Design Data Report
Final Submittal

(VOLUME 1)

September 2002

Bethany Home/Grand Canal Flood Control Project

Bethany Home Outfall Channel

SR101L to 83rd Avenue

Project No. 2001C053, PCN No. 620 03 32

Registered Professional Engineer (Civil)
CERTIFICATE NO. 24999
JEFFREY R. MINCH
DATE SIGNED 9/10/02
ARIZONA, U.S.A.

Prepared for:
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009
Project No. 98-46

Prepared by:
DMJM+HARRIS
2777 East Camelback Road, Suite 200
Phoenix, Arizona 85016
Project No. 6888

Prepared in Cooperation with:
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5850 West Glendale Avenue
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Prepared in Cooperation with:
The City of Phoenix
200 West Washington
Phoenix, Arizona 85003

TABLE OF CONTENTS

PAAC MEETING MINUTES

HYDROLOGY

PROJECT GEOMETRY

HYDRAULICS

EROSION CONTROL MEASURES

INVENTORY OF CONFLICTING UTILITIES

UTILITY POTHOLE DATA

RIGHT-OF-WAY AND EASEMENTS

STRUCTURAL CALCULATIONS (UNDER SEPARATE COVER -VOLUME 2, 3 & 4)

QUANTITY AND COST CALCULATIONS

GEOTECHNICAL CALCULATIONS

UTILITY CALCULATIONS

IRRIGATION CALCULATIONS

Registered Professional Engineer (Civil)
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JEFFREY R. MINCH
DATE SIGNED 9/10/02
ARIZONA, U.S.A.

PAAC MEETING MINUTES

(Project Aesthetics Advisory Committee)

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Please return to
2801 W. Durango
Phoenix, AZ 85009

DMJM HARRIS

MEETING MINUTES

Date: May 16, 2001

To: File

From: Wade Gendreau
Bob Gladwin
Jeff Minch

Re: Bethany Home Outfall Channel, Phase II
Bethany Home/Grand Canal (BH/GC) Flood Control Project
Flood Control District of Maricopa County (FCD)
Contract No.: FCD 98-46
DMJM+HARRIS Project No. 6888

Subject: Project Aesthetics Advisiory Committee (PAAC) Meeting No. 1
May 16, 2001 (7:00 p.m. to 9:00 p.m.)
City of Glendale City Hall,

Attendees: See attached list.

The following meeting minutes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions or comments please contact the author immediately at (602) 337-2777. If we do not hear from you within 10 days, we will assume that our understandings are the same. We are proceeding based upon the contents of these meeting minutes.

Action Items are identified in bold italics.

I. Introductions: The meeting participants made self-introductions. DMJM+HARRIS (D+H) identified the goals and objectives as outlined below:

A. Meeting Goal

To ensure that the PAAC participants understand the project parameters, process, methodology and resultant outcomes as it relates to the research, documentation, analysis, concept development and final design of the landscape, aesthetic and multi-use elements and to make sure that they are integrated with the flood control facility along the entire length of the corridor.

B. Objectives

- Discuss the project overview
- Review project tasks completed to date, current project status and future tasks
- Review the project scope of work for the landscape, aesthetic and multi-use tasks.
- Define the process and methodology of the tasks and their interrelationship to one another
- Define the resultant outcomes of the different tasks.
- Define the roles and responsibilities of the PAAC participants

II. PROJECT OVERVIEW – Jeff Minch, Wade Gendreau (DMJM+HARRIS)

A. Jeff Minch reviewed the over-all project goals both from a linear park and storm water management perspective. Examples of previous flood events in the area and damages caused by the flooding were shown to the Committee, and reasons for the design and implementation of the project were established.

B. Wade Gendreau presented an overview of the linear park element of the pre-design study. The exhibits with oblique aerial photos, perspective sketch and photo examples of intended improvements were presented. Discussion and questions from the Committee accompanied each slide. These included the removal of houses in Segment 6, the direction of flow of the canal and stormwater, and the source of stormwater that enters Sunset Basin.

