approach channel that has the same width as the gate;
c. The gate opening over water depth ratio should not exceed 0.8 ($w/y_1 \leqslant 0.8$);
d. The downstream water level should be such that modular flow occurs (see Equation 8-18).

FHWA-EPD-86-110

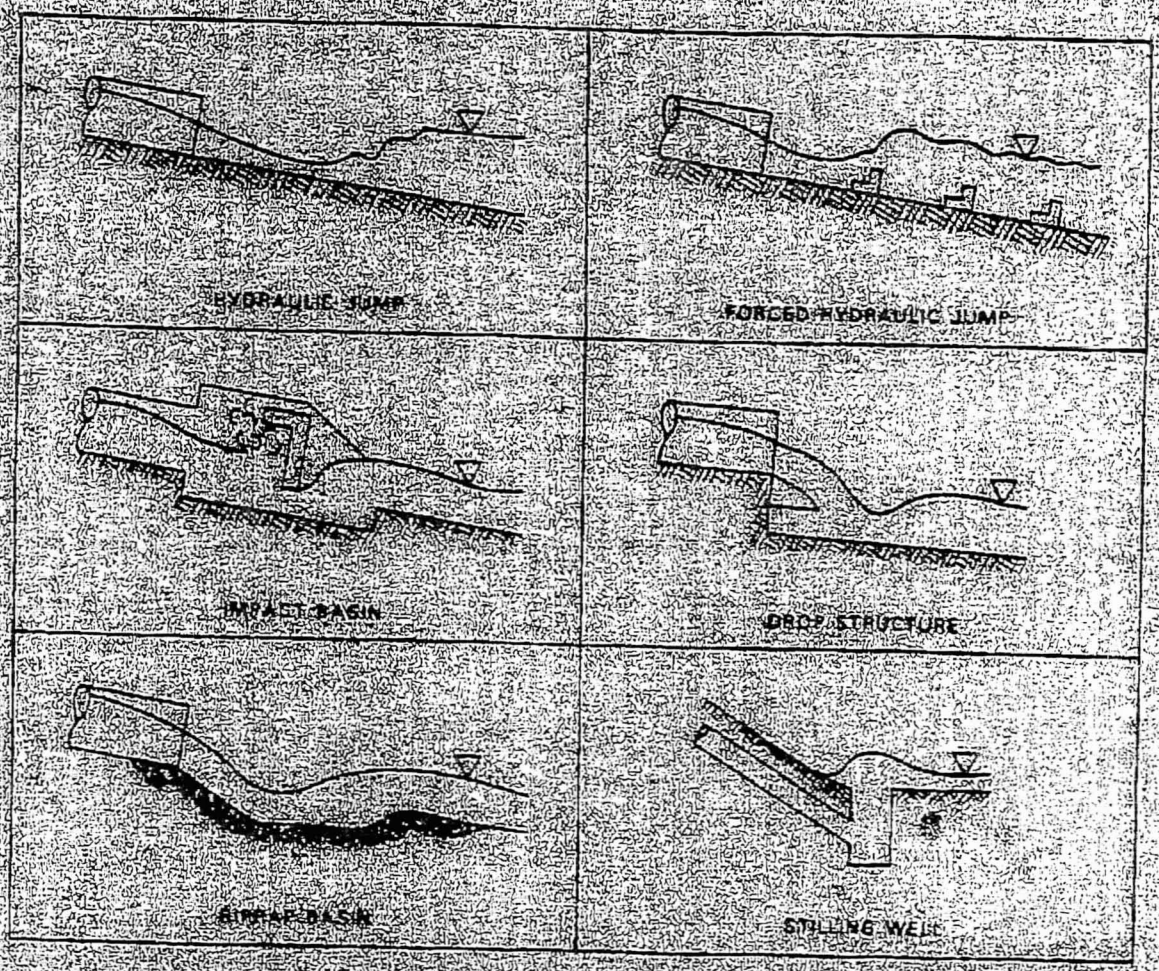
Hydraulic Design of Energy Dissipators for Culverts and Channels

Hydraulic Engineering Circular No. 14

September 1983

U.S. Department of Transportation

Federal Highway Administration



INCREASED RESISTANCE IN BOX CULVERTS

Material for this section was drawn primarily from an preliminary FHWA report on fish baffles in box culverts (VII-C-1). This report used Morris' (VII-C-4) categorization of flow regimes and basic friction equations, but a more representative approach velocity, V_A, in one of the regimes. Experimental data by Shoemaker (VII-C-2) was also utilized to define the transition curves. For several reasons, modifications to the fish baffle development were necessary to better fit energy dissipator needs. In fish baffle design, the interest is in a conservative estimate of resistance in order to size a culvert; whereas, in this manual, a conservative estimate of the outlet velocity is also important. Also, fish baffle design curves involve bottom roughness only.

The use of a representative approach velocity, V_A, allows an opportunity to input culvert parameters that will lean towards either an overprediction or an underprediction of resistance. For this manual, it is appropriate to develop high as well as low resistance curves. Rather than attempt to define the transition between these curves, an abrupt transition is used as the worst condition for the high curves, and a straight line transition is assumed as the mildest condition for the low curves. This is illustrated in figure VII-C-7.

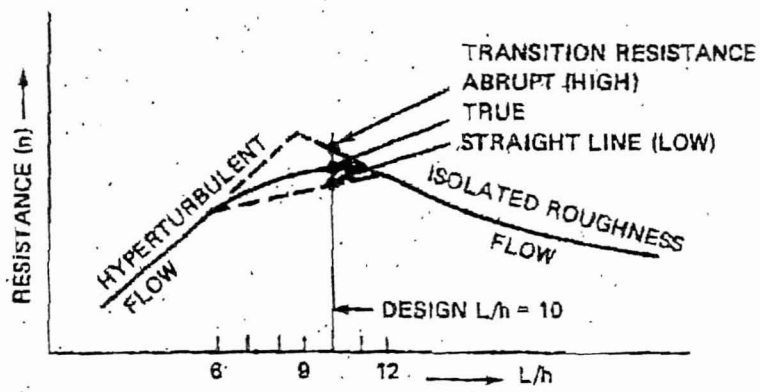


FIGURE VII-C-7. TRANSITION CURVES BETWEEN FLOW REGIMES

Observations by Powell (VII-C-3) are the basis for assuming the 6 to 12 range of L/h for the transition curve. An L/h=10 is chosen for design because it yields the largest n value.

Design Recommendations

The three equations below form the basis for determining, through a procedure simular to that shown in figure VII-C-7, the upper and lower design curves which can be used to conservatively compute resistance for culvert sizing and outlet velocities.

$$(n_{IR}/n)_{Low}=[1+200(h/L)(L_r/P)]^{1/2} \quad \text{VII-C-7}$$

$$(n_{IR}/n)_{High}=[1+390(h/L)(L_r/P)]^{1/2} \quad \text{VII-C-8}$$

$$(n_{HT}/n)=\{(1-L_r/P)+70.6(L_r/P)/[2\log((R_i/h)(h/L))+1.75]^2\}^{1/2} \quad \text{VII-C-9}$$

The equations are based on $C_D=1.9$, $f=0.14$ (where f is the Darcy friction factor for the culvert surface without roughness elements), and $V_A/V=0.60$ or 0.85. The lower value of V_A/V is implicitly included in equation VII-C-7 and the higher value in equation VII-C-8. It is assumed that $(R/R_i)^{1/3}$ is approximately one. R is the hydraulic radius of the culvert proper and R_i is the hydraulic radius taken inside the crests of the roughness elements.

Since the above equations are normal flow equation and since roughness elements may be relatively small using this method, it is necessary to compute the length of culvert to be roughened. The momentum equation, written for the roughened section of culvert, is used to compute the number of rows of roughness element needed. The number of rows should never be less than five. Furthermore, it is recommended that one large element be used at the beginning of the roughened zone to accelerate the asymptotic approach to normal flow. The recommended height of the larger element is twice the height of the regular elements. The spacing is the same for all rows of elements.

The procedure is limited to solid strip roughness elements with sharp upstream edges. Rectangular cross section roughness elements will best fit the assumptions made.

Due to the assumed velocity distribution, application of the procedure must be limited to small roughness heights and to relatively flat slopes. The roughness height should not exceed ten percent of the flow depth. This restriction is inherently included in the suggested range of h/Ri in the design procedure. Slope should not exceed 6 percent.

Design Procedure

Note: Steps 1 through 7 are concerned with computing an outlet velocity to evaluate scouring potential and/or to design additional outlet protection.

1. Use $L/h=10$

2. Select h/R_i from 0.10 to 0.40.

3. Compute L_r/P, where L_r= peripheral roughness length including slots. $L_r/P=1$ when roughness length extents through the flow or when the culvert is flowing full with a roughness length equal to the circumference. Slots are provided for low flow drainage. Their width should not exceed $h/2$. P is the total wetted perimeter of the culvert. In this step assume the culvert will flow full; so

$$P=2(B+D)$$

and

$$L_r=B \text{ for bottom roughness only}$$

4. Determine (n_r/n) from the lower set of curves of figure VII-C-8. In this ratio, "n" is the Manning resistance coefficient for the culvert without roughness elements or .015, whichever is smaller. Compute n_r which is the overall effective Manning resistance coefficient for the roughened portion of the culvert.

5. Determine the flow depth, y_i, measured from the roughness element crests:

   a. Assume a value of h from $h=((h/R_i)BD)/(2(B+D))$

   b. Assume a trial value of y_i. Initally assume $y_i=D-h$. Compute $C=1.49S_o^{1/2}/n_r$

   c. Compute A_i and R_i

   $$A_i=By_i$$
   $$R_i=A_i/(B+2y_i)$$

   d. Compute "Q" from the Manning equation

   $$Q=[(1.49/n_r)S_o^{1/2}]A_i R_i^{2/3}$$

   where S_o = bottom slope of the culvert

   e. Compare Q with Q(DESIGN); and increase y_i if Q is less than Q(DESIGN); decrease y_i if Q is greater than Q(DESIGN).

   f. Repeat steps 5c, d, and e until Q and Q(DESIGN) are approximately equal.

6. a. Compute the velocity, V, using A_i from the last iteration

   $$V=Q/A_i$$

b. Compare V with the allowable outlet velocity. If a different value of V is required, select a new h/R_i and repeat steps 2 through 6.

7. Compute the required number of rows of roughness elements from the momentum equation written as follows:

$$0.5\gamma By_n^2+\rho QV_n=(N)C_DA_f\rho V_w^2/2+0.5\gamma By_i^2+\rho QV_i \quad \text{. . . . .VII-C-10}$$

where: y_n and V_n are normal depth and velocity for the smooth culvert.
y_i and V_i are normal depth and velocity for the rough culvert

$C_D=1.9$
A_f=wetted frontal area of a roughness row
$=B(h)$ for bottom roughness
$\rho=1.94$
V_w=average wall velocity acting on the roughness elements
$\approx V_{avg.}/3=(V_n+V_i)/6$
N=required number of rows of roughness elements

Note: Steps 8 through 9 check the height of the culvert for capacity.

8. Determine (n_r/n) from the upper set of curves of figure VII-C-8, using L_r/P from step 3. Compute "n_r."

9. Check adequacy of culvert height and compute flow depth if necessary by trial and error:

a. Compute h using R_i from step 5

$$h=(h/R_i)R_i$$

b. Try $y_i=D-h$
Compute $C=1.49S_o^{1/2}/n_r$

c. Compute A_i and R_i

$$A_i=By_i$$
$$R_i=A_i/2(B+y_i)$$

d. Compute "Q" from the Manning equation

$$Q=[(1.49/n_r)S_o^{1/2}]A_iR_i^{2/3}$$

e. Compare "Q" with "Q(DESIGN)." If "Q" is greater than or equal to Q(DESIGN), the culvert size is adequate. If "Q" is less than "Q(DESIGN)," increase D and repeat steps 9b through e.

10. Use the last value of D as the height of the culvert for the roughened section.

11. Specify dimensions:

Use h from step 9a
Compute L=10h
Use one upstream element twice the height of the others; $h_1=2h$

Design Example

Given: 4'x4' box culvert, 200 feet long
n=.013, 6% slope
Q(DESIGN)100 cfs
Allowable outlet velocity=15 fps
$V_o=V_n=22.3$ ft/sec.
$Y_o=Y_n=1.12$ feet

1. Use L/h=10

2. Select h/R_i =0.10; use bottom roughness only

3. $L_r=B=4$ ft.
$P=2(B+D)=16$ ft.
$L_r/P=.25$

4. $(n_r/n)=2.25$ from the lower set of curves of figure VII-C-8
$n_r=.225x.013=0.029$

5. Flow depth is:

a. $h=0.10(4x4)/2(4+4)=0.10$ ft.
b. Try $y_i=4-0.10=3.9'$, C=12.6
c. $A_i=4(3.9)=15.6$
$R_i=15.6/(4+7.8)=1.32$
d. $Q=[(1.49/n_r)S_o^{1/2}]A_iR_i^{2/3}=[12.6](15.6)(1.20)=$
237 cfs>100 cfs
try smaller y_i

Trial y_i	A_i	R_i	Q cfs
3.9			237
2.5	10	1.11	135
2.0	8.0	1.0	100.8

6. $V=Q/A_i=100/8.0=12.5$ ft/sec<15 ft/sec OK

7. $.5(62.4)(4)(1.12)^2+1.94(100)(22.3)=$
$N(1.9)(4)(.103)(1.94)[(22.3+12.5)/6]^2/2$
$+62.4(4)(2.0)^2/2+1.94(100)12.5$

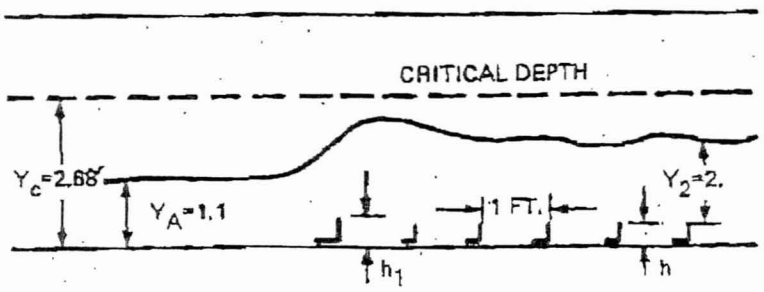
$156.5+4326.2=26.1N+499.2+2425$
$N=59.7$ use 60 rows

8. $(n_r/n)=2.5$ from the upper curves figure VII-C-8
$n_r=2.5x0.013=0.033$

9. a. $h=0.10(1)=0.1$
b. Try $y_i=4-0.1=3.9'$, $C=11.1$
c. $A_i=4(3.9)=15.6$
$R_i=15.6/(4+7.8)=1.32$
d. $Q=[11.1](15.6)(1.32)^{2/3}=208$
e. $Q>Q$(DESIGN); therefore the culvert size is adequate

10. D=4 ft.

11. h=0.1', use 1 1/4" angles
L=10h=1'; use 1'-0'
h_1=2h; use 2 1/2" angles



VII-C-1. Normann, J. M., HYDRAULIC ASPECTS OF FISH-LADDER BAFFLES IN BOX CULVERTS, Preliminary FHWA Hydraulics Engineering Circular, Jan. 1974.

VII-C-2. Shoemaker, R. H., HYDRAULICS OF BOX CULVERTS WITH FISH-LADDER BAFFLES, Proceedings of the 35th Ann. Meeting of the HRB, Washington, D.C., 1956, pp. 196-209.

VII-C-3. Powell, R. W., FLOW IN A CHANNEL OF DEFINITE ROUGHNESS, ASCE Transactions, Figure 10, p. 544, 1946.

VII-C-4. MORRIS, H. M., APPLIED HYDRAULICS IN ENGINEERING, The Ronald Press Company, New York, 1963.

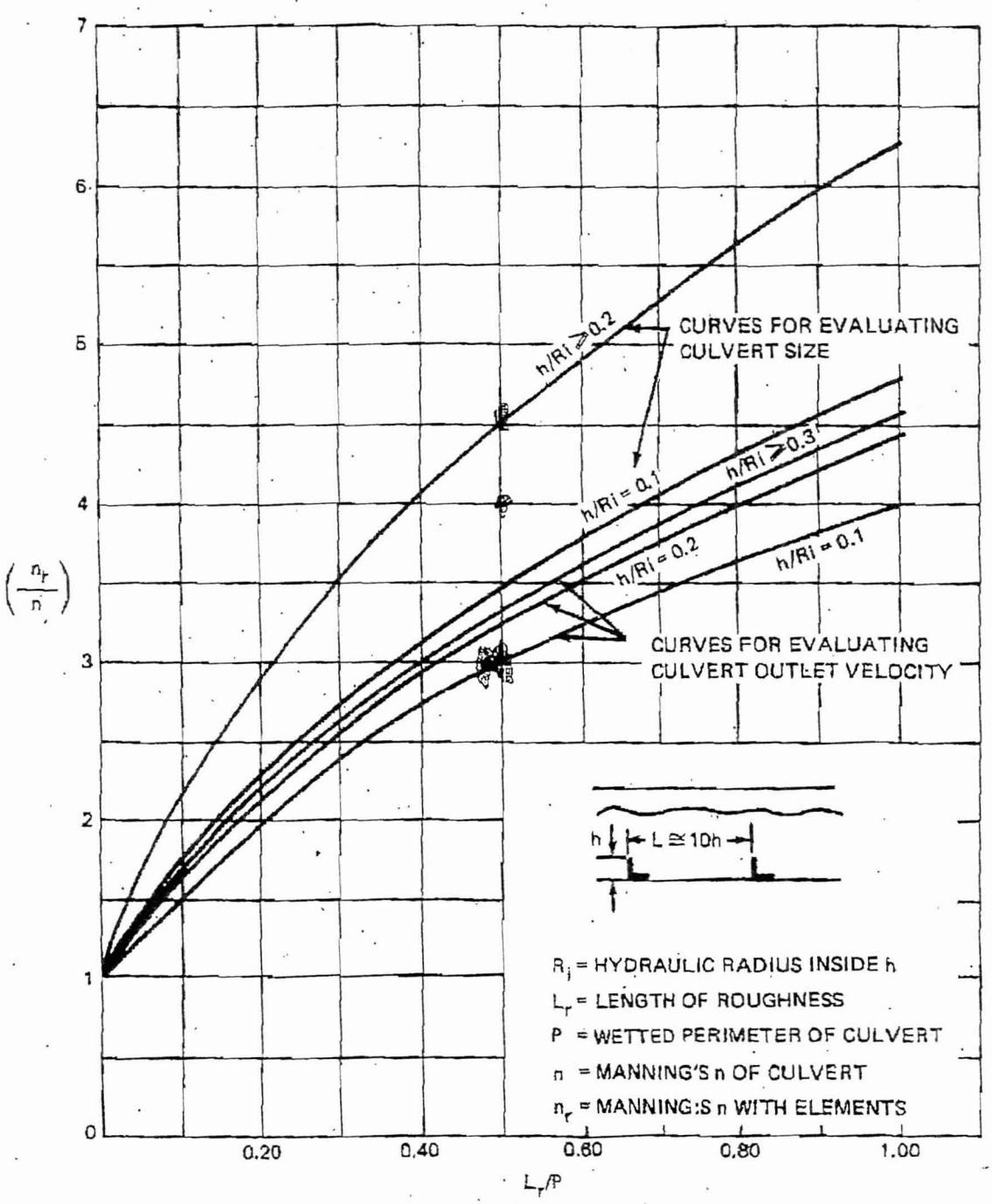


FIGURE VII-C-8 RELATIVE RESISTANCE CURVES FOR SHARP EDGED RECTANGULAR ROUGHNESS ELEMENTS SPACED AT L/h = 10

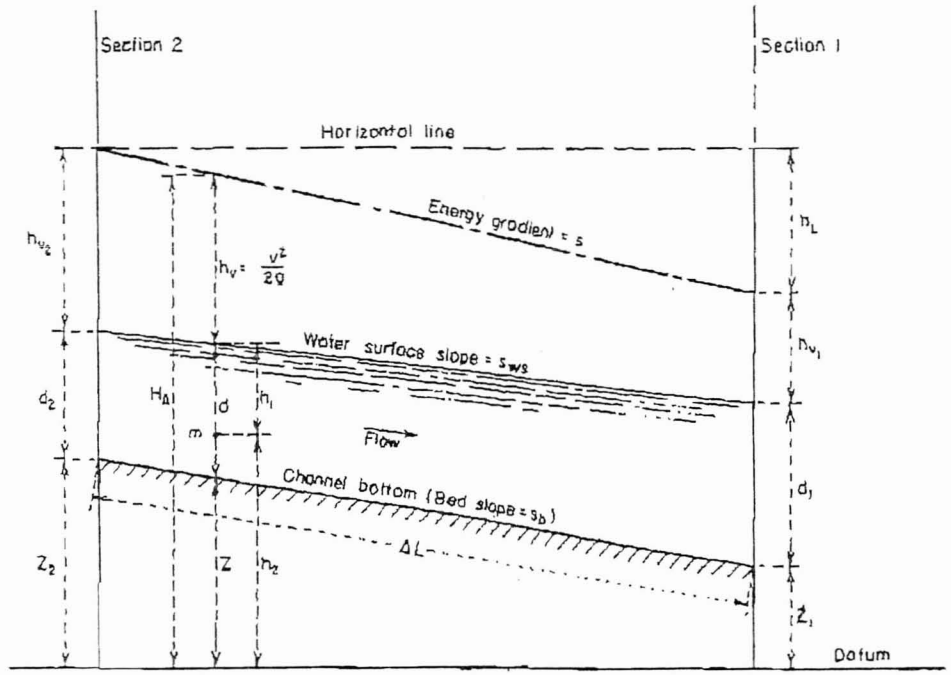


Figure B-1.—Characteristics of open-channel flow. 288-D-2550.

The portion of equation (2) in the parentheses is termed the absolute head, and is written:

$$H_A = d + Z + \frac{v^2}{2g} \tag{3}$$

Equation (3) is called the Bernoulli equation.

The energy in the cross section, with respect to the bottom of the channel, is termed the specific energy. The corresponding head is referred to as the specific energy head and is expressed as:

$$\boxed{H_E = d + \frac{v^2}{2g}} \tag{4}$$

total available U/S energy

Where $Q = av$, equation (4) can be stated:

$$\boxed{H_E = d + \frac{Q^2}{2ga^2}} \tag{5}$$

For a trapezoidal channel where b is the bottom width and z defines the side slope, if q is expressed as $\frac{Q}{b}$ and a is expressed as $d(b+zd)$, equation (5) becomes:

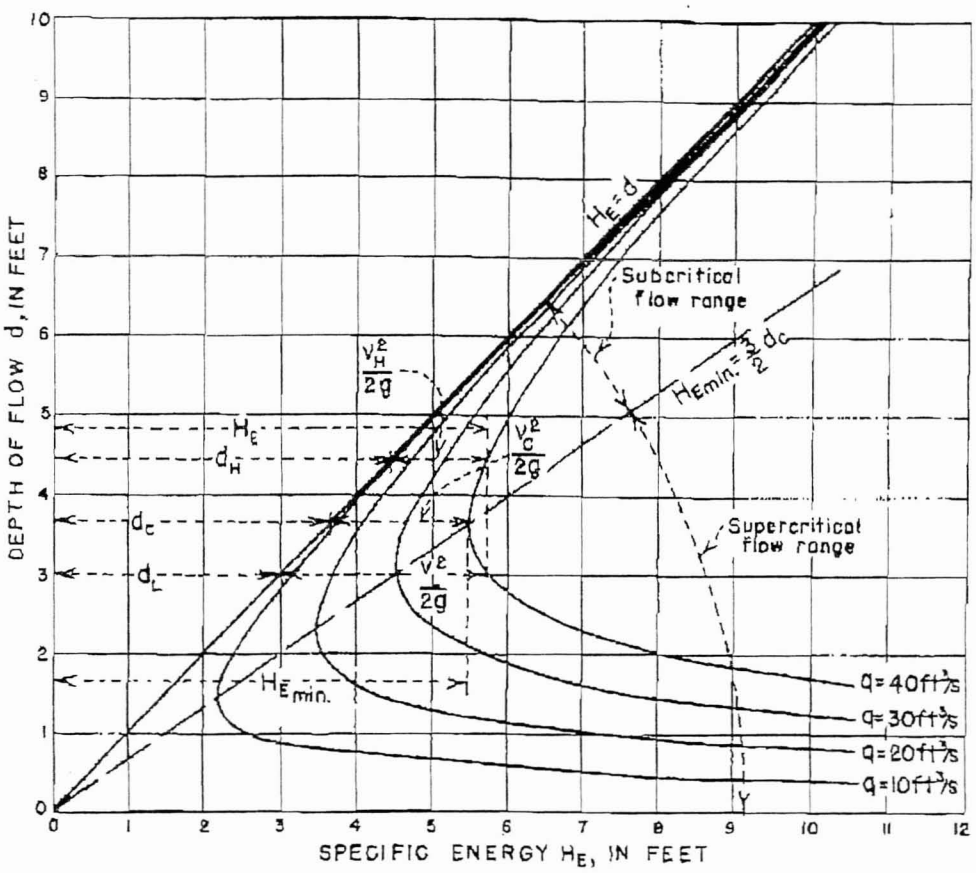
$$H_E = d + \frac{q^2}{2gd^2\left(1+\frac{zd}{b}\right)^2} \tag{6}$$

Equation (5) is represented in diagrammatic form on figure B-2 to show the relationships between discharge, energy, and depth of flow in an open channel. The diagram is drawn for several values of unit discharge in a rectangular channel.

It can be seen that there are two values of d, d_H and d_L, for each value of H_E, except at the point where H_E is minimum, where only a single value exists. The depth at energy $H_{E_{min}}$ is called the critical depth, and the depths for other values of H_E are called alternate depths. Those depths lying above the trace through the locus of minimum depths are in the subcritical flow range and are termed subcritical depths, while those lying below the trace are in the supercritical flow range and are termed supercritical depths.

Figure B-3 plots the relationships of d to H_E as stated in equation (6), for various values of unit discharge q and side slope z. The curves can be used to quickly determine alternate depths of flow in open channel spillways.

(b) *Critical Flow.*—Critical flow is the term used to describe open channel flow when certain relationships exist between specific energy and discharge and between specific energy



$$H_E = d + \frac{V^2}{2g} = d + \frac{q^2}{2gd^2} \text{ where } q = \text{discharge per unit width.}$$

$$d_c = \left(\frac{q_c}{\sqrt{g}}\right)^{\frac{2}{3}} = \frac{2}{3} H_{E_{min.}} \text{ where } d_c = \text{critical depth}$$

q_c = critical discharge per unit width

$H_{E_{min.}}$ = minimum energy content.

Figure B–2.—Depth of flow and specific energy for a rectangular section in open channel. 288–D–2551.

and depth. As indicated in section B–2(a) and as demonstrated on figure B–2, critical flow terms can be defined as follows:

(1) *Critical discharge.*—The maximum discharge for a given specific energy, or the discharge which will occur with minimum specific energy.

(2) *Critical depth.*—The depth of flow at which the discharge is maximum for a given specific energy, or the depth at which a given discharge occurs with minimum specific energy.

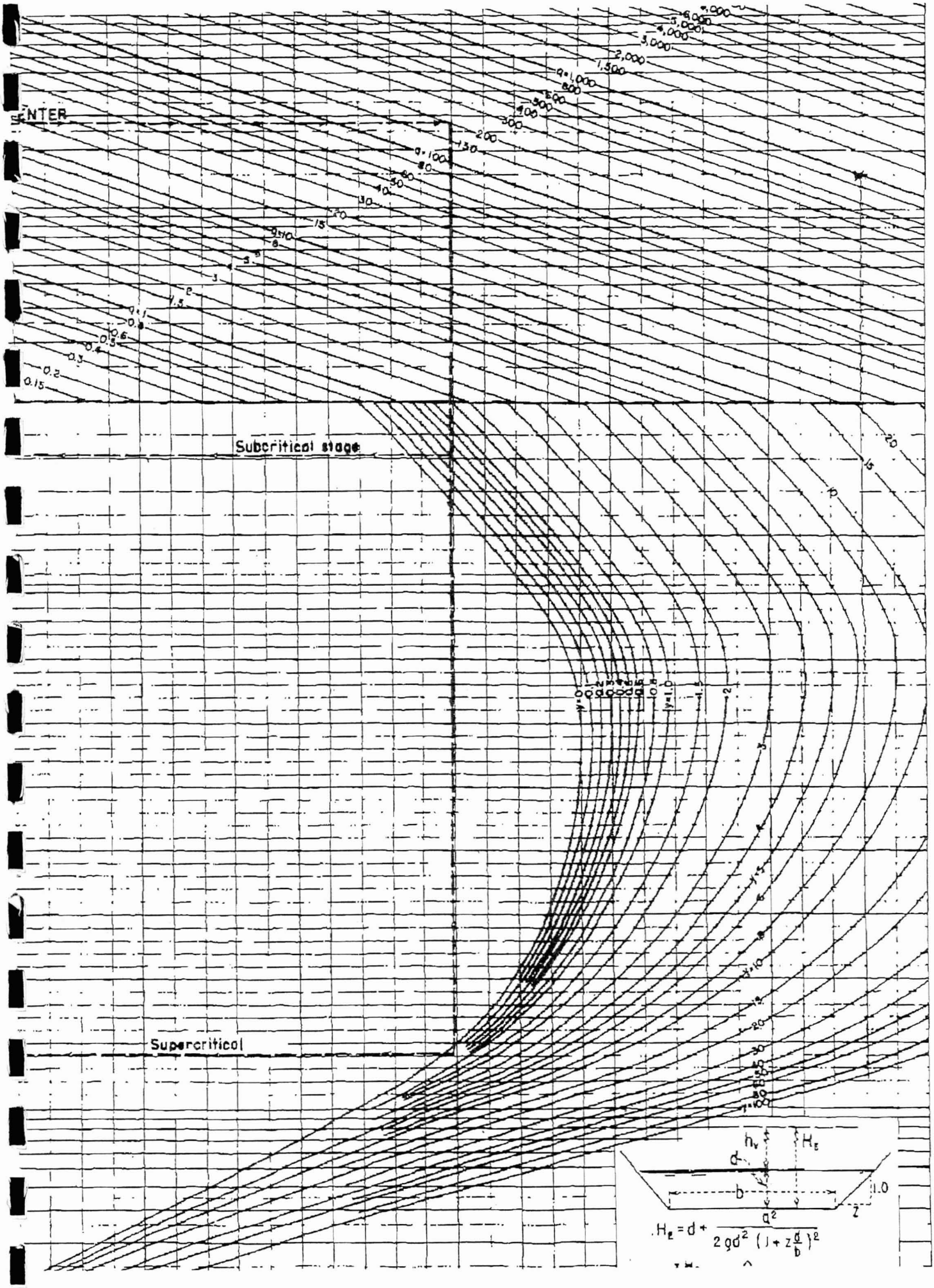
(3) *Critical velocity.*—The mean velocity when the discharge is critical.

(4) *Critical slope.*—That slope which will sustain a given discharge at uniform critical depth in a given channel.

(5) *Subcritical flow.*—Those conditions of flow for which the depths are greater than critical and the velocities are less than critical.

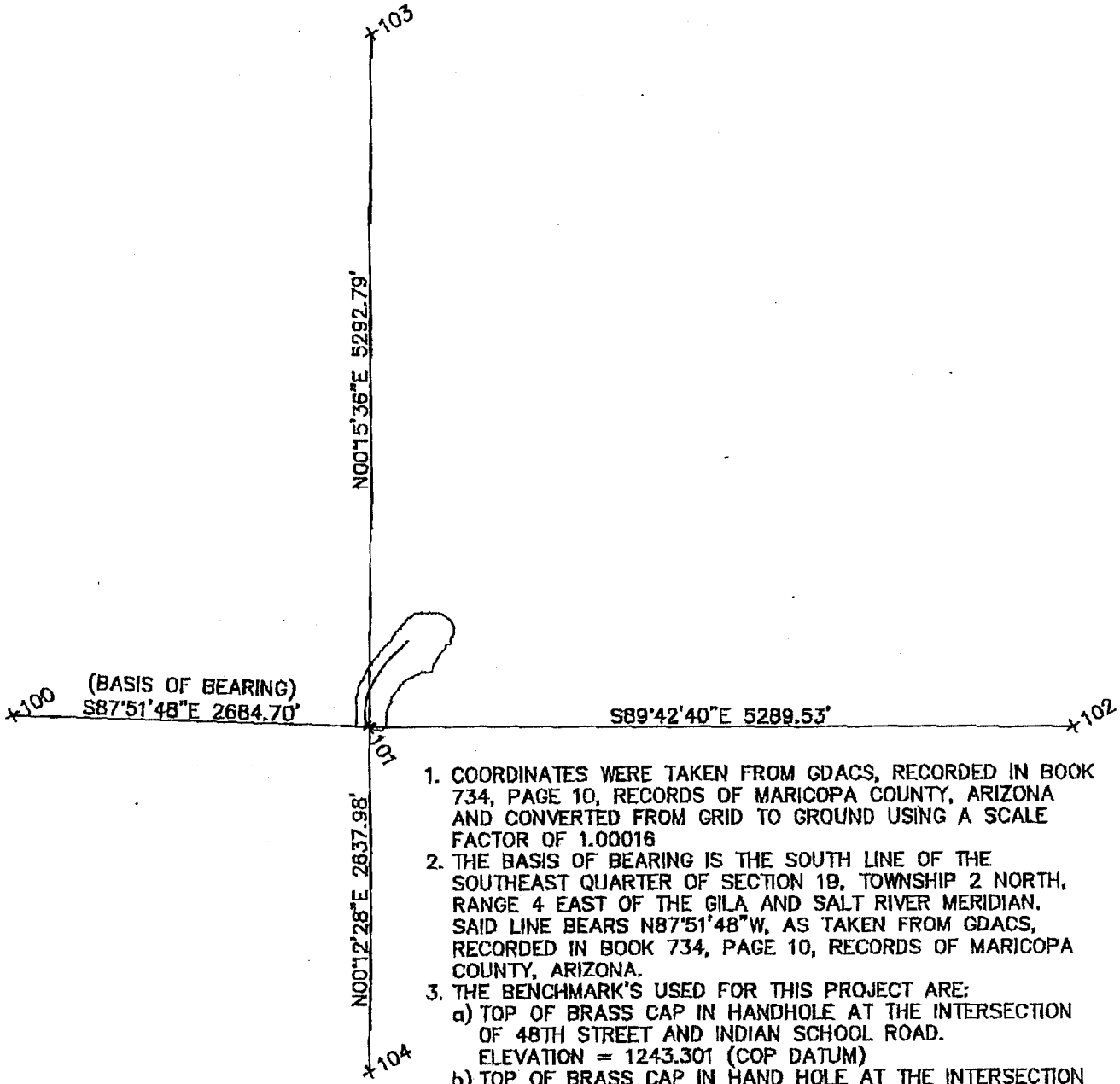
(6) *Supercritical flow.*—Those conditions of flow for which the depths are less than critical and the velocities are greater than critical.

More complete discussions of the critical


NTER
Subcritical stage
Supercritical
h_v
H_E
d
b
1.0
z
$H_E = d + \frac{q^2}{2gd^2\left(1 + z\frac{d}{b}\right)^2}$