C. Wade then reviewed the PAAC Mission Statement and responsibilities.

D. Additional discussion occurred regarding the construction schedule and sequence. Jeff reviewed the contents of the handout material (maps, sketches, flow chart, PAAC membership) and presented the schedule as follows:
- Loop 101 to east of 83rd Avenue: 6/02 – 1/04
- 73rd Avenue to 67th Avenue: 6/04 – 6/05
- 83rd Avenue to 73rd Avenue: 6/05 – 1/06
- 67th Avenue to 64th Avenue: 6/07 – 6/08
- Camelback Road storm drain: 6/08 – 6/09

(ISSUE) drainage flows through unimproved segments should not be impeded or blocked by the construction of Segment A.

E. Project funding was discussed. The first phase is presently funded and although the funding amount is adequate, there is not much "wiggle room". Funding for the entire project is in the Capital Plan and funds are expected to be available. The Bethany Home storm drain project funding has not yet been established in the City of Glendale's 5-year plan Capital Improvement Plan.

F. The Committee's concerns then focused upon the various trail crossings. One member stated that the trail underpass crossings are a great idea and these crossings should be constructed all over Phoenix.

- *(ISSUE) The trail crossing at 75th and Camelback will not be underground as this tunnel would be nearly 500' long, much too long for a trail in terms of safety and security. Trail users will have to cross at the intersection traffic light(s).*
- *(NEED) At 95th Avenue, the trail design should reflect the future alignment and structure of the vehicular bridge. It should be properly planned to minimize disruption to the current corridor improvements during bridge construction.*

IV. LANDSCAPE, AESTHETICS AND MULTI-USE PROJECT PROCESS & ELEMENTS – Wade Gendreau (DMJM+HARRIS)

A. The project flow chart was briefly presented, and the Committee was advised that the design team will be looking to them for review and guidance regarding the design process and products.

B. The Committee was advised that the design team is currently working on the Site Analysis, the Visual Analysis and the Needs Assessment. Following the completion of these three tasks, the team will complete Design Alternatives, Design Guidelines, the Corridor Master Plan and Construction Documents for Segment A.

V. PAAC MEETING SCHEDULE AND OBJECTIVES - Wade Gendreau (DMJM+HARRIS)

The Committee reviewed the schedule of the five proposed PAAC meetings and the anticipated agenda items for each meeting.

VI. PUBLIC INVOLVEMENT COORDINATION – Wade Gendreau (DMJM+HARRIS)

There was a significant public involvement process as a part of the Pre-design Study contract. As a part of this final design process, there will be general, project-wide public information meetings, public information meetings within the City of Glendale regarding the recreation component of the corridor, and five PAAC meetings.

VII. OPEN DISCUSSION – Wade Gendreau, Jeff Minch, Bob Gladwin (DMJM+HARRIS) & Scott Vogel (FCDMC)

- *(ISSUE) There was considerable concern about the maintenance practices by SRP. Specifically, the practice of depositing canal dredged material along the north edge of the right-of-way. The Committee would like to discuss these practices with SRP and see if other maintenance accommodations can be made.*
- The County's design consultant, DMJM+HARRIS is under contract to provide a master plan for the entire corridor and construction documents for the project from the Loop 101 to east of 83rd Avenue.
- There are no specific public meetings for the Phoenix Segments schedule at this time. It is anticipated that public meetings will be scheduled during the design of the Phoenix segments of the project.
- Each Partner City will perform Linear Park maintenance for their Segments.
- Use landscaping to buffer the SRP maintenance road.

The following needs and issues list was generated at the meeting's open forum.

NEEDS

1. 95TH Ave. underpass plan up front, easy construction later.
2. Underpass at 67th Ave. & Indian School Road.
3. Pedestrian crossings at the half-mile points.
4. Phoenix:
   - Greenbelt
   - Trail
   - Seating
   - Decorative treatments
5. Glendale:
   - Active L. Park
   - Playgrounds (75th Ave. and 83rd Ave.
   - Dog Park
   - Equestrian Park
   - Multi-Purpose Trail

ISSUES

1. Concrete Channel treatment, safety.
2. SRP maintenance practices.
3. Appearance of towers.
4. SRP edge.
5. Pedestrian bridge side improvements.
6. Maintenance by who? (Graffiti)
7. Lighting and security.
8. SRP – blending improvements with corridor.
9. Maintain agricultural drainage.
10. Keep path away from residential property lines.
11. Equestrian crossings – not on surface.
12. Crossing at 83rd Ave. (corridor under canal).
13. How does the trail continue to New River?

Cc: Attendees

Files 6888 – 200.2, 3, 4, 400.17, 400.20, 600.3

bethany home / grand canal
flood control project

Attendees of the May 16, 2001 PAAC Meeting:

ORGANIZATION	NAME	PHONE/FAX	E-MAIL
FDCMC	Scott Vogel	602-506-4771 / 602-506-8561	csv@mail.maricopa.gov
FDCMC	Dennis Holcomb	602-506-4074 / 602-506-4601	dbh@mail.maricopa.gov
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DMJM+HARRIS	Jeff Minch	602-337-2540 / 602-337-2620	jeff.minch@dmjmharris.com
DMJM+HARRIS	Wade Gendreau	602-337-2565 / 602-337-2620	wade.gendreau@dmjmharris.com
DMJM+HARRIS	Bob Gladwin	602-337-2591 / 602-337-2620	bob.gladwin@dmjmharris.com
Glendale Parks & Recreation Commission	John Kolodziej		
Heatherbrae Neighborhood Association	Charles Hoyt		
Holiday Park Block Watch	Carina Cost		
John F. Long Properties	Jacob F. Long		
Pendergast Properties	Clarence Pendergast		
Pendergast Properties	Colleen Pendergast		
Larry Rovey Farms	Larry Rovey		
Joe Martinez	Citizen		

DMJM HARRIS

MEETING MINUTES

Date: June 14, 2001

To: File

From: Wade Gendreau, Bob Gladwin & Jeff Minch

Re: Bethany Home Outfall Channel, Phase II
Bethany Home/Grand Canal (BH/GC) Flood Control Project
Flood Control District of Maricopa County (FCD)
Contract No.: FCD 98-46
DMJM+HARRIS Project No. 6888

Subject: Project Aesthetics Advisory Committee (PAAC) Meeting No. 2
June 14, 2001 (7:00 p.m. to 9:00 p.m.)
City of Phoenix, West Human Services Center
3454 North 51st Avenue
Phoenix, Arizona

Attendees: See attached list.

The following meeting minutes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions or comments please contact the author immediately at (602) 337-2777. If we do not hear from you within 10 days, we will assume that our understandings are the same. We are proceeding based upon the contents of these meeting minutes.

Action Items are identified in bold italics.

I INTRODUCTIONS – Scott Vogel (FCD)

The meeting participants made self-introductions. DMJM+HARRIS identified the goals and objectives as outlined below:

A. Review the status of the landscape/aesthetic analyses
B. Present examples of landscape/aesthetic/multi-use treatments
C. Obtain feedback on the treatment options

II APPROACH - Wade Gendreau (DMJM+HARRIS)

A. Overview - Wade updated the committee as to the current status of our analysis effort. The update of the Pre-Design Study Site Analysis is nearly complete, and the fieldwork for the Visual Analysis has been completed. The exhibits to be shown in the Power Point presentation represents a work in progress; final documentation including graphic exhibits will be given to committee members when complete.

B. Site Analysis - A presentation of the Opportunities & Constraints Plan served to review the site analysis efforts of the Pre-Design Study and to include new information currently observed.