Appendix F

Survey Data



1. COORDINATES WERE TAKEN FROM GDACS, RECORDED IN BOOK 734, PAGE 10, RECORDS OF MARICOPA COUNTY, ARIZONA AND CONVERTED FROM GRID TO GROUND USING A SCALE FACTOR OF 1.00016
2. THE BASIS OF BEARING IS THE SOUTH LINE OF THE SOUTHEAST QUARTER OF SECTION 19, TOWNSHIP 2 NORTH, RANGE 4 EAST OF THE GILA AND SALT RIVER MERIDIAN. SAID LINE BEARS N87°51'48"W, AS TAKEN FROM GDACS, RECORDED IN BOOK 734, PAGE 10, RECORDS OF MARICOPA COUNTY, ARIZONA.
3. THE BENCHMARK'S USED FOR THIS PROJECT ARE:
   a) TOP OF BRASS CAP IN HANDHOLE AT THE INTERSECTION OF 48TH STREET AND INDIAN SCHOOL ROAD. ELEVATION = 1243.301 (COP DATUM)
   b) TOP OF BRASS CAP IN HAND HOLE AT THE INTERSECTION OF 44TH STREET AND INDIAN SCHOOL ROAD. ELEVATION = 1222.577 (COP DATUM)

```
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10004,904996.618,681363.720,1221.608,BCHH
105,907734.621,678690.579,1222.577,SEARCH
106,907634.527,681373.413,1243.301,SEARCH
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10015,907666.402,681460.750,1244.003,B BCV01
10016,907671.213,681460.779,1244.107,B EOS01
10017,907666.492,681455.617,1243.606,BCV01
10018,907666.819,681427.611,1243.373,BCV01
10019,907666.801,681422.109,1243.756,BCV01
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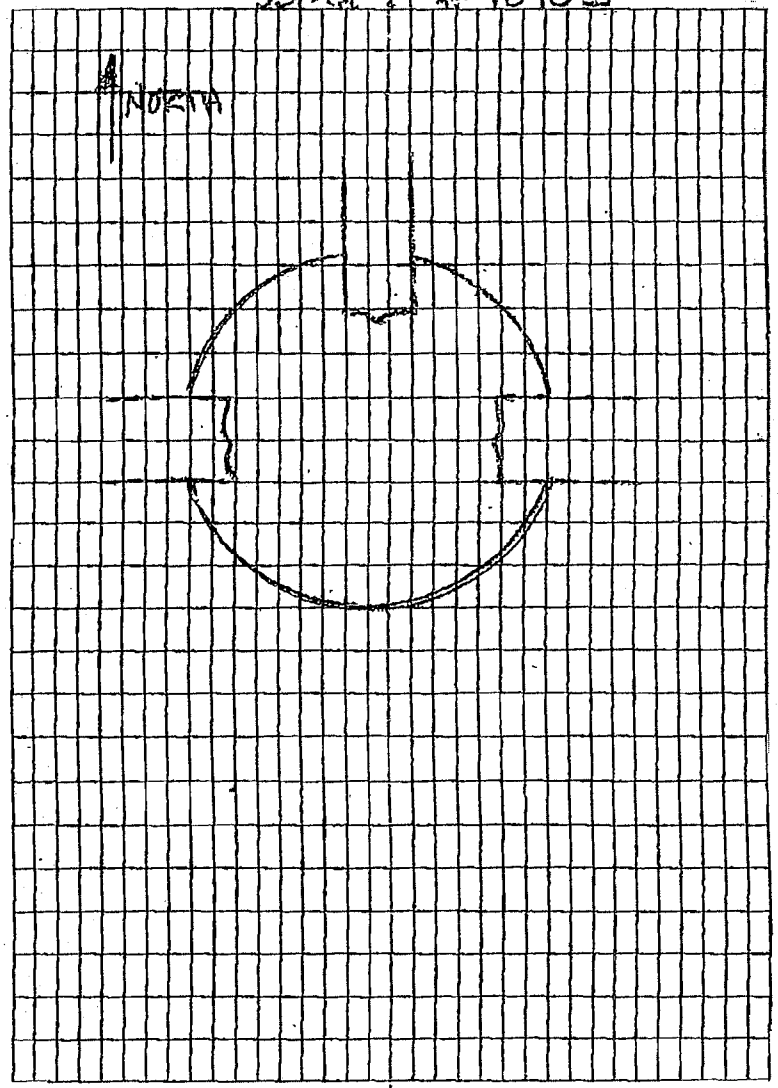
10-0216
ARCADIA
N. CRAIG
T. HAEHN
3-24-10
SUNNY 70°F

Rim	N.	S.	E.	W.
1253.60	-9.46		-9.55	-9.28
	1244.14		1244.05	1244.32

SSMH Pr # 10905



PT #		DESC.
	CANAL INV. DIPS	
11104	EAST INV. MEASURE DOWN -16.10'	SOUTH IRR. STRUCTURE
11105	WEST INV. " " -16.15'	
11177	WEST INV. MEASURE DOWN -16.20	NORTH IRR. STRUCTURE
11178	CENTER INV. " " -16.20	
11179	EAST INV. " " -16.20	

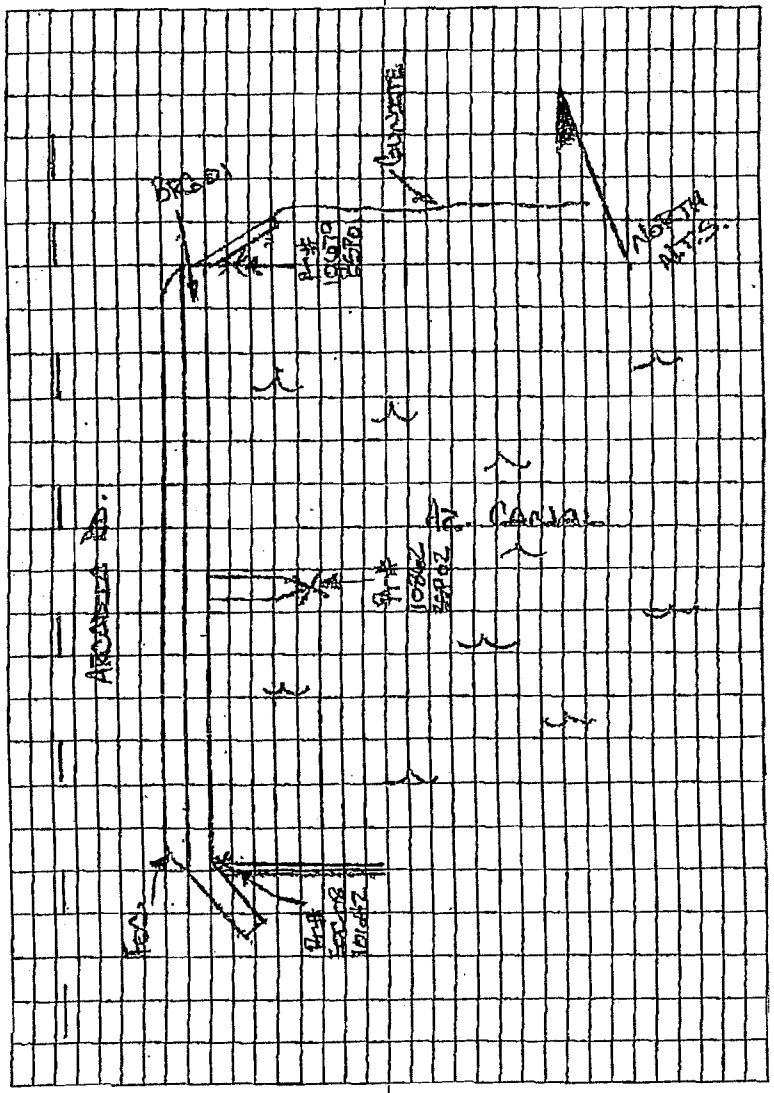
MISC. CODE DESC.

BUR02 = 5' WIDE SHOT @ CLN
REG01 = CCW ON BRIDGE (GUARD RAIL)
UGG01 = 8" LINE
WIF01 = 6' TALL
BUR01 = 2' WIDE SHOT @ CLN
WDP = 17 TOTAL ≈ 7' APART ON AFC

* ROD BUST *

11188 SHOT @ .26 ROD SHOULD BE A 4.95 ROD

Pt #	MEASURE DOWN @ AZ. CANAL BRIDGE ON ARCADIA DR.
10642	-9.55'
10679	-8.90'
10862	-8.00'



Appendix G

Pothole Results

BASEPLANS U.S.A.

2750 S. Hardy Dr. Suite 2
Tempe, AZ 85282

LOCATION BOOKLET

PREPARED FOR:

MARICOPA COUNTY FLOOD CONTROL DISTRICT

Project Name	: Arcadia Drainage Improvements Phase 1
Contract No.	: 2010C006
Project No.	: ST83110066
Assignment	: 1
BasePlans Job No.	: 317-01
Date	: June 15, 2010

TABLE OF CONTENTS

LOCATION BOOKLET

LOCATION REPORT

REQUEST OF POTHOLE LOCATIONS

VACUUM EXCAVATION DAILY REPORT

VACUUM EXCAVATION DATA SHEETS

TESTHOLE SUMMARY REPORT

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
23949
BRUCE R.
HEYSE
Date Signed 6-15-10
ARIZONA, U.S.A.
Exp 3-31-12

Location Report

Maricopa County Flood Control District Location Contract

Location Report

Date:	June 15, 2010
Project Name:	Arcadia Drainage Improvements Phase 1
MCFCD Project No.:	ST83110066
Contract No.:	2010C006
Requested by:	Gary Maiers
Job No.:	317-01

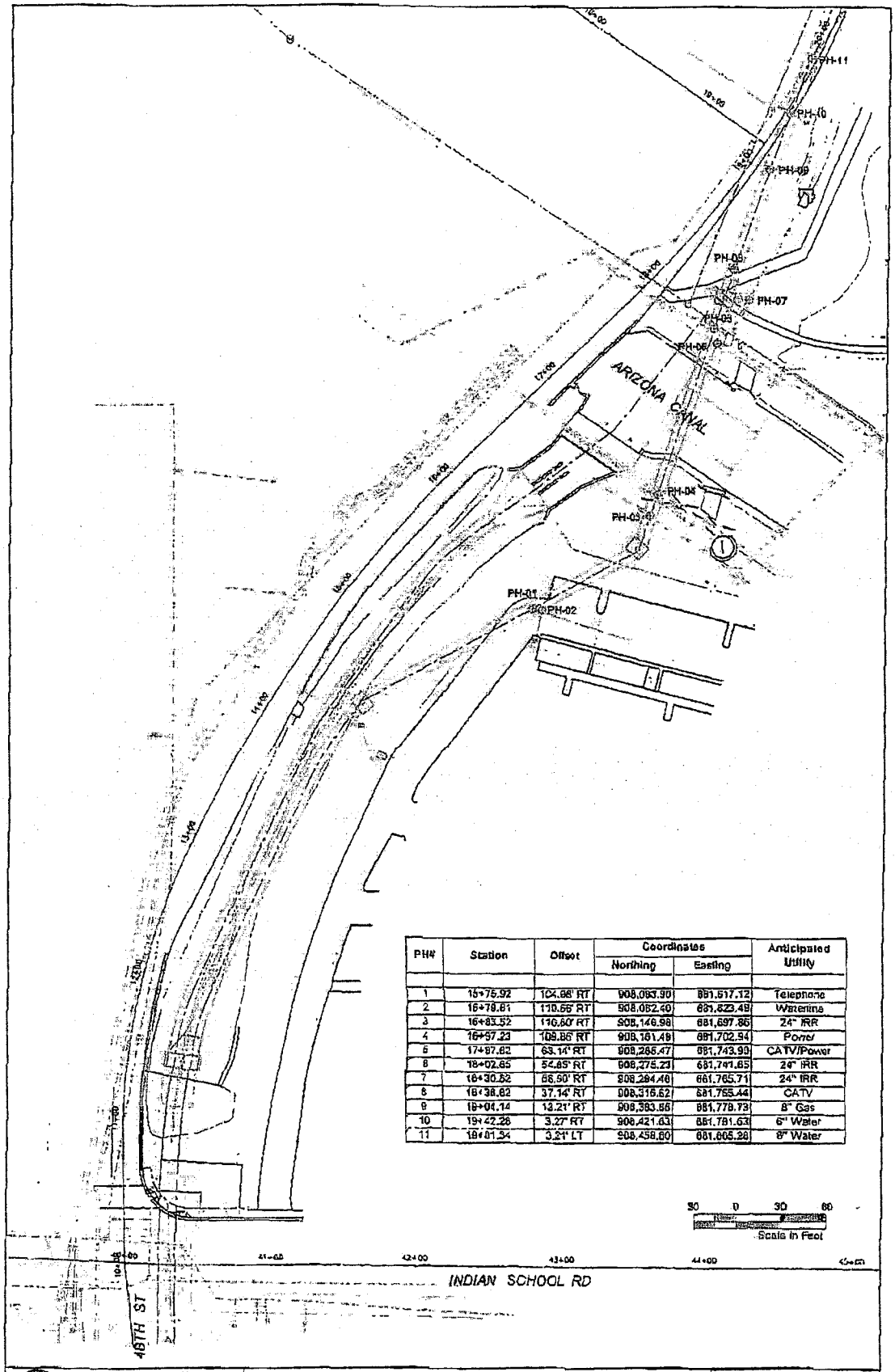
Vacuum Extraction Crew Chief: Kevin Acosta

Survey Crew Chief: Bruce R. Heyse

Special Notes:

1. All data is in English and is based on information received from MCFCD.
2. Stationing is based on drawings supplied by MCDOT.
3. Utility sizes noted are as seen in the pothole opening and are approximate.
4. Pothole 1 was not potholed, there was no Bluestake markings or signal detected in the area.
5. Pothole 3 was not found, potholed 4 feet across and 6 feet deep. The line is capped at the irrigation structure to the east.

Request of Pothole Locations



PH#	Station	Offset	Coordinates		Anticipated Utility
			Northing	Easting	
1	15+75.92	104.98' RT	908,093.90	681,617.12	Telephone
2	16+78.81	110.66' RT	908,052.40	681,623.49	Waterline
3	16+83.52	110.60' RT	908,149.98	681,697.86	24" IRR
4	16+87.23	109.86' RT	908,161.49	681,702.94	Power
5	17+87.82	63.14' RT	908,265.47	681,743.90	CATV/Power
6	18+02.65	54.65' RT	908,275.23	681,741.65	24" IRR
7	18+30.52	56.50' RT	908,294.46	681,765.71	24" IRR
8	18+38.62	37.14' RT	908,316.62	681,755.44	CATV
9	18+04.14	13.21' RT	908,383.56	681,779.73	8" Gas
10	19+42.28	3.27' RT	908,421.63	681,781.63	6" Water
11	19+01.34	3.21' LT	908,458.80	681,805.28	8" Water

ARCADIA DRIVE
DRAINAGE IMPROVEMENTS
PHASE 1

POTHOLE REQUEST MAP

OLSSON ASSOCIATES

Vacuum Excavation Daily Report

Vacuum Excavation Daily Report

Baseplans Job #: 317-01 **Crew:** Juan Acosta

Job Name: Arcadia Drainage **Date:** 6-5-10

Pothole Number	Utility Type	Utility Diameter	Type of Material	Width of Bank	Utility Depth: Surface to Top	Utility Depth: Surface to Bottom	Config. Of Multi-Conduit system	Soil Type & Condition
1	Tele	—	NO Blueprint -		NO Signal			
2	Water	6"	DI		2.65			
3	IRR	—	NOT Found due		4 feet Across	6 feet Deep		
4	Elec	6-1 1/4" 5-2 1/2"	Steel	1.50	3.00	3.30		
5	TV-Elec	1-2" 3-3"	Plastic	1.00	3.00	3.20	o = TV ooo - Elec	
6	IRR	24"	Conc		3.50			
7	IRR	36"	Conc		3.33			
8	TV	2-1"	DBC		2.00	2.25	—	cap 1° Deep
9	Gas	8"	Steel		5.15			
10	Water	6"	Steel		2.70			
11	Water	8"	Conc		4.50			

Vacuum Excavation Data Sheets

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 1 - NOT POTHOLED - No Bluestake or signal detected in this area.

Type of Utility: Telephone

Approx. Outside Diameter of Pipe: n/a

Structure/Pipe Material Composition: n/a

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
15+75.92	n/a	104.98' Rt	n/a	n/a	n/a	n/a

Pothole Coordinates: n/a

Surface to Top: n/a

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties: Distance	Description	Approx. Location
No. 1		
No. 2		
No. 3		

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.

2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 2

Type of Utility: Water

Approx. Outside Diameter of Pipe: 6"

Structure/Pipe Material Composition: Ductile Iron

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
15+79.61	15+77.06	110.86' Rt	112.25' Rt	1248.92	1246.27	n/a

Pothole Coordinates: N= 908079.671, E= 681623.102

Surface to Top: 2.65

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	2.46	Water Valve	15+74.62, 113.48' Rt
No. 2	18.32	Fire Hydrant	15+58.64, 121.12' Rt
No. 3	19.82	Back of Curb	15+68.76, 93.84' Rt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 3 - NOT FOUND - Potholed 4 feet across, 6 feet deep

Type of Utility: Irrigation

Approx. Outside Diameter of Pipe: n/a

Structure/Pipe Material Composition: n/a

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
16+83.52	n/a	116.50' Rt	n/a	n/a	n/a	n/a

Pothole Coordinates: n/a

Surface to Top: n/a

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties: Distance	Description	Approx. Location
No. 1		
No. 2		
No. 3		

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 4

Type of Utility: Power

Approx. Outside Diameter of Pipe: 6 @ 1 1/4", 5 @ 2 1/2"

Structure/Pipe Material Composition: Steel conduit

Approx. Width of Conduit/Slurry Bank: 1.50

Config. of Non-encased Multi Conduit System: random

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
16+97.23	16+94.72	109.65' Rt	109.15' Rt	1253.41	1250.41	1250.11

Pothole Coordinates: N= 908160.110, E= 681700.774

Surface to Top: 3.00
Surface to Bottom: 3.30

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	7.78	Power pole	17+02.29, 110.98' Rt
No. 2	18.17	Metal Post	16+99.65, 126.64' Rt
No. 3	22.03	Aluminum cap	17+03.76, 89.05' Rt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 5

Type of Utility: CATV/Power

Approx. Outside Diameter of Pipe: 3 @ 3", 1 @ 2"

Structure/Pipe Material Composition: Plastic conduit

Approx. Width of Conduit/Slurry Bank: 1.00

Config. of Non-encased Multi Conduit System: 2" over 3 - 3"

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
17+97.82	17+97.08	63.14' Rt	66.38' Rt	1253.51	1250.51	1246.31

Pothole Coordinates: N= 908262.581, E= 681745.591

Surface to Top: 3.00
Surface to Bottom: 7.20

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	12.31	NW corner Irr structure	17+97.08, 66.38' Rt
No. 2	6.29	Power pole	18+01.20, 52.57' Rt
No. 3	36.89	Sewer manhole	18+31.77, 57.23' Rt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 6

Type of Utility: Irrigation

Approx. Outside Diameter of Pipe: 24"

Structure/Pipe Material Composition: Concrete

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
18+02.65	18+01.20	54.65' Rt	52.57' Rt	1253.78	1250.28	n/a

Pothole Coordinates: N= 908275.570, E= 681739.054

Surface to Top: 3.50

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	12.68	NW corner Irr structure	17+97.08, 66.38' Rt
No. 2	9.34	Power pole	18+01.20, 52.57' Rt
No. 3	22.76	Sewer manhole	18+31.77, 57.23' Rt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.

2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 7

Type of Utility: Irrigation

Approx. Outside Diameter of Pipe: 36"

Structure/Pipe Material Composition: Concrete

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
18+30.52	18+31.77	58.90' Rt	57.23' Rt	1253.73	1250.40	n/a

Pothole Coordinates: N= 908296.581, E= 681765.389

Surface to Top: 3.33

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	27.04	NW corner Irr structure	17+97.08, 66.38' Rt
No. 2	39.12	Power pole	18+01.20, 52.57' Rt
No. 3	42.50	Sewer manhole	18+31.77, 57.23' Rt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 8

Type of Utility: CATV

Approx. Outside Diameter of Pipe: 2 @ 1"

Structure/Pipe Material Composition: Under concrete cap, 3' wide, 1" thick, 1.00' deep
Direct bury cable

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: stacked

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
18+38.62	18+94.65	37.14' Rt	10.00' Rt	1252.91	1250.91	1250.66

Pothole Coordinates: N= 908377.846, E= 681770.500

Surface to Top: 2.00
Surface to Bottom: 2.25

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	49.22	Fire Hydrant	19+42.42, 16.39' Rt
No. 2	49.85	Water Valve	19+42.08, 4.77' Lt
No. 3	71.92	Power pole	19+54.36, 31.76' Lt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.

2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 9

Type of Utility: Gas

Approx. Outside Diameter of Pipe: 8"

Structure/Pipe Material Composition: Steel

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
19+04.14	19+04.08	13.21' Rt	21.45' Rt	1252.85	1247.70	n/a

Pothole Coordinates: N= 908379.060, E= 681785.435

Surface to Top: 5.15

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	39.86	Fire Hydrant	19+42.42, 16.39' Rt
No. 2	46.59	Water Valve	19+42.08, 4.77' Lt
No. 3	72.87	Power pole	19+54.36, 31.76' Lt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 10

Type of Utility: Water

Approx. Outside Diameter of Pipe: 6"

Structure/Pipe Material Composition: Steel

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
19+42.28	19+42.03	3.27' Rt	6.48' Rt	1253.20	1250.50	n/a

Pothole Coordinates: N= 908419.732, E= 681794.239

Surface to Top: 2.70

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	9.91	Fire Hydrant	19+42.42, 16.39' Rt
No. 2	11.26	Water Valve	19+42.08, 4.77' Lt
No. 3	40.10	Power pole	19+54.36, 31.76' Lt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

BP Form No. 1009 Rev. 4/99

VACUUM EXCAVATION DATA SHEET

BASEPLANS U.S.A.
2750 S. Hardy Dr. Suite 2, Tempe, AZ 85282 - Ph: (480)784-4452

Date: 15-Jun-10

MCFCD Proj. Name: Arcadia Drainage Improvements Phase 1

BasePlans Job No.: 317-01

MCFCD Project No: ST83110066

Pothole No.: 11

Type of Utility: Water

Approx. Outside Diameter of Pipe: 8"

Structure/Pipe Material Composition: Concrete

Approx. Width of Conduit/Slurry Bank: n/a

Config. of Non-encased Multi Conduit System: n/a

Station		Offset		Surface	Top	Bottom
Given	Actual	Given	Actual	Elev.	Elev.	Elev.
19+81.34	19+78.62	3.21' Lt	4.28' Lt	1253.47	1248.97	n/a

Pothole Coordinates: N= 908456.893, E= 681803.060

Surface to Top: 4.50

Surface to Bottom: n/a

Benchmark Provided #1: BCHH just east of int. 48th St. & Indian School Rd
Elev.= 1243.301
C.O.P. Datum

Benchmark Provided #2: BCHH at the int. 44th St. & Indian School Rd
Elev.= 1222.577
C.O.P. Datum

Swing Ties:	Distance	Description	Approx. Location
No. 1	41.99	Fire Hydrant	19+42.42, 16.39' Rt
No. 2	36.26	Water Valve	19+42.08, 4.77' Lt
No. 3	36.17	Power pole	19+54.36, 31.76' Lt

Remarks: All data is in English and based on information received from MCFCD.
All stationing is Arcadia Drive construction centerline.

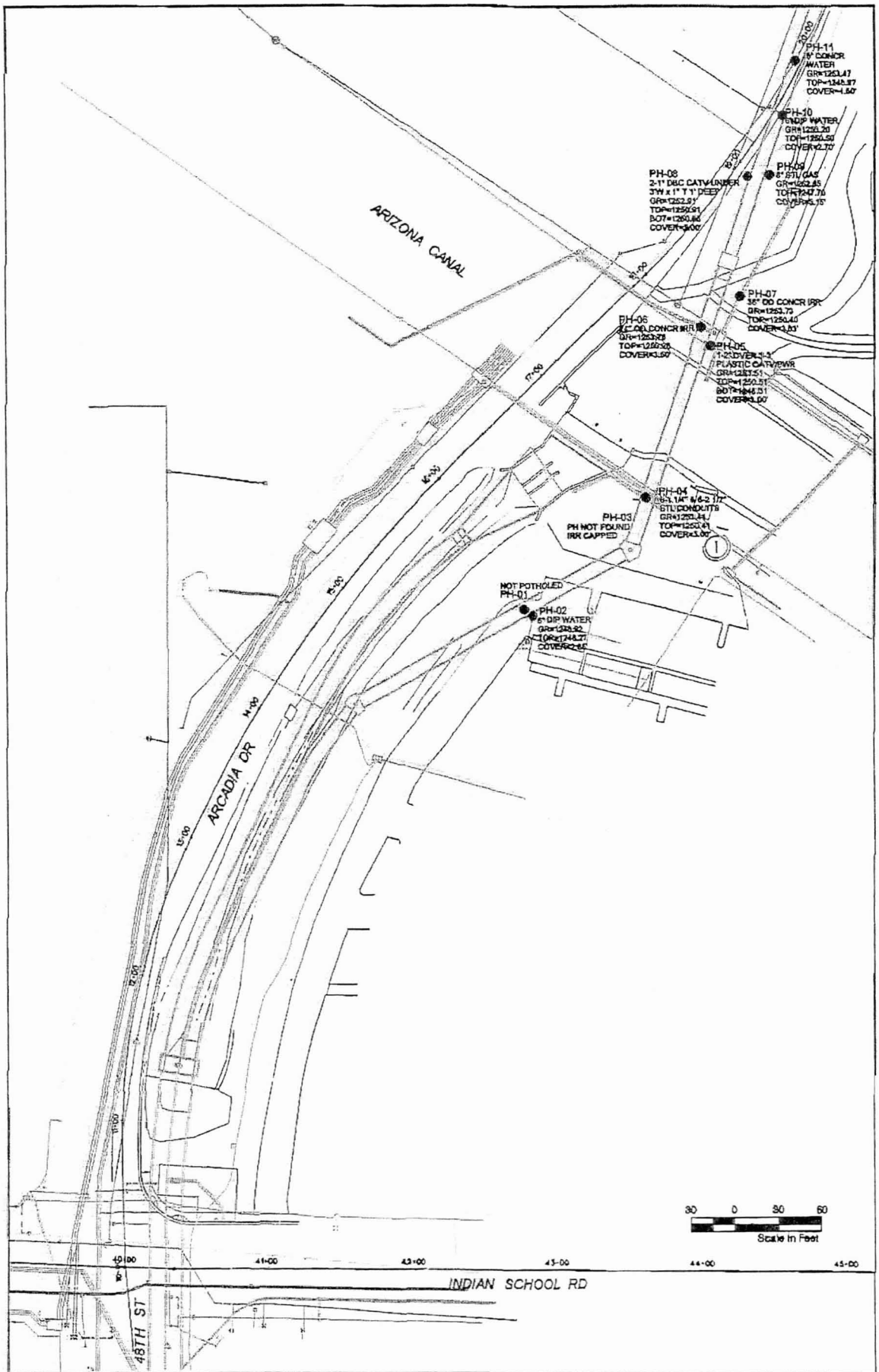
Testhole Summary Report

Project Name: Arcadia Drainage Improvements Phase 1

Testhole Summary Report

6/15/2010

Pothole #	Street	Station	Offset	Anticipated Utility	Ground Elev.	Surface to top of Pipe	Top of Pipe Elev.	Bottom Elev.	Width of Bank	Actual Material Type, Outside Diameter	Utility Owner
1	Arcadia Drive	15+75.92	104.98' Rt	Telephone	NOT POTHOLED - No Bluestake or signal detected in this area						Qwest
2	Arcadia Drive	15+77.06	112.25' Rt	Water	1248.92	2.65	1246.27	na	na	6" Ductile Iron	City of Phoenix
3	Arcadia Drive	16+83.52	116.60' Rt	Irrigation	NOT FOUND - Potholed 4 feet across, the line is capped in the structure to the east						SRP
4	Arcadia Drive	16+94.72	109.15' Rt	Power	1253.41	3.00	1250.41	1250.11	1.50	6 @ 1 1/4", 5 @ 2 1/2" conduit	SRP
5	Arcadia Drive	17+97.08	66.38' Rt	CATV/Power	1253.51	3.00	1250.51	1246.31	1.00	3 @ 3", 1 @ 2" Plastic conduit	Cox/SRP
6	Arcadia Drive	18+01.20	52.57' Rt	Irrigation	1253.78	3.50	1250.28	na	na	24" Concrete	SRP
7	Arcadia Drive	18+31.77	57.23' Rt	Irrigation	1253.73	3.33	1250.40	na	na	36" Concrete	SRP
8	Arcadia Drive	18+94.66	10.00' Rt	CATV	1252.91	2.00	1250.91	1250.66	na	2 @ 1" Direct bury cable	COX
9	Arcadia Drive	19+04.08	21.45' Rt	Gas	1252.85	5.15	1247.70	na	na	8" Steel	SWGas
10	Arcadia Drive	19+42.03	6.48' Rt	Water	1253.20	2.70	1250.50	na	na	6" Steel	City of Phoenix
11	Arcadia Drive	19+78.62	4.29' Lt	Water	1253.47	4.50	1248.97	na	na	8" Concrete	City of Phoenix



ARCADIA DRIVE
DRAINAGE IMPROVEMENTS
PHASE 1

POTHOLE RESULTS

OLSSON

Appendix H

Geotechnical Report

GEOTECHNICAL EXPLORATION
OLD CROSS CUT CANAL IMPROVEMENTS
ARIZONA CANAL TO INDIAN SCHOOL ROAD
N.E.C. OF 48TH STREET AND INDIAN SCHOOL ROAD
PHOENIX, ARIZONA

Prepared for:
Olsson Associates
7250 N. 16th Street, Suite 210
Phoenix, AZ 85020

Prepared by:
Alpha Geotechnical & Materials, Inc.
2504 W. Southern Avenue
Tempe, Arizona 85282

PCN 625.02.30
Job # 10-G-1735 and 10-G-1837

Registered Professional Engineer (Civil)
CERTIFICATE NO.
39511
ARMANDO
ORTEGA
Date Signed
ARIZONA, U.S.A.

Expires 9/30/2012

Alpha
Geotechnical & Materials, Inc.

July 27, 2010
Alpha Project #10-G-1735 and 10-G-1837

Olsson Associates
7250 N 16th Street, Suite 210
Phoenix, Arizona 85020

Attention: Mr. Jeff Ford, P.E.

RE: GEOTECHNICAL EXPLORATION
Old Cross Cut Canal Improvements
Arizona Canal to Indian School Road
N.E.C. of 48th Street and Indian School Road
Phoenix, Arizona

Dear Mr. Ford:

In accordance with your request and authorization, Alpha Geotechnical & Materials, Inc. (Alpha) has performed a geotechnical subsurface exploration for phase 1 of the proposed Old Cross Cut Canal Improvements project located on the northeastern corner of 48th Street and Indian School Road in Phoenix, Arizona. The purpose of this report is to provide recommendations relative to the geotechnical aspects of design and construction of the project.

Based on our findings, the site is considered suitable for the proposed construction. Specific recommendations regarding the geotechnical aspects of project design and construction are presented in the following report. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,

ALPHA GEOTECHNICAL & MATERIALS, INC.

Registered Professional Engineer (Civil) CERTIFICATE NO. 28609 JAMES P. FLOYD Date Signed 7/27/10 ARIZONA, U.S.A.

Expires 9/30/2011

James P Floyd, P.E.
Project Manager

Registered Professional Engineer (Civil) CERTIFICATE NO. 39511 ARMANDO ORTEGA Date Signed 7/27/10 ARIZONA, U.S.A.

Expires 9/30/2012

Armando Ortega, P.E.
Vice-President, Engineering

Dist: Addressee (5)

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Registered Professional Engineer (Civil)
CERTIFICATE NO. 39511
ARMANDO ORTEGA
Date Signed
ARIZONA, U.S.A.
Expires 9/30/2012

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
39511
ARMANDO
ORTEGA
Date Signed 7/27/10
ARIZONA, U.S.A.

Expires 9/30/2012

1. INTRODUCTION

1.1. General

The purpose of this geotechnical exploration was to evaluate the general surface and subsurface conditions at the referenced site, and to present recommendations related to geotechnical aspects of design and construction of the project. Results of our laboratory testing are also presented within this report. Our scope of services was in general accordance with our proposal 10GP027 – Revision 1, dated February 10, 2010 and 10090 dated June 29, 2010. This geotechnical report is based on available project information and the site plan provided by the client and our experience with similar construction and soil conditions.

Our study included a site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. This report presents recommendations for design of suitable foundation types, site grading and structural fill placement, moisture protection, and construction considerations. The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the "Limitations" section of this report.

1.2. Proposed Project

This project consists of improvements to the existing canal located on the east side of Arcadia Drive north of Indian School Road in Phoenix, Arizona. Specifically this project includes development of subsurface soil data as it relates to the design and construction of a 120-inch cast-in-place pipe (CIPP) and a box culvert type inlet structure to connect water released from the Arizona Canal to the Old Cross Cut Canal. In addition the project will include a storm drain crossing below the existing Arizona Canal.

2. FIELD EXPLORATION

Five soil test borings were advanced at the subject site to a depths ranging between five (5) feet and forty (40) feet below existing ground level with a Diedrich D-50 power drill rig. The soil test borings were advanced using 8-inch hollow stem augers to develop information relative to foundation, slope stability, and storm drain design recommendations. The borings were located in the field at the approximate locations shown on the sample location plan included in the **Appendix A** of this report. Prior to the start of drilling, the Arizona Bluestake Center was contacted to locate existing utilities at the boring locations. Upon completion of the borings, the boreholes were backfilled with excavated materials.

Soil classifications made during our field exploration from excavated soil samples were confirmed in the laboratory after further examination. The site soils were classified in accordance with the Unified Soil Classification System presented, along with the soil test logs, in **Appendix B**. Sample classifications and other related information are recorded on the soil boring logs which are presented in **Appendix B**.

3. LABORATORY TESTING

Selected soil samples from the borings were tested in the laboratory for classification purposes and to evaluate their engineering properties. The laboratory tests included:

- Gradation
- Atterberg limits
- Moisture content
- One-dimensional consolidation
- One-dimensional swell/settlement
- Undisturbed ring density
- Proctor test
- pH test
- Resistivity test