C. Visual Analysis – The presentation of the Visual Analysis field inventory included a description of the method and rationale for identifying the Visual Character Units along the project's length. The criteria for establishing these units include the physical condition of the proposed flood control structure (turf channel, open concrete box, buried/closed concrete box) and the general character of the adjacent land uses. Following the review of the over-all project character units, each unit was highlighted, shown in an aerial photograph, and represented by several photographs indicating typical or representative character elements and distant focal points and views. The following items were discussed by the committee:

a. There are three drainage corridors in at the Maryvale Detention Basin site where storm water enters the drainage channel. These major drainage features should be identified on the Opportunities and Constraints plan
b. The property acquisition limits were identified and discussed.
c. It appeared that the plan was in error regarding the location of the proposed turf channel west of the SRP substation. DMJM+HARRIS will check into this and will correct the plan if necessary.
d. Feature views should include the pedestrian bridges (as a foreground feature).
e. There was significant discussion about the overhead power lines that run with and across the corridor. Each city receives some level of SRP aesthetics money and prioritizes its expenditure. It could be used to bury power lines. U.S. West should be contacted regarding any overhead telephone lines in the corridor, and requests for funding assistance made. It was suggested that the consultant should identify where we want to bury these lines, examine the costs for this treatment, and examine funding sources and mechanisms that are available in Maricopa County, including Federal funds. This research should be reported back at the next PAAC meeting. The consultants project manager will discuss this request with the FCDMC. SRP representatives should be encouraged to attend these meetings – it was noted that they are always invited. Other contacts with appropriate City utility engineers should also be considered.
f. A committee member mentioned that a 900 unit residential development might be planned for an area south of the canal, near Heatherbrae and 67th Avenue.
g. SRP's practice of leaving canal dredging material, including trash was discussed. Continuing efforts to work with SRP are desired to minimize impact to the proposed park and trail corridor.
h. Graffiti removal in the open concrete channel at the radio towers will be an important maintenance consideration for both the designer and the City of Phoenix.
i. The Heatherbrae School principal has been actively involved in neighborhood issues and might want to be a part of the PAAC. It was suggested that she be invited to the next meeting.
j. Design tree locations to be grouped along the trail to provide intermittent shade.
k. Turf and desert planting irrigation resources may be limited. The designers should coordinate this effort with each municipality. Glendale indicated that reclaimed water from their newly constructed water reclamation plant might be available for use in the future.
l. Phoenix uses bubblers for irrigating trees and shrubs in planting beds, and relies on turf spray systems to irrigate trees in turf areas. Glendale uses a combination of bubblers and emitters for plants in beds. Jim Keeler (Glendale) would be a good contact.

m. Joe Cascio mentioned that SRP requires both vertical and horizontal clearance (20') along their lines and poles. Locate trees outside of these clear zones or extensive pruning will occur. Also, no trees were permitted over the box culvert at the Old Cross-Cut Canal Park Canal Park.
n. DMJM+HARRIS will coordinate with the City of Glendale consultant regarding a connection from the trail system to the regional park.

D. Needs Assessment – This item in the program was eliminated from the presentation because of time constraints. These slides will be printed out and included with the meeting minutes to the committee. The entire Power Point slide show will be put on the DMJM+HARRIS FTP site for review and downloading by committee members.

E. Goals & Objectives – This item was also eliminated from the program discussion and will be made available in the minutes and on the FTP site.