- And direct shear test

A brief description of each test preformed on the soil samples and the results are presented in **Appendix C**.

4. GENERAL SITE CONDITIONS

4.1. Surface Conditions

The project is located along the east side of Arcadia Drive and north of East Indian School Road. Both Arcadia Drive and Indian School Road were paved with asphaltic concrete at the time of our field study. Water within the Arizona Canal flows from southeast to northwest, a set of gates diverts water from the Arizona canal into the inlet structure of the Old Cross Cut Canal which flows north to south. The areas adjacent to both wing walls, by the Arizona Canal and Indian school, is protected by shotcrete (in areas the underlying reinforcement was visible) however localized slope failures were noted throughout the sides of the old cross cut canal.

4.2. Subsurface Conditions

The naturally occurring coarse-grained site surface and subsurface soils extending throughout the depth of our borings consisted of silty sand with gravel (SM), clayey sand (SC), and sand with silt (SP-SM). The relative densities of these soils ranged from loose to very dense. Carbonate cementation was found in both soil test borings and ranged from weak to moderate. Cementation generally increased with depth. No bedrock was encountered during our field investigation.

4.3. Groundwater Conditions

At the time of our field investigation, free groundwater was not encountered in our explorations, though in boring B-3 located on the south bank of the Arizona Canal the 40 foot samples was found to be wet. It should be noted that groundwater and soil

moisture conditions within the area will vary depending on rainfall, irrigation practices, and/or runoff conditions not apparent at the time of our field investigation. Based on the wet conditions found in boring B-3 it would be expected that some infiltration of water from the canal is present and may create areas of perched groundwater.

4.4. Seismic Considerations

The project site is located in south-central Arizona which is an area of low seismic activity. The following values were developed using the 2006 International Building Code (IBC) and are based on knowledge of local geologic conditions, and subsurface soils encountered during our investigation. A 100-foot soil test boring was not advanced during our field investigation. A site class C (very dense soil and soft rock) may be used for design.

Central Latitude.....33.49541°
Central Longitude.....-111.97795°
S_s Spectral Acceleration for Short Period.....0.188g
S_1 Spectral Acceleration for a 1-Second Period.....0.063g
F_a Site Coefficient for Short Period.....1.20
F_v Site Coefficient for a 1-Second Period.....1.70

4.5. Liquefaction Potential

Based on the site soils encountered during this investigation and low ground motion hazard (relatively low ground acceleration), the potential for soil liquefaction is considered to be negligible.

4.6. Land Subsidence and Earth Fissures

The project site is located in an area with no documented earthen fissures and a measured land subsidence of between zero and one foot (Land Subsidence and Earth Fissures in Alluvial Deposits in Phoenix area, Arizona by H.H. Schumann, 1974, and http://azmap.org/fissures).

5. ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1. Earthwork

5.1.1. Site Grading

5.1.1.1. Pavement Site Preparation and Grading

All existing structures/structural remnants, fill, topsoil, vegetation and organic soils should be removed from below the pavement areas. The site soils tested have low expansive potentials and are considered suitable for use as engineered fill in the pavement areas. The native soils should be scarified to a depth of 12-inches: moisture conditioned to within ±2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by American Society for Testing and Materials (ASTM) D 698.

5.1.1.2. Grading Below Box Culvert Structure

The native soils should be scarified to a depth of 8-inches, moisture conditioned to ±2 percent of optimal moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

5.1.1.3. General Grading

Areas to receive fill should be scarified to a depth of 8-inches, moisture conditioned to ±2 percent of optimal moisture content and compacted to a minimum of 95 percent of maximum dry density. Fill material placed should be moisture conditioned to ±2 percent of optimal moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

5.1.1.4. Engineered Fill

Engineered fill materials should be composed of on-site soils or imported soils meeting the requirements for imported soils presented below. The site soils tested are non-expansive and are suitable for use as engineered fill, although due to their low resistivity should not be used in direct contact with the concrete structure. All engineered fills should be compacted as noted.

1. Native soils or imported soils with low expansive potentials could be used as fill material for the following:

   - general site grading
   - embankment construction

2. Structural backfill should be used against concrete structures designed to resist earth loads, such as box culverts, wingwalls and retaining walls. All Structural backfill should meet the material requirements of Section 206 MAG Uniform Standard Specification.

3. Imported soils (if required) should conform to the following:

Gradation	**Percent finer by weight (ASTM C136)**
6"	100
No. 200 Sieve	60 (max)

Expansion Index	**(ASTM D4829)**
Maximum expansive index	20

Additional requirements for import in contact with ferrous material or concrete:

Corrosion Potential	
Minimum Resistivity (ohm-cm)	2,000
Sulfate Content (percent)	0.1

4. Aggregate base should conform to MAG and/or local governing specifications.
5. The following are intended to guide in establishing adequate support for the conventional foundation elements:
   - Any natural washes, depressions or new excavations which are to be filled, should be widened as necessary to accommodate compaction equipment and provide a level base for placing fill.
   - Any engineered fill (backfill) materials placed beneath the foundations should meet the requirements for Engineered Fill Materials.

- All footing excavations should be relatively level and free of loose or disturbed material and inspected by a qualified representative of the Geotechnical Engineer.

6. All fill soils to be used beneath the foundations, slabs and pavements should be approved by the Geotechnical Engineer. Fill should be placed in 8-inch loose lifts and should extend beyond the edge of the structure for a minimum distance of five (5) feet.

5.1.2. Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 8-inch diameter hollow stem augers. We present the following general comments regarding excavatability with the understanding that they are opinions based on the test borings. The project consultant and contractor should become familiar with this report including boring logs to evaluate potential hard dig conditions.

Excavations in the site soils can most likely be accomplished by conventional earth moving equipment. Site soils in the upper five to 10 feet are generally less dense than soils at depth and may experience greater potential for instability during excavation. Areas of sandy and wet soils are present and may create areas of instability during trench excavation. Please refer to Section 4 and sample logs for more information.

5.1.3. Temporary Excavations

All excavations must comply with applicable local, state, and federal safety regulations including the current Occupational Safety Health Association (OSHA) Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing the information below solely

as a service to our client. Under no circumstances should the information provided be interpreted to mean that the consultant team or the District assumes responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

Near-surface soils encountered during our field investigation consisted predominantly of silty sand and sandy silts. In our opinion, these soils would be considered a Type C soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1½ (h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than 5 feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within one-third the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Arizona.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water should be collected and disposed of outside the construction limits.

5.1.4. Permanent Excavations and Slopes

We recommend all permanent cut and fill slopes in soil be constructed at a gradient no steeper than 3(h):1(v). During wet weather, erosion could become a problem. Proper drainage and maintenance is recommended. To reduce the potential for surface erosion, a berm or "V" ditch may be located at the top of slopes subject to significant overland water flows in order to intercept and redirect surface runoff.

Fill placed on slopes steeper than 5(h):1(v) should be benched into the existing slope. It is recommended that the slope face be compacted as presented in the earthwork section of this report.

5.2. Slopes Analysis

Slope profiles including existing slope from the Old Cross Cut Canal Improvements project were modeled using soil data obtained from field and laboratory test in XSTABL Version 5.0 by Interactive Software Design, Inc. Factor of safety against failure in the critical surfaces identified by the Bishop method were calculated using a Generalized Limit Equilibrium (GLE) method. A summary of the soil properties is presented below.

Unit Weight (psf)	
Moist	105
Saturated	115
Soil Strength	
Cohesion (psf)	0
Angle of Internal Friction (deg)	34

The slope stability was analyzed using the soil properties presented above to identify critical slope sections. The slopes were assumed to be dry (no groundwater) and soil characteristics modeled in the XSTABL software were near optimal moisture content.

The most critical surfaces as calculated by XSTBL are depicted in **Appendix D** of this report. A summary of the resulting factor of safety have been tabulated below.

Calculation Method	Slope	Factor of Safety
Original Slope	1 (H) : 1 (V)	0.763
XSTABL	1 ½ (H) :1 (V)	1.031
	1 ¾ (H) : 1 (V)	1.201
	2 (H) : 1 (V)	1.356
	2 ¼ (H) : 1 (V)	1.524
	2 ½ (H) : 1 (V)	1.704

5.3. Design Values for Buried Pipes

The following sections provide design information relative to flexible and rigid pipes. The recommendations provided within the following sections are based on the pipe being installed by open cut excavations. If an alternative construction process is utilized, Alpha should be contacted for additional recommendations.

5.3.1.1. Soil Loads on Buried Rigid Pipes

Soil loads on buried rigid pipes such as concrete or clay pipes can be analyzed using the Marston's Formula as follows:

$$W_c = C_d \gamma B_d^2$$

C_d = Load Coefficient based on $K\mu'$

γ = Moist unit weight of backfill material (pcf)

B_d = Width of trench at top of pipe (ft)

The coefficient C_d is dependent on the backfill type, which depends on the pipe manufacture's recommendation or local municipality requirements, the trench width, and pipe installation depth. Where the ratio of the backfill depth to trench width at the top of the pipe (H/B_d) is at least 1 and where trench width, at top of pipe, is no greater than 3

times the pipe diameter, the value of C_d may be determined using the following formula for load coefficient, C_d:

$$C_d = \frac{1 - e^{-2K\mu' (H / B_d)}}{2K\mu'}$$

K = Active earth pressure coefficient

μ' = Friction coefficient between fill material and sides of trench

H = Backfill height above the pipe crown

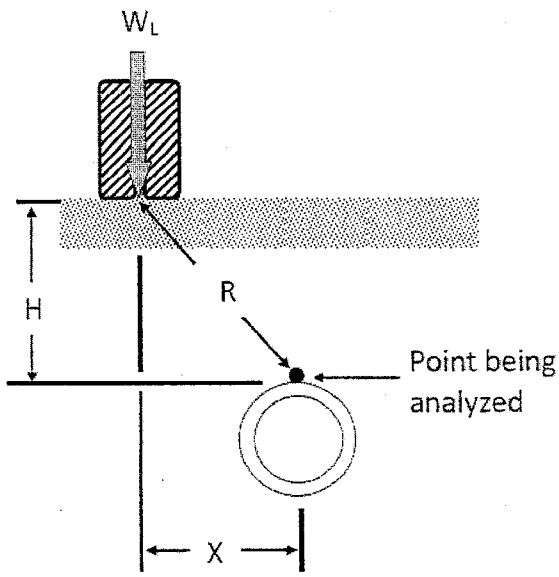
The product Kμ' in the above referenced equation is dependent on the backfill type, degree of compaction, and moisture content. The following table provides estimates for the Kμ' product based on various soil types.

Soil Type	Kμ'
Clay (CL,CH)	0.12
Silt (ML)	0.13
Silty Sand (SM)	0.15
Well and Poorly Graded 'Clean' Sands (SW, SP)	0.165
Sandy Gravels and Cobbles (GW, GP, GM, GC)	0.18
Source: ASCE (1982)	

Based on soils encountered during our field investigation, we recommend using a Kμ' value of 0.13 for design and a wet soil unit weigh, γ, equal to 125 pcf for soil backfill material.

5.3.1.2. Live Loads on Buried Conduits

Live loads on buried conduits due to vehicular loads may be determined as presented below:



$$P_L = \frac{3 I_f W_L H^3}{2\pi R^5}$$

Where:

P_L = live load soil pressure from a concentrated surface load, psf
I_f = impact factor, dimensionless (See Table below)
W_L = live load, lbs
H = height of fill above the top of the pipe, ft
R = distance from the point of load application to top of pipe, ft

Height of Cover , H (ft)	Impact Factor, I_f
0 to 1 ft	1.3
1 ft, 1 in to 2 ft	1.2
2 ft, 1 in to 3 ft	1.1
Over 3 ft	1.0

Source: ASCE Manual No. 60 / WEF MOP No. FD-5, 2007

The proposed storm drain below the Arizona Canal has a cover of 18 feet within the maintenance road area. It is anticipated that the roadway may be used by large SRP equipment, thus the loads on the buried pipe were calculated based on an SRP design vehicle. In our calculation we modeled the SRP design vehicle as a point load of 183,000 pounds. Using the equation present above and an impact factor (I_f) of 1.0, the calculated vertical pressure at the top of pipe due to the SRP design vehicle is 270 pounds per square foot.

5.4. Structures

5.4.1. Shallow spread footings

Shallow spread footings bearing on undisturbed native or engineered fill can be used to support the structures as recommended. Recommended footing depths and allowable bearing pressures are presented below.

Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.0	2,500
3.0	3,000
4.0 and greater	4,000

***Note**: Footing depth is defined as the depth below the lowest adjacent finished grade elevation within 2-feet of the edge of the footing.

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

Continuous footings should have a minimum width of 12-inches. The minimum widths are recommended for ease of construction, and to provide a margin of safety against a local or punching shear failure of the foundation soils. All footings should be reinforced to reduce potential distress caused by differential foundation movement.

All the footing excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. If subsurface conditions are encountered that are different than indicated by the test borings, revised recommendations may be required.

5.4.1.1. Estimated Settlements

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements between similarly loaded, adjacent footings are expected to be less than ½-inch. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.4.1.2. Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 33 PCF. Restrained walls should be designed to withstand a residual or long-term at-rest (Ko) earth pressure condition of 51 pounds per cubic foot (PCF).

A passive EFP of 300 PCF may be used for shallow spread footings. A coefficient of friction of 0.40 is recommended for computing lateral resistance between the base of

footing and soil in analyzing lateral loads. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

Only cohesionless, free-draining granular materials should be used as backfill, adjacent to earth-retaining structures. We recommend that backfill directly behind the walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 3 feet of the walls during backfilling, to avoid developing excessive temporary or long-term lateral soil pressures. Positive gravity drainage of the backfill should be provided.

5.4.2. Retaining Walls

5.4.2.1. Lateral Earth Pressures

If retaining walls are utilized in this project, they should be designed to resist the earth pressure exerted by the retained, compacted backfill plus any additional lateral force that will be applied to the wall due to surface loads placed at or near the top of the wall. The at-rest earth pressure against walls that are restrained at the top and with level backfill may be taken as equivalent to the pressure exerted by a fluid weighing 51 pounds per cubic foot (pcf). Fifty percent of any uniform areal surcharge placed at the top of a restrained wall may be assumed to act as a uniform horizontal pressure over the entire height of the wall.

Retaining walls that are not restrained at the top and with backfill, which is level behind the wall, may be designed for an active earth pressure developed by an equivalent fluid weighing 33 pcf. Thirty percent of any uniform surcharge may be assumed to act as a uniform horizontal pressure over the entire height of the wall.

5.4.2.2. Wall Drainage

The above-recommended values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose of excess water that may accumulate behind earth retaining structures.

Wall drainage should be collected by continuous perforated drainpipes, filter fabric, and gravel connected to weep holes. The drainpipe must run parallel to the wall. We recommend drainrock consist of durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should have an equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a permeability of at least 0.02 centimeters per second and minimum puncture strength of 50 pounds.

5.4.2.3. Backfill Placement

All backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Light equipment should be used during backfill compaction to minimize possible overstressing of the wall.

5.4.3. Box Culvert

The box culvert is anticipated to extend along the entire project alignment from the Arizona Canal to Indian School Road.. Based on our understanding of the proposed design the culverts will bear on native soils approximately 15 feet below adjacent grade. We anticipate that the scour depth will not exceed the bottom elevation of the culvert. Base on our exploration and the above assumptions, we provide the following design recommendations:

- An allowable bearing pressure of 3,000 pounds per square foot may be used for box culverts bearing at a depth of 10 feet below adjacent grade or greater.
- A passive EFP of 300 PCF may be used for design. A coefficient of friction of 0.40 is recommended for computing lateral resistance between the base and soil in analyzing lateral loads.
- Estimated settlement of the box culvert is estimated to be 1-inch total and 1/2 – inch differential.
- The excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete.

Culvert walls which are laterally supported and can be expected to undergo only a slight amount of movement should be designed for an at rest lateral earth pressure of 51 pounds per cubic foot (PCF). Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 33 PCF. The pressures assume drained soil conditioned behind structure, a horizontal backfill surface, and no surcharge.

5.5. Corrosion Potential

5.5.1. Electrical Resistivity

Electrical Resistivity of a soil is a measure of resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. As a soil's resistivity decreases, its corrosivity increases.

A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is shown in the following table.

Resistivity (ohm-cm)	Corrosivity Classification