IV. OPEN DISCUSSION – Wade Gendreau (DMJM+HARRIS)

1. Photographs of the different categories of treatment alternatives for landscape, aesthetics and multi-use facilities were shown and discussed. The following comments were received:
   a. Check to see if there is any transit opportunities at the major and/or minor linear park nodes. ***Ray Dovalina will review this issue with City of Phoenix staff and identify potential funding sources.*** Federal and City funding may be available to build these areas. Bus stops could enhance the park nodes.
   b. Consider skateboarding activities on our hardscape design elements. Low retaining and seat walls are popular with skateboarders. Design the facilities to discourage skateboarding on these hardscape elements.
   c. Consider inviting a member of the Tucson urban artist group to a PAAC meeting. This group works with kids to develop urban art material in public spaces.
   d. Develop a definite continuity all along the corridor. Create unifying elements, logos or themes that are continually appearing along the trail system.
   e. Consider alternatives to the typical shoebox light fixture.
   f. Work with City representatives with regard to safety, crime prevention (CPTED) and ADA issues.
   g. Consider dog bag boxes.
   h. Pleasing trash receptacles.
   i. Maintenance commitment from each City is important.
   j. Consider water features at major entry nodes. Reclaimed water (non-contact) and the canal could be a water source.
   k. Stagnant water and mosquitoes need to be addressed by the FCD. Maintain positive low flow drainage and/or a buried pipe.

Cc: Attendees

Files 6888 – 200.2, 3, 4, 400.17, 400.20, 600.3

BETHANY HOME / GRAND CANAL FLOOD CONTROL PROJECT
NEEDS ASSESSMENT SUMMARY
(Predominant Responses)

A. LANDSCAPE

Glendale & Phoenix:
- Irrigated turf greenbelt with lots of trees for shade
- Buffered SRP maintenance road with meandering desert adapted tree and shrub masses

Phoenix:
- Desert adapted trees, shrubs, ground covers and decomposed granite between the trail and curb and around entry and rest nodes
- Bubblers to irrigate trees, shrubs and ground covers in desert planting areas
- Trees in turf areas shall not have the bubbler added.

B. AESTHETICS

Glendale:
- Incorporate public art within the linear park, with a preference for freestanding sculpture.
- Major linear park entries should provide for a significant artistic feature.
- The use of recycled materials in the art element was suggested.
- Care and maintenance of art features including graffiti removal is a concern.

Phoenix:
- Utilize landform (variable slope gradients) to meander the channel bottom.
- Provide decorative treatments to hardscape and flood control structures (retaining walls, culvert walls, slope protection, fences, railings, etc.) to incorporate aesthetics within the corridor.

C. MULTI-USE FACILITY

MULTI-USE TRAIL

Glendale & Phoenix:
- A ten-foot wide concrete multi-use trail
- Security lighting along the trail; not intrusive on neighboring homes

Phoenix:
- Integrally colored concrete

Glendale:
- Benches along the trail, signs and mile markers
- Police and park ranger security patrols, rescue equipment along the canal edge
- Connection to the new linear park at 83rd Avenue and Bethany Home Road

EQUESTRIAN TRAIL

Glendale & Phoenix:

- Use the existing SRP maintenance road for horseback riding
- Surface street crossings should be avoided

Glendale:

- Equestrian staging areas at primary trail entry points
- Consider a horse "park"

STREET UNDERCROSSINGS

- Underpasses to accommodate equestrians, pedestrians and bicyclists
- Security is very important - crossings to be lighted, call boxes / panic buttons recommended
- Plan for future vehicular bridges and desired community linkages

PEDESTRIAN BRIDGES

- Non-vehicular bridges for pedestrians, skaters and bicyclists at trail / canal crossings
- Non-vehicular bridges for community access paths at canal crossings

TRAIL NODES

- Passive entry and rest nodes along the trail system
- Entry nodes located at convenient neighborhood access points
- Seating, drinking water, shade from trees, trash cans and signage
- Decorative water features in the node areas.

RECREATION FACILITIES

Phoenix:

- No active recreation facilities
- Provide large open turf areas, where available, for informal recreation

Glendale:

- Neighborhood scale park improvements at the larger, open node areas
- Park facilities include fully accessible playgrounds for different age groups, lighted basketball courts, a large ramada, drinking fountains, small parking area and security lighting
- Other trail activities include a dog park, Par Course, Frisbee Golf, Bicycle trail and BMX facility, skate park, fishing lake, soccer fields, picnic and barbecue facilities and restrooms
- Parking for recreation and trail use preferred within the regional park
- Some suggested that parallel parking on the trailside of adjacent streets would be acceptable as long as no parking was permitted on the residential side of the street.

BETHANY HOME / GRAND CANAL FLOOD CONTROL PROJECT
DRAFT GOALS AND OBJECTIVES

GOAL (Multi-Use)
To enhance the flood control project by providing multi-use opportunities on the surface of the Bethany Home / Grand Canal Flood Control Project, from the Sunset Detention Basin (64th Avenue) to the Loop 101. These facilities shall integrate with the flood control functions of the facility. This system shall be fully accessible to all people, shall accommodate multiple modes of transportation and shall provide linkages with the adjacent community.

Objectives:
- ADA accessible, multi-modal, and to the extent possible, an all-weather surface.
- Trail width to accommodate multi-modal trail users and maintenance vehicles.
- Linkages to adjacent neighborhoods, public facilities, commercial areas and bicycle paths.
- Entry nodes with seating, information signage, landscape shade and visual recognition.
- Equestrians to use the SRP maintenance road; provide underpasses - minimize surface street crossings.
- Wide greenbelt to maximize informal recreation potential; amenities for comfort, relaxation and creativity.

GOAL: (Aesthetics)
To create aesthetically pleasing elements (including landscaping, decorative hardscape treatments and public art) that are safe, secure and vandal-resistant.

Objectives:
- Durable, non-skid trail moving through the landscape; grading transitions; gentle horizontal curves.
- Park design for safety; eliminate hiding places; coordinate with CPTED groups.
- Durable and vandal-resistant materials; materials and treatments to discourage graffiti.
- Site and landscape design that enhances adjacent residential neighborhoods.
- Aesthetic treatments to provide a unifying theme throughout the corridor.
- Security lighting and good visibility into the corridor.

GOAL: (Landscape)
To provide landscape improvements that are in character with the surrounding area or future development of the area and that will enhance the project and minimize maintenance concerns.

Objectives:
- Enhance and/or mitigate climatic conditions with plants; enhance seasonal interest with flowering plants.
- Concentrate landscape in nodes where the people congregate; simplify plantings in areas between nodes.
- Landscaping should engage the visitor; incorporate color, contrast, and enhancement of off-site views.

GOAL: (Recreation)
To provide recreational opportunities that are desired by the community and that are appropriate to the area and are integrated with the overall recreational facilities provided by the respective municipalities.

Objectives:

- Recreational amenities in scale with the adjacent community; desired by the municipality and residents.
- Varied recreational opportunities that can be utilized by users of all ages and abilities.

bethany home / grand canal
flood control project

Attendees of the May 16, 2001 PAAC Meeting:

ORGANIZATION	NAME	PHONE/FAX	E-MAIL
FDCMC	Scott Vogel	602-506-4771 / 602-506-8561	csv@mail.maricopa.gov
FDCMC	Dennis Holcomb	602-506-4074 / 602-506-4601	dbh@mail.maricopa.gov
City of Glendale	Warren Smith	623-930-2827 / 623-931-9651	wsmith@ci.glendale.az.us
City of Glendale	Jennifer Sokol	623-930-2043 / 623-931-9651	jsokol@ci.glendale.az.us
City of Phoenix	Ray Dovalina	602-262-4026 / 602-262-7322	rdovalin@ci.phoenix.az.us
City of Phoenix	Joe Cascio	602-262-4897 / 602-534-3787	jcascio@ci.phoenix.az.us
DMJM+HARRIS	Jeff Minch	602-337-2540 / 602-337-2620	jeff.minch@dmjmharris.com
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Glendale Parks & Recreation Commission	John Kolodziej	602-872-8641	jkolodz@chw.edu
Maryvale Village Planning Committee	Elayne Taylor-Tyler	602-261-8771	etaylor@ci.phoenix.az.us
Heatherbrae Neighborhood Association	Charles Hoyt	623-846-7237	choyt@ade.az.gov
Holiday Park Block Watch	Carina Cost		cost@qwest.net
Larry Rovey Farms	Larry Rovey		azmilk@att.net
West Valley Community Collation	Richard Schwartz		sdgras@msn.com