0 to 1,000	severely corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately corrosive
Over 10,000	Mildly corrosive

Sample Location	pH	Resistivity (Ohm-cm)
Bulk Sample B-1 0'-2'	8.5	1534
Bulk Sample B-2 15'-20'	8.5	534

Based on the laboratory tests as shown in the preceding table, this soil would be considered "corrosive to severely corrosive". It should be noted that these corrosion conditions are for the soils at submerged moisture conditions. Resistivities at drier moisture contents would be less corrosive than the results of the test.

5.5.2. Sulfate and Chlorides

Selected samples of the near-surface soils encountered at the site were subjected to chemical analysis for the purpose of corrosion assessment. The samples were tested for soluble sulfates, and soluble chlorides. The samples were tested in general accordance with Arizona Test Methods 733, and 736 for soluble chlorides, and soluble sulfates, respectively. The test results are provided in **Appendix C**.

Based on provisions of American Concrete Institute (ACI) 318 Section 4.3, Table 4.3.1, *Requirements for Concrete Exposed to Sulfate-Containing Solutions* a sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible. Based on the laboratory results, sulfate contents of the site soils tested indicate a negligible corrosion potential to concrete.

Based on a review of available published data regarding chloride Ion content for corrosion protection of concrete reinforcement, soils with a chloride concentration of 500 ppm or greater are considered corrosive. Based on the laboratory result of the samples

collected for this project, chloride contents of the site soils tested indicate negligible corrosion potential.

5.6. Pavement

5.6.1. Existing Asphalt Pavement

The existing pavement on 49th Street was cored as part of the field study at the location labeled as B-5 on our Sample Location Plan (Appendix A). The pavement section of the area explored was 1.69-inches of asphaltic concrete over 7-inches of aggregate base (Appendix B&C).

5.6.2. New Asphalt Pavement

We are basing our recommendation for pavement design on our classification of the subsurface soils, the site preparation and grading recommendations provided in this report, and correlated R-values of 58 and 67 (based on percent passing the No. 200 screen and the plasticity index). The pavement design recommendations given in this section are based on the AASHTO method for flexible pavements.

The design criteria used for 49th Street are maximum Equivalent Single Axle Loads (ESAL) of 250,000 and 20-year design. Considering the above, we recommend the following minimum pavement structural section options:

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)
North 49th Street	3	6
	2	8

The flexible pavement section should consist of Central Plant Mix Asphaltic Concrete Pavement (AC) on compacted Aggregate Base Course (ABC) as recommended in the table below. Flexible pavement should be placed in accordance with MAG Section 321 and local municipality standards.

5.6.3. Aggregate Base Course

Aggregate base used in support of concrete or asphalt pavements should conform to the local governing and/or M.A.G. Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40.

All aggregate base should be placed in lifts not thicker than eight inches and compacted to a minimum of 98 percent of maximum dry density as determined by American Society for Testing and Materials (ASTM) Test Method D 698 or as specified by local specifications. The moisture content during compaction should be maintained within two percent of optimum moisture content.

6. CLOSURE

6.1. Limitations

Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar localities. No warranty is expressed or implied.

The recommendations contained in this report are based on our field exploration, laboratory test results, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the test

borings excavated during the field subsurface exploration. It is anticipated that some variations in the soil conditions will exist on-site. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractor, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on and off-site), or other factors may change over time, and additional work may be required with the passage of time. Any party, other than the Client, who wishes to use this report, shall notify Alpha of such intended use. Based on the intended use of this report, Alpha may require that additional work be performed and that an updated report be issued.

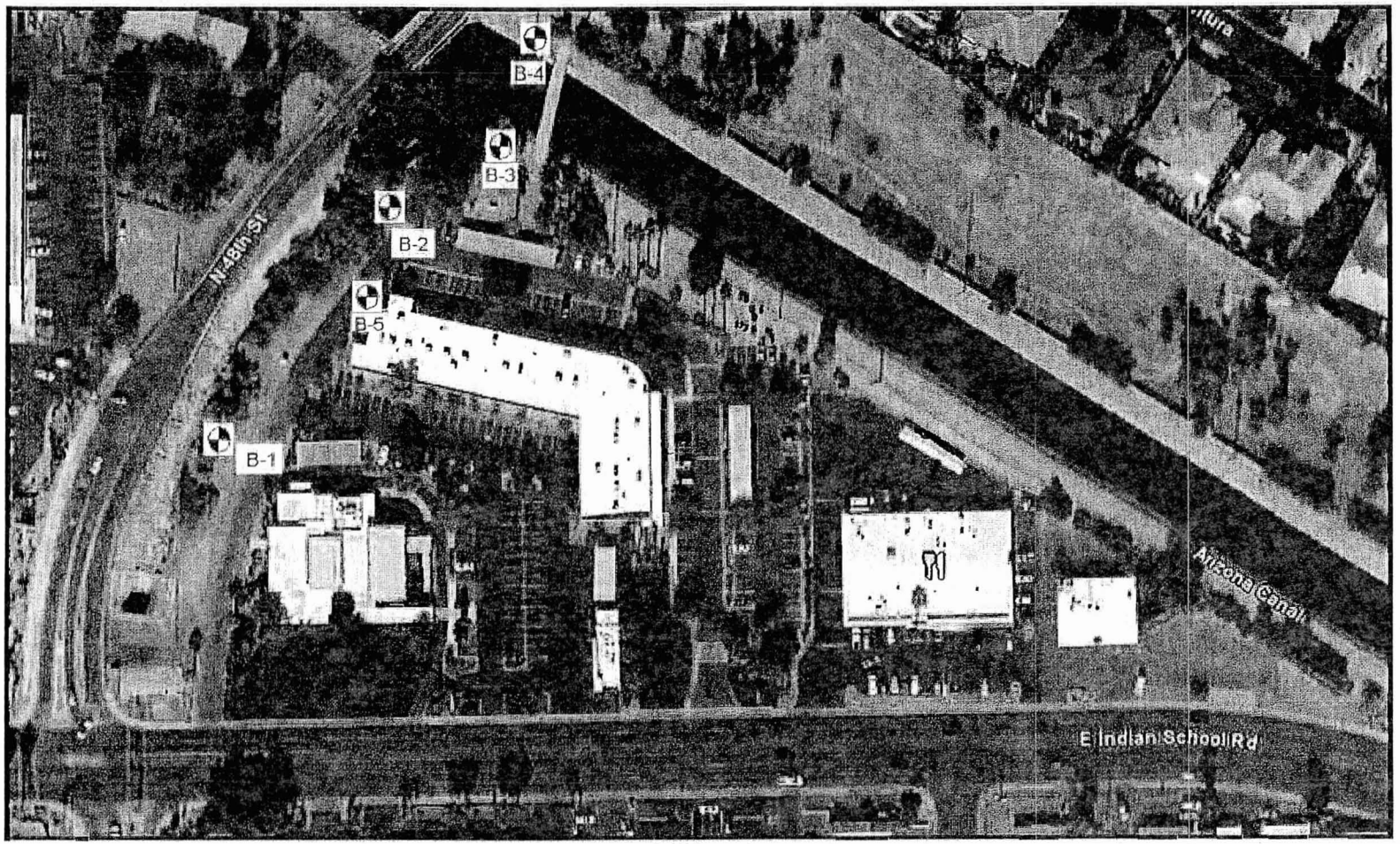
6.2. Recommended Additional Services

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction. These tests and observations should be performed by the Geotechnical Engineer's representative and should include, but are not necessarily be limited to the following:

- Observe and document that any existing surficial vegetation and other deleterious materials have been removed from the site as required in site preparation section.
- Approve any material used as engineered fill in structural areas to document that it meets the requirements outlined above before placement.
- Monitor the scarification operations of the exposed subgrade.
- Monitor excavation operations to document those footings are bearing in soils as recommended above.
- Monitor the backfill procedures.
- Perform field density tests, as needed, to verify compaction compliance. The representative should monitor the progress of compaction and filling operations.
- Keep records of on-site activity and progress.

Observation of footing excavations should be performed prior to placement of reinforcing and concrete to confirm that satisfactory bearing materials are present. Construction testing, including field and laboratory evaluation of fill and backfill materials, concrete and steel should be performed to determine whether applicable project requirements have been met.

APPENDIX A
Sample Location Plan



N

(NOT TO SCALE)

LEGEND

Boring Location

ALPHA

Alpha Geotechnical and Materials, Inc.
2504 W. Southern Avenue
Tempe, Az 85282

Sample Location Plan

Project: Arcadia Drive Drainage Improvement - Phase 1, 10-G-1735

Location: Phoenix, Arizona

Date: 07/23/10

Drawn By: J Floyd

APPENDIX B
BORING LOGS

APPENDIX B
FIELD INVESTIGATION

TEST BORINGS

The subsurface conditions at the site were explored on March 18, 2010, July 14, 2010 and July 17, 2010 by advancing 4 soil test borings using a Diedrich D-50 power drill rig and one core on 49th Street. The locations of soil test borings performed for this investigation are shown in appendix A of the report.

Our engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table) and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Bulk samples were taken from the test borings at selected intervals. Soil samples were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After the soil test borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System
Logs of Soil Test Borings

UNIFIED SOIL CLASSIFICATION SYSTEM					CONSISTENCY OR RELATIVE DENSITY
Major Divisions			Group Symbols	Typical Names	CRITERIA
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels 50% or more of coarse fraction retained on No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Standard Penetration Test Density of Granular Soils
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Penetration Resistance N (blows/ft) — Relative Density
		Gravels With Fines	GM	Silty gravels, gravel-sand-silt mixtures	
			GC	Clayey gravels, gravel-sand-clay mixtures	0-4 — Very Loose
	Sands More than 50% of coarse fraction passes No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines	5-10 — Loose 11-30 — Medium Dense
			SP	Poorly graded sands and gravelly sands, little or no fines	31-50 — Dense >50 — Very Dense
		Sands With Fines	SM	Silty sands, sand-silt mixtures	
			SC	Clayey sands, sand-clay mixtures	
Fine-Grained Soils 50% or more passes No. 200 sieve	Silts and Clays Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Standard Penetration Test Consistency of Cohesive Soils
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Penetration Resistance N (blows/ft) — Consistency — Unconfined Compressive Strength (Tons/ft2)
			OL	Organic silts and organic silty clays of low plasticity	<2 — Very Soft — <0.25
	Silts and Clays Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	2-4 — Soft — 0.25-0.50 4-8 — Firm — 0.50-1.00
			CH	Inorganic clays of high plasticity, fat clays	8-15 — Stiff — 1.00-2.00
			OH	Organic clays of medium to high plasticity	15-30 — Very Stiff — 2.00-4.00 >30 — Hard — >4.0
Highly Organic Soils			PT	Peat, muck, and other highly organic soils	

3" 3/4" #4 #10 #40 #200 U.S. Standard Sieve

Unified Soil Classification	Cobbles	Gravel		Sand			Silt or Clay
		coarse	fine	coarse	medium	fine	

MOISTURE CONDITIONS	
Dry	Absence of moist, dusty, dry to the touch
Slightly Damp	Below optimum moisture content for compaction
Moist	Near optimum moisture content, will moisten the hand
Very Moist	Above optimum moisture content
Wet	Visible free water; below water table

MATERIAL QUANTITY	
trace	0 - 5%
few	5 - 10%
little	10 - 25%
some	25 - 45%
mostly	50 - 100%

OTHER SYMBOLS	
C	Core Sample
S	SPT Sample
B	Bulk Sample
▼	Groundwater
Qp	Pocket Penetrometer

BASIC LOG FORMAT:
Group name, Group symbol, (grain size), color, moisture, consistency or relative density. Additional comments: odor, presence of roots, mica, gypsum, coarse grained particles, etc.

EXAMPLE:
Brown, loose fine to medium Sand (SP), trace silt, little fine gravel, damp

UNIFIED SOIL
CLASSIFICATION SYSTEM

Alpha Project Number:	10-G-1735	**Log of Boring No.**	B-1
Project:	Arcadia Drive Drainage Improvement - Phase 1	**Client:**	Olsson Associates
Project Location:	Phoenix, Arizona	**Boring Location:**	See attached site plan

Longitude: 33.49537° **Latitude:** -111.97787°

Remarks: Bulk Sample collected from 0'-2' and 20'-25', Ring Samples driven at 2'-3', 5'-6', 10'-11', 15'-16', and 20'-21', and Split Spoon Sample driven at 25'-26.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			8.5		SM	**SILTY SAND WITH GRAVEL** Light to medium brown, predominately fine graded, subrounded, loose to medium dense to very dense to medium dense to dense to loose, slightly damp to moist to slight damp, non-plastic, non to weakly cemented.
R	4-5			2		
				4		
R	9-16	102	9.3	6		
				8		
R	30-50/5"			10		
				12		
				14		
R/B	8-16	86	15.6/9.0	16		
				18		
R/B	17-25	112	11.1	20		
				22		
				24		
S	4-4-4		13.3	26		
				28		Bottom of boring @ 26.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 06/04/09 & 06/05/09

Drill Rig: Diedrich D-50

Alpha Project Number:	10-G-1735	**Log of Boring No.**	B-2
Project:	Arcadia Drive Drainage Improvement - Phase 1	**Client:**	Olsson Associates
Project Location:	Phoenix, Arizona	**Boring Location:**	See attached site plan

Longitude: 33.49590° **Latitude:** -111.97736°

Remarks: Bulk Sample collected from 15'-20', Ring Samples driven at 10-11', 15'-16', 20'-21' and 25'-26', and Split Spoon Sample driven at 2'-3.5' and 5'-6.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Light brown, predominately coarse graded, subrounded, medium dense to dense to very dense to dense, slightly damp, non-plastic, non to weakly to moderately cemented.
S	6-6-7			2		
				4		
S	7-7-6			6		
				8		
R	10-25			10		
				12		
				14		
R/B	30-35		7.7	16		
				18		
R	30-34	100	12.7	20		
				22		
				24		
R	15-24	106	10.6	26		
				28		**Bottom of boring @ 26.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

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2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 06/04/09 & 06/05/09

Drill Rig: Diedrich D-50

Alpha Project Number:	10-G-1837	**Log of Boring No.**	B-3
Project:	Arcadia Drive Drainage Improvement - Phase 1	**Client:**	Olsson Associates
Project Location:	Phoenix, Arizona	**Boring Location:**	See attached site plan

Longitude: 33.49612° **Latitude:** -111.97701°

Remarks: Bulk Sample collected from 0'-5' and 23'-25', Split Spoon Samples driven at 5'-6.5', 10'-11.5', 15'-16.5', 20'-21.5', 25'-26.5', 30'-31.5, 35'-36.5', and 40'-41.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			7.6		SM	**SILTY SAND WITH GRAVEL** Medium brown, well graded, subrounded, loose, slightly damp, non-plastic.
				3		
S	3-4-4			6		
				9	SC	**CLAYEY SAND** Reddish brown, predominately fine graded, subrounded, firm, slightly damp, medium plasticity.
S	4-9-10					
				12		
				15	SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subangular, medium dense to dense to medium dense to dense to medium dense, slightly damp to moist to wet, non-plastic.
S	9-12-11					
				18		
S	11-14-17					
				21		
B			11.2			
S	2-3-8			24		
				27		
				30		
S	10-16-24					
				33		
S	3-5-6			36		
				39		
S	6-8-7					
				42		**Bottom of boring @ 41.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

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Tempe, Arizona 85282

Sample Date: 07/14/10

Drill Rig: Diedrich D-50

Alpha Project Number:	10-G-1837	**Log of Boring No.**	B-4
Project:	Arcadia Drive Drainage Improvement - Phase 1	**Client:**	Olsson Associates
Project Location:	Phoenix, Arizona	**Boring Location:**	See attached site plan

Longitude: 33.49632 ° **Latitude:** -111.97695 °

Remarks: Bulk Sample collected from 2'-5', and Split Spoon Samples driven at 5'-6.5', 10'-11.5', 15'-16.5', 20'-21.5', 25'-26.5', 30'-31.5, 35'-36.5', and 40'-41.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	**SILTY SAND WITH GRAVEL** Light to medium to reddish brown, predominately coarse graded to well graded, subrounded, medium dense, dry to slightly damp, non-plastic, non-cemented.
B				3		
S	3-8-10			6		
					SC	**CLAYEY SAND** Medium brown, well graded, subrounded, firm, slightly damp, medium plasticity, non-cemented.
S	6-10-8			9		
			15.1	12		
				15	SM	**SILTY SAND WITH GRAVEL** Light brown, well graded, subrounded, medium dense to very dense to dense to medium dense to dense, slightly damp to moist to wet, medium plasticity, weakly cemented.
S	10-14-9					
				18		
S	19-26-34		11.3	21		
				24		
S	14-19-21					
				27		
				30		
S	9-14-26					
				33		
S	11-12-13			36		
				39		
S	14-17-19					
				42		**Bottom of boring @ 41.5'; no groundwater encountered.**

The stratification lines represent the approximate boundary lines
Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample
BN = Bull Nose R = Ring Sample

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2504 West Southern Avenue
Tempe, Arizona 85282

Sample Date: 07/14/10

Drill Rig: Diedrich D-50

Alpha Project Number:	10-G-1837	**Log of Boring No.**	B-5
Project:	Arcadia Drive Drainage Improvement - Phase 1	**Client:**	Olsson Associates
Project Location:	Phoenix, Arizona	**Boring Location:**	See attached site plan

Longitude: **Latitude:**

Remarks: Bulk Sample collected from 1'-5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
						ASPHALTIC CONCRETE (1.69")
						AGGREGATE BASE COURSE (7")
				2	**SP-SM**	**SAND WITH SILT**
				4		Light brown, well graded, subrounded, slightly damp, non-plastic.
				6		**Bottom of boring @ 5'; no groundwater encountered.**
				8		
				10		
				12		
				14		
				16		
				18		
				20		
				22		
				24		
				26		
				28		

The stratification lines represent the approximate boundary lines Between soil and rock types: In-situ, the transition may be gradual.

Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

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Tempe, Arizona 85282

Sample Date: 07/17/10

Drill Rig: Core Rig

APPENDIX C
Laboratory Test

APPENDIX C
LABORATORY TESTING

LABORATORY TESTS

Laboratory tests were performed on selected samples to aid in soil classification and to evaluate physical properties of the soils, which may affect the Geotechnical aspects of project design and construction. A description of the laboratory testing program is presented below.

Sieve Analysis

Sieve analyses were performed to evaluate the gradation characteristics of the material and to aid in soil classification. Tests were performed in general accordance with ASTM Test Method C 136 and D 2487.

Atterberg Limits

Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Additionally, test results were correlated to published data to evaluate the shrink/swell potential of near-surface site soils. Tests were performed in general accordance with ASTM Test Method D 4318.

Moisture Content

Moisture content tests were performed to evaluate moisture-conditioning requirements during site preparation and earthwork grading. Moisture content was evaluated in general accordance with ASTM Test Method D 2216.

Moisture-Density

Standard proctor tests were performed on bulk soil samples to evaluate maximum dry density and optimum moisture content. Test procedures were in general accordance with ASTM Test Method D 2937.

Swell Test

Swell tests were performed on bulk soil samples to evaluate the expansion potential of the site soils. Test procedures were in general accordance with ASTM Test Method D 4546.

One-Dimensional Consolidation

A one-dimensional consolidation test was performed on a ring samples to evaluate consolidation potential of the site soil. Test procedure was in general accordance with ASTM Test Method D 2435.

pH and Resistivity

pH and resistivity tests were performed on the bulk soil sample to evaluate the site soil corrosion potential. Test procedure was in general accordance with Arizona Test Method 236.

Alpha Geotechnical & Materials, Inc.

Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1735
Project Location:	Phoenix, Arizona	**Work Order Number:**	1
Client:	Olsson Associates	**Sample Date:**	03/18/10
Sample Source:	See Below	**Material:**	Native

Mechanical Sieve Analysis
Group Sumbol, USCS (ASTM D-2487)

					Silt or	Sand								Gravel									Moisture
					Clay	Fine			Medium			Coarse		Fine				Coarse					
Lab Number	**Location & Depth**	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**%**
					Percent Passing By Weight																		
1	Bulk Sample B-1 @ 0'-2'	SM	NV	NP	39	48	53	55	58	65	73	77	84	100	100	100	100	100	100	100	100	100	8.5
2	Bulk Sample B-1 @ 15'-20'	SM	NV	NP	25	31	36	39	42	52	64	69	82	100	100	100	100	100	100	100	100	100	9.0
3	Bulk Sample B-2 @ 15'-20'	SM	NV	NP	27	31	35	38	42	52	64	69	84	100	100	100	100	100	100	100	100	100	7.7
4	STP B-1 @ 25'-26.5'	SM	NV	NP	32	40	44	46	49	58	66	70	86	100	100	100	100	100	100	100	100	100	13.3

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Tempe, Arizona 85282

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Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1837
Project Location:	Phoenix, Arizona	**Work Order Number:**	1
Client:	Olsson Associates	**Sample Date:**	07/14/10
Sample Source:	See Below	**Material:**	Native

Mechanical Sieve Analysis
Group Sumbol, USCS (ASTM D-2487)

					Silt or	Sand								Gravel									Moisture
					Clay	Fine			Medium			Coarse		Fine				Coarse					
Lab Number	Location & Depth	USCS	LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	3"	%

Percent Passing By Weight

1	Bulk Sample B-3 @ 0'-5'	SM	NV	NP	29	35	39	41	44	51	59	63	80	100	100	100	100	100	100	100	100	100	7.6
2	Bulk Sample B-3 @ 23'-25'	SM	NV	NP	14	19	24	29	34	51	63	67	80	100	100	100	100	100	100	100	100	100	11.2