DMJM HARRIS

MEETING MINUTES

Date: July 23, 2001

To: File

From: Wade Gendreau, Bob Gladwin & Jeff Minch

Re: Bethany Home Outfall Channel, Phase II
Bethany Home/Grand Canal (BH/GC) Flood Control Project
Flood Control District of Maricopa County (FCD)
Contract No.: FCD 98-46
DMJM+HARRIS Project No. 6888

Subject: Project Aesthetics Advisory Committee (PAAC) Meeting No. 3
July 19, 2001 (7:00 p.m. to 9:00 p.m.)
City of Glendale City Hall, Conference Room B3

Attendees: See attached list.

The following meeting minutes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions or comments please contact the author immediately at (602) 337-2777. If we do not hear from you within 10 days, we will assume that our understandings are the same. We are proceeding based upon the contents of these meeting minutes.

Action Items are identified in bold italics.

I. Introductions: The meeting participants made self-introductions. DMJM+HARRIS (D+H) identified the meeting objectives as outlined below:

- Present the Concept Alternatives for the Landscape & Aesthetic Treatments
- Obtain feedback on the alternatives presented

II. Concept Alternatives:

A. Bob Gladwin presented to the committee the overall plan of the proposed recreation and multi-use elements by corridor segment. Comments that were generated by the PAAC members for each of the corridor segments are summarized as follows.

Sunset Basin

1. Parking provisions at Sunset Basin
2. How does south side parking at basin integrate with node?
3. Underground power at Indian School Road crossing Grand Canal cost $300,000 to $400,000

Indian School Road to 67th Avenue

1. Meet with church to allow parking for public access

2. Coordinate trail/canal/Indian School Road intersection on how it effects parking access to church
3. Discourage traffic on canal back to avoid 67th Avenue and Indian School Road intersection through use of gates and bollards
4. Is length of residential privacy wall a safety issue?
5. Costly to underground power along canal due to power drops to houses. Would require that all residential service drops be placed underground
6. Screening with landscaping along south side of canal along former SRP operations facility a low priority with the City of Phoenix
7. Add landscape berming to south side screening option, contingent upon SRP ownership status of property
8. Power crossing at 67th Avenue and the Grand Canal under grounding cost $350,000 to $450,000

<u>67th Avenue to 75th Avenue</u>

1. Add pedestrian under crossing label at 67th Avenue
2. Low Flow Alternatives:
   - Pipe (Phoenix preference)
   - Bridge trail over
3. Remove existing sidewalk adjacent to street to construct basin
4. Under grounding of 12Kv power along canal cost $200,000 to $300,000
5. Parking issues along adjacent streets
6. Meander trail across basin
7. Possible bridge enhancement at Heatherbrae School
8. Add node to south side of canal at pedestrian bridge
9. Opportunity with City of Phoenix Arts Commission for vertical wall channel at radio tower site (City of Phoenix contact – Greg Esser)
10. Keep mature landscape from overhanging SRP maintenance road. It interferes with operations may be a problem at the vertically lined channel segment

<u>75th Avenue to 83rd Avenue</u>

1. A "big scupper" is needed in the northwest corner of the 75th Avenue and Camelback intersection. This facility needs to be considered when designing nodal elements at this location.
2. Add small staging area for equestrians at 75th and Camelback (note this was revised to be located at 83rd & Bethany Home Road)
3. Consider vehicle parking in 5 acre dry area
4. Parking lot off of 75th Avenue may be too close to intersection – consider other alternatives
5. 15-foot sewer easement on the south side of canal may be used for access to proposed pedestrian bridge at 79th Avenue and Missouri Avenue alignments
6. Potential node site on south side of canal at 79th Avenue/Missouri Avenue
7. Berry property opportunities for parking and save mature existing trees
8. Consider at-grade crossing of Bethany Home Road to Regional Park, Coordinate this with the park designer