3	STP B-4 @ 10'-11.5'	SC	28	9	46	57	62	64	65	73	80	82	93	100	100	100	100	100	100	100	100	100	15.1
4	STP B-4 @ 20'-21.5'	SM	31	8	44	53	58	60	64	72	80	83	94	100	100	100	100	100	100	100	100	100	11.3

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Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1837
Location:	Phoenix, Arizona		
Material:	Native	**Sample Number:**	10415
Sample Source:	30' North & 35' West of Arcadia Dental Building, N.W.C.	**Sample Date:**	07/17/10
Proposed Use:	Roadway - Subgrade	**Sampled by:**	Jeremy Fraser

Sieve Analysis of Fine and Coarse Aggregates (ASTM C136/C117)

Mechanical Analysis

Sieve Size	% Passing	MAG
6 in / 152mm	100	
4 in / 100mm	100	
3 in / 75mm	100	
2 in / 50mm	100	
1 1/2 in / 37.5mm	100	
1 1/4 in / 32 mm	100	
1 in / 25 mm	100	
3/4 in / 19 mm	100	
1/2 in / 12.5 mm	100	
3/8 in / 9.5 mm	97	
1/4 in / 6.4 mm	94	
#4, 4.75mm	88	
#8, 2.36mm	73	
#10, 2.00mm	61	
#16, 1.18mm	55	
#30, 0.60mm	44	
#40, .425mm	35	
#50, .300mm	25	
#100, .150mm	14	
#200, .075mm	8.0	

Atterberg Limits		MAG
LL:	NV	
PI:	NP	
USCS:	SP-SM	
AASHTO:	A-1-b(1)	

AASHTO description:

Silty gravel and sand

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Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1837
Location:	Phoenix, Arizona		
Material:	Asphalt Core	**Sample Number:**	See Below
Sample Source:	See Below		
Supplier:	Unknown (Product Code Unknown)	**Date Sampled:**	07/17/10
Sampled By:	Jeremy Fraser		

Unit Weight & Thickness (AASHTO T-245/T166A, as Applicable)

Lab Number	Sample Locations		Total Thickness
10408	Northwest Parking Lot - Location B-5		1.69

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Tempe, Arizona 85282

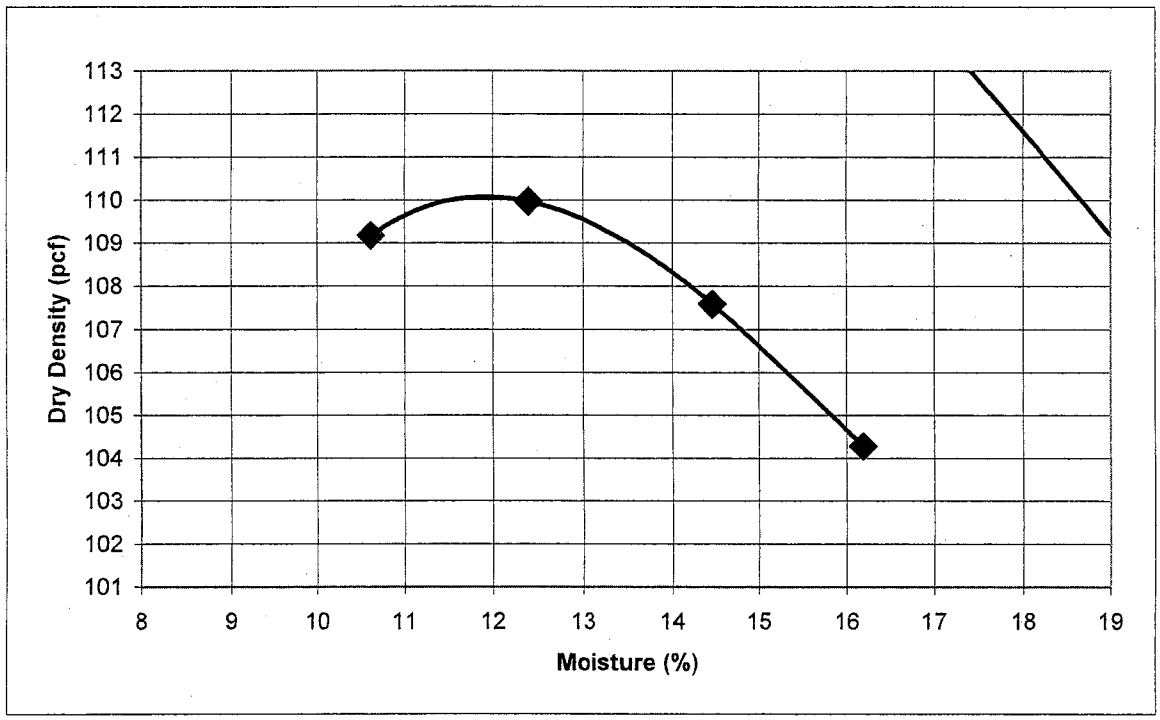
ALPHA Geotechnical & Materials, Inc.

Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1735
Location:	Phoenix, Arizona	**Work Order Number:**	1
Material:	Native	**Lab Number:**	5
Sample Source:	Bulk Sample B-1 @ 15'-20'	**Sample Date:**	03/18/10
Proposed Use:	Pads/ Mass Grading	**Sampled by:**	J. Floyd

Laboratory Compaction Characteristics of Soils Using
Standard Efforts (12,400ft-lb-ft/cu.ft) (ASTMD698A)

Curve: A

	English (pcf)	Metric (kg/ cu.m.)
Maximum Dry Density:	110.1	1763
Optimum Moisture (%):	11.9	11.9



Notes:
- The Zero Air Void Curve Represents a Specific Gravity of: 2.65 (Assumed).
- This is a Summarized Report of the Referenced Procedures and Does Not Include All Reporting Requirements. Additional Data Can be Provided at Clients Request.

Reviewed by: AC

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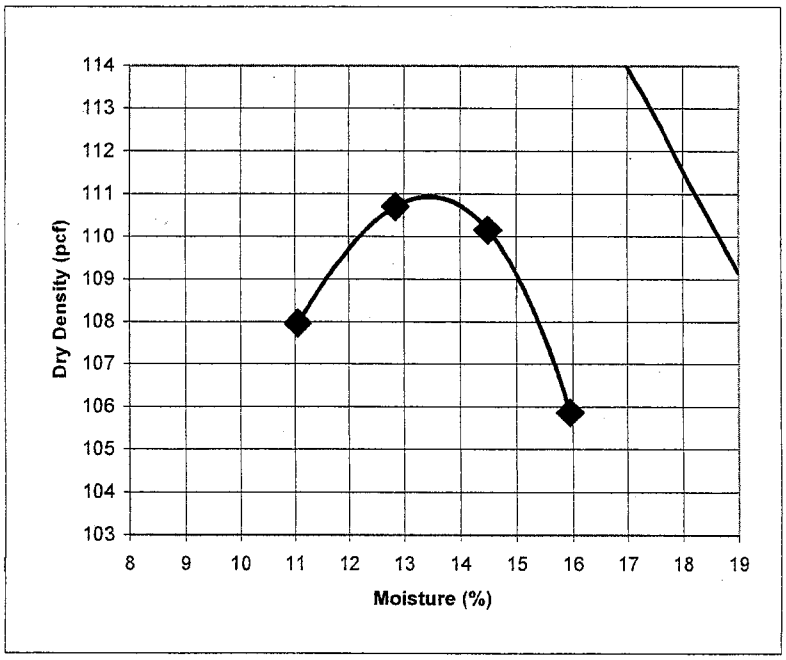
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1837
Location:	Phoenix, Arizona	**Work Order Number:**	1
Material:	Native	**Lab Number:**	5
Sample Source:	Bulk Sample B-3 @ 23'-25'	**Sample Date:**	07/14/10
Proposed Use:	Pads/ Mass Grading	**Sampled by:**	J. Floyd

Laboratory Compaction Characteristics of Soils Using
Standard Efforts (12,400ft-lb-ft/cu.ft) (ASTMD698A)
ONE DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS (ASTM D-4546)

	English (pcf)	Metric Specs
Maximum Dry Density:	110.9	1777
Optimum Moisture (%):	13.5	13.5



% Swell: 0.6

Notes:

- The Zero Air Void Curve Represents a Specific Gravity of: 2.65 Assumed for the -#4 Material.
- This is a Summarized Report of the Referenced Procedures and Does Not Include All Reporting Requirements. Additional Data Can be Provided at Clients Request.

Reviewed by: AC

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MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 10-G-1837
Sampler:
Date Received: 7/16/2010
Date Reported: 7/20/2010

PO Number: 10-G-1837

Lab Number: 902125-01 **B-1 @ 23'-25' Old Cross Cut Canal I**

Chloride (ARIZ 736)	Method	Result	Units	Levels
Chloride, Cl	ARIZ 736	53	ppm	

Sulfate (ARIZ 733)	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	63	ppm	

Redox Potential	Method	Result	Units	Levels
Redox Potential	Saturated Paste	168	(Eo) mV	

Redox performed on saturation paste. Eo is the potential developed by the platinum redox electrode.

Alpha Geotechnical & Materials, Inc.

Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1837
Location:	Phoenix, Arizona	**Work Order Number:**	1
Client:	Olsson Associates	**Lab Number:**	See Below
Material:	See Below	**Date Sampled:**	07/14/10
Sample Source:	See Below		

pH & Resistivity (AZ 236)

Lab Number	Sample Source	Material	Resistivity (Ohm-cm)	pH
6	Bulk Sample B-3 @ 0'-5'	Native	6,940	6.9
7	Bulk Sample B-3 @ 23'-25'	Native	5,210	7.1

Reviewed by: AC

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Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 10-G-1735 Arcadia Dr Drain.
Sampler:
Date Received: 3/22/2010
Date Reported: 3/24/2010

PO Number: 10-G-1735

Lab Number: 901535-02
Sample ID: B-1 0-2'
Description: Arcadia Dr Drainage Improvement Phase 1

Crop:
Growth Stage:

pH & Minimum Resistivity Box

Test	Method	Result	Units	Levels
pH (ARIZ 236b)	ARIZ 236b	8.5	SU	
Minimum Resistivity, Box	ARIZ 236b	1534	ohm-cm	

MOTZZ LABORATORY, INC.
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Soil Analysis Report

Alpha Geotechnical and Materials
Jamie Floyd
2504 W. Southern Ave
Tempe, AZ 85282

Project: 10-G-1735 Arcadia Dr Drain.
Sampler:
Date Received: 3/22/2010
Date Reported: 3/24/2010
PO Number: 10-G-1735
Crop:
Growth Stage:

Lab Number: 901535-01
Sample ID: B-2 15-20'
Description: Arcadia Dr Drainage Improvement Phase 1

pH & Minimum Resistivity Box

Test	Method	Result	Units	Levels
pH (ARIZ 236b)	ARIZ 236b	8.5	SU	
Minimum Resistivity, Box	ARIZ 236b	534	ohm-cm	

Alpha Geotechnical & Materials, Inc.

Project: Arcadia Drive Drainage Improvement - Phase 1
Project Location: Phoenx, Arizona
Client: Olsson Associates
Material: Native
Sample Source: See Below
Sample Prep: And at 2% Below Optimum Moisture

Project Number: 10-G-1735
Work Order Number: 1
Lab Number: See Below
Sample Date: 3/18/10
Load: 100 psf

One Dimensional Swell or Settlement Potential of Cohesive Soils (ASTM D-4546)

Lab Number	Sample Description	Initial Reading (in)	Final Reading (in)	% Swell
6	Bulk Sample B-1 @ 15'-20'	0.00	0.0025	0.25
7	Bulk Sample B-2 @ 15'-20'	0.00	0.0031	0.31

Reviewed by: AC

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1735
Project Location:	Phoenix, Arizona	**Work Order Number:**	1
Client:	Olsson Associates	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	3/18/10
Sample Source:	See Below		

Density of Soil in Place by the Drive-Cylinder Method (ASTM D2937)

Lab Number	Boring	Wet Wt. (g)	Moisture Dry Wt. (g)	Moist. Content	# Of Rings	Wet Wt'+ Rings (g)	Wt.of Rings (g)	Dry Density (pcf)
8	**Ring Sample B-1 @ 5'-6'**	117.9	107.9	**9.3%**	6	1064.9	258.2	**101.9**
9	**Ring Sample B-1 @ 20'-21'**	102.2	92.0	**11.1%**	6	1157.7	259.8	**111.5**
10	**Ring Sample B-2 @ 20'-21'**	103.5	91.8	**12.7%**	6	1077.4	263.7	**99.6**
11	**Ring Sample B-2 @ 25'-26'**	104.7	94.7	**10.6%**	6	1116.7	266.5	**106.1**

Reviewed by: AC

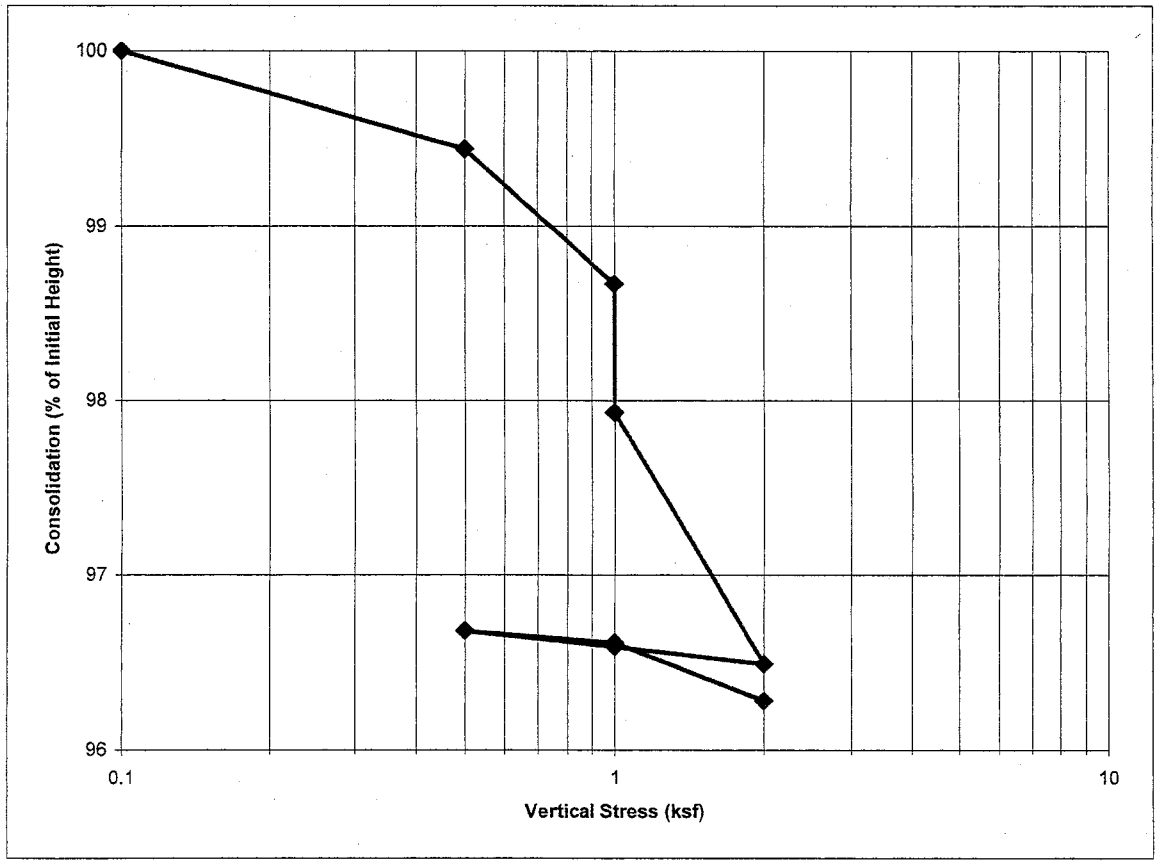
Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

Project:	Arcadia Drive Drainage Improvement - Phase 1	**Project Number:**	10-G-1735
Project Loaction:	Phoenix, Arizona	**Work Order Number:**	1
Client:	Olsson Associates	**Lab Number:**	12
Material:	Native	**Date Sampled:**	03/18/10
Sample Source:	Ring Sample B-1 @ 15'-16'		
Sample Prep:	Insitu		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.43
Initial Moisture Content	15.6%	Final Moisture Content	31.3%
Initial Dry Density(pcf)	85.7	Final Dry Density(pcf)	89.0
Initial Degree of Saturation	45%	Final Degree of Saturation	97%
Initial Void Ratio	0.9	Final Void Ratio	0.9
Estimated Specific Gravity	2.65	Saturated at	1 ksf



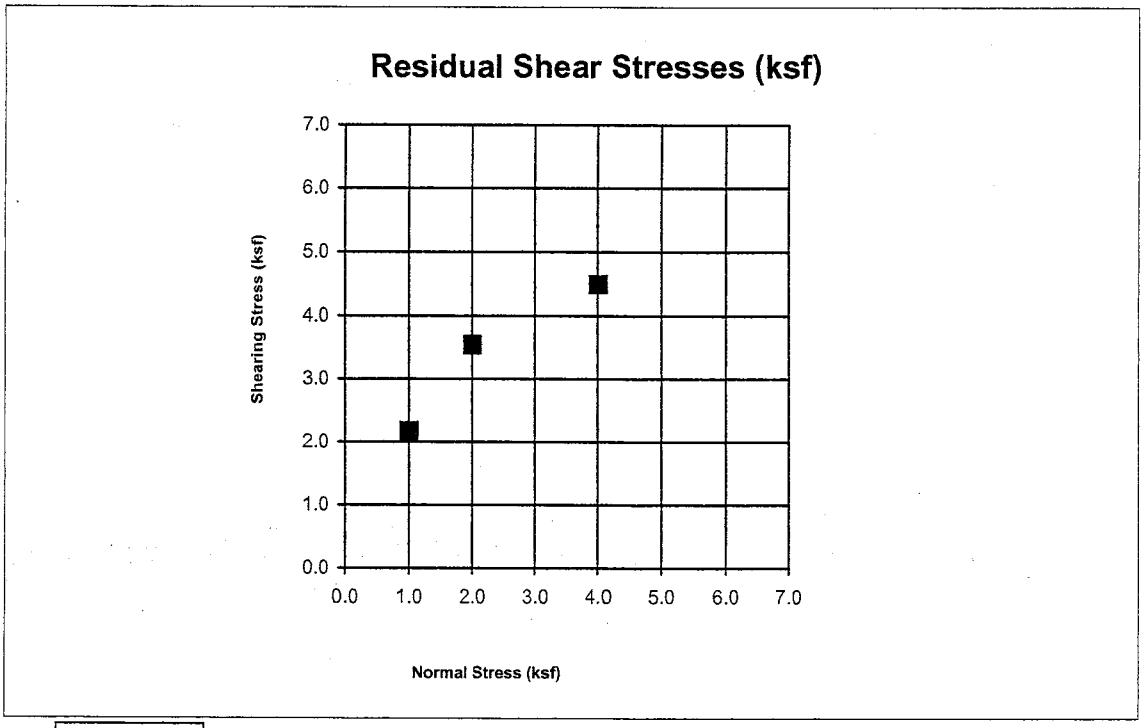
Reviewed by: AC

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

PROJECT:	Arcadia Drive Drainage Improvement-Phase I	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**ALPHA JOB NO:**	10-G-1735
MATERIAL:	Soil	**WORK ORDER NO:**	214
SAMPLE SOURCE:	Project Site	**LAB NO:**	299
SAMPLE PREPARATION:	Insitu	**DATE ASSIGNED:**	3/18/2010
	Innundated for 30 minutes prior to shear		

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

Initial thickness of specimen (in.):	1.00		
Initial diameter of specimen (in.):	2.42		
Shearing device used:	DigiShear Automated Shear Test System by Trautwein Soil Testing Equipment		
Rate of deformation (in/min):	0.016		
Direct shear point:	1	2	3
Dry mass of specimen (g):	122.8	122.8	119.6
Initial Moisture Content:	11.3%	12.9%	13.4%
Initial Wet Density (lb per cu.ft):	113.2	114.7	112.3
Initial Dry Density (lb per cu.ft):	101.7	101.7	99.1
Final Moisture Content:	26.7%	28.1%	25.8%
Final Wet Density (lb per cu.ft):	128.8	130.2	124.6
Final Dry Density (lb per cu.ft):	101.7	101.6	99.0
Normal Stress (ksf):	1.0	2.0	4.0
Maximum Shearing Stress (kips per sq. ft):	2.18	3.55	4.49
Vertical Deformation @ Max Shear (in):	0.014	0.017	0.028
Horizontal Deformation @ Max Shear (in):	0.403	0.402	0.402



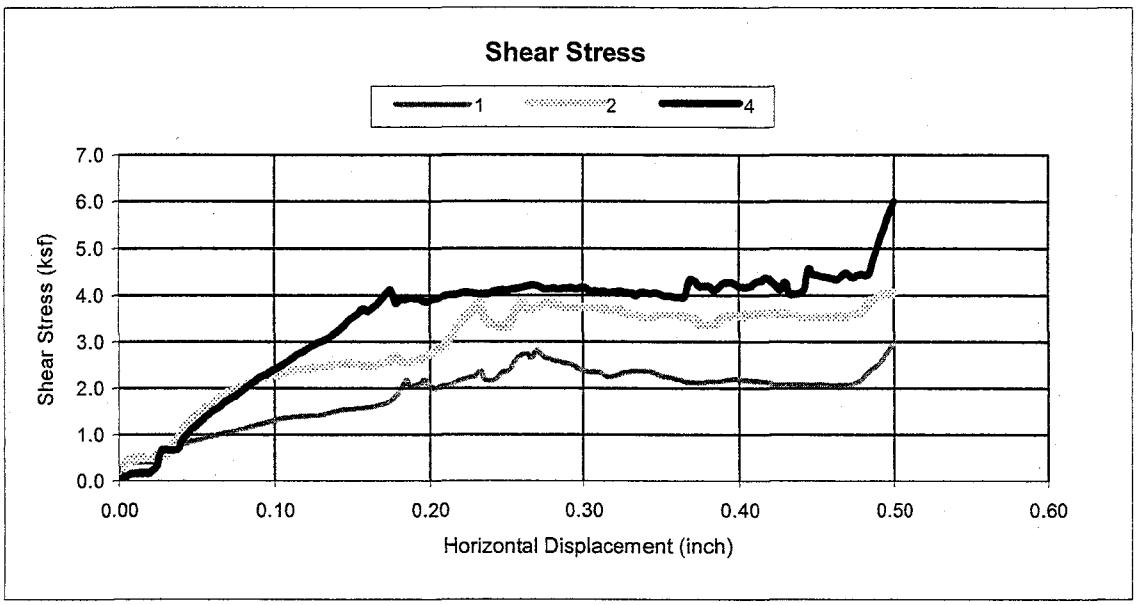
AASHTO R18

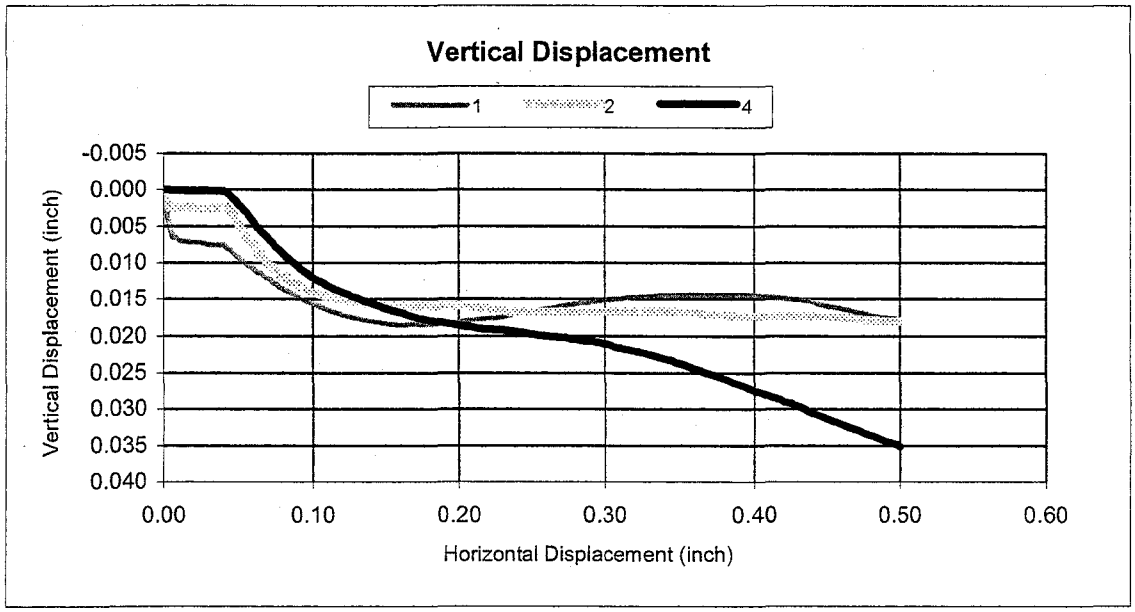
REVIEWED BY AO

PROJECT:	Arcadia Drive Drainage Improvement-Phase I	**JOB NO:**	3-119-000186
LOCATION:	Phoenix, Arizona	**ALPHA JOB NO:**	10-G-1735
MATERIAL:	Soil	**WORK ORDER NO:**	214
SAMPLE SOURCE:	Project Site	**LAB NO:**	299
SAMPLE PREPARATION:	Insitu Innundated for 30 minutes prior to shear	**DATE ASSIGNED:**	3/18/2010

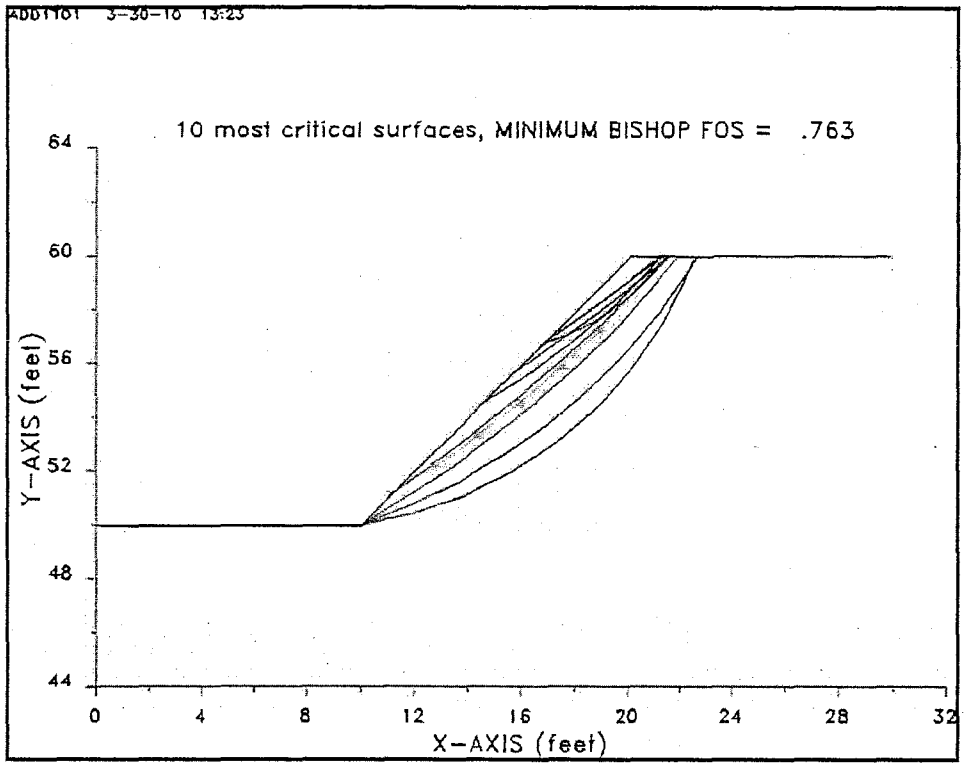
NORMAL LOADS (ksf): 1 2 4

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS(ASTM D3080)

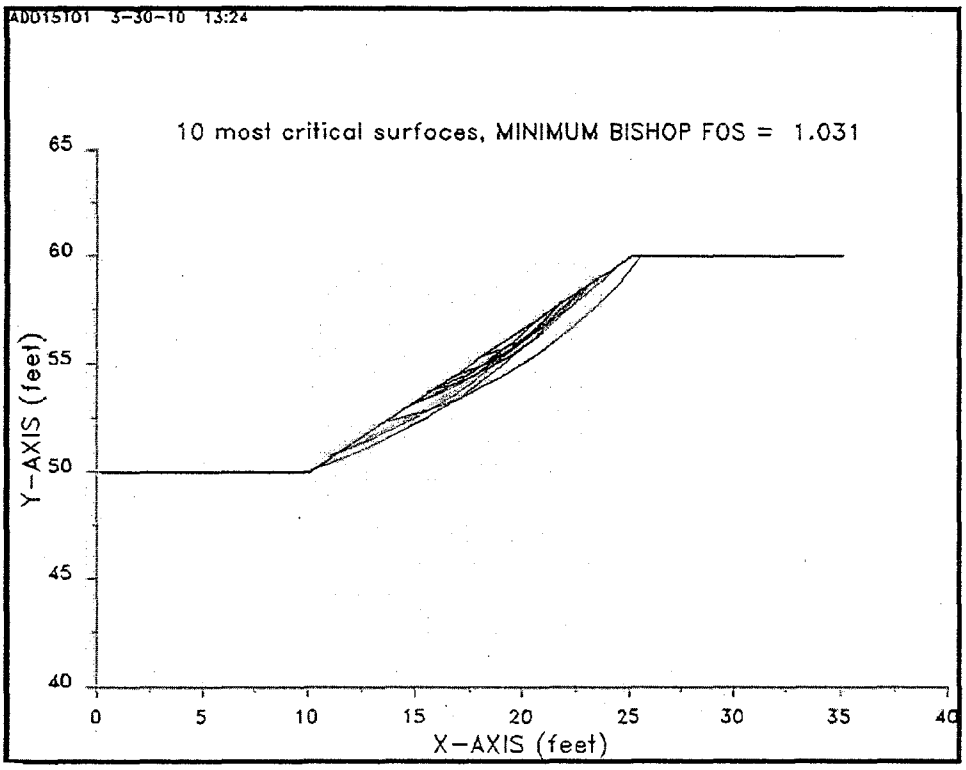




APPENDIX D
Slope Stability Analysis



Existing Slope Adjacent to 48th Street 1 (H) to 1 (V)



Slope 11/2 (H) to 1 (V)

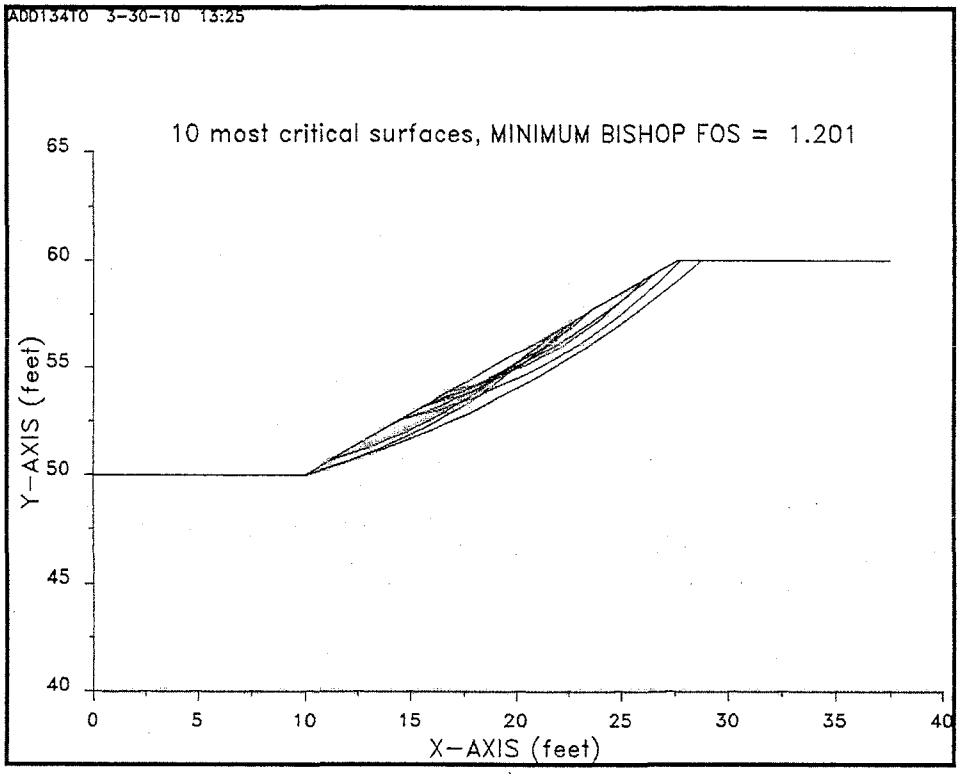
ALPHA
Geotechnical and Materials, Inc.
2504 W. Southern Avenue
Tempe, AZ 85282

Slope Stability Analysis (1 of 3)

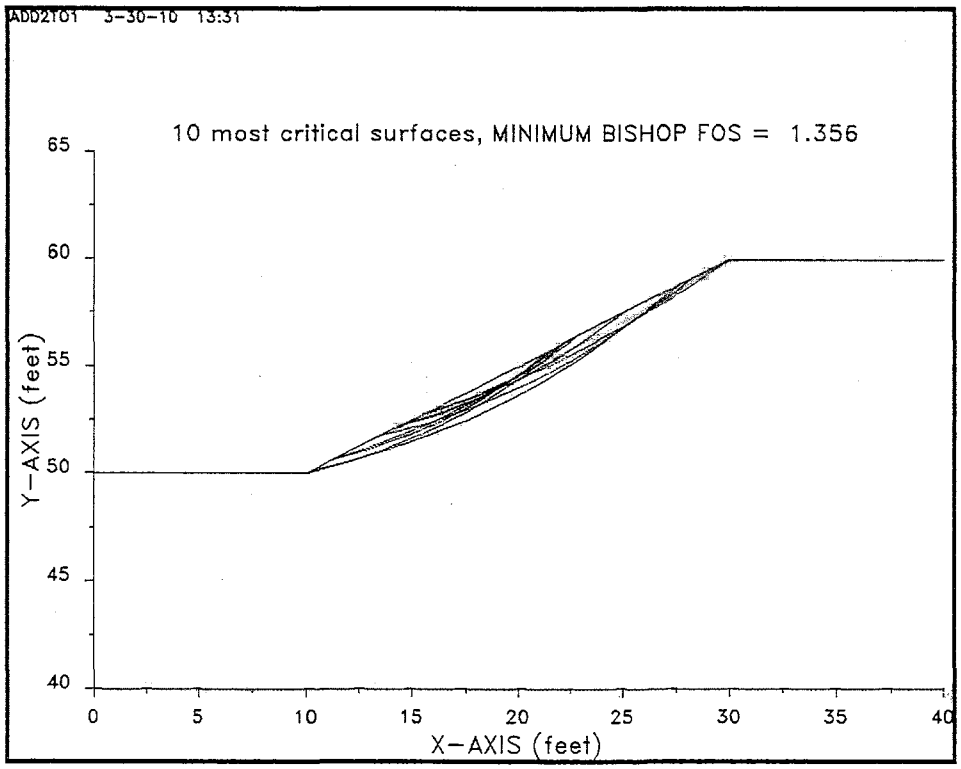
Project: Arcadia Drive Drainage Improvement - Phase 1, 10-G-1735

Location: Phoenix, Arizona

Date: 03/30/10 | Drawn By: J Floyd



Slope 1 3/4 (H) to 1 (V)



Slope 2 (H) to 1 (V)

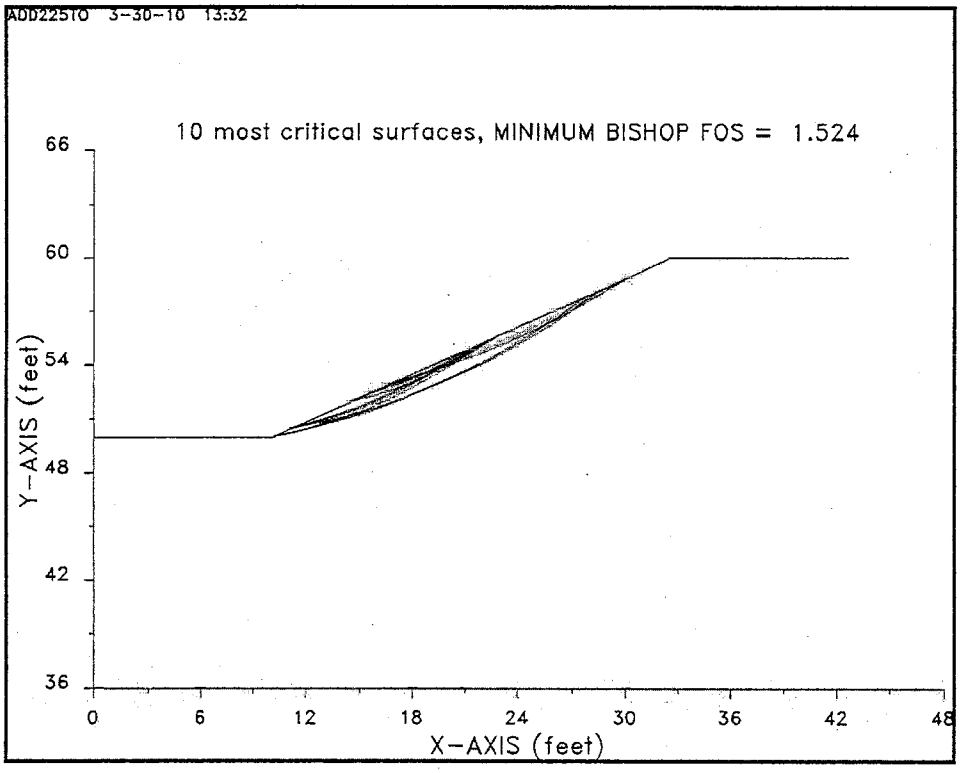
ALPHA
Geotechnical and Materials, Inc.
2504 W. Southern Avenue
Tempe, AZ 85282

Slope Stability Analysis (2 of 3)

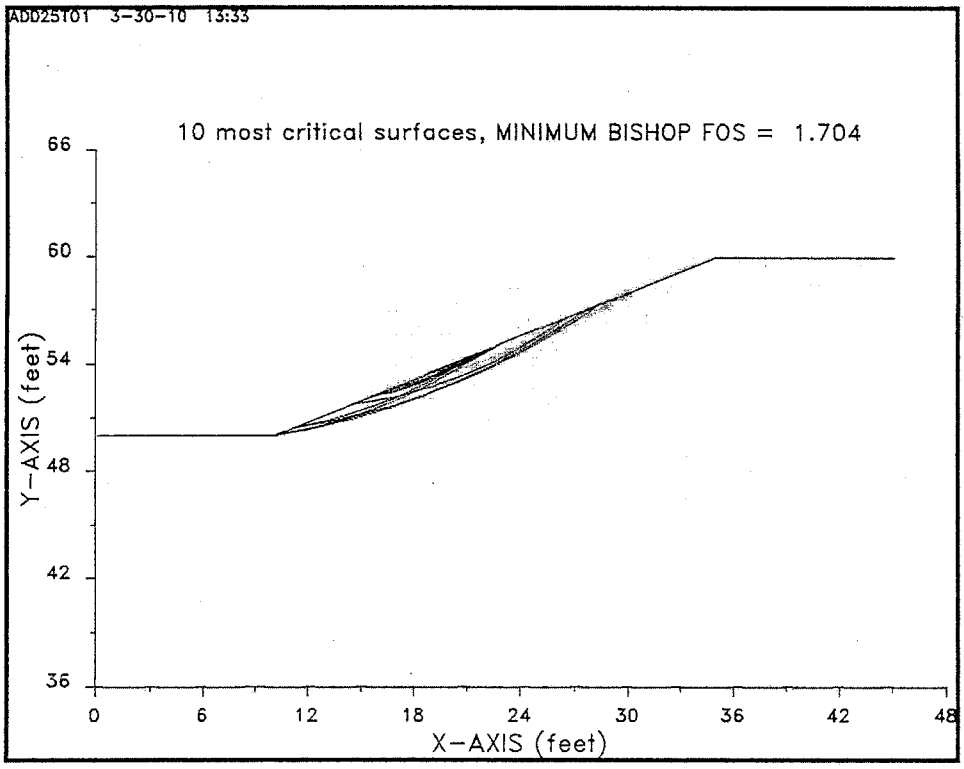
Project: Arcadia Drive Drainage Improvement - Phase 1, 10-G-1735

Location: Phoenix, Arizona

Date: 03/30/10 | **Drawn By:** J Floyd



Slope 2 1/4 (H) to 1 (V)



Slope 2 1/2 (H) to 1 (V)

ALPHA
Geotechnical and Materials, Inc.
2504 W. Southern Avenue
Tempe, AZ 85282

Slope Stability Analysis (3 of 3)

Project: Arcadia Drive Drainage Improvement - Phase 1, 10-G-1735	
Location: Phoenix, Arizona	
Date: 03/30/10	Drawn By: J Floyd

Appendix I

Construction Plans

CITY OF PHOENIX
STREET TRANSPORTATION DEPARTMENT
DESIGN & CONSTRUCTION MANAGEMENT DIVISION

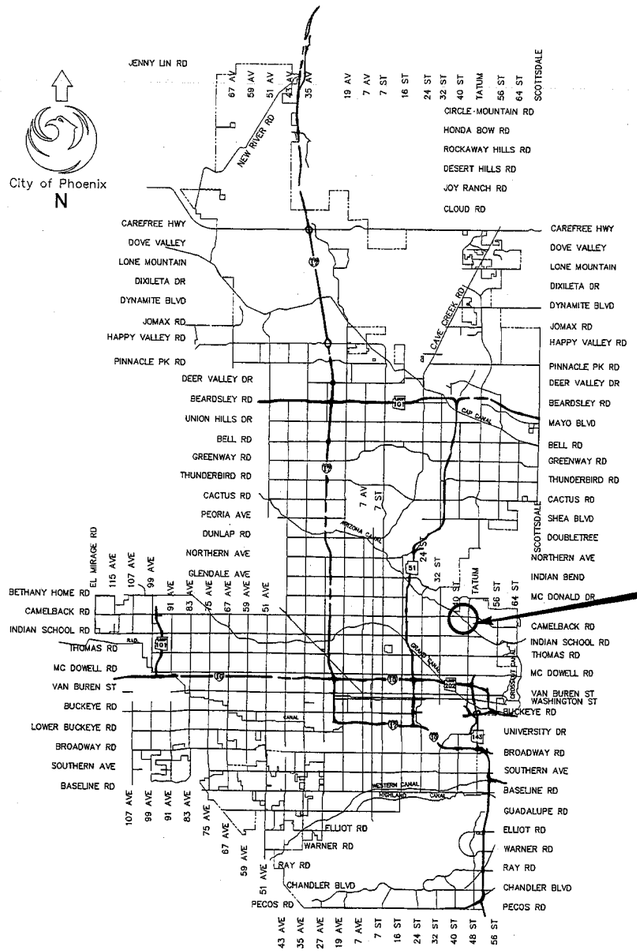
OLD CROSS CUT CANAL IMPROVEMENTS
ARIZONA CANAL TO INDIAN SCHOOL ROAD
ST83110066

2010

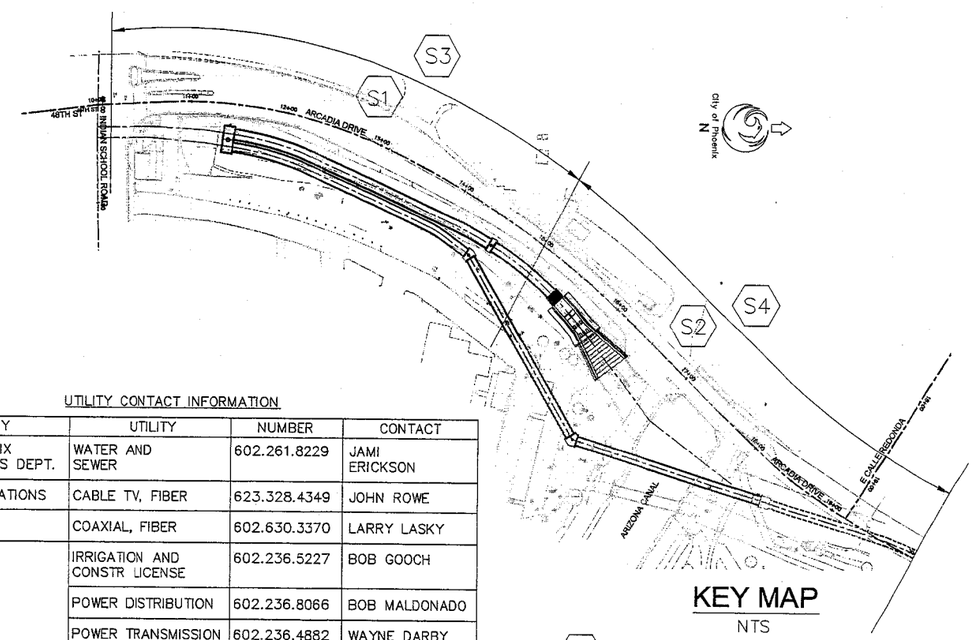
PRELIMINARY 100% REVIEW NOT FOR CONSTRUCTION OR RECORDING	F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
	9	ARIZ.	ST83110066	1	24

OLSSON ASSOCIATES — CONSULTING ENGINEER

DES: DVD DR: JLD CK: JCF DATE: 8/10



VICINITY MAP



KEY MAP
NTS

S1 STORM DRAIN PLAN/PROFILE SHEETS

LENGTH OF PROJECT = 650 LF = 0.123 MILES
AREA OF DISTURBANCE = 1.56 ACRES

UTILITY CONTACT INFORMATION

COMPANY	UTILITY	NUMBER	CONTACT
CITY OF PHOENIX WATER SERVICES DEPT.	WATER AND SEWER	602.261.8229	JAMI ERICKSON
COX COMMUNICATIONS	CABLE TV, FIBER	623.328.4349	JOHN ROWE
QWEST LOCAL	COAXIAL, FIBER	602.630.3370	LARRY LASKY
SRP	IRRIGATION AND CONSTR LICENSE	602.236.5227	BOB GOOCH
	POWER DISTRIBUTION	602.236.8066	BOB MALDONADO
	POWER TRANSMISSION	602.236.4882	WAYNE DARBY
SOUTHWEST GAS	GAS	480.730.3855	ZACH STEVENSON

APPROVED _____ DEPUTY STREET TRANSPORTATION DIRECTOR _____ DATE

APPROVED _____ ASSISTANT STREET TRANSPORTATION DIRECTOR _____ DATE

APPROVED _____ FLOOD CONTROL DISTRICT OF MARICOPA COUNTY _____ DATE

MAYOR
PHIL GORDON

CITY MANAGER
DAVID CAVAZOS

CITY COUNCIL

DISTRICT NO 1.	THELDA WILLIAMS
DISTRICT NO 2.	PEGGY NEELY
DISTRICT NO 3.	BILL GATES
DISTRICT NO 4.	TOM SIMPLOT
DISTRICT NO 5.	CLAUDE MATTOX
DISTRICT NO 6.	SAL DICICCIO
DISTRICT NO 7.	MICHAEL NOWAKOWSKI
DISTRICT NO 8.	MICHAEL JOHNSON

INDEX OF SHEETS

1	COVER SHEET
2	LEGEND AND NOTE SHEET
3	STORM DRAIN SUMMARY SHEET
4	ALTERNATE PIPE TABLE
5	GEOMETRIC PLAN
6 - 9	STORM DRAIN PLAN AND PROFILE SHEETS
10	GRADING PLAN
11-13	TRANSITION STRUCTURE DETAILS
14-22	INLET STRUCTURE DETAILS
23	SRP STANDARD DETAILS
24	SOIL BORING LOGS

CITY BENCHMARKS:

▲ TOP OF BRASS CAP IN HAND HOLE JUST EAST OF THE INTERSECTION OF 48TH ST AND INDIAN SCHOOL RD. (PROJECT BENCHMARK) ELEV=1243.301 (C.O.P. DATUM)

▲ TOP OF BRASS CAP IN HAND HOLE AT THE INTERSECTION OF 44TH ST AND INDIAN SCHOOL RD. ELELEV=V=1222.577 (C.O.P. DATUM)

THE BASIS OF BEARING IS THE SOUTH LINE OF THE SOUTHEAST QUARTER OF SECTION 19, TOWNSHIP 28 NORTH, RANGE 4 EAST OF THE GILA AND SALT RIVER MERIDIAN. SAID LINE BEARS N87°51'48", AS TAKEN FROM GDACS RECORDED IN BOOK 734 PAGE 10, RECORDS OF MARICOPA COUNTY, ARIZONA

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

"PER CITY OF PHOENIX ORDINANCE G-4396, THESE PLANS ARE FOR OFFICIAL USE ONLY AND MAY NOT BE SHARED WITH OTHERS EXCEPT AS REQUIRED TO FULFILL THE OBLIGATIONS OF YOUR CONTRACT WITH THE CITY OF PHOENIX."

PROJECT NUMBER: ST83110066 100% SUBMITTAL

ST83110066CS.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	2	24

OLSSON ASSOCIATES — 7250 North 16th Street, Suite 210, Phoenix, AZ 85020-5282, TEL 602.748.1000, FAX 602.748.1001 — CONSULTING ENGINEER

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

LEGEND

- BENCHMARK
- NEW SURVEY MONUMENT – M.A.G. DETAIL 120–1 TYPE "B"
- NEW SURVEY MONUMENT – M.A.G. DETAIL 120–1 TYPE "A"
- COMBINED CURB & GUTTER – M.A.G. DETAIL 220 TYPE "A"
- BACKFILL TYPE & SQ. YD. PVMT. REPLACEMENT – C.O.P. DETAIL P1200
- EXISTING CONCRETE PAVEMENT OR SIDEWALK
- NEW CONCRETE SIDEWALK – STD. DETAIL P1230
- NEW CONCRETE DRIVEWAY OR ALLEY ENT. PER DETAIL NO. ON PLANS
- NEW CONCRETE SIDEWALK RAMP PER DETAIL ON PLANS
- AVERAGE GROUND ELEVATION AT R/W LINE
- BACKFILL COMPACTION TYPE
- EXISTING DITCH
- 24" IRR SRP EXISTING IRRIGATION LINE W/SIZE (NOTE PRIVATE, SALT RIVER OR R.I.D.)
- EXISTING IRRIGATION STRUCTURE
- EXISTING IRRIGATION STANDPIPE
- NEW IRRIGATION STANDPIPE – M.A.G. DETAIL 503
- NEW IRRIGATION VALVE – M.A.G. DETAIL 506 W/ CONC. SCOURING BASIN
- IRRIGATION BERM
- NEW IRRIGATION STRUCTURE PER DETAIL ON PLANS
- 12" DIP W EXISTING WATER LINE W/SIZE & TYPE (12" AND SMALLER)
- 16" DIP W EXISTING WATER LINE W/SIZE & TYPE (GREATER THAN 12")
- ADJUST EXIST. WATER VALVE BOX – C.O.P. DETAIL P1391
- 3/4" W WATER SERVICE W/SIZE AND WATER METER BOX
- EXISTING FIRE HYDRANT
- NEW OR RELOCATED FIRE HYDRANT BY CONTRACTOR
- T.N. EXISTING WATER VALVE W/TOP OF OPERATING NUT ELEVATION
- 8" VCP S EXISTING SANITARY SEWER LINE W/SIZE & TYPE (12" AND SMALLER)
- 15" VCP S EXISTING SANITARY SEWER LINE W/SIZE & TYPE (GREATER THAN 12")
- EXISTING MANHOLE
- NEW MANHOLE
- CATCH BASIN, GUTTER INLET (LENGTH TO SCALE)
- CATCH BASIN, CURB INLET (LENGTH TO SCALE)
- CATCH BASIN, CURB & GUTTER INLET (LENGTH TO SCALE)
- 30" SD RCP EXISTING STORM DRAIN LINE W/SIZE & TYPE (GREATER THAN 12")
- NEW PIPE FOR STORM DRAIN OR IRRIGATION LINE
- 4"G EXISTING GAS LINE W/SIZE
- E EXISTING UNDERGROUND ELECTRIC CABLE OR SINGLE CONDUIT
- E-4D EXISTING UNDERGROUND ELECTRIC DUCT (SPECIFY NUMBER)
- T EXISTING TELEPHONE BURIED CABLE OR SINGLE CONDUIT
- T-4D EXISTING UNDERGROUND TELEPHONE DUCT (SPECIFY NUMBER)
- CATV EXISTING UNDERGROUND CABLE TV
- FO EXISTING UNDERGROUND FIBER OPTIC LINE
- EXISTING TRAFFIC SIGNAL POLE W/MAST ARM & SIGNAL INDICATIONS
- EXISTING STREET OR TRAFFIC SIGN
- EXISTING UTILITY POLE W/LINE INDICATING WIRE DIRECTION
- EXISTING WIRE FENCE
- EXISTING BLOCK FENCE
- EXISTING WOOD FENCE
- MAIL BOX
- EXISTING POWER POLE DOWN GUY ANCHOR
- EXISTING STREET LIGHT & POLE
- EXISTING TREE OR STUMP TO BE REMOVED – MORE THAN 12" DIA.
- EXISTING TREE TO BE TRANSPLANTED BY CONTRACTOR
- EASEMENT LINE
- EXISTING OR NEW R/W LINE
- PAVEMENT CENTER LINE OR MONUMENT LINE
- EXISTING TREE OR STUMP TO BE REMOVED 12" DIA. OR LESS (NON PAY ITEM)
- EXISTING TREE TO REMAIN

NOTES

1. ALL CONSTRUCTION SHALL BE PERFORMED IN ACCORDANCE WITH CONTRACT SPECIAL PROVISIONS, DETAILS, CONSTRUCTION PLANS, CITY OF PHOENIX SUPPLEMENTS TO MAG STANDARD SPECIFICATIONS AND DETAILS, AND MAG STANDARD SPECIFICATIONS AND DETAILS, IN THAT ORDER OF PRECEDENCE, AT THE TIME OF CONSTUCTION BID.
2. ALL STORM SEWER MANHOLES ARE TO BE CONSTRUCTED WITHOUT STEPS
3. PIPE CONNECTIONS TO EXISTING CONCRETE PIPE MAINS SHALL BE MADE IN ACCORDANCE WITH DETAILS CALLED OUT ON THE PLANS. CONNECTION TO MAINS SHALL NOT BE CLOSER THAN 5', CENTER TO CENTER.
4. PIPE CONNECTIONS TO NEW PRECAST CONCRETE PIPE MAINS, SHALL BE MADE WITH FACTORY MADE WYES OR TEES. THE DETAIL OF THE FITTINGS MUST BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO MANUFACTURE. PIPE CONNECTIONS TO NEW CAST IN PLACE CONCRETE PIPE MAINS SHALL BE MADE PER C.O.P. DETAIL P1576.
5. CATCH BASIN CONNECTOR PIPES SHALL BE LAID ON A STRAIGHT ALIGNMENT AND SLOPE UNLESS OTHERWISE SPECIFIED. IF BREAKS IN ALIGNMENT OR SLOPE ARE NECESSARY TO MEET FIELD CONDITIONS, THE MAXIMUM DEFLECTION SHALL BE 22–1/2°. THE BEND SHALL BE COLLARED ACCORDING TO C.O.P. DETAIL P1505. ANY ANGLE BENDS GREATER THAN 22–1/2° SHALL BE PREFABRICATED.
6. CONNECTOR PIPES SHALL CONNECT TO CATCH BASIN WALLS AT AN ANGLE NOT TO EXCEED 22–1/2° FROM PERPENDICULAR.
7. FACILITIES WHICH ARE NOT SPECIFICALLY LOCATED WITH ACTUAL VERTICAL AND HORIZONTAL CONTROLS, ARE LOCATED ONLY APPROXIMATELY AND TO THE BEST AVAILABLE INFORMATION PROVIDED BY VARIOUS OWNERS OF THE FACILITIES, AND SUPPLEMENTED BY VISUAL SURFACE INFORMATION WHERE APPROPRIATE. ACCURACY, LOCATION AND COMPLETENESS OF THIS INFORMATION SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO INITIATION OF CONSTRUCTION.
8. AT LEAST TWO WORKING DAYS BEFORE CONSTRUCTION, THE CONTRACTOR SHALL CONTACT BLUESTAKE TO FIND AND FLAG UNDERGROUND UTILITIES. THE CONTRACTOR SHALL CONTACT OTHER APPROPRIATE UTILITIES DIRECTLY IF THEY ARE NOT ON BLUESTAKE SYSTEM.
9. VERTICAL CONTROL IS BASED ON NATIONAL GEODETIC SURVEY.
10. UNLESS OTHERWISE NOTED, STATIONS SHOWN ON PIPE PROFILES ARE ALONG CENTERLINE OF PIPE.
11. UNLESS OTHERWISE NOTED, PIPE SHALL BE BEDDED IN ACCORDANCE WITH CITY OF PHOENIX DETAIL P1200.
12. CATCH BASINS ARE STATIONED PERPENDICULAR TO THE CENTERLINE OF THE STREET AT THE CENTERLINE OF THE MAINTENANCE BASIN OF THE CATCH BASIN.
13. SANITARY SEWER MAINS AND TAPS CROSSING OVER STORM DRAIN MAINS SHALL BE SUPPORTED PER M.A.G. DETAIL 403–1 AND 403–2.
14. ALL EXISTING PRECAST CONCRETE SAFETY CURBS, WHICH ARE INSIDE THE RIGHT OF WAY AND APPROXIMATELY PARALLEL TO THE NEW CURB LINE, SHALL BE RESET ON THE RIGHT OF WAY DIRECTLY OPPOSITE THEIR EXISTING LOCATION, WITH THE BACK EDGE ON THE RIGHT OF WAY LINE. ALL OTHER PRECAST CONCRETE SAFETY CURBS INSIDE THE STREET RIGHT OF WAY SHALL BE SALVAGED AND STOCK PILED FOR THE OWNER AT THE RIGHT OF WAY LINE.
15. EXISTING PRECAST CONCRETE SAFETY CURBS OUTSIDE THE RIGHT OF WAY, WHICH ARE DISTURBED BY NEW CONSTRUCTION, SHALL BE RESET IN THEIR ORIGINAL POSITION BY THE CONTRACTOR.
16. ALL EXISTING DRIVEWAYS AND ALL EXISTING ALLEYS SHALL BE GRADED TO MATCH THE NEW WORK IN ACCORDANCE WITH STD. DETAIL P1164, UNLESS OTHERWISE SPECIFIED. EXISTING SURFACING SHALL BE REMOVED AND REPLACED AS NECESSARY.

NOTES (cont.)

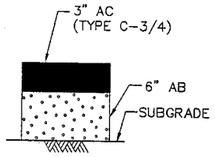
17. EXISTING IRRIGATION BERMS DISTURBED BY NEW CONSTRUCTION SHALL BE RECONSTRUCTED AS SHOWN ON PLANS.
18. CATCH BASIN ACCESS FRAME AND COVERS SHALL BE CONSTRUCTED PER C.O.P. DETAIL P1561.
19. THERE ARE SEVERAL OTHER CONSTRUCTION PROJECTS IN THE AREA THAT WILL TAKE PLACE CONCURRENTLY WITH THE PROPOSED PROJECT. THE CONTRACTOR SHALL COORDINATE THE CONSTRUCTION WORK WITH THESE OTHER PROJECTS AND SCHEDULE THE WORK ACCORDINGLY. THESE OTHER PROJECTS ARE:
    - ST87600045 – ARCADIA PORTAL MULTI–USE TRAIL ENHANCEMENT
    - ST83140025 – 48TH STREET SIDEWALK IMPROVEMENTS, INDIAN SCHOOL ROAD TO CALLE REDONDA
    - ST8150005 – ARCADIA DRIVE PAVING AND GRADING IMPROVEMENTS

STRUCTURAL NOTES

1. "CLEAR" DIMENSIONS FOR DEPTH OF REINFORCING STEEL ARE FROM FACE OF CONCRETE TO FACE OF BARS.
2. ALL EXPOSED EDGES OF CONCRETE SHALL BE BEVELED OR ROUNDED.
3. ALL EXPOSED CONCRETE SURFACES SHALL BE FINISHED IN ACCORDANCE WITH ARIZONA DEPT. OF TRANSPORTATION STANDARD SPECIFICATION 601–3.05 – FINISHING CONCRETE, UNLESS OTHERWISE SPECIFIED.

ABBREVIATIONS

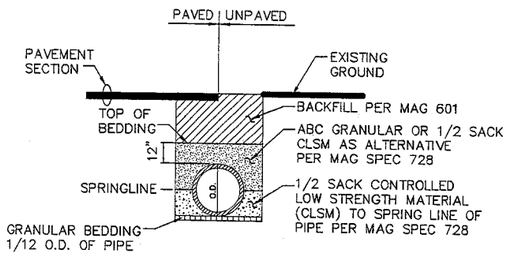
BC	BRASS CAP	PIP	PROTECT IN PLACE
℄	CENTERLINE	PP	PRIVATE PROPERTY
CIPP	CAST IN PLACE PIPE	R/W	RIGHT OF WAY
C.O.P.	CITY OF PHOENIX	S	SLOPE
HH	HAND HOLE	SD	STORM DRAIN
INV	INVERT	STD	STANDARD
M	MONUMENT LINE	TYP.	TYPICAL



TOTAL THICKNESS = 9"

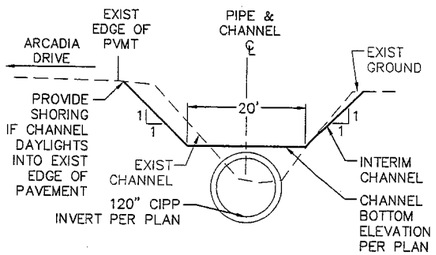
PAVEMENT REPLACEMENT SECTION

NOT TO SCALE



TYPICAL PIPE TRENCH DETAIL

NOT TO SCALE



TYPICAL SECTION
INTERIM CHANNEL

NOT TO SCALE

PRELIMINARY
100%
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

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

"PER CITY OF PHOENIX ORDINANCE G–4396, THESE PLANS ARE FOR OFFICIAL USE ONLY AND MAY NOT BE SHARED WITH OTHERS EXCEPT AS REQUIRED TO FULFILL THE OBLIGATIONS OF YOUR CONTRACT WITH THE CITY OF PHOENIX."

LEGEND AND NOTES

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	2	24
SCALE NONE				

ST83110066LN.dwg, 8/2/10

STORM DRAIN SUMMARY

ITEM NO.	DESCRIPTION	UNIT	SHEET NUMBERS 6	7	8	9	11	15	TOTAL QTY
	SEE ALTERNATE PIPE TABLE (SHEET 4)								
	FOR MAINLINE & CONNECTOR PIPES								
M3002220	PERMANENT PAVEMENT REPLACEMENT (ASPHALT PARKING AREAS OR ASPHALT DRIVEWAYS)	SQ. YD.				154			154
C3002225	PERMANENT PAVEMENT REPLACEMENT (PER PLANS), CONTINGENT ITEM	SQ. FT.			994	206			1200
M3400445	REPLACE CONCRETE SIDEWALK	SQ. FT.				241			241
M3402222	CONCRETE SINGLE CURB, STD. DETAIL 222, TYPE "B"	LIN. FT.				126			126
M3500010	REMOVE PORTLAND CEMENT CONCRETE SINGLE CURB; CURB AND GUTTER; HEADER CURB AND EMBANKMENT CURB	LIN. FT.				126			126
M3500015	REMOVE EXISTING HANDRAIL	LIN. FT.		51					51
M3500026	REMOVE AND REPLACE DECORATIVE PAVERS	EACH				7			7
M3500030	REMOVE STRUCTURES, BACKFILL & COMPACT	JOB					1		1
M3500031	REMOVE AND REPLACE HEADWALL PER DETAIL	JOB		1					1
M3500150	REMOVE TREE, 12" DIAM. AND LARGER	EACH		6					5
M3500304	REMOVE CONCRETE DITCH	SQ. FT.	4618	4760		1263			10,641
M3500307	REMOVE AND REINSTALL EXISTING TRAFFIC SIGNS	JOB				1			1
M4200013	8-FOOT CHAIN LINK FENCE (GALV)	LIN. FT.						335	335
M4201006	REMOVE & REPLACE 6-FOOT CHAIN LINK FENCE	LIN. FT.	235						235
M4311000	RELOCATE PALM TREE	EACH		2					2
M5052074	CONCRETE CHANNEL LINING PER PLANS	SQ. YD.				141			141
M5057082	JUNCTION STRUCTURE AS DETAILED	EACH	1						1
M5057093	INLET STRUCTURE PER SPECIAL DETAIL	EACH		1					1
M6012000	WATERLINE REPLACEMENT	EACH				1			1
M6106001	REMOVE EXISTING VALVE, BOX & COVER	EACH				1			1
M6180102	102" STORM SEWER PIPE	LIN. FT.			332	355			687
M6180120	120" STORM SEWER PIPE	LIN. FT.	335	37					372
M6180427	PIPE PLUG, STANDARD DETAIL 427	EACH				1			1
M6186081	102"X102"X18" PREFABRICATED TEE	EACH				1			1
M6250015	STORM SEWER MANHOLE BASE TRANSITION, PHOENIX SUPP. DETAIL P-1560 AND MAG STD. DETAIL 522	EACH	1		1	1			3
M6303006	6" VALVE, BOX AND COVER, FURNISH AND INSTALL	EACH				1			1
Y0390080	SALVAGED ROCKS AND BOULDERS BOULDERS (2' OR MORE SQUARE)	EACH	8						8

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	3	24

OLSSON ASSOCIATES
2122 North 16th Street
Suite 210
Phoenix, AZ 85006-4362
TEL 602.748.1000
FAX 602.748.1001
CONSULTING ENGINEER

DES: DVD DR: JLD CK: JCF DATE: 8/10

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STORM DRAIN SUMMARY

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10		
SCALE NONE			3	24

ST83110066SDS.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

STORM DRAIN
ALTERNATE PIPE MATERIAL

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	4	24

OLSSON ASSOCIATES — 7250 North 16th Street, Suite 210, Phoenix, AZ 85020-5282, TEL 602.748.1000, FAX 602.748.1001 — CONSULTING ENGINEER

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MAIN LINE PIPE

STATION FROM	STATION TO	QUANTITY L.F.	PIPE DIAMETER R.C.P. (I.D.) IN.	PIPE DIAMETER HDPE *** (I.D.) IN.	PIPE DIAMETER CIPP & C.S.P. (I.D.) IN.	DEPTH TO TOP OF PIPE MIN. (FT.)	DEPTH TO TOP OF PIPE MAX. (FT.)	MAX TRENCH WIDTH AT TOP OF PIPE R.C.P.,C.S.P., & HDPE *** FT.	REINFORCED CONCRETE PIPE ** MIN. D-LOAD (TO PRODUCE 0.01" CRACK)	REINFORCED CONCRETE PIPE ** PIPE CLASS	CAST-IN-PLACE CONCRETE PIPE **** MINIMUM WALL THICKNESS IN.	CORRUGATED STEEL PIPES $2\frac{2}{3}$" x $\frac{1}{2}$" CORR. TYPE "F"* MIN. GAGE	CORRUGATED STEEL PIPES 3" x 1" CORR. TYPE "F"* MIN. GAGE
11+47.01, 43.80' RT	15+40.02, 93.84' RT	371	102"	NA	NA	12.2	15.7	UNRESTRICTED	2000	IV	NA	NA	NA
15+40.02, 93.84' RT	16+16.09, 115.64' RT	71	102"	NA	NA	15.7	17.1	13.2	3000	V	NA	NA	NA
16+16.09, 115.64' RT	17+19.39, 98.09' RT	111	102"	NA	NA	17.1	18.2	UNRESTRICTED	3000	V	NA	NA	NA
17+19.39, 98.09' RT	17+82.47, 65.55' RT	71	102"	NA	NA	18.2	18.2	13.2	3000	V	NA	NA	NA
17+82.47, 65.55' RT	18+38.38, 38.67' RT	63	102"	NA	NA	17.8	18.2	UNRESTRICTED	3000	V	NA	NA	NA
11+47.46, 30.70' RT	15+37.57, 33.96' RT	372	NA	NA	120"	10.5	14.8	12.0	NA	NA	12"	NA	NA

CONNECTOR PIPE

LOCATION STATION (LT. or RT.)	QUANTITY L.F.	DEPTH TO TOP OF PIPE MIN. (FT.)	DEPTH TO TOP OF PIPE MAX (FT.)	PIPE DIA. R.C.P.,C.S.P., & HDPE *** (I.D.) IN.	R.C.P. ** MIN. D-LOAD (TO PRODUCE 0.01" CRACK)	C.S.P. $2\frac{2}{3}$" x $\frac{1}{2}$" CORR. ALUMINIZED TYPE "2" MIN. GAGE

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NO.	DESCRIPTION	REV BY	CKD BY	DATE

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NO.	DESCRIPTION	REV BY	CKD BY	DATE

GENERAL NOTES:

1. ONLY PIPE MATERIALS SPECIFIED ON THIS SHEET ARE ACCEPTABLE FOR THIS PROJECT.
2. WHERE MAXIMUM TRENCH WIDTH IS NOTED AS "UNRESTRICTED", PIPE STRENGTHS ARE SPECIFIED FOR A POSITIVE PROJECTING OR EMBANKMENT LOADING CONDITION. TRENCH WIDTH RESTRICTIONS FOR THE CAST-IN-PLACE CONCRETE PIPE OPERATION, SHALL COMPLY WITH SECTION 620.
3. CITY POLICY REQUIRES THAT CAST-IN-PLACE PIPE AND CORRUGATED STEEL PIPE MAINLINES BE UPSIZED A MINIMUM OF 6-INCHES GREATER DIAMETER THAN THE SPECIFIED REINFORCED CONCRETE PIPE DIAMETER. IF EITHER OF THESE OPTIONS ARE USED, THE CONTRACTOR SHALL BE RESPONSIBLE FOR RESOLVING ANY UTILITY CONFLICTS ASSOCIATED WITH THE INCREASED PIPE DIAMETER. MINIMUM WALL THICKNESS FOR CAST-IN-PLACE PIPE SHALL BE 1/12 OF INSIDE DIAMETER PLUS ONE INCH, BASED ON THE UPSIZED DIAMETER.
4. A MINIMUM OF 14 GAUGE IS REQUIRED FOR ALL CSP BY CITY OF PHOENIX TO OBTAIN DESIGN LIFE REQUIREMENTS OF 75 YEARS TO FIRST PERFORATION.
5. WHERE NEW MAINLINE STORM DRAIN CONNECTION TO EXISTING MAINLINE SYSTEM IS REQUIRED, AND THE NEW MAINLINE IS LARGER THAN THE EXISTING, (SUCH AS NEW 6" OVERSIZED CIPP OR CSP CONNECTING TO EXISTING RGRCP), PIPE INVERTS SHALL BE MATCHED. IN ALL OTHER CASES, INSIDE TOP OF PIPE (CROWN) ELEVATIONS SHALL BE MATCHED.
6. MAX TRENCH WIDTH AT TOP OF PIPE SHALL BE BASED ON MAG PAY WIDTH ON PROJECTS WITH MINIMUM PAVEMENT REPLACEMENT ("PATCH"). ON PROJECTS WITH NEW FULL PAVEMENT (SUCH AS MAJOR ARTERIAL STREET CONSTRUCTION PROJECTS), THE MAX TRENCH WIDTH SHALL BE LABELED, "UNRESTRICTED".

* TYPE "F" – COATED AND CONCRETE LINED CSP
CITY OF PHOENIX SUPPLEMENT TO MARICOPA ASSOCIATION OF GOVERNMENTS UNIFORM STANDARD SPECIFICATIONS.

** RUBBER GASKETED PIPE REQUIRED FOR ALL REINFORCED CONCRETE PIPE

*** HIGH DENSITY POLYETHYLENE (HDPE), TYPE "S" WITH WATERTIGHT JOINTS PER AASHTO 252, AASHTO M294, MAG AND CITY SUPPLEMENTS TO MAG. JOINTS SHALL MEET ASTM D-3212 WATERTIGHT REQUIREMENT (10.8 psi). MAXIMUM DIAMETER ALLOWED = 48-INCH.

**** THE MINIMUM DIAMETER FOR CIPP IS 30 INCHES

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ALTERNATE PIPE TABLE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10		
SCALE NONE			4	24

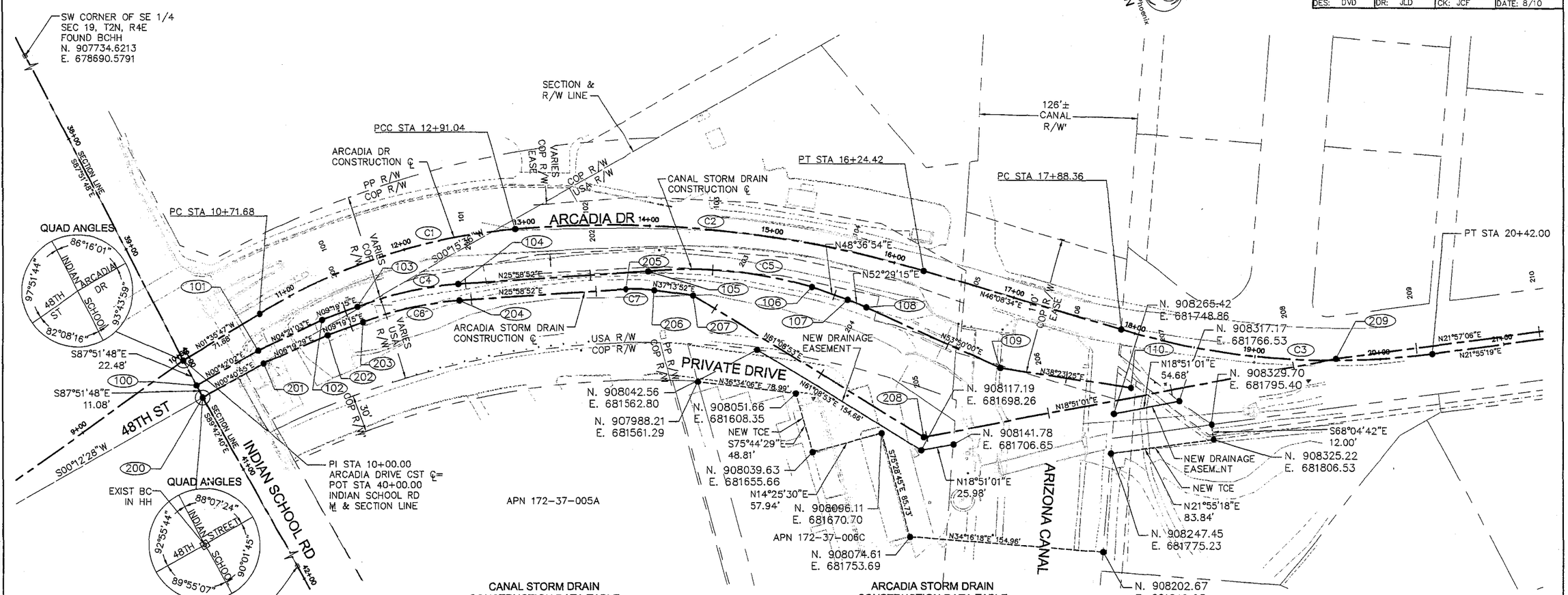
ST83110066APT.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

20 0 20 40
Scale in Feet
Horizontal Scale

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	5	24

OLSSON ASSOCIATES — CONSULTING ENGINEER
DES: DVD DR: JLD CK: JCF DATE: 8/10



NOTE:

KEEP AT LEAST ONE LANE ON ARCADIA DRIVE OPEN TO THE PUBILC FOR LOCAL TRAFFIC. ACCESS TO AND FROM THE FUNERAL HOME LOCATED AT 4800 EAST INDIAN SCHOOL ROAD TO BE MAINTAINED.

CANAL STORM DRAIN CONSTRUCTION DATA TABLE

PT#	SD STATION	CONSTR STATION	NORTHING	EASTING
100	98+65.39	9+96.92, 22.27' RT	907634.94	681362.34
101	99+22.62	10+55.71, 24.73' RT	907692.16	681363.04
102	99+80.00	11+15.51, 28.77' RT	907749.38	681367.40
103	100+10.00	11+47.46, 30.70' RT	907778.98	681372.26
104	100+93.97	12+37.47, 37.02' RT	907858.89	681397.16
105	102+47.29	13+99.69, 36.36' RT	907996.71	681464.33
106	103+80.47	15+37.57, 33.96' RT	908104.90	681540.61
107	104+11.33	15+69.47, 37.71' RT	908125.30	681563.76
108	104+27.77	15+86.43, 40.37' RT	908135.31	681576.80
109	105+45.77	17+05.09, 56.93' RT	908204.95	681672.07
110	106+51.18	18+08.12, 43.06' RT	908287.57	681737.53

ARCADIA STORM DRAIN CONSTRUCTION DATA TABLE

PT#	SD STATION	CONSTR STATION	NORTHING	EASTING
200	198+66.92	9+95.41, 33.25' RT	907634.53	681373.42
201	199+23.35	10+54.20, 35.73' RT	907690.95	681374.09
202	199+80.00	11+14.10, 41.81' RT	907747.26	681380.33
203	200+10.00	11+47.01, 43.80' RT	907776.86	681385.19
204	200+90.31	12+35.72, 50.03' RT	907853.29	681409.01
205	202+23.87	13+80.30, 51.21' RT	907973.24	681467.46
206	202+47.82	14+05.66, 51.30' RT	907993.61	681480.00
207	202+79.70	14+39.43, 53.49' RT	908018.98	681499.28
208	204+97.49	16+62.02,127.70' RT	908124.08	681690.04
209	208+34.77	19+64.65, 1.30' LT	908443.27	681799.02

CURVE DATA

C1
PI STA 11+83.36
N=907819.0668
E=681334.7685
MAIN CURVE
Δ=26°30'55"
D=12°05'16"
R=474.00'
L=219.36'
T=111.68'
EXT=12.98'
SUPER=N/C

C2
PI STA 14+59.66
N=908073.2755
E=681452.8702
MAIN CURVE
Δ=21°13'26"
D=06°21'58"
R=900.00'
L=333.38'
T=168.62'
EXT=15.66'
SUPER=N/C

C3
PI STA 19+17.11
N=908392.8993
E=681785.5052
MAIN CURVE
Δ=24°13'15"
D=09°32'57"
R=600.00'
L=253.64'
T=128.74'
EXT=13.66'
SUPER=N/C

C4
RADIUS CENTER
N=907730.2300
E=681669.28
MAIN CURVE
Δ=15°59'00"
D=19°02'07"
R=301.00'
L=83.97'
T=42.26'
EXT=2.95'
SUPER=N/C

C5
RADIUS CENTER
N=907852.7600
E=681783.3500
MAIN CURVE
Δ=27°51'19"
D=19°05'55"
R=300.00'
L=145.85'
T=74.40'
EXT=9.09'
SUPER=N/C

C6
RADIUS CENTER
N=907730.2300
E=681669.2800
MAIN CURVE
Δ=15°59'00"
D=19°54'06"
R=287.90'
L=80.31'
T=40.42'
EXT=2.82'
SUPER=N/C

C7
RADIUS CENTER
N=907919.7900
E=681577.1400
MAIN CURVE
Δ=11°15'00"
D=46°57'50"
R=122.00'
L=23.95'
T=12.02'
EXT=0.59'
SUPER=N/C

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GEOMETRIC PLAN

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

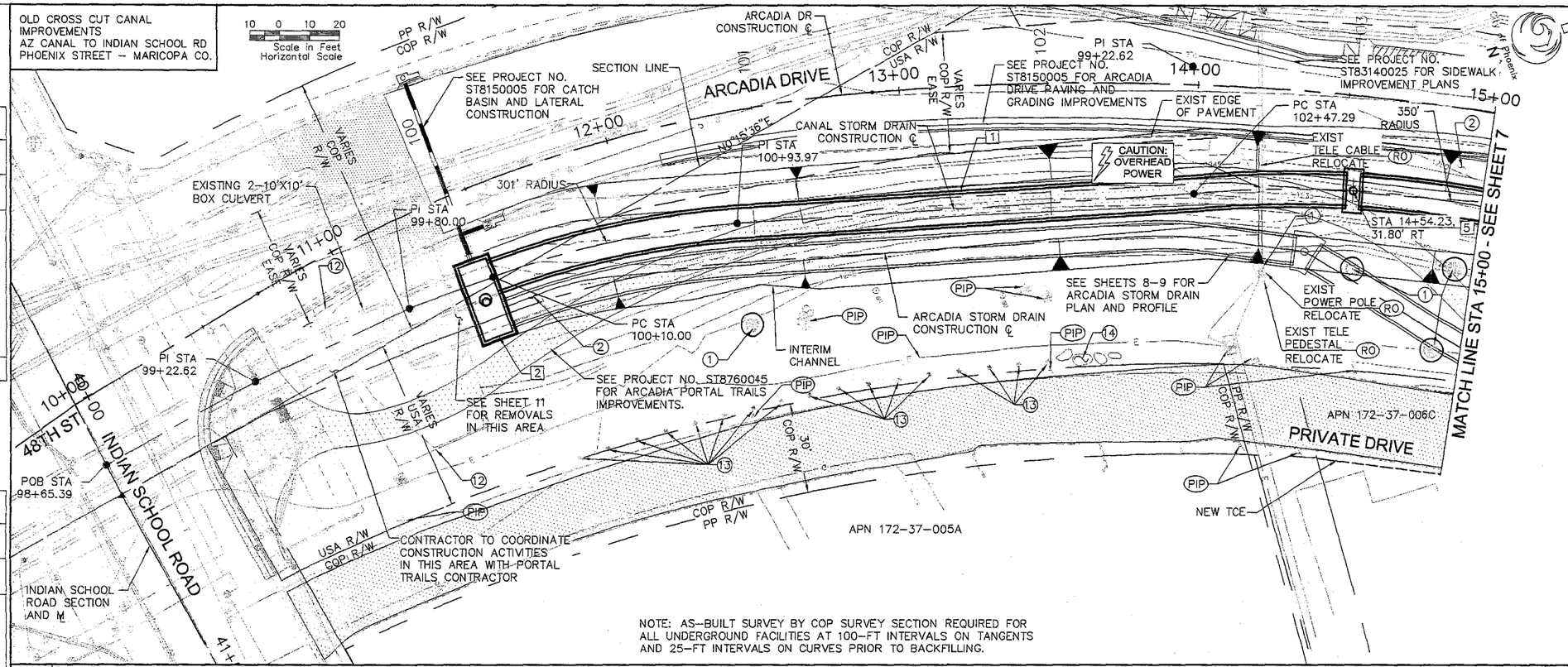
DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	5	24

SCALE 1"=40'

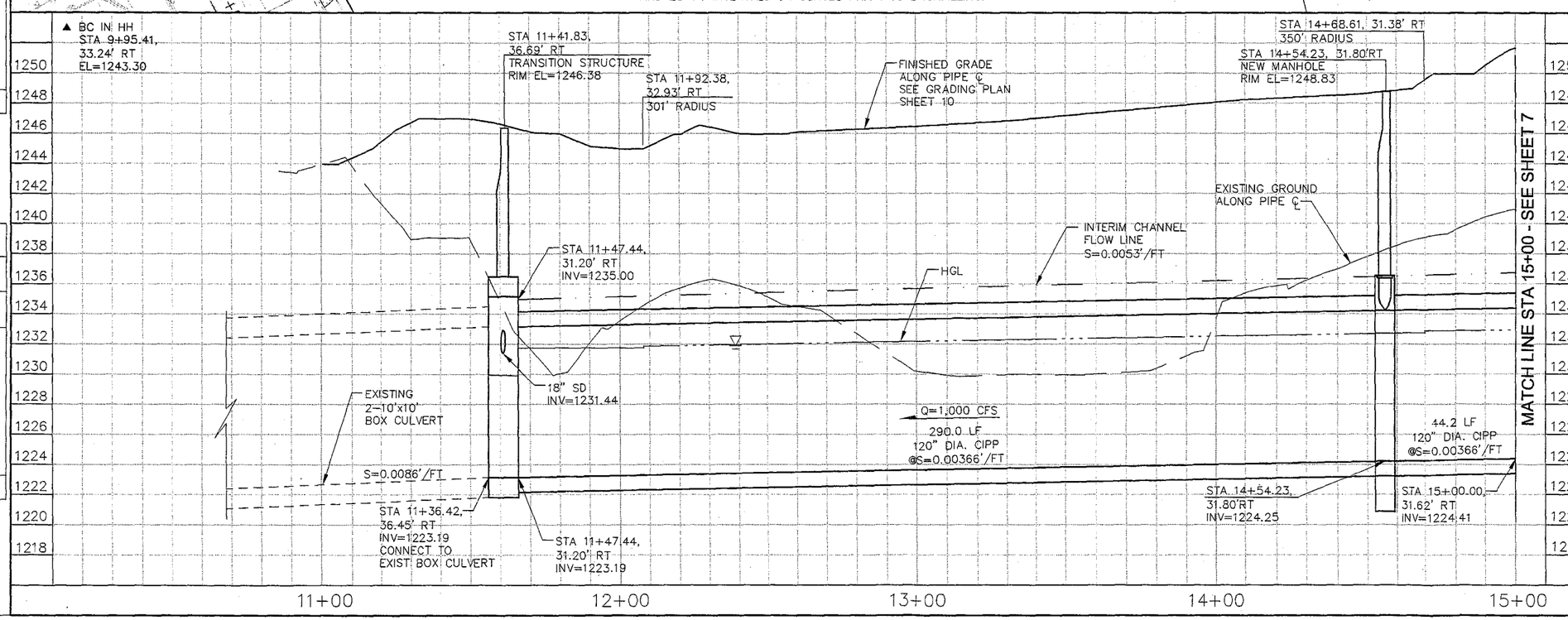
ST83110066GEO.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

Scale in Feet
Horizontal Scale
10 0 10 20



NOTE: AS–BUILT SURVEY BY COP SURVEY SECTION REQUIRED FOR ALL UNDERGROUND FACILITIES AT 100–FT INTERVALS ON TANGENTS AND 25–FT INTERVALS ON CURVES PRIOR TO BACKFILLING.



F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	6	24

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7250 North 16th Street, Suite 210, Phoenix, AZ 85020-5282, TEL 602.748.1000, FAX 602.748.1001

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

REMOVAL/RELOCATION NOTES

NO.	DESCRIPTION	UNIT	QTY
1	REMOVE EXISTING VEGETATION (SEE PLANT DISPOSITION DETAIL ON GRADING PLAN, SHEET 10)	JOB	1
2	REMOVE EXISTING CONCRETE CHANNEL LINING	SQ. FT.	4,618
12	REMOVE EXISTING CHAIN LINK FENCE, WITH GATE	LIN. FT.	235
13	REMOVE EXISTING WOOD POSTS	JOB	1
14	RELOCATE EXISTING BOULDERS (>2'). LOCATION TO BE COORDINATED WITH SRP.	EACH	8

CONSTRUCTION NOTES

NO.	DESCRIPTION	UNIT	QTY
1	CONSTRUCT NEW 120" DIA. CIPP	LIN. FT.	335
2	CONSTRUCT NEW TRANSITION STRUCTURE SEE DETAIL SHEET 11	EACH	1
5	CONSTRUCT NEW MANHOLE WITHOUT STEPS AND VENTED LID PER COP DETAIL P–1560 'F' = 28" FOR 120" PIPE	EACH	1

GENERAL NOTES

1. SEE PROJECT NO. ST8760045 FOR ARCADIA PORTAL TRAILS IMROVEMENTS.
2. PROTECT EXISTING LANDSCAPE IRRIGATION SYSTEM IN PLACE AND REPLACE ANY DAMAGED COMPONENT IN KIND.

(PIP) PROTECT IN PLACE
(R) RELOCATE
(RO) RELOCATE BY OTHERS

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CANAL STORM DRAIN
PLAN AND PROFILE
STA 10+00 TO 15+00

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	6	24
SCALE H 1"=20' V 1"=4'				

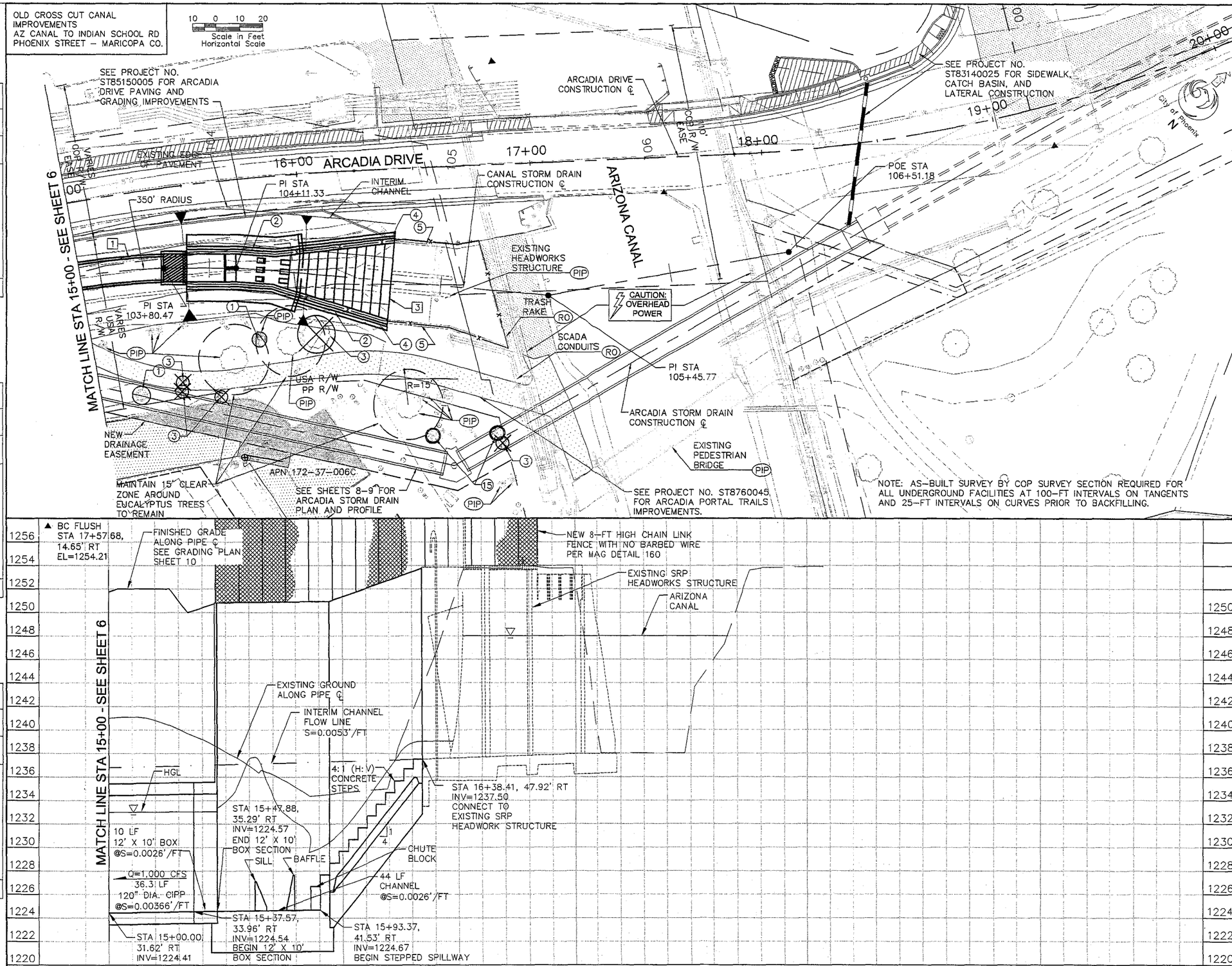
ST83110066S001.dwg, 8/2/10

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

10 0 10 20
Scale in Feet
Horizontal Scale



F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	7	24

OLSSON ASSOCIATES
7250 North 16th Street
Suite 210
Phoenix, AZ 85020-5282
TEL 602.748.1000
FAX 602.748.1001
CONSULTING ENGINEER

DES: DVD DR: JLD CK: JCF DATE: 8/10

REMOVAL/RELOCATION NOTES

NO.	DESCRIPTION	UNIT	QTY
1	REMOVE EXISTING VEGETATION (SEE PLANT DISPOSITION DETAIL ON GRADING PLAN, SHEET 10)	JOB	1
2	REMOVE EXISTING CONCRETE CHANNEL LINING	SQ. FT.	4,760
3	REMOVE EXISTING TREE (DIA. > 12")	EACH	5
4	REMOVE EXISTING CONCRETE WINGWALL	JOB	1
5	REMOVE EXISTING HANDRAIL	LIN. FT.	51
15	RELOCATE PALM TREE	EACH	2

CONSTRUCTION NOTES

NO.	DESCRIPTION	UNIT	QTY
1	CONSTRUCT NEW 120" DIA. CIPP	LIN. FT.	37
3	CONSTRUCT NEW INLET STRUCTURE SEE DETAIL SHEETS 12-13	EACH	1

GENERAL NOTES

1. SEE PROJECT NO. ST8760045 FOR ARCADIA PORTAL TRAILS IMROVEMENTS.
2. PROTECT EXISTING LANDSCAPE IRRIGATION SYSTEM IN PLACE AND REPLACE ANY DAMAGED COMPONENT IN KIND.
3. MAINTAIN 15' CLEAR ZONE AROUND EUCALYPTUS TREES TO REMAIN.

(PIP) PROTECT IN PLACE
(R) RELOCATE
(RO) RELOCATE BY OTHERS

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CANAL STORM DRAIN
PLAN AND PROFILE
STA 15+00 to 20+00

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	7	24

SCALE H 1"=20' V 1"=4'

ST83110066SD02.dwg, 8/2/10

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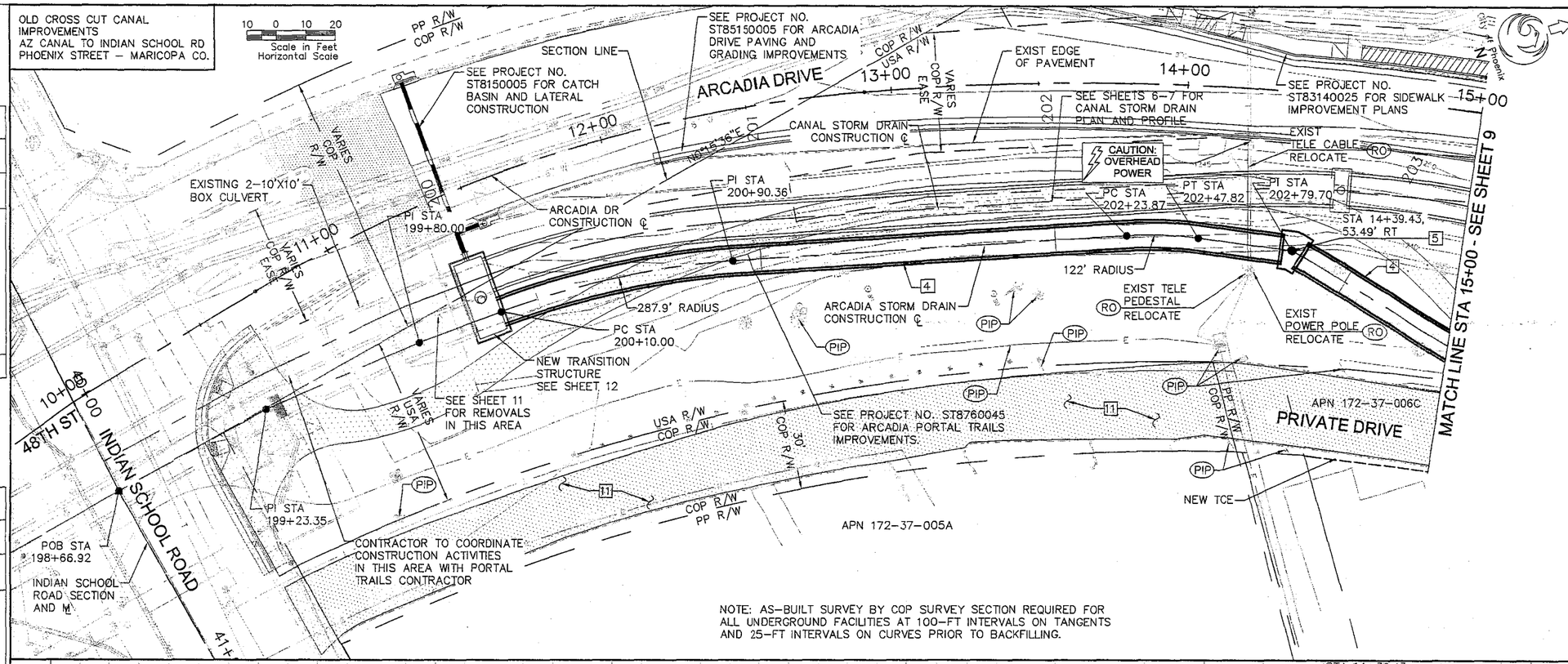
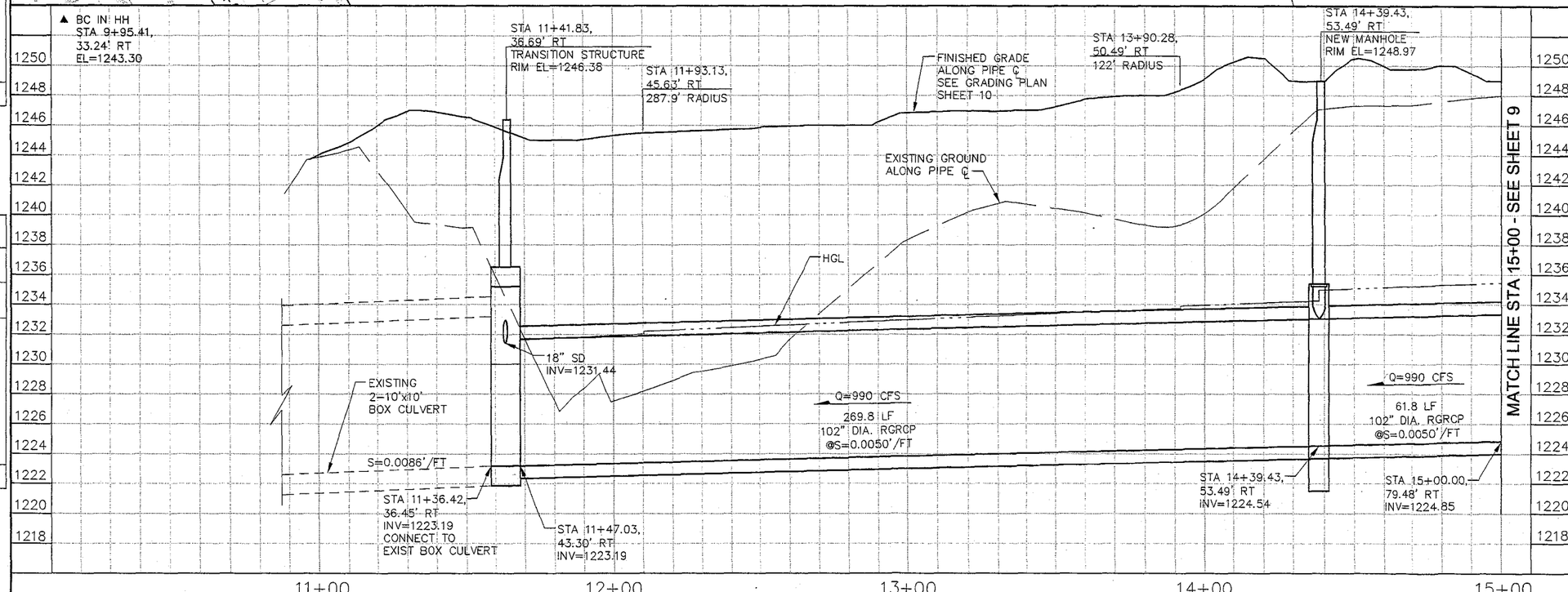
NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.





F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	8	24

OLSSON ASSOCIATES
7250 North 16th Street Suite 210 Phoenix, AZ 85020-5262 Phone 602.748.1000 FAX 602.748.1001
CONSULTING ENGINEER

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

REMOVAL/RELOCATION NOTES

NO.	DESCRIPTION	UNIT	QTY

CONSTRUCTION NOTES

NO.	DESCRIPTION	UNIT	QTY
4	FURNISH AND INSTALL 102" DIA. RGRCP	LIN. FT.	332
5	CONSTRUCT NEW MANHOLE WITHOUT STEPS PER COP DETAIL P–1560, MODIFIED FOR 24° BEND F=24¼" FOR 102" WALL 'A' F=26" FOR 102" WALL 'C'	EACH	1
11	PERMANENT PAVEMENT REPLACEMENT, CONTINGENT ITEM	SQ. YD.	994

GENERAL NOTES

1. SEE PROJECT NO. ST8760045 FOR ARCADIA PORTAL TRAILS IMROVEMENTS.
2. PROTECT EXISTING LANDSCAPE IRRIGATION SYSTEM IN PLACE AND REPLACE ANY DAMAGED COMPONENT IN KIND.

(PIP) PROTECT IN PLACE
(R) RELOCATE
(RO) RELOCATE BY OTHERS

PRELIMINARY
100%
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

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

"PER CITY OF PHOENIX ORDINANCE G–4396, THESE PLANS ARE FOR OFFICIAL USE ONLY AND MAY NOT BE SHARED WITH OTHERS EXCEPT AS REQUIRED TO FULFILL THE OBLIGATIONS OF YOUR CONTRACT WITH THE CITY OF PHOENIX."

ARCADIA STORM DRAIN
PLAN AND PROFILE
STA 10+00 TO 15+00

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	8	24
SCALE H 1"=20' V 1"=4'				

ST83110066SD03.dwg, 8/2/10

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

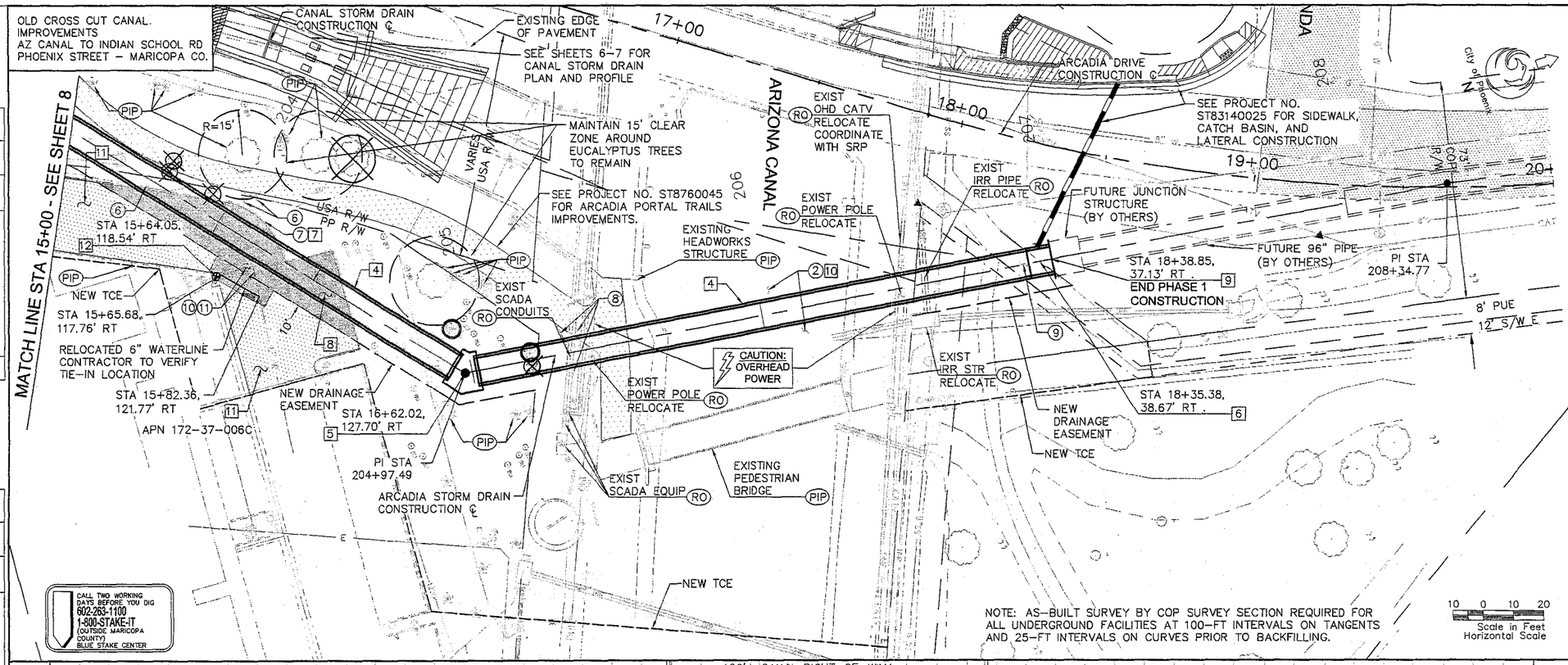
REVISION BY CITY OF PHOENIX

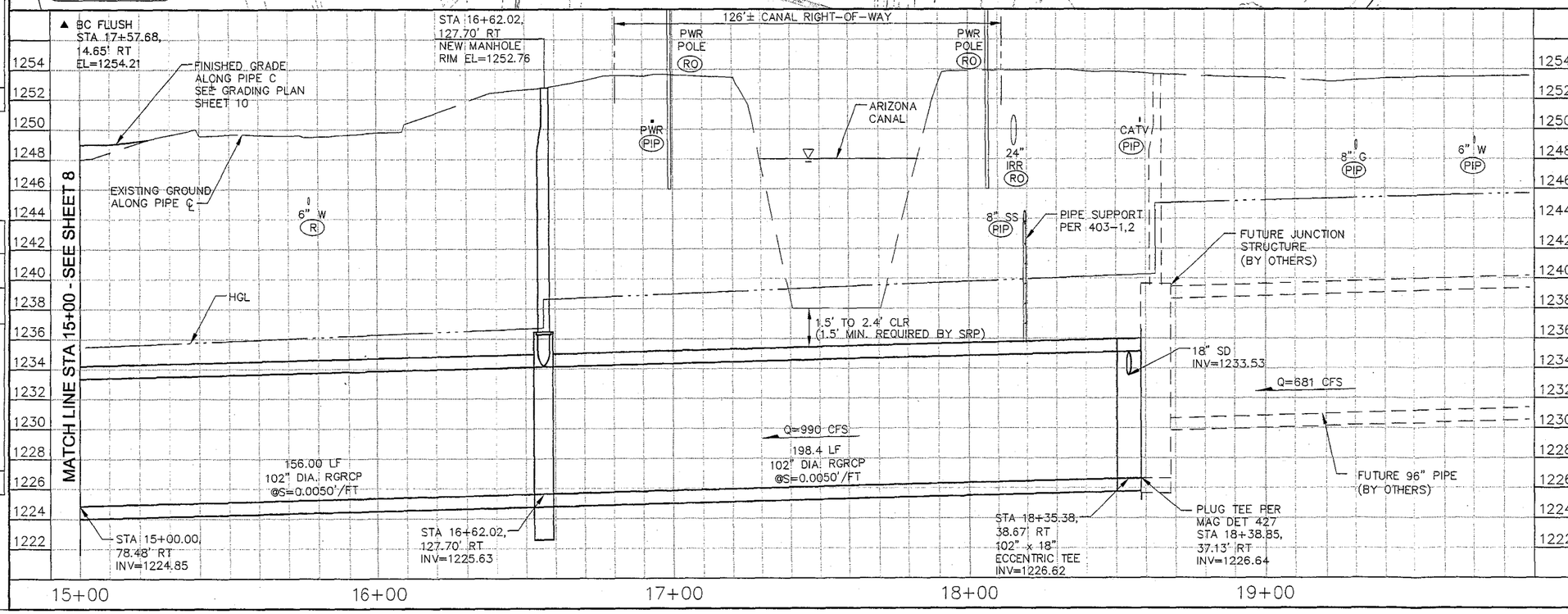
NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL.
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.





F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	9	24

OLSSON ASSOCIATES — CONSULTING ENGINEER

DES: DVD DR: JLD CK: JCF DATE: 8/10

REMOVAL/RELOCATION NOTES

NO.	DESCRIPTION	UNIT	QTY
2	REMOVE EXISTING CONCRETE CHANNEL LINING	SQ. FT.	1263
6	REMOVE AND SALVAGE EXISTING SIGN	JOB	1
7	REMOVE EXISTING CONCRETE CURB	LIN. FT.	126
8	SALVAGE AND RELOCATE EXISTING CONCRETE ART BLOCKS	EACH	7
9	REPLACE CONCRETE SIDEWALK	SQ. FT.	241
10	REMOVE EXISTING 6" WATER VALVE, BOX, AND COVER	EACH	1
11	RELOCATE EXISTING 6" WATERLINE	EACH	1

CONSTRUCTION NOTES

NO.	DESCRIPTION	UNIT	QTY
4	FURNISH AND INSTALL 102" DIA. RGRCP	LIN. FT.	355
5	CONSTRUCT NEW MANHOLE WITHOUT STEPS PER COP DETAIL P-1560, MODIFIED FOR 42° BEND F=24¼" FOR 102" WALL 'A' F=26" FOR 102" WALL 'C'	EACH	1
6	102"X18" ECCENTRIC TEE CONNECT TO 18" SD PER PROJECT ST8150005	EACH.	1
7	CONCRETE SINGLE CURB MAG DETAIL 222, TYPE "B"	LIN. FT.	126
8	PERMANENT PAVEMENT REPLACEMENT FOR ASPHALT PARKING AREA	SQ. YD.	154
9	CONSTRUCT PIPE PLUG PER MAG DET 427	EACH	1
10	CONSTRUCT NEW CANAL LINING PER DETAIL, SHT 23	SQ. YD.	141
11	PERMANENT PAVEMENT REPLACEMENT, CONTINGENT ITEM	SQ. YD.	206
12	NEW 6" VALVE, BOX & COVER	EACH	1

GENERAL NOTES

1. SEE PROJECT NO. ST8760045 FOR ARCADIA PORTAL TRAILS IMROVEMENTS.
2. PROTECT EXISTING LANDSCAPE IRRIGATION SYSTEM IN PLACE AND REPLACE ANY DAMAGED COMPONENT IN KIND.
3. MAINTAIN 15' CLEAR ZONE AROUND EUCALYPTUS TREES TO REMAIN.
4. CANAL CROSSING TO BE COORDINATED WITH SRP DURING DRY-UP PERIOD.

PRELIMINARY
100%
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

(PIP) PROTECT IN PLACE
(R) RELOCATE
(RO) RELOCATE BY OTHERS

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CANAL STORM DRAIN
PLAN AND PROFILE
STA 15+00 TO 20+00

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10		
SCALE H 1"=20' V 1"=4'			9	24

ST83110066SD04.dwg, 8/2/10

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

10 0 10 20
Scale in Feet
Horizontal Scale

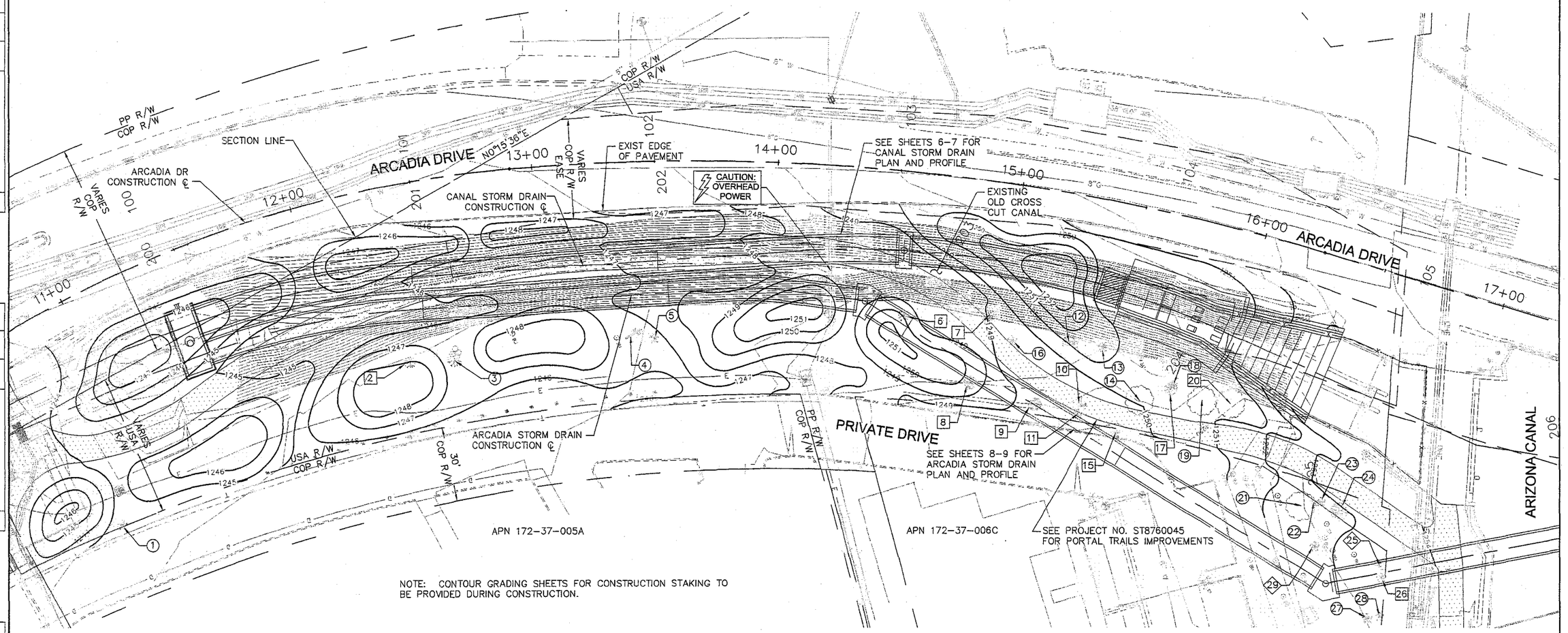
F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	10	24

OLSSON ASSOCIATES
2335 West 19th Street
Suite 210
Phoenix, AZ 85009-6383
TEL 602.748.1000
FAX 602.748.1001
CONSULTING ENGINEER

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	QKD BY	DATE



NOTE: CONTOUR GRADING SHEETS FOR CONSTRUCTION STAKING TO BE PROVIDED DURING CONSTRUCTION.

PLANT DISPOSITION SUMMARY

PLANT ID NO.	COMMON NAME	BOTANICAL NAME	DISPOSITION
1	Mexican Fan Palm	*Washingtonia robusta*	Protect in Place
2	Mexican Palo Verde	*Parkinsonia mexicana*	Remove
3	Soaptree Yucca	*Yucca elata*	Protect in Place
4	Saguaro	*Carnegia gigantaea*	Protect in Place
5	California Fan Palm	*Washingtonia filifera*	Protect in Place
6	Mexican Palo Verde	*Parkinsonia mexicana*	Remove
7	Mexican Palo Verde	*Parkinsonia mexicana*	Remove
8	Chilean Mesquite	*Prosopis chilensis*	Remove
9	Chilean Mesquite	*Prosopis chilensis*	Remove
10	California Fan Palm	*Washingtonia filifera*	Remove

PLANT DISPOSITION SUMMARY

PLANT ID NO.	COMMON NAME	BOTANICAL NAME	DISPOSITION
11	Mexican Fan Palm	*Washingtonia robusta*	Remove
12	Mexican Fan Palm	*Washingtonia robusta*	Protect in Place
13	Mexican Fan Palm	*Washingtonia robusta*	Protect in Place
14	Red Gum	*Eucalyptus spathulata*	Protect in Place
15	Mexican Fan Palm	*Washingtonia robusta*	Remove
16	Pineapple Palm	*Phoenix canariensis*	Protect in Place
17	Chilean Mesquite	*Prosopis chilensis*	Remove
18	Mexican Fan Palm	*Washingtonia robusta*	Protect in Place
19	Red Gum	*Eucalyptus spathulata*	Protect in Place
20	Red Gum	*Eucalyptus spathulata*	Remove

PLANT DISPOSITION SUMMARY

PLANT ID NO.	COMMON NAME	BOTANICAL NAME	DISPOSITION
21	Red Gum	*Eucalyptus spathulata*	Protect In Place
22	California Date Palm	*Phoenix dactylifera*	Protect In Place
23	Mexican Fan Palm	*Washingtonia robusta*	Protect In Place
24	Chilean Mesquite	*Prosopis chilensis*	Protect In Place
25	California Date Palm	*Phoenix dactylifera*	Relocate
26	California Date Palm	*Phoenix dactylifera*	Remove
27	California Date Palm	*Phoenix dactylifera*	Protect In Place
28	California Date Palm	*Phoenix dactylifera*	Protect In Place
29	California Date Palm	*Phoenix dactylifera*	Relocate

GENERAL NOTES

1. SEE PROJECT NO. ST8760045 FOR ARCADIA PORTAL TRAILS IMPROVEMENTS.
2. PROTECT EXISTING UTILITIES IN PLACE, UNLESS OTHERWISE INDICATED.
3. BUSHES AND TREES UNDER 12" DIA. REMOVED ARE PAID PER JOB UNDER ITEM M3500300, MISCELLANEOUS REMOVAL AND OTHER WORK.

PRELIMINARY
100%
REVIEW
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CONSTRUCTION
OR RECORDING

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GRADING PLAN AND
PLANT DISPOSITION

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	10	24

SCALE 1"=20'

ST83110066D01.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	11	24

OLSSON ASSOCIATES
2120 North 16th Street, Suite 210, Phoenix, AZ 85006-0063, TEL 602.748.1000, FAX 602.748.1001
CONSULTING ENGINEER

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

REVISION BY CITY OF PHOENIX

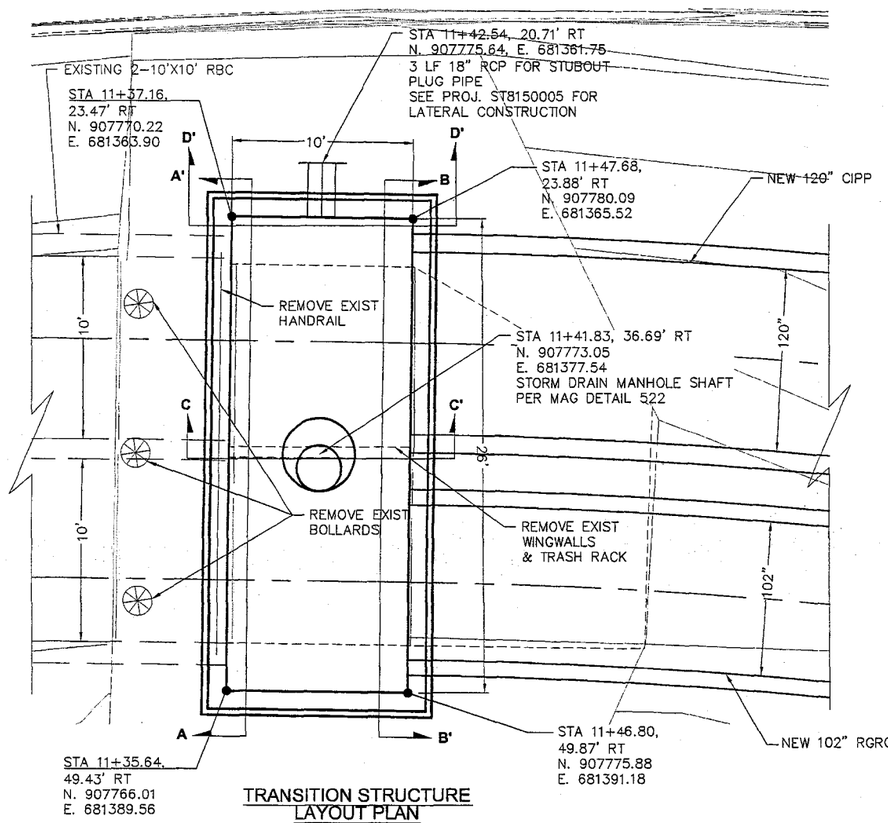
NO.	DESCRIPTION	REV BY	QKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	QKD BY	DATE

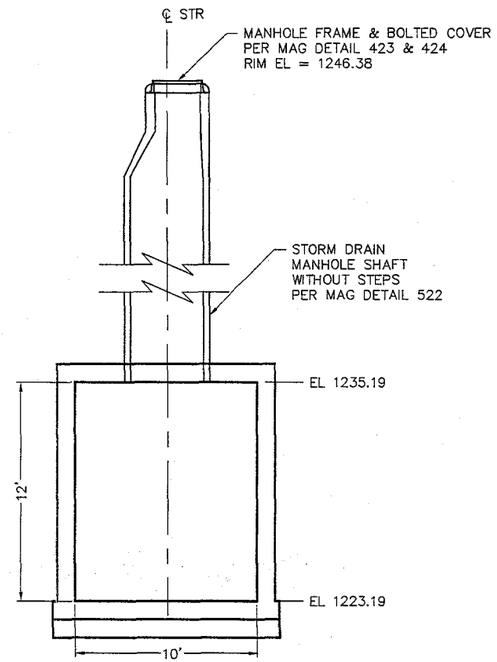
REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	QKD BY	DATE



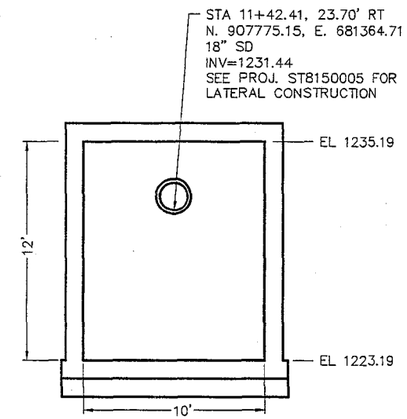
TRANSITION STRUCTURE
LAYOUT PLAN

2 0 2 4
Scale in Feet
Horizontal Scale



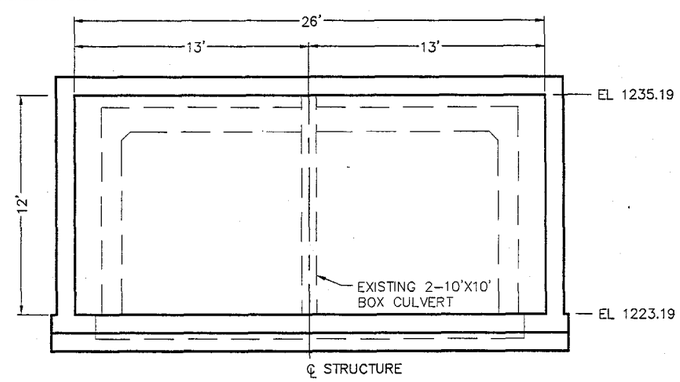
SECTION C-C'

2 0 2 4
Scale in Feet
Horizontal Scale



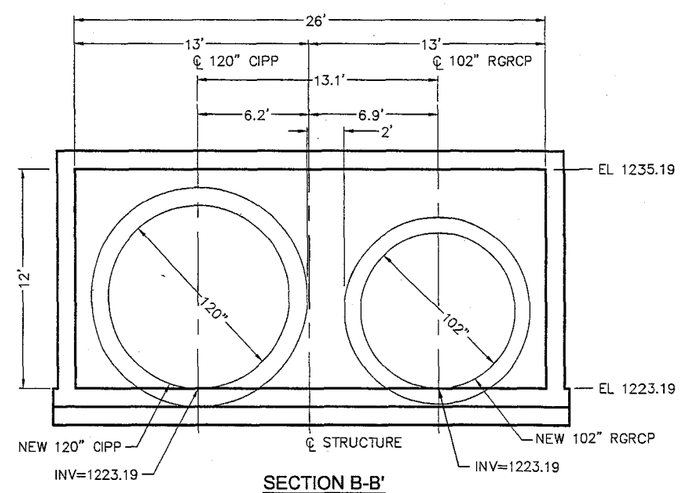
SECTION D-D'

2 0 2 4
Scale in Feet
Horizontal Scale



SECTION A-A'

2 0 2 4
Scale in Feet
Horizontal Scale



SECTION B-B'

2 0 2 4
Scale in Feet
Horizontal Scale

NOTES:

1. REMOVAL OF EXISTING FEATURES AROUND THE PROPOSED TRANSITION STRUCTURE WILL BE PAID PER JOB UNDER ITEM NUMBER M3500030.
2. SEE SHEETS 12 – 13 FOR STRUCTURAL DETAILS OF TRANSITION STRUCTURE.

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TRANSITION STRUCTURE
LAYOUT DETAILS

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10		
SCALE 1"=4'			11	24

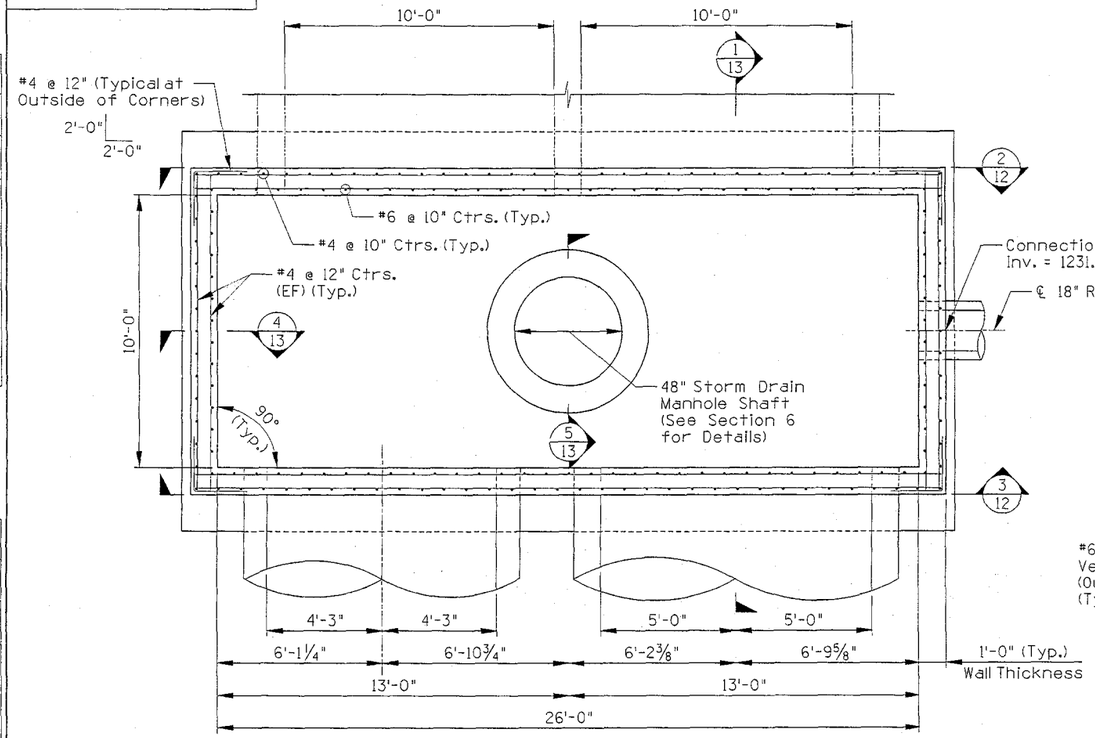
ST83110066D101.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

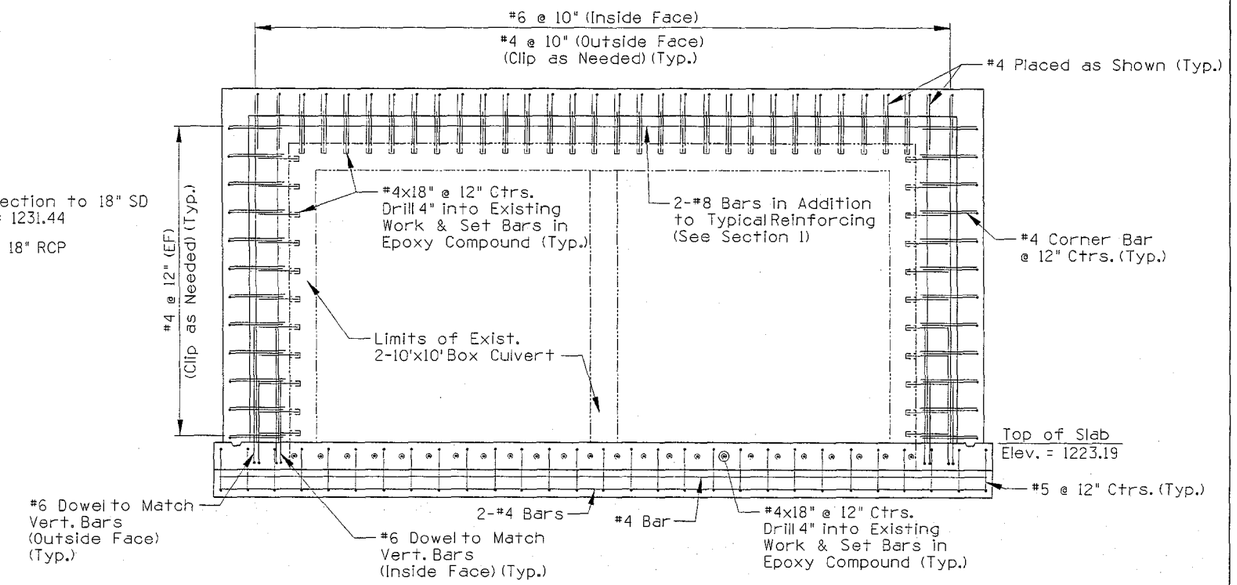
F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	12	24

OLSSON ASSOCIATES — 7250 North 16th Street, Suite 210, Phoenix, AZ 85020-5282, TEL 602.748.1000, FAX 602.748.1001 — CONSULTING ENGINEER

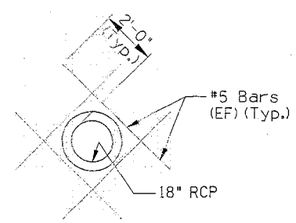
DES: RDB | DR: MWS | CK: AMB | DATE: 8/10



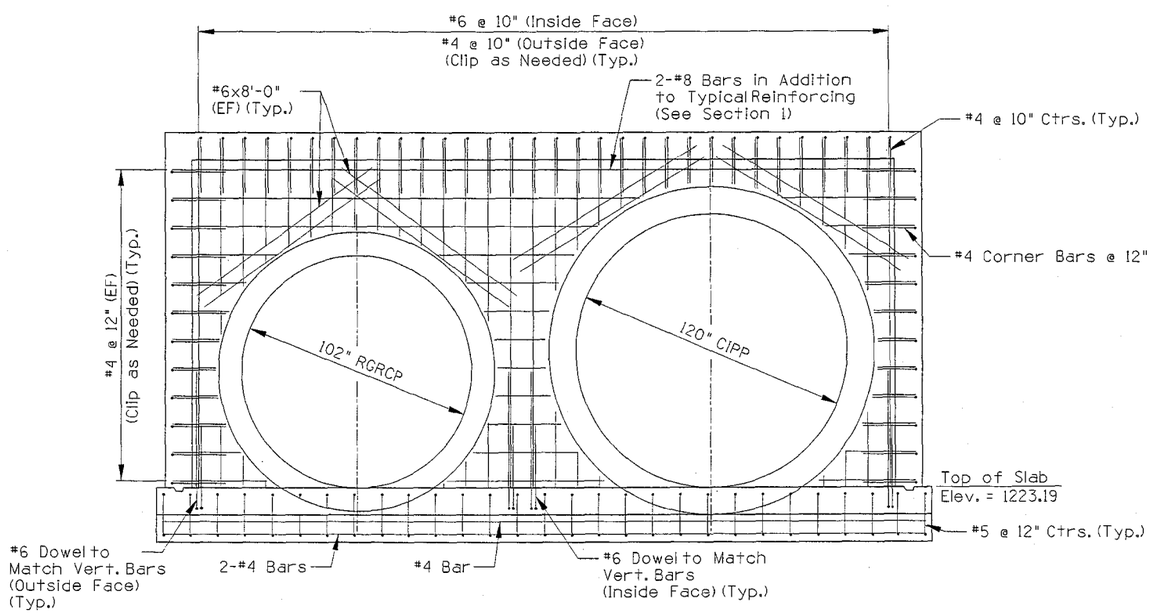
PLAN OF TRANSITION STRUCTURE
Scale: ⅜" = 1'-0"



WALL SECTION 2/12
SHOWING WALL REINFORCING
Scale: ⅜" = 1'-0"



PIPE PENETRATION DETAIL
Scale: ⅜" = 1'-0"



WALL SECTION 3/12
SHOWING WALL REINFORCING
Scale: ⅜" = 1'-0"

GENERAL STRUCTURAL NOTES:
All concrete shall have a 28-day cylinder strength of at least 3,500 psi.

All exposed edges of concrete shall be finished with a ¾" chamfer.

The minimum covering, measured from the face of the concrete to the surface of a reinforcing bar, shall be 2 inches unless otherwise noted. The minimum covering for bars near the underside of footings or slabs cast against earth shall be 3 inches.

All reinforcing steel shall be black, uncoated steel and shall conform to the requirements of ASTM designation A-615 or A-617, grade 60.

The minimum lap for spliced bars shall be 48 bar diameters.

Field bend and/or clip reinforcing steel to allow for minimum clearance around all openings.

All elastic water stop shall be polyvinyl chloride (PVC), Ribbed or serrated type, ⅜" thick with an "O" bulb closed center section. Water stop shall be 9" wide greenstreak "735" or Vinylex "RB9-38H." Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12" ctrs. entire length.

PRELIMINARY
100%
REVIEW
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STRUCTURAL DETAILS
TRANSITION STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			12	24

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

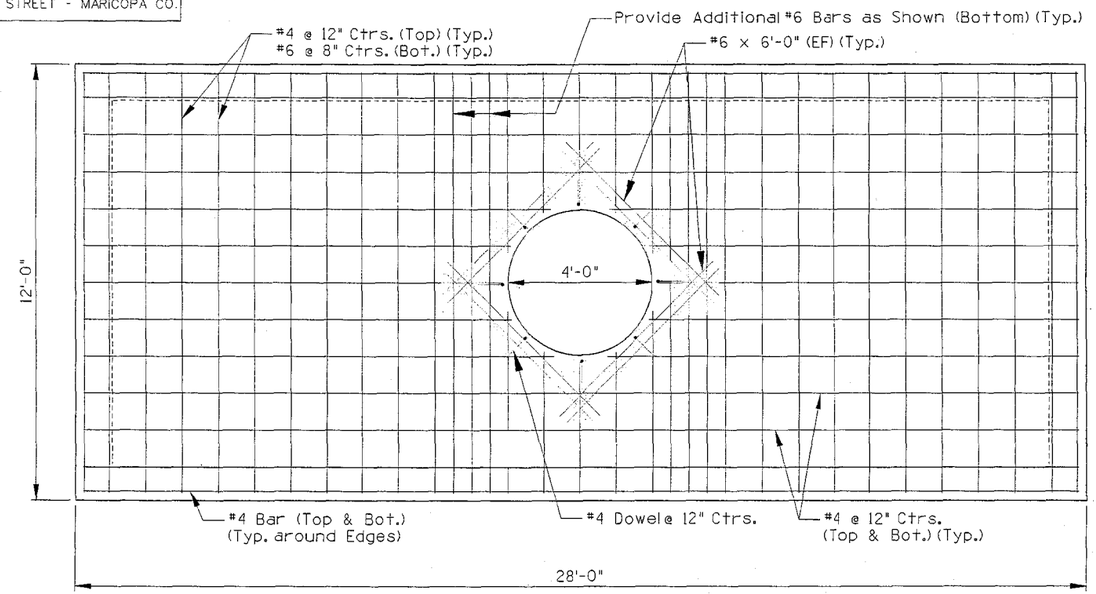
NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

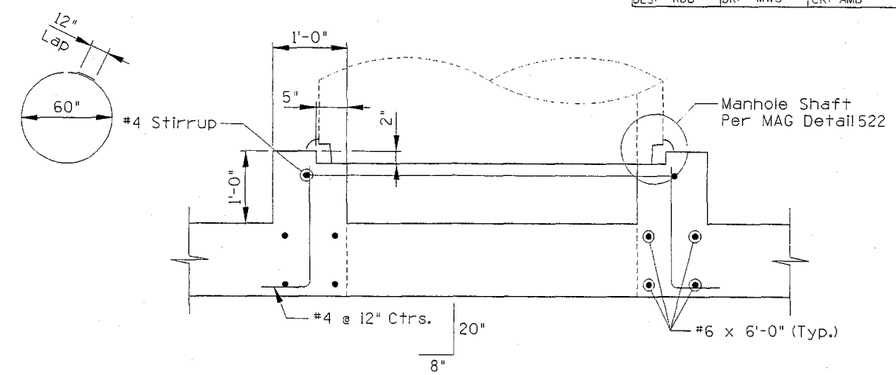
F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	13	24

OLSSON ASSOCIATES — CONSULTING ENGINEER

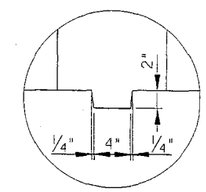
DES: RDB	DR: MWS	CK: AMB	DATE: 8/10



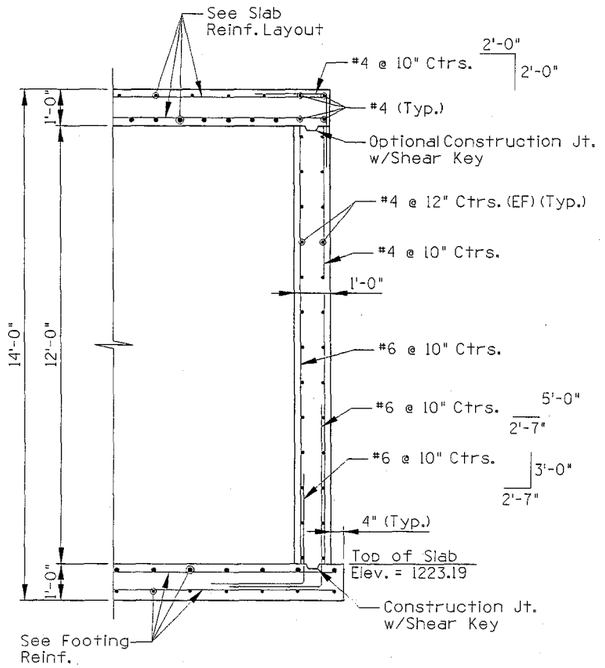
TOP SLAB REINFORCING
Scale: ½" = 1'-0"



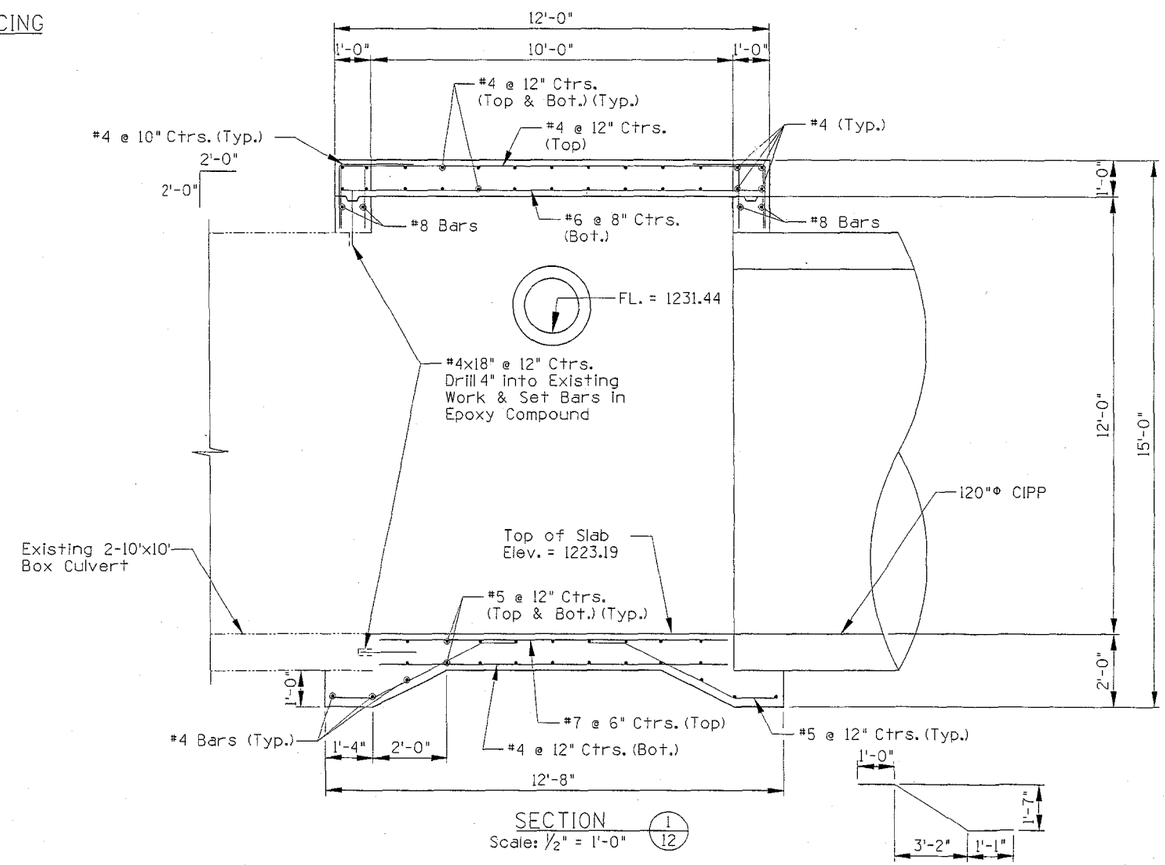
SECTION 5/12
Note: Typical Slab
Reinforcing not Shown for Clarity
Scale: 1" = 1'-0"



SHEAR KEY DETAIL



TYPICAL WALL SECTION 4/12
Scale: ½" = 1'-0"



SECTION 1/12
Scale: ½" = 1'-0"

PRELIMINARY
100%
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CONSTRUCTION
OR RECORDING

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STRUCTURAL DETAILS
TRANSITION STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			13	24

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

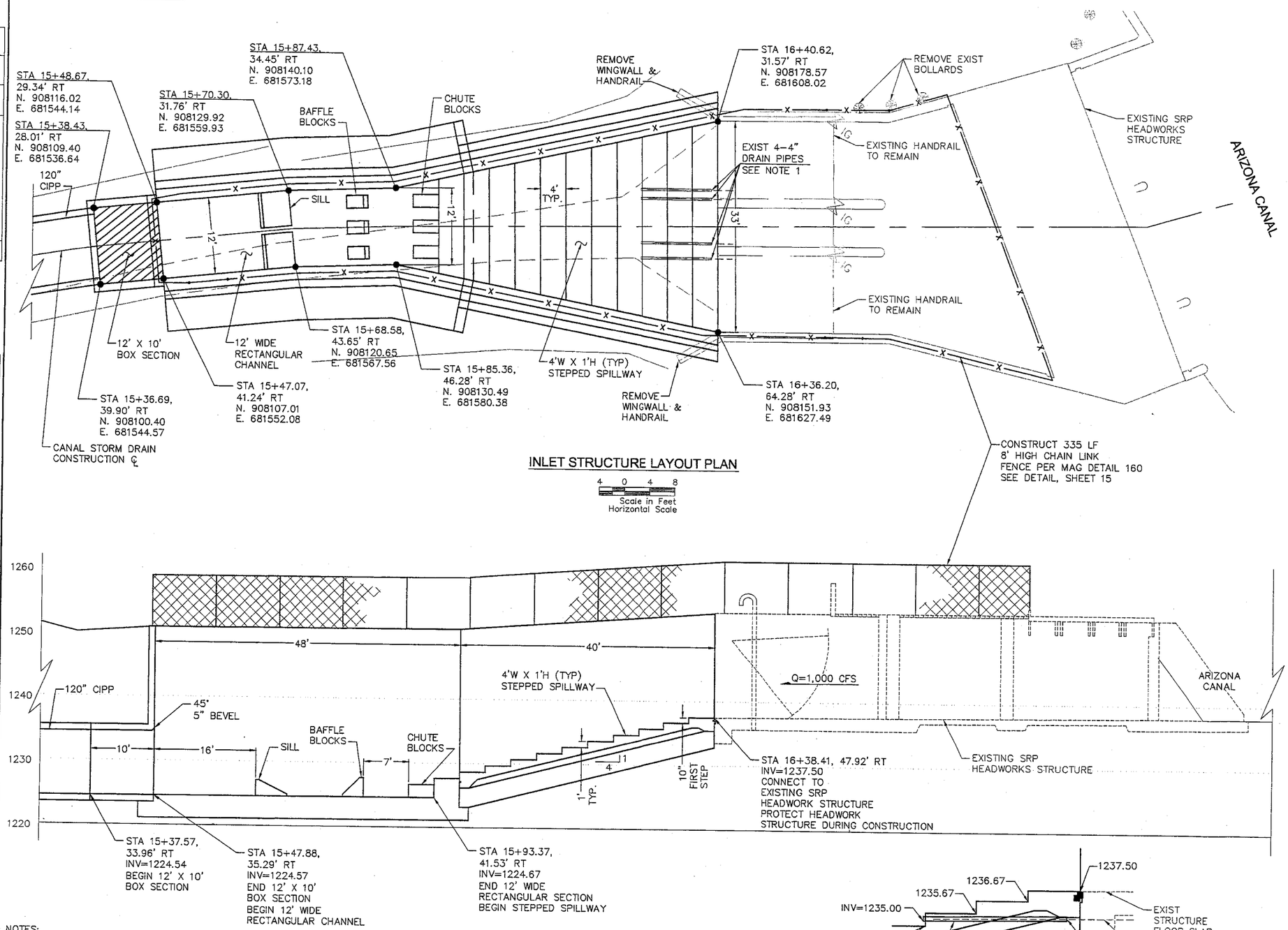
NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	14	24

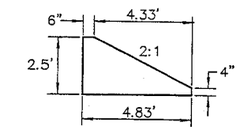
OLSSON ASSOCIATES — CONSULTING ENGINEER

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

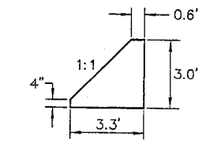


INLET STRUCTURE LAYOUT PLAN

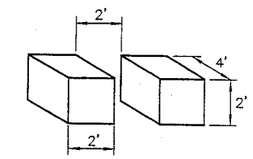
4 0 4 8
Scale in Feet
Horizontal Scale



SILL DETAIL
N.T.S.



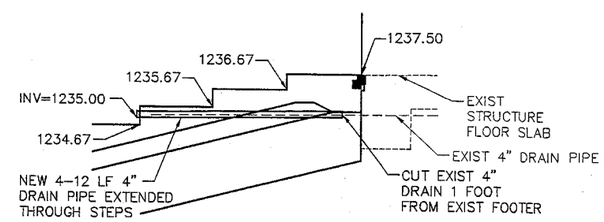
BAFFLE BLOCK DETAIL
N.T.S.



CHUTE BLOCK DETAIL
N.T.S.

INLET STRUCTURE PROFILE

4 0 4 8
Scale in Feet
Horizontal Scale



4" DRAIN PIPE DETAIL
N.T.S.

NOTES:

1. CUT EXISTING DRAIN PIPES 1' FROM EXIST FOOTING AND INSTALL 4–12 LF 4" DRAIN PIPE THROUGH STEPS. SALVAGE EXIST FLAP GATE AND INSTALL ON NEW PIPE.
2. SEE SHEETS 17 – 22 FOR STRUCTURAL DETAILS OF INLET STRUCTURE.

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

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INLET STRUCTURE LAYOUT DETAILS

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

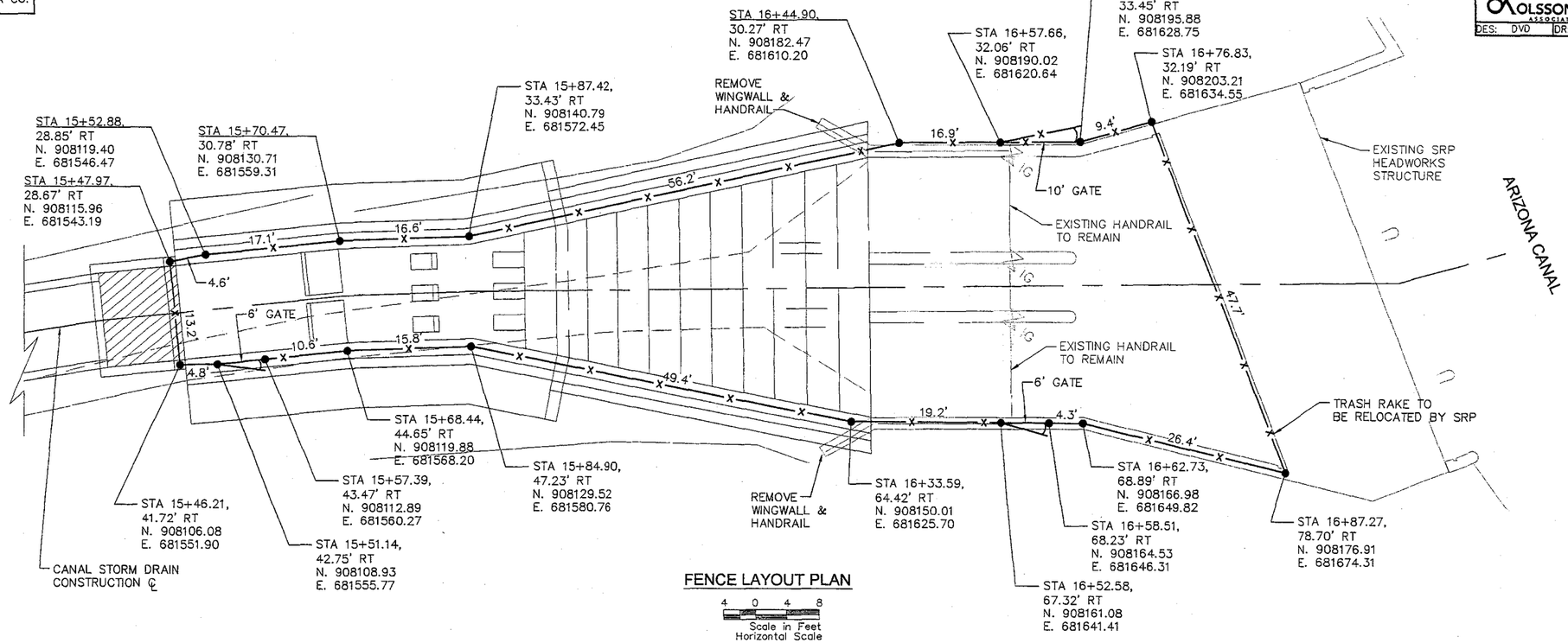
DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	14	24
SCALE 1"=8'				

ST83110066DT04.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

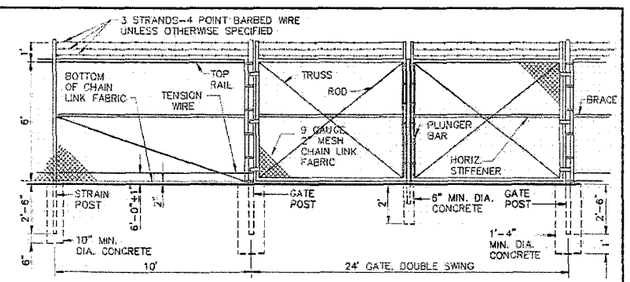
F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	15	24

OLSSON ASSOCIATES — CONSULTING ENGINEER
DES: DVD DR: JLD CK: JCF DATE: 8/10



FENCE LAYOUT PLAN

4 0 4 8
Scale in Feet
Horizontal Scale

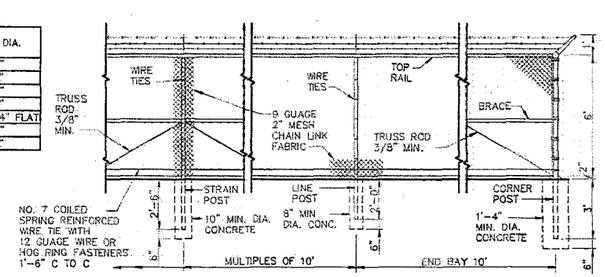


NOTES

1. ALL CONCRETE SHALL BE CLASS 'C' PER SECT. 725.
2. FITTINGS NOT SPECIFICALLY DETAILED SHALL BE HEAVY DUTY DESIGN.
3. STRAIN POSTS SHALL BE SPACED AT 500' MAXIMUM SPACING.
4. BOTH CORNER AND STRAIN POSTS SHALL HAVE STRAIN PANELS.
5. ALL POSTS SHALL BE CAPPED.
6. MEMBER SIZES SHALL BE THE FOLLOWING:

MEMBER	AISC SIZE	OUTSIDE DIA.
CORNER POST	2-1/2"	2.875"
LINE POST	1-1/2"	1.900"
STRAIN POST	1-1/2"	1.900"
BRACE	1-1/4"	1.666"
STRETCH BAR	3/16"x3/4" FLAT	3/16"x3/4" FLAT
GATE POST	3-1/2"	4.000"
TOP RAIL	1-1/4"	1.666"

7. CONSTRUCTION AND MATERIALS SHALL CONFORM TO SECT. 420 AND 722, RESPECTIVELY. SEE TABLE 722 FOR WEIGHTS OF MEMBERS.



DETAIL NO.			REVISED	DETAIL NO.
160	MARICOPA ASSOCIATION of GOVERNMENTS — STANDARD DETAIL ENGLISH	6' CHAIN LINK FENCE AND GATE	01-01-2003	160

NOTES:

1. NO BARBED WIRE ON CHAIN LINK FENCE.
2. CHAIN LINK FENCE TO INCLUDE TOP AND BOTTOM RAILS.
3. TOTAL FENCE QUANTITY OF 335 LF INCLUDES GATE LENGTHS.
4. SEE SHEETS 17 – 22 FOR STRUCTURAL DETAILS OF INLET STRUCTURE.

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INLET STRUCTURE
FENCE DETAILS

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10		
SCALE 1"=8'			15	24

ST83110066DT05.dwg, 8/2/10

REVISION BY CITY OF PHOENIX

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REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

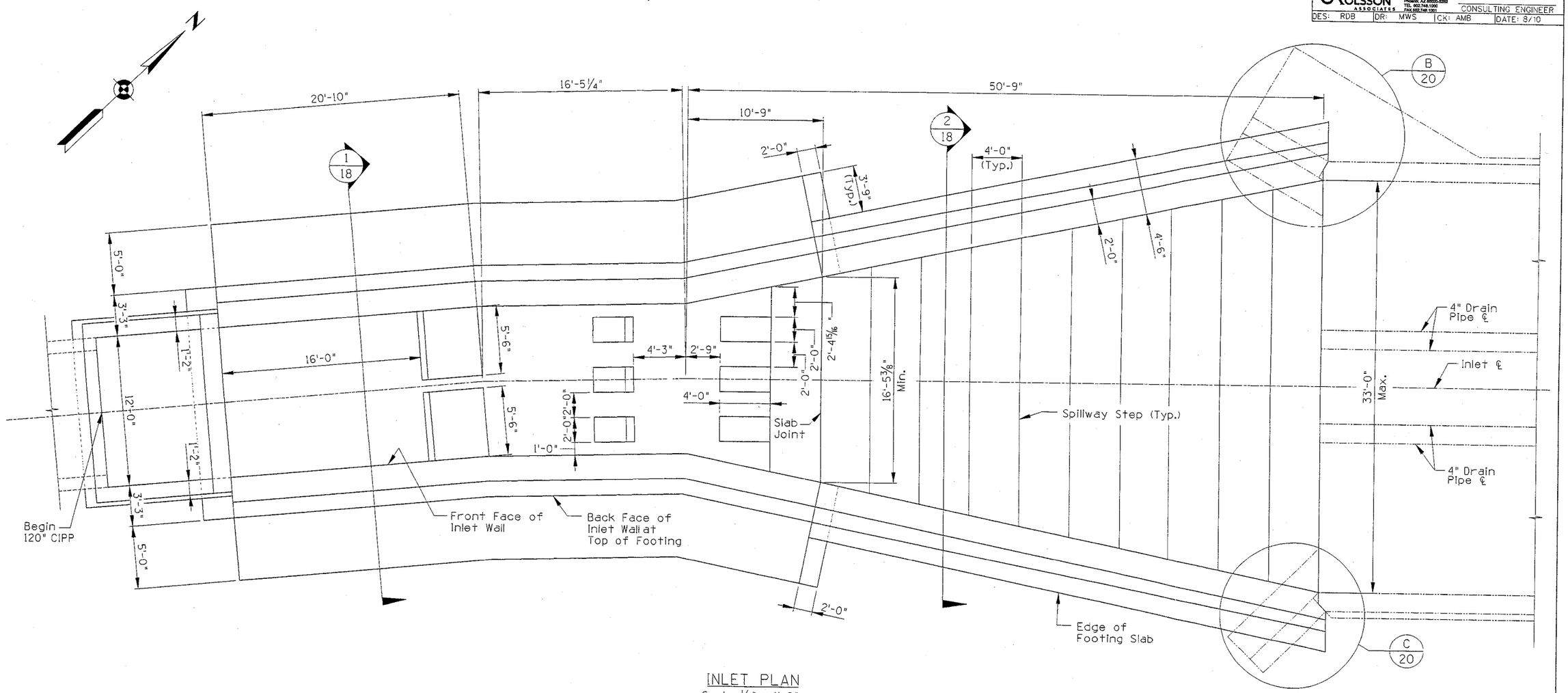
NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	16	24

OLSSON ASSOCIATES — 7250 North 16th Street, Suite 210, Phoenix, AZ 85020-5263, TEL 602.748.1000, FAX 602.748.1001 — CONSULTING ENGINEER

DES: RDB | DR: MWS | CK: AMB | DATE: 8/10



INLET PLAN
Scale: ¼" = 1'-0"

GENERAL STRUCTURAL NOTES:
All concrete shall have a 28-day cylinder strength of at least 3,500 psi.

All exposed edges of concrete shall be finished with a ¾" chamfer.

The minimum covering, measured from the face of the concrete to the surface of a reinforcing bar, shall be 2 inches unless otherwise noted. The minimum covering for bars near the underside of footings or slabs cast against earth shall be 3 inches.

All reinforcing steel shall be black, uncoated steel and shall conform to the requirements of ASTM designation A-615 or A-617, grade 60.

The minimum lap for spliced bars shall be 48 bar diameters.

Field bend and/or clip reinforcing steel to allow for minimum clearance around all openings.

All elastic water stop shall be polyvinyl chloride (PVC), Ribbed or serrated type, ⅜" thick with an "O" bulb closed center section. Water stop shall be 9" wide greenstreak "735" or Vinylex "RB9-38H." Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12" ctrs. entire length.

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STRUCTURAL DETAILS
INLET STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			16	24

REVISION BY CITY OF PHOENIX

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REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	17	24

OLSSON ASSOCIATES
7250 North 16th Street
Suite 310
Phoenix, AZ 85020-5292
TEL 602.748.1000
FAX 602.748.1021
CONSULTING ENGINEER

DES: RDB | DR: MWS | CK: AMB | DATE: 8/10

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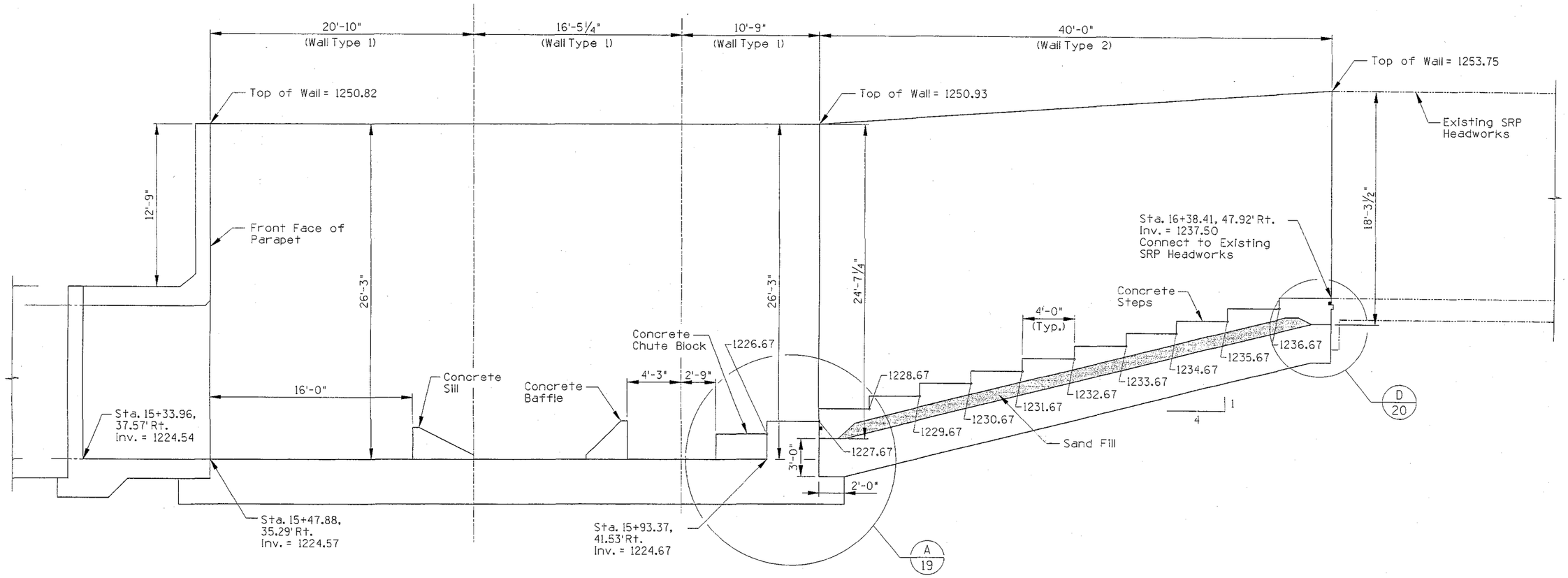
REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV BY	CKD BY	DATE



INLET ELEVATION

Note: Measurments Taken from Inlet Centerline
Scale: ¼" = 1'-0"

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STRUCTURAL DETAILS
INLET STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

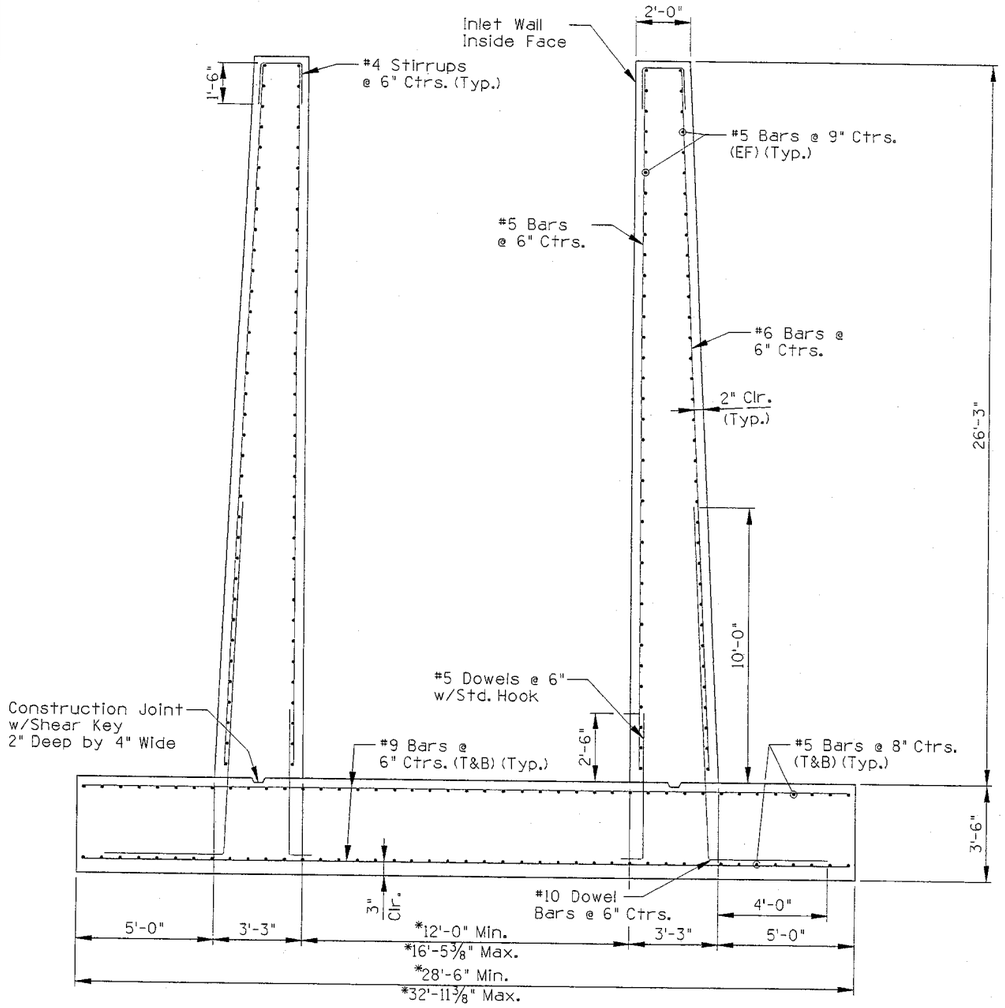
OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE:08/10	DATE:08/10		
SCALE: AS NOTED			17	24

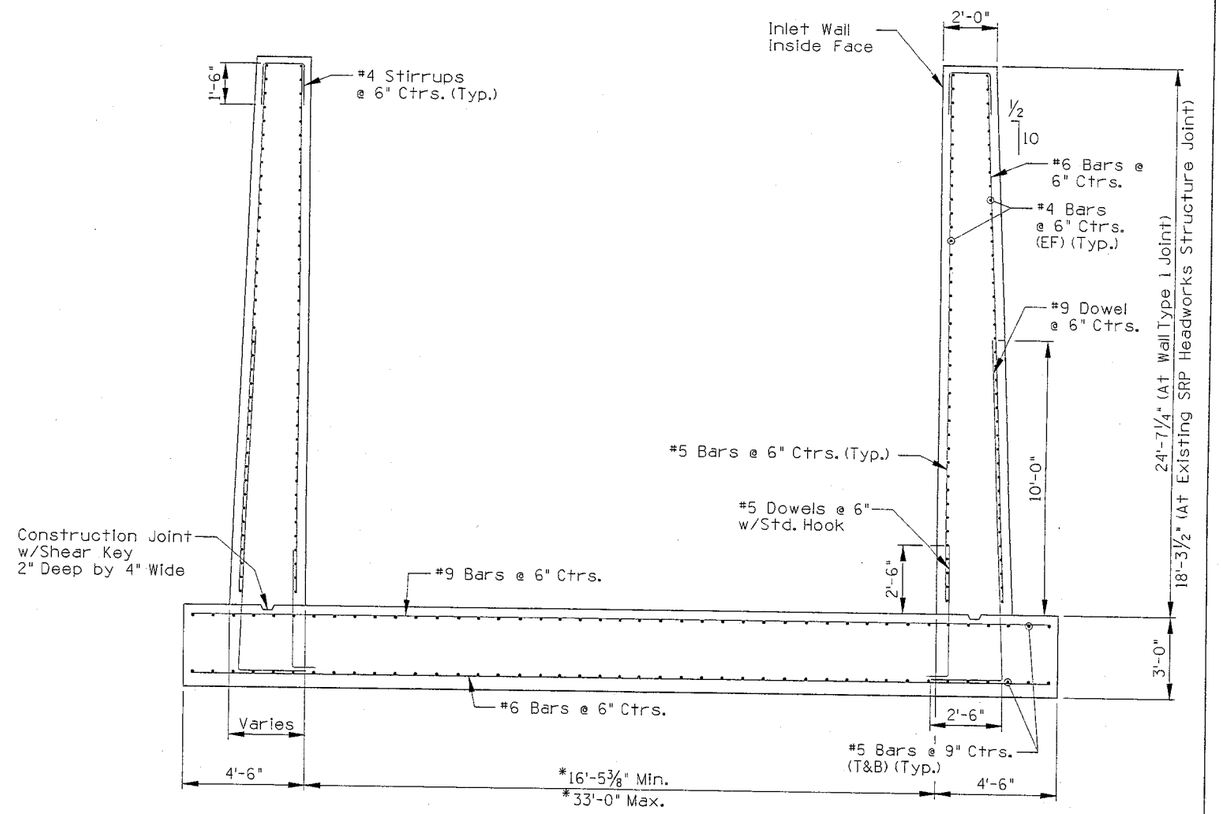
OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	18	24

OLSSON ASSOCIATES — CONSULTING ENGINEER
DES: RDB DR: MWS CK: AMB DATE: 8/10



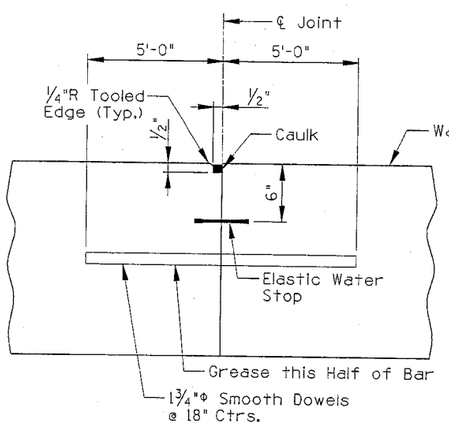
WALL SECTION 1/16
Wall Type 1
Scale: ⅜" = 1'-0"



WALL SECTION 2/16
Wall Type 2
Scale: ⅜" = 1'-0"

*Measured Perpendicular to Channel ℄

Note:
Spillway steps not shown for clarity.



STEM JOINT BETWEEN WALL TYPE 1 & WALL TYPE 2
Scale: ⅜" = 1'-0"

Notes:
1. Reinforcing Steel Shall not Extend Across the Joint
2. Provide 2" Clr. from waterstop to reinforcing

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STRUCTURAL DETAILS
INLET STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO.	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			18	24

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NO.	DESCRIPTION	REV BY	CKD BY	DATE

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OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	19	24

OLSSON ASSOCIATES — CONSULTING ENGINEER

DES: RDB | DR: MWS | CK: AMB | DATE: 8/10

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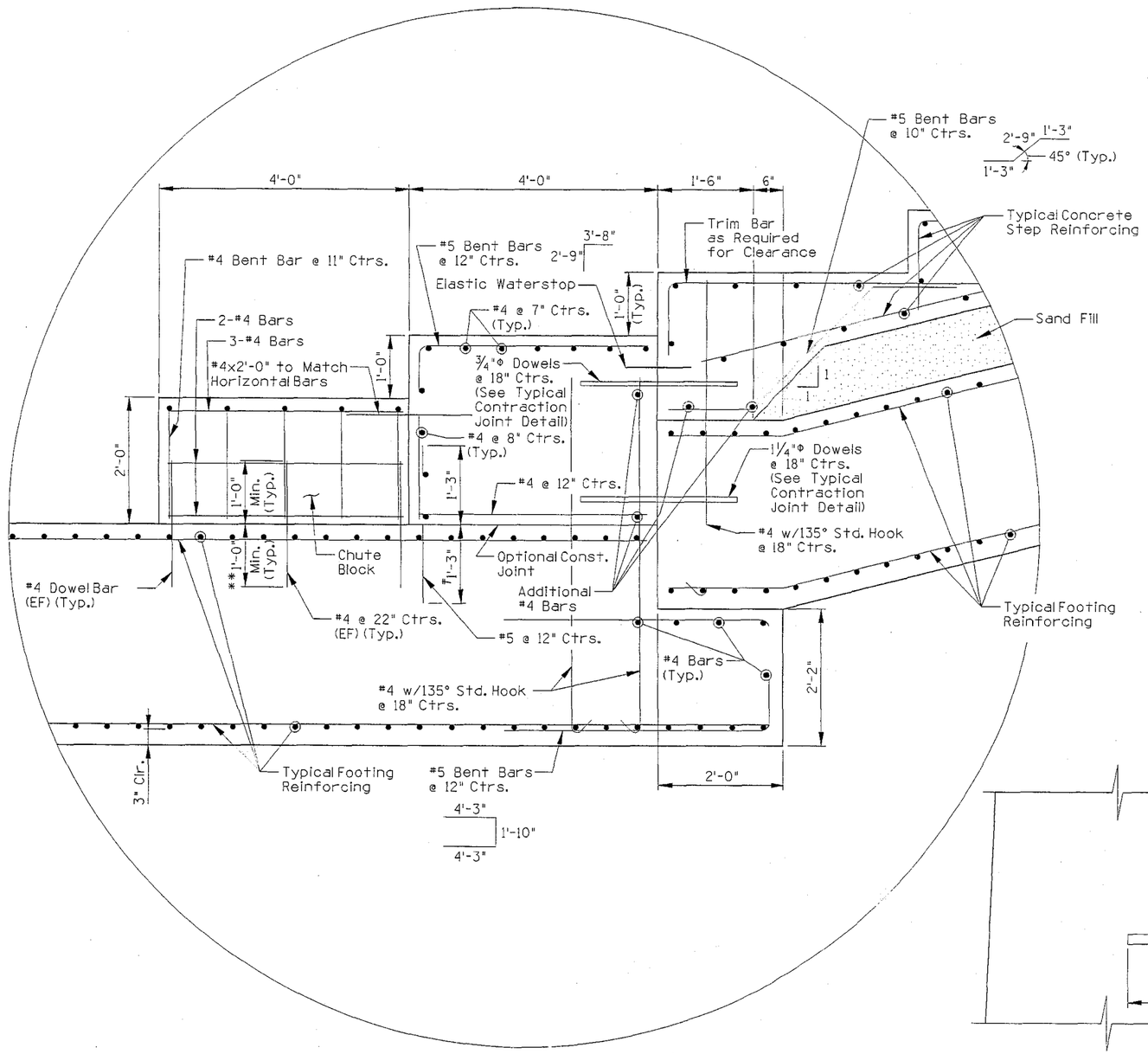
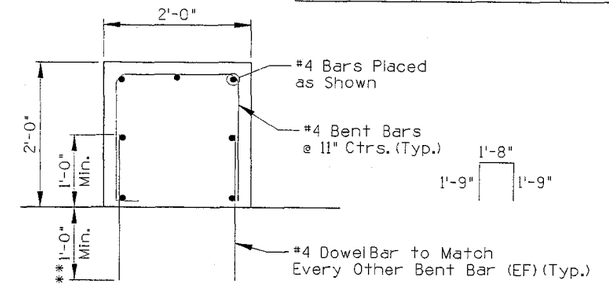


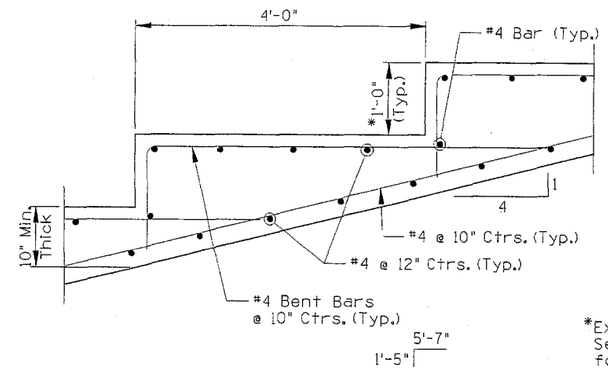
SECTION OF FOOTING TRANSITION (A/17)
Scale: 1" = 1'-0"



**As an alternative, drill 6" into existing work & set bars in epoxy compound.

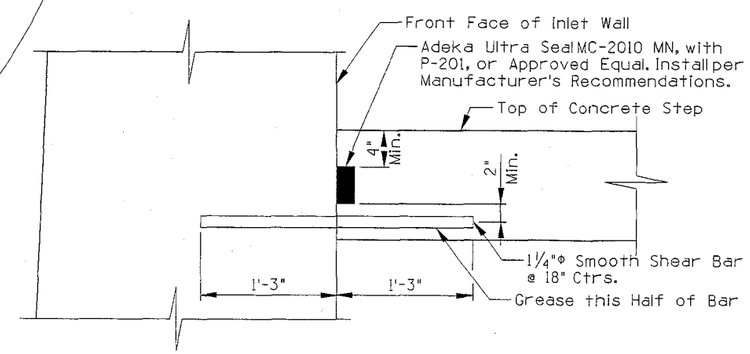
‡As an alternative, drill 7" into existing work & set bars in epoxy compound.

CHUTE BLOCK SECTION
Scale: 1" = 1'-0"



*Except top step. See Sheet 20 for details.

SECTION OF CONCRETE STEPS
Scale: 1" = 1'-0"



TYPICAL JOINT AT INLET WALL AND CONCRETE STEPS
Scale: 1½" = 1'-0"

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STRUCTURAL DETAILS
INLET STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			19	24

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	21	24

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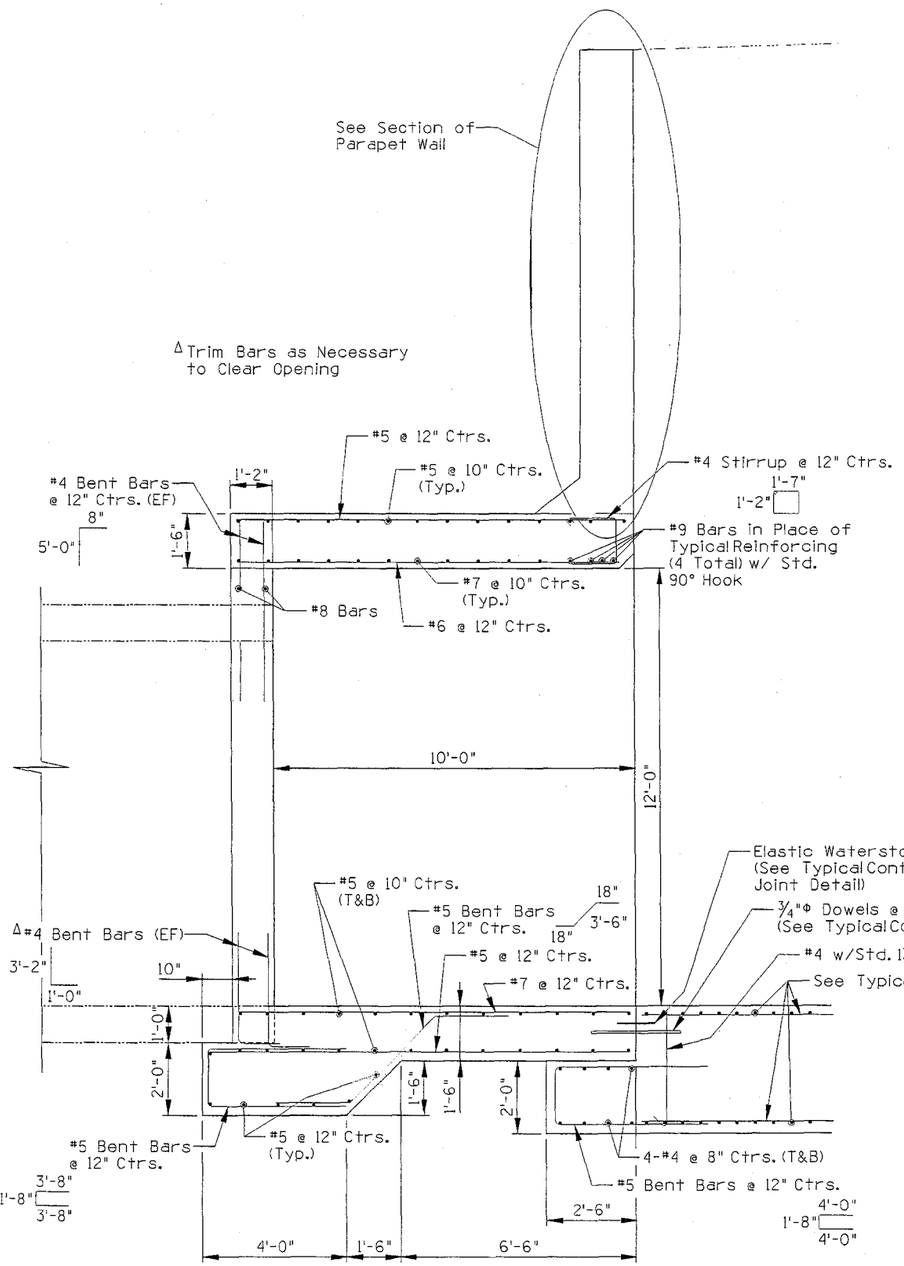
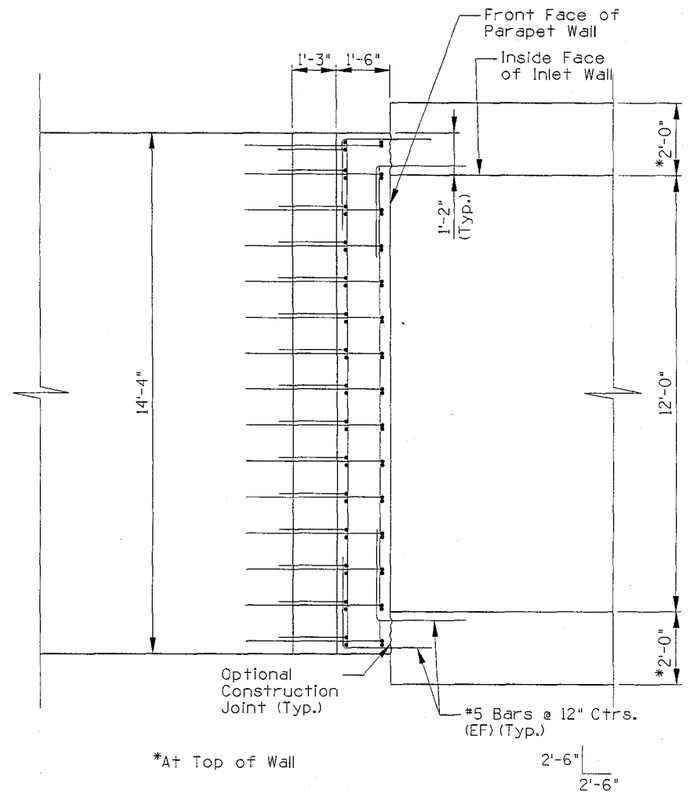
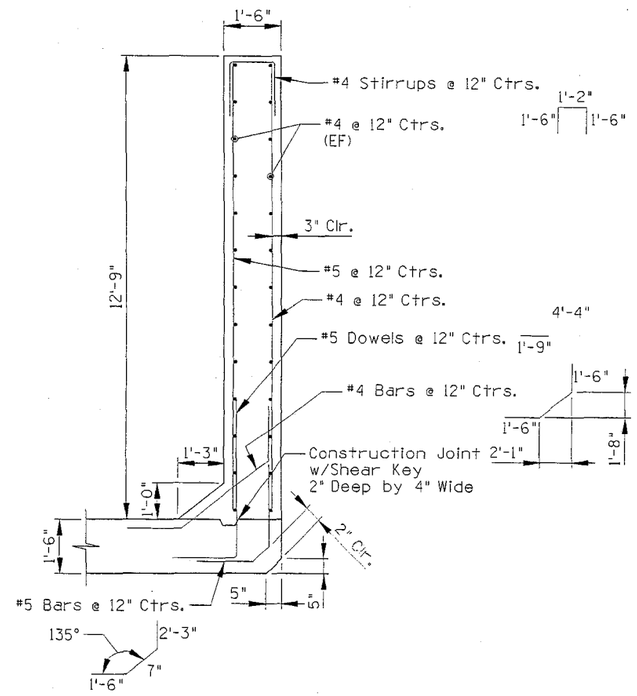


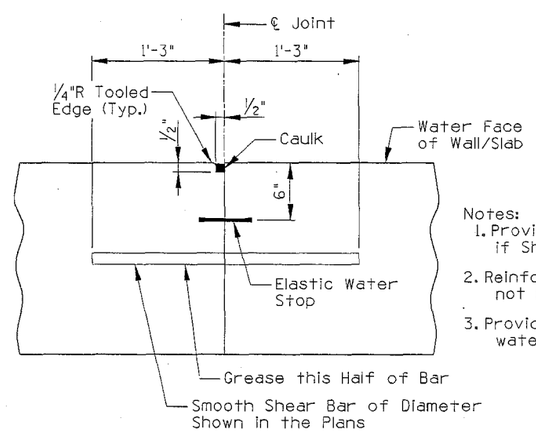
SECTION 3/22
Scale: 1/2" = 1'-0"



PLAN OF PARAPET
Note: Typical Inlet Wall Reinforcing not Shown for Clarity
Scale: 1/2" = 1'-0"



SECTION OF PARAPET WALL
Note: Barrel Reinforcing not Shown for Clarity
Scale: 1/2" = 1'-0"



TYPICAL CONTRACTION JOINT DETAIL
Not to Scale

Notes:
1. Provide Shear Key at Joint if Shown in Plans
2. Reinforcing Steel Shall not Extend Across the Joint
3. Provide 2" Clr. from waterstop to reinforcing

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STRUCTURAL DETAILS
INLET STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			21	24

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET - MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	22	24

OLSSON ASSOCIATES
7250 North 16th Street
Suite 210
Phoenix, AZ 85020-5252
TEL 602.748.1000
FAX 602.748.1001
CONSULTING ENGINEER

DES: RDB | DR: MWS | CK: AMB | DATE: 8/10

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REVISION BY CITY OF PHOENIX

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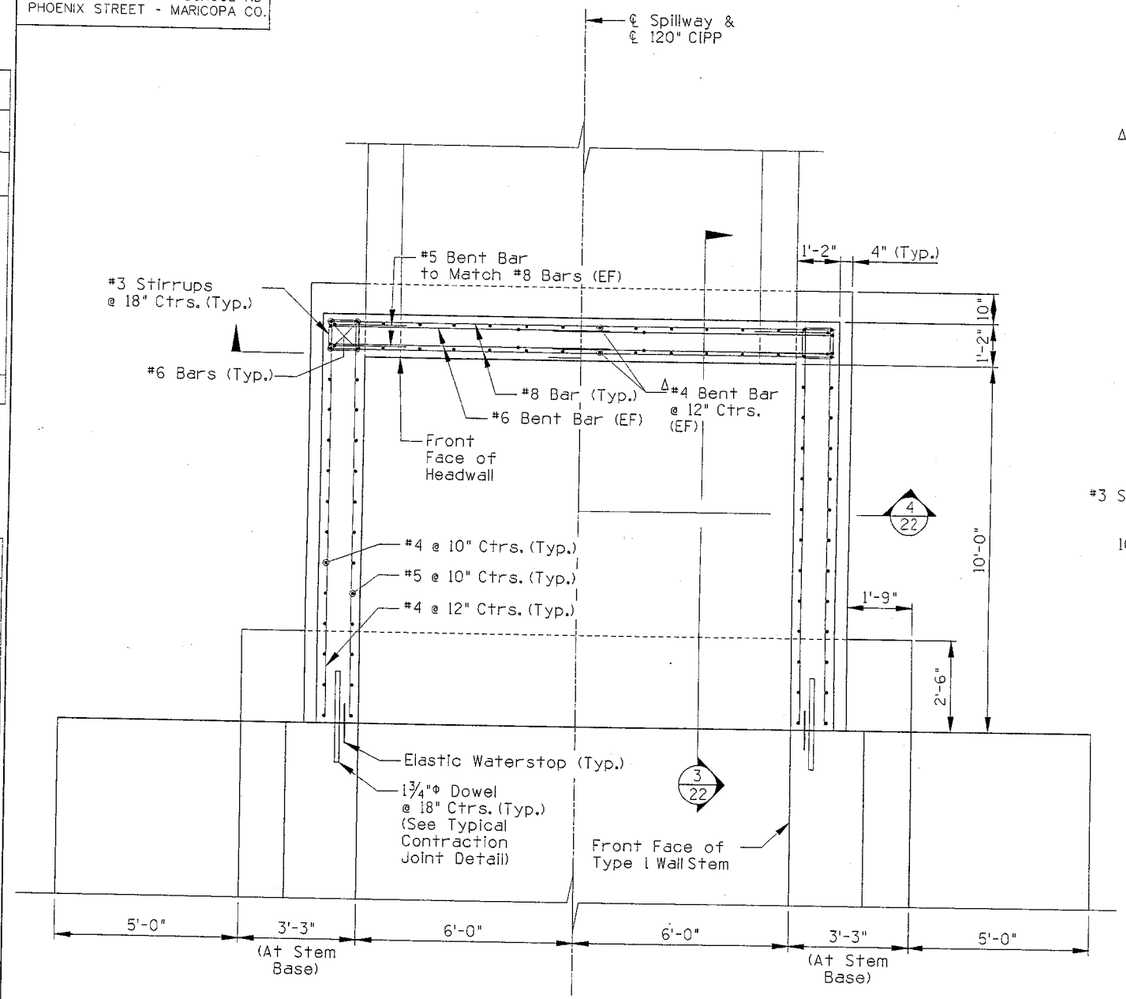
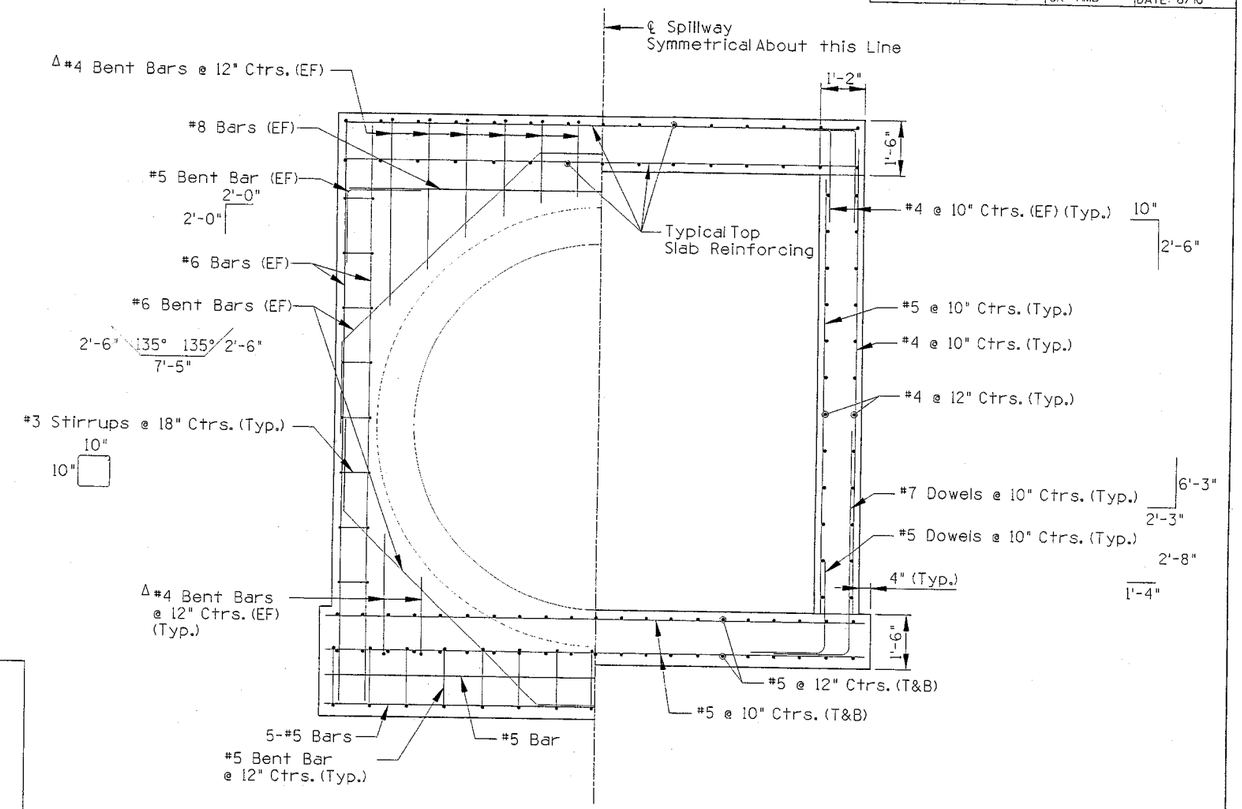


PLAN OF 12'x10' BOX
Scale: ½" = 1'-0"



SHOWING REINFORCING AT HEADWALL

SHOWING TYPICAL REINFORCING

SECTION 4/22
Scale: ½" = 1'-0"

ΔTrim Bars as Necessary
to Clear Opening

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STRUCTURAL DETAILS
INLET STRUCTURE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL
IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: MWS	DES: RDB	CK: AMB	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE: AS NOTED			22	24

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	23	24

OLSSON ASSOCIATES — 7250 North 16th Street, Suite 210, Phoenix, AZ 85020-5262, TEL 602.748.1000, FAX 602.748.1001 — CONSULTING ENGINEER

DES: DVD | DR: JLD | CK: JCF | DATE: 8/10

REVISION BY CITY OF PHOENIX

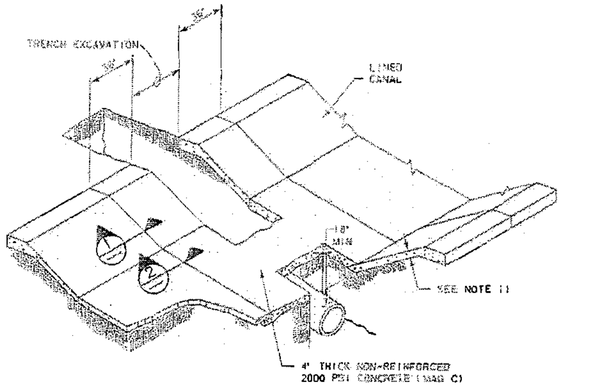
NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

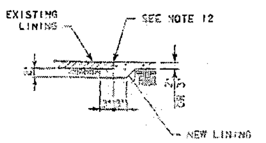
NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX

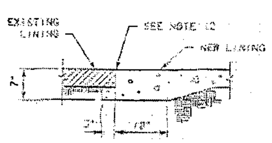
NO.	DESCRIPTION	REV BY	CKD BY	DATE



LINED CANAL UNDERCROSSING



BANK LINING TIE DETAIL (1)



BOTTOM LINING TIE DETAIL (2)

NOTES

1. NO MANHOLES, RISERS, VALVES OR OTHER SIMILAR FACILITIES ARE TO BE PLACED IN ANY PORTION OF SRP RIGHT-OF-WAY WITHOUT SPECIFIC AUTHORIZATION IN AN SRP LICENSE.
2. TOP OF PIPE, CONDUIT, CABLE OR ENCASEMENT IN SRP RIGHT-OF-WAY IS TO BE A MINIMUM OF 36 INCHES BELOW GRADE OR ROAD SURFACE.
3. ALL AFFECTED PORTIONS OF SRP RIGHT-OF-WAY, INCLUDING ROAD SURFACES, SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR BETTER.
4. SRP FACILITIES DAMAGED OR DESTROYED SHALL BE REPAIRED OR REPLACED TO THE SATISFACTION OF THE SRP ENGINEER.
5. COMPLETELY REMOVE ALL DIRT AND DEBRIS AFTER COMPLETION OF CROSSING CONSTRUCTION.
6. REMOVE UNSUITABLE/DELETERIOUS MATERIAL TO A MINIMUM TWO FOOT DEPTH AND REPLACE WITH APPROVED BACKFILL.
7. BACKFILL SHALL BE CLEAN, COHESIVE NATIVE MATERIAL AS APPROVED BY THE SRP ENGINEER OR MAG 728 1-SACK CLSM (CONTROLLED LOW STRENGTH MATERIAL).
8. PLACE COHESIVE BACKFILL AT OPTIMUM MOISTURE CONTENT IN 6 INCH LIFTS AND COMPACT TO 95% OF MAXIMUM PROCTOR DENSITY (ASTM D698 STANDARD PROCTOR).
9. ELEVATIONS AND SLOPES SHALL BE AS DETERMINED BY THE SRP ENGINEER.
10. APPLY WHITE PIGMENTED CURING COMPOUND WITHIN ONE HOUR AFTER PLACING/FINISHING CONCRETE.
11. 3 INCH THICK HAND PLACED OR 2 INCH THICK PNEUMATICALLY PLACED 3000 PSI CONCRETE. FIBER REINFORCED CONCRETE SHALL COMPLY WITH REQUIREMENTS OF SRP STANDARD SPECIFICATION WTR 03364. WWF REINFORCED CONCRETE SHALL BE MAG 4 WITH ASTM C33 #4 COARSE AGGREGATE AND A MAXIMUM AGGREGATE SIZE OF 3/8". WWF SHALL BE 6x6-W0.5xW0.5 OR 6x6-10 GAUGE x 10 GAUGE. EXTEND WWF MINIMUM 4" INTO BOTTOM LINING.
12. EXISTING BANK AND BOTTOM LINING SHALL BE SAWCUT OR MECHANICALLY SCORED AND REMOVED 18 INCHES (EACH SIDE) FROM THE EDGE OF EXCAVATION TO A NEAT VERTICAL EDGE. REMOVE ANY LOOSE OR FOREIGN MATERIAL.
13. THE TOP OF PIPE AND/OR CONCRETE ENCASEMENT WITHIN THE CANAL SECTION IS TO BE A MINIMUM OF 18 INCHES BELOW THE BOTTOM OF THE CANAL BOTTOM CONCRETE.

REFERENCES	
PREPARATION OF SUBGRADE FOR CANAL LINING SPECS.	CE 02.490
CONCRETE MATERIALS & CONCRETE SPECIFICATION	SRP 03300
PLACEMENT OF CANAL BOT. CONCRETE SPECIFICATION	CE 03.361
FIBER REINFORCED SHOTCRETE FOR CANAL BANK	WTR 03364

REVISIONS

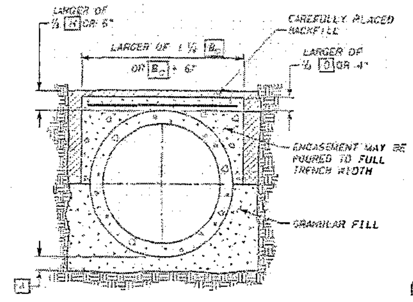
REV. NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
REVISED NOTE 7, 8 & 11. RENUMBERED SUBSEQUENT NOTES TO 12 & 13.					
1	JWS / JWS	– / –	CWT / CWT	REL / REL	01/31/05
INITIAL ISSUE.					
0	MDD / MDD	CWT / CWT	CWT / CWT	REL / REL	01/20/98

SALT RIVER PROJECT — WATER ENGINEERING STANDARD

LINED CANAL UNDERCROSSING

SCALE: NONE | DWG SIZE: 22X17 | WES-30100-007

THIS DRAWING REPLACES B-54-225

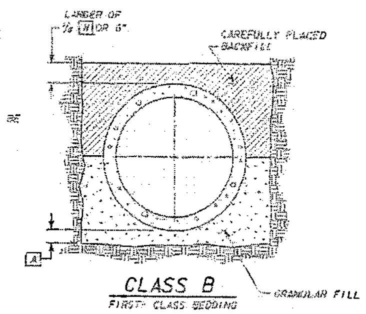


CLASS A
ARCH ENCASEMENT

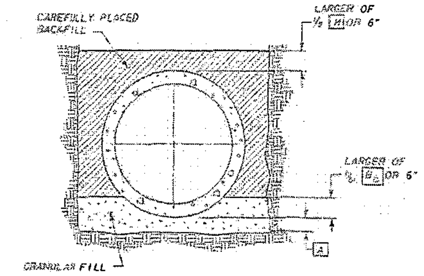
LOAD FACTOR: REINFORCED, A_s = 0.40% = 3.5; REINFORCED, A_s = 1.00% = 4.8; PLAIN = 2.8

A_s = PERCENTAGE OF AREA OF TRANSVERSE STEEL IN THE CONCRETE ABOVE CROWN OF PIPE

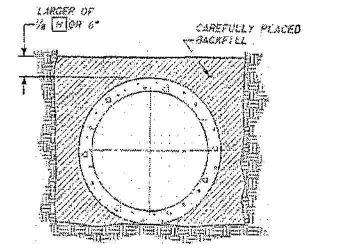
ENCASEMENT SHALL BE 2000 psi CONCRETE (MAG C)



CLASS B
FIRST CLASS BEDDING
LOAD FACTOR 1.9



CLASS C
ORDINARY BEDDING
LOAD FACTOR 1.5



CLASS D
FLAT BOTTOM BEDDING
LOAD FACTOR 1.15

TABLE OF FILL DEPTHS BELOW PIPE

D DIAMETER	A MINIMUM
36" & SMALLER	4"
OVER 36"	OF Bc

H = DEPTH OF FILL ABOVE TOP OF PIPE
Bc = OUTSIDE DIMENSION OF PIPE

REFERENCES	
PRECAST CONCRETE PIPE SPECIFICATION	WTR 02614

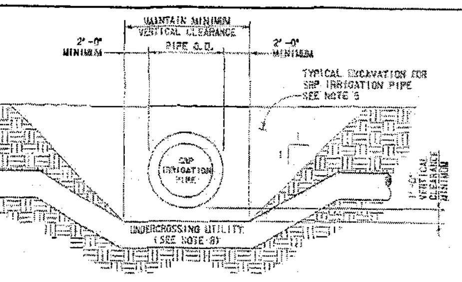
REVISIONS

REV NO.	DATE	DFTR	CHKR	ENGR APP.	SUPV APPD	ISSUE AUTH
ADDED CONCRETE ENCASEMENT NOTE AND REMOVED METRIC REFERENCES.						
2	[illegible]	JWS	–	CWT	–	REL
ADDED METRIC DIMENSIONS.						
1	4/97	MD	–	CWT	–	REL
INITIAL ISSUE.						
0	2/69	AR	WJC	REL	AAR	THS

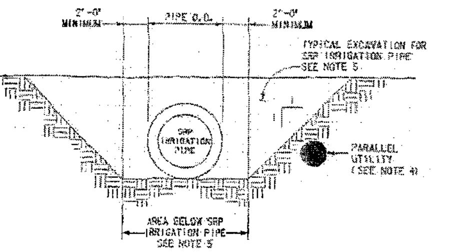
SALT RIVER PROJECT — WATER ENGINEERING STANDARDS

PIPELINE BEDDING/BACKFILL REQUIREMENTS

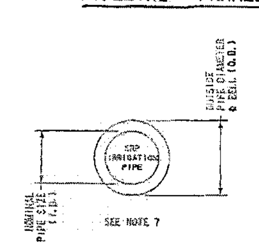
SCALE: NONE | DWG SIZE: 17 X 22 | WES-30300-001



PIPELINE - UTILITY CROSSING



PIPELINE - PARALLEL UTILITY



NOMINAL PIPE SIZE (I.D.)	OUTSIDE PIPE DIAMETER AT BELL (O.D.)
24"	37"
30"	45"
36"	53"
42"	60"
48"	68"
54"	75"
60"	82"
66"	89"
72"	91"

OUTSIDE DIAMETER SRP IRRIGATION PIPE

NOTES

1. OVERCROSSINGS OF SRP IRRIGATION PIPE ARE REVIEWED ON A CASE-BY-CASE BASIS. EXCEPT FOR THOSE CASES SPECIFICALLY IDENTIFIED BELOW, OVERCROSSINGS ARE TYPICALLY NOT ALLOWED.
2. MAINTAIN MINIMUM 3" CLEARANCE BETWEEN SRP IRRIGATION PIPE AND OVERCROSSING SINGLE-SERVICE (RESIDENTIAL) UTILITY LINES OF 1" DIAMETER OR LESS, STREET LIGHT ELECTRIC LINES, OR TRAFFIC SIGNAL ELECTRIC LINES.
3. MAINTAIN MINIMUM 12" CLEARANCE BETWEEN SRP IRRIGATION PIPE AND CLOSEST POINT OF OVERCROSSING SCUPPER. SCUPPER SHALL CONFORM TO MAG STANDARD DETAIL 203 OR 206.
4. UTILITIES PARALLEL TO SRP IRRIGATION PIPE ARE REVIEWED ON A CASE-BY-CASE BASIS. LOCATE PARALLEL UTILITY OUTSIDE OF AREA SRP EXCAVATES WHEN MAINTAINING IRRIGATION PIPE. TYPICAL EXCAVATION INCLUDES AREA ABOVE AND TO EACH SIDE OF SRP IRRIGATION PIPE. SIDE EXCAVATION INCLUDES AREA ABOVE A LINE EXTENDING UPWARD AND OUTWARD AT A ONE-TO-ONE SLOPE FROM A POINT LEVEL WITH THE BOTTOM OF AND TWO FEET BEYOND THE SIDE OF THE OUTSIDE BELL DIAMETER OF THE SRP IRRIGATION PIPE.
5. OTHER UTILITIES NOT PERMITTED IN THESE AREAS.
6. CLEARANCE IS MEASURED FROM OUTSIDE BELL DIAMETER OF SRP IRRIGATION PIPE. OUTSIDE BELL DIAMETER IS SIGNIFICANTLY LARGER THAN NOMINAL PIPE SIZE (INSIDE DIAMETER) NOTED ON PLAN/PROFILE DRAWINGS. SEE TABLE FOR NOMINAL PIPE SIZES AND OUTSIDE BELL DIAMETERS.
7. SPECIFIED CLEARANCES ARE FOR USE WITH RUBBER GASKETED REINFORCED CONCRETE PIPE (RGRCP) UP TO AND INCLUDING 72" NOMINAL PIPE SIZE. GREATER CLEARANCE OR REPLACEMENT IS REQUIRED FOR LARGER DIAMETER RGRCP, CAST-IN-PLACE PIPE (CIPP) AND NON-REINFORCED CONCRETE PIPE.
8. ASSURE CONTINUOUS SUPPORT AND PROTECTION OF SRP IRRIGATION PIPE. DAMAGE TO SRP IRRIGATION PIPE/SYSTEM WILL BE REPAIRED BY SRP. ALL DIRECT AND INDIRECT COSTS SHALL BE BORNE BY OTHER UTILITY/LICENSEE.
9. TRENCH BACKFILL COMPACTION SHALL BE MARICOPA ASSOCIATION OF GOVERNMENTS (MAG) TYPE I OR TYPE III, EXCEPT THAT 95% COMPACTION SHALL BE REQUIRED FROM ONE FOOT ABOVE TOP OF PIPE TO BOTTOM OF TRENCH. WATER CONSOLIDATION IS NOT PERMITTED.
10. COMPLY WITH MAG UNIFORM STANDARD SPECIFICATIONS AND STANDARD DETAILS UNLESS OTHERWISE NOTED IN PROJECT SPECIFIC SRP DOCUMENTS. MOST STRINGENT REQUIREMENTS SHALL APPLY UNLESS SPECIFICALLY NOTED OTHERWISE IN SRP DOCUMENTS.
11. COMPLY WITH ALL APPLICABLE STATUTES, ORDINANCES AND REGULATIONS INCLUDING BLUE STAKE LAW (A.R.S. SEC. 40-360-21 ET SEQ.).
12. THESE GUIDELINES ARE PROVIDED AS A GENERAL AID TO PLANNING. ACTUAL SRP REQUIREMENTS MAY VARY BASED ON SITE-SPECIFIC CONDITIONS, OPERATIONAL CONSIDERATIONS, ETC.
13. AN SRP LICENSE IS REQUIRED FOR UTILITIES CROSSING/PARALLEL TO SRP IRRIGATION PIPE IN SRP RIGHT-OF-WAY. SRP REQUIRES ENGINEER DESIGNED UTILITY CROSSING/LOCATION AND EXCAVATION PLAN.
14. REQUESTS FOR SRP LICENSES ARE HANDLED ON A CASE-BY-CASE BASIS. CONTACT SRP AT 602-236-2062 REGARDING LICENSES FOR SITES LOCATED NORTH OF THE SALT RIVER AND AT 602-236-8789 REGARDING LICENSES FOR SITES SOUTH OF THE SALT RIVER.
15. NOTIFY SRP INSPECTOR A MINIMUM OF 72 HOURS BEFORE STARTING CONSTRUCTION IN OR AROUND SRP IRRIGATION FACILITIES. AN IRRIGATION OUTAGE AGREEMENT MUST BE COMPLETED BY THE CONTRACTOR IF A DRY-UP OF ANY PART OF THE IRRIGATION SYSTEM WILL BE NECESSARY DURING CONSTRUCTION. ISSUANCE OF A LICENSE DOES NOT PROVIDE FOR A CONSTRUCTION DRY-UP.

REFERENCES	
SALT RIVER PROJECT RIGHT-OF-WAY GUIDELINES	WES-ROWGUIDE

REVISIONS

REV NO.	DFTR	DSGN	ENGR CHK	ISSUE AUTH	DATE
ADDED NOTE 3 AND RENUMBERED SUBSEQUENT NOTES.					
3	JWS / JWS	CWT / CWT	CWT / CWT	REL / REL	10/18/05
INITIAL ISSUE.					
0	MDD / MDD	CWT / CWT	CWT / CWT	REL / REL	04/06/98

SALT RIVER PROJECT — WATER ENGINEERING STANDARD

UTILITIES CROSSING OR PARALLEL TO SRP IRRIGATION PIPE

SCALE: NONE | DWG SIZE: 17X22 | WES-02604-001

PRELIMINARY
100%
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

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

"PER CITY OF PHOENIX ORDINANCE G-4396, THESE PLANS ARE FOR OFFICIAL USE ONLY AND MAY NOT BE SHARED WITH OTHERS EXCEPT AS REQUIRED TO FULFILL THE OBLIGATIONS OF YOUR CONTRACT WITH THE CITY OF PHOENIX."

SRP STANDARD DETAILS

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE: 08/10	DATE: 08/10	DATE: 08/10		
SCALE NONE			23	24

ST83110066DT-13.dwg, 8/2/10

OLD CROSS CUT CANAL
IMPROVEMENTS
AZ CANAL TO INDIAN SCHOOL RD
PHOENIX STREET – MARICOPA CO.

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL
9	ARIZ.	ST83110066	23	24

OLSSON ASSOCIATES — CONSULTING ENGINEER
DES: DVD DR: JLD CK: JCF DATE: 8/10

REVISION BY CITY OF PHOENIX				
NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX				
NO.	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY CITY OF PHOENIX				
NO.	DESCRIPTION	REV BY	CKD BY	DATE

Alpha Project Number: 10-G-1735 — Log of Boring No. B-1
Project: Arcadia Drive Drainage Improvement - Phase 1 — Client: Olsson Associates
Project Location: Phoenix, Arizona — Boring Location: See attached site plan
Longitude: 33.49537° Latitude: -111.97737°
Remarks: Bulk Sample collected from 0'-2' and 20'-23'. Ring Samples driven at 2'-3', 5'-6', 10'-11', 15'-16', and 20'-21'. and Split Spoon Sample driven at 25'-26.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			8.3		SM	SILTY SAND WITH GRAVEL Light to medium brown, predominately fine graded, subrounded, loose to medium dense to very dense to medium dense to dense to loose, slightly damp to moist to slight damp, non-plastic, non to weakly cemented.
R	4-5			2, 4		
R	9-16	102	9.3	6, 8		
R	30-50/5"			10, 12, 14		
R/B	8-16	86	15.6/9.0	16, 18		
R/B	17-25	112	11.1	20, 22, 24		
S	4-4-4		13.3	26		
				28		Bottom of boring @ 26.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.
Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282
Sample Date: 06/04/09 & 06/05/09
Drill Rig: Diedrich D-50

Alpha Project Number: 10-G-1735 — Log of Boring No. B-2
Project: Arcadia Drive Drainage Improvement - Phase 1 — Client: Olsson Associates
Project Location: Phoenix, Arizona — Boring Location: See attached site plan
Longitude: 33.49999° Latitude: -111.97738°
Remarks: Bulk Sample collected from 15'-20'. Ring Samples driven at 10'-11', 15'-16', 20'-21' and 25'-26', and Split Spoon Sample driven at 2'-3.5' and 5'-6.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
					SM	SILTY SAND WITH GRAVEL Light brown, predominately coarse graded, subrounded, medium dense to dense to very dense to dense, slightly damp, non-plastic, non to weakly to moderately cemented.
S	6-8-7			2, 4		
S	7-7-6			6, 8		
R	18-25			10, 12, 14		
R/B	30-35		7.7	16, 18		
R	30-34	100	12.7	20, 22, 24		
R	15-24	106	10.6	26		
				28		Bottom of boring @ 28.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.
Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282
Sample Date: 06/04/09 & 06/05/09
Drill Rig: Diedrich D-50

Alpha Project Number: 10-G-1837 — Log of Boring No. B-3
Project: Arcadia Drive Drainage Improvement - Phase 1 — Client: Olsson Associates
Project Location: Phoenix, Arizona — Boring Location: See attached site plan
Longitude: 33.49912° Latitude: -111.97701
Remarks: Bulk Sample collected from 0'-5' and 23'-25'. Split Spoon Samples driven at 5'-6.5', 10'-11.5', 15'-16.5', 20'-21.5', 25'-26.5', 30'-31.5, 35'-36.5', and 40'-41.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B			7.6		SM	SILTY SAND WITH GRAVEL Medium brown, well graded, subrounded, loose, slightly damp, non-plastic.
S	3-4-4			3, 6		
S	4-9-10			9, 12	SC	CLAYEY SAND Reddish brown, predominately fine graded, subrounded, firm, slightly damp, medium plasticity.
S	9-12-11			15, 18	SM	SILTY SAND WITH GRAVEL Light brown, well graded, subangular, medium dense to dense to medium dense to dense to medium dense, slightly damp to moist to wet, non-plastic.
S	11-14-17			21		
B			11.2	24		
S	2-3-8			27		
S	10-16-24			30, 33		
S	3-5-6			36		
S	6-8-7			39		
				42		Bottom of boring @ 41.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.
Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

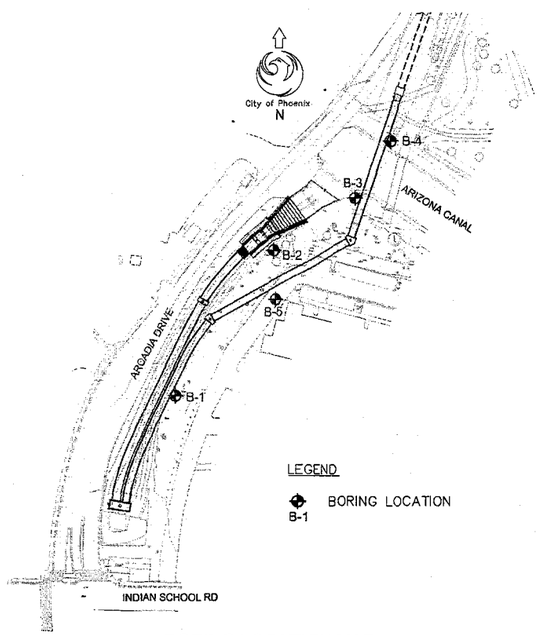
Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282
Sample Date: 07/14/10
Drill Rig: Diedrich D-50

Alpha Project Number: 10-G-1837 — Log of Boring No. B-4
Project: Arcadia Drive Drainage Improvement - Phase 1 — Client: Olsson Associates
Project Location: Phoenix, Arizona — Boring Location: See attached site plan
Longitude: 33.49532° Latitude: -111.97695
Remarks: Bulk Sample collected from 2'-5'. and Split Spoon Samples driven at 5'-6.5', 10'-11.5', 15'-16.5', 20'-21.5', 25'-26.5', 30'-31.5, 35'-36.5', and 40'-41.5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
B					SM	SILTY SAND WITH GRAVEL Light to medium to reddish brown, predominately coarse graded to well graded, subrounded, medium dense, dry to slightly damp, non-plastic, non-cemented.
S	3-8-10			3, 6		
S	6-10-8			9, 12	SC	CLAYEY SAND Medium brown, well graded, subrounded, firm, slightly damp, medium plasticity, non-cemented.
			15.1	15		
S	10-14-9			18	SM	SILTY SAND WITH GRAVEL Light brown, well graded, subrounded, medium dense to very dense to dense to medium dense to dense, slightly damp to moist to wet, medium plasticity, weakly cemented.
S	19-28-34		11.3	21		
S	14-19-21			24, 27		
S	9-14-28			30, 33		
S	11-12-13			36		
S	14-17-19			39		
				42		Bottom of boring @ 41.5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.
Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282
Sample Date: 07/14/10
Drill Rig: Diedrich D-50



LEGEND
BORING LOCATION
B-1

BORING LOCATION MAP
NOT TO SCALE

Alpha Project Number: 10-G-1837 — Log of Boring No. B-5
Project: Arcadia Drive Drainage Improvement - Phase 1 — Client: Olsson Associates
Project Location: Phoenix, Arizona — Boring Location: See attached site plan
Longitude: Latitude:
Remarks: Bulk Sample collected from 1'-5'.

Sample Type	Blows Per 6"	Dry Density (PCF)	Moisture (%)	Depth (Feet)	USCS Code	Description of Subsurface Conditions
						ASPHALTIC CONCRETE (1.69") AGGREGATE BASE COURSE (7")
				2	SP-SM	SAND WITH SILT Light brown, well graded, subrounded, slightly damp, non-plastic.
				4		
				6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28		Bottom of boring @ 5'; no groundwater encountered.

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.
Sample Type Key: S = Split Spoon B = Bulk Sample BN = Bull Nose R = Ring Sample

Alpha Geotechnical & Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282
Sample Date: 07/17/10
Drill Rig: Core Rig

UNIFIED SOIL CLASSIFICATION SYSTEM					CONSISTENCY OR RELATIVE DENSITY		
Major Divisions			Group Symbols	Typical Names	CRITERIA		
Coarse-Grained Soils (More than 50% retained on No. 200 sieve)	Gravels (50% or more of coarse fraction retained on No. 4 sieve)	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Standard Penetration Test Density of Granular Soils		
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Penetration Resistance N (blows/ft)	Relative Density	
		Gravels With Fines	GM	Silty gravels, gravel-sand-silt mixtures	0-4	Very Loose	
			GC	Clayey gravels, gravel-sand-clay mixtures	5-10	Loose	
	Sands (More than 50% of coarse fraction passes No. 4 sieve)	Clean Sands	SW	Well-graded sands and sand-gravel mixtures, little or no fines	11-30	Medium	
			SP	Poorly graded sands and sand-gravel mixtures, little or no fines	31-50	Dense	Very
		Sands With Fines	SM	Silty sands, sand-gravel-silt mixtures	>50	Dense	
			SC	Clayey sands, sand-gravel-clay mixtures			
Fine-Grained Soils (50% or more passes No. 200 sieve)	Silts and Clays (Liquid Limit 50% or less)		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands, clayey silts with slight plasticity	Standard Penetration Test Consistency of Cohesive Soils		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Penetration Resistance N (blows/ft)	Consistency	Unconfined Compressive Strength (Tons/ft2)
			OL	Organic silts and organic silty clays of low plasticity	<2	Very Soft	<0.25
	Silts and Clays (Liquid Limit greater than 50%)		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, organic silts	2-4	Soft	0.25-0.50
			CH	Inorganic clays of high plasticity, fat clays	4-8	Firm	0.50-1.00
			OH	Organic clays and organic silts of medium to high plasticity	8-15	Stiff	1.00-2.00
Highly Organic Soils			PT	Peat, humus, and swamp soils with high organic content	15-30	Very Stiff	2.00-4.00
					>30	Hard	>4.0

Unified Soil Classification	Cobbles	Gravel		Sand			Silt or Clay
		coarse	fine	coarse	medium	fine	

3" 3/4" #4 #10 #40 #200 U.S. Standard Sieve

MOISTURE CONDITIONS		MATERIAL QUANTITY		OTHER SYMBOLS	
Dry	Absence of moisture, dusty, dry to the touch	trace	0-5%	C	Core Sample
Slightly Moist	Below optimum moisture content for compaction	few	5-10%	S	SPT Sample
Moist	Near optimum moisture content, well moisten the hand	little	10-25%	B	Bulk Sample
Very Moist	Above optimum moisture content	some	25-45%	▼	Groundwater
Wet	Visible free water; below water table	mostly	50-100%	DP	Pocket Penetrometer

BASIC LOG FORMAT:
Group name, Group symbol, (grain size), color, moisture, consistency or relative density. Additional comments: odor, presence of roots, mica, gypsum, coarse grained particles, ect

EXAMPLE
Brown, loose, fine to medium Sand (SP), trace silt, little fine gravel, damp

UNIFIED SOIL CLASSIFICATION SYSTEM

PRELIMINARY
100%
REVIEW
NOT FOR CONSTRUCTION OR RECORDING

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

"PER CITY OF PHOENIX ORDINANCE G-4396, THESE PLANS ARE FOR OFFICIAL USE ONLY AND MAY NOT BE SHARED WITH OTHERS EXCEPT AS REQUIRED TO FULFILL THE OBLIGATIONS OF YOUR CONTRACT WITH THE CITY OF PHOENIX."

SOIL BORING LOGS

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

OLD CROSS CUT CANAL IMPROVEMENTS
INDIAN SCHOOL ROAD TO ARIZONA CANAL
ST83110066

DR: JLD	DES: DVD	CK: JCF	SHEET NO:	TOTAL SHEETS
DATE:08/10	DATE: 08/10	DATE: 08/10	24	24
SCALE NONE				

ST83110066SB-01.dwg, 8/2/10

Appendix J

Arborist Evaluation

Artistic Arborist, Inc.

Tim A. Johnson – Registered Consulting Arborist # 360

Via email only

PLANT HEALTH EVALUATION

CLIENT: Olsson Associates
7250 N. 16th St.
Phoenix, AZ 85020

DATE: March 11, 2010

PHONE: (O) 602-748-1000 (C) 602-402-9909 (Email) jford@oaconsulting.com

AUTHORIZED BY: Jeff Ford

SITE LOCATION: Arcadia Drive Drainage Improvements – Phase 1
From Indian School Road to Arizona Canal along east side of 48th St.

PLANT(S) INVOLVED & LOCATION: 4 or 5 Eucalyptus trees

CLIENT CONCERN: Eucalyptus and Date Palms are near or next to construction foot print of canal improvement project. Can these survive and what are the guidelines to facilitate short and long term survival.

DIAGNOSIS: ☐ Mechanical ☒ Visual ☐ Chemical ☐ Other

It is my professional opinion that these trees can survive and be assets to the landscape well into the future.

CONDITION: OK **SURVIVABILITY:** 80%+ **(with regard to life)** **RECOVERABILITY:** 80% **(with regard to appearance)**

PROGNOSIS: Tree preservation and conservation practices must be implemented and adhered to for these trees to remain assets and not become liabilities in the future.

INSPECTION COMPLETED:
BY: Tim A. Johnson, Registered Consulting Arborist #360
FOLLOW-UP DATE:
Prepared by:

INSPECTION: $ 525.00
LAB WORK:
MATERIALS:
TOTAL DUE: $ 525.00

4519 N. 7th Avenue, Phoenix, AZ 85013
(602) 263-8889 • (602)-265-1423 Fax • www.artistic-arborist.com

CONSULTATION • SERVICE • SUPPLIES

The trees in question are a mature, relatively unmanaged stand of trees, surviving in a harsh environment. Currently there is very minimal activity under these trees yet activity will increase at the completion of this project due to a new walking path that will pass under the trees. Due to this implied invitation to the area, long term risk management is also an issue that needs to be addressed concurrently with the tree health issue.

SUGGESTED ACTION PLAN

(For your use – fill in date steps completed and any comments)

Pre- Construction

STEP	TIMING	DATE	TREATMENT
1.			Remove the Eucalyptus Tree that recently lost two major scaffold branches from the crown. This tree could be retained if an annual management plan could be committed to, otherwise the risk of failure exceeds acceptable thresholds. COMMENTS:
			The desired root zone (DRZ) radius for these trees is: Eucalyptus 18'+, Date Palms 6'+. The critical root zone* (CRZ) radius is 12' for the Eucalyptus and 3' for the date palms. * Area that cannot be violated by surface traffic or excavation of any kind without more detailed mechanically and analytical assessment. COMMENTS:

STEP	TIMING	DATE	TREATMENT
2.			Survey- A. Determine and mark root DRZ and CRZ of each tree to remain in place to make decision on which to use. B. Remove granite cap and any excessive soil over root plate in the designated area. C. Test for soil compaction (bulk density) and aerate if necessary. D. Set up temporary irrigation system using numerous emitters to evenly distribute water (as opposed to water volume), including a separate spray valve to maintain moisture in compost. E. Cover area with 4" layer of compost. Note: if traffic cannot be kept off root zone area use 12"-14" layer of compost. F. Maintain moist, not wet, soil to a depth of 30"-38". G. Soil and tissue analysis could be completed at this time, primarily for future assessment. COMMENTS:
3.			Prune trees solely to reduce branch failure potential - Reduce branch end weight with thinning or reduction cuts, and remove dead branches. Thinning the inner crown at this time would be detrimental to long term health. Pruning should take place prior to any landscaping under the trees. It does not need to be completed prior to construction unless working under unpruned trees is an issue with the trades on the job. COMMENTS:

During Construction

			Excavation should stay well away from the designated boundaries. Work toward the tree boundary as opposed to starting at the boundary. The soil spoils excavated from near the boundary of the root zone should be stock piled and used as back fill for the area it was taken from. When roots 3" diameter +, are encountered on-site, an Arborist or person qualified to assess root management issues should be consulted prior to continuing. If excavation needs to adjoin the designated root zone, the final 2' to 3' of excavation near and around roots should be done by hand. Roots should then be cut at the boundary. At completion of excavation/construction, the remaining void should be back filled with the stock pile of the soil excavated from the area. COMMENTS:

Post Construction

			- Prune trees not completed previously. - Install appropriate permanent irrigation system. - Complete current soil and tissue analyses for comparison and for monitoring tree vitality; follow up accordingly. - Set up bi-annual monitoring schedule for risk and health. COMMENTS:

ENCLOSURES: Arbor Bucks