83rd Avenue to 91st Avenue

1. Show equestrian connection under 83rd Avenue bridge
2. Show entry node on the south side of the drainage facility at the 87th Avenue alignment
3. Consider treatment of box culvert crossing under the Grand Canal to discourage use by people
4. Add trail by-pass around nodes to avoid conflicts between bicyclists and pedestrians
5. Keep pedestrians away from residential back walls on the north side of the basin area at 91st Avenue

91st Avenue to Loop 101

1. Show equestrian crossing under 91st Avenue bridge

Loop 101 to New River

1. Consider southern alternate trail crossing of 99th Avenue at future Bethany Home Road intersection
2. Second trail alternate location south of the Grand Canal
3. Check ADOT R/W for surplus on the north side of the existing outlet channel
4. There is a sewer force main easement on the south side of the Grand Canal west of the Roosevelt Irrigation District canal crossing of the Grand Canal

B. Wade Gendreau presented to the committee two "themes" that were developed for the landscape, aesthetics and multi-use elements of the corridor. These themes were identified as the "natural" and the "urban" themes. The specific elements of each of these themes were depicted on presentation boards. The boards illustrated the various treatments for walls, fencing, railing, vehicular bridges and site furnishings. The committee was invited to review the boards in greater detail and make specific comments using post-it-notes placed directly on the boards. The general comments were that the urban treatments were preferred for the major entry nodes, the use of the project logo and it's various interpretations on the walls fencing and railing also received favorable comments.

Comments received on "Theme" Boards

Landform Grading / Bridge Concepts Board

1. Like the variety of slope treatments where appropriate (channel grading slope with rock retaining wall treatment)
2. Like to see pedestrian trail to wander through the slopes and bottom of channel (photo of grass channel with path in bottom and on sides)
3. Wing wall treatment that form to slopes – very nicely transitions from built form to landscape (photo of path through landform held back by keystone retaining wall)
4. Like meandering form, don't like blocks (photo of path through landform held back by keystone retaining wall)
5. Urban better (graphic of wing wall treatment with swoosh pattern at top and score pattern columns)
6. Nice detail and form (photo of stone bridge abutment)
7. This one (graphic of under bridge slope paving with swoosh pattern in differing textures)

Natural Theme Description Board

1. Like this nodal treatment (graphic of freeform play area)
2. Glendale expressed preference for monument sign with rock base
3. Like the "swoosh"(channel vertical wall treatment graphic)
4. Like treatment for drainage way (photo of drainage channel with large rock rip-rap in bottom)
5. Nice slope treatment (photo of retaining wall with DG slope and large boulders and concrete paver plaza)
6. Like the "Santa Fe" style rock forms (photo of gateway to Tempe Beach Park)
7. Retaining walls and partial walls (as barriers) would be good to incorporate seating (photo of stone retaining wall in turf area)
8. Nice simple detail (photo of boulder in turf)
9. Like this floor treatment for inside box culvert to discourage pedestrians (photo of rock sculpture garden with rock pavement)

Natural Theme Details Board

1. Nice to see this grading level at nodes to create visual interest (graphic of minor entry node)
2. Warren preferences – Urban Gateway, Natural sign/entry, natural seat walls, boulders/bollards
3. Great for graffiti control (photo of stone retaining wall)
4. Like seat wall retaining walls (photo of curving retaining wall set into slope)
5. No/OK (no – photo of steel bollard, OK – photo of exposed aggregate concrete bollard)

Urban Theme Description Board

1. Equestrian staging area (graphic of node area at 83rd Avenue & Bethany Home Road use of triangular SRP parcel)
2. Location of potential Bethany Home Road extension needs to be accommodated and considered (graphic of node area at 83rd Avenue & Bethany Home Road)
3. Glendale preferred urban for gateway graphic

Urban Theme Details Board

Nice (graphic of node area with ramada)
Don't like (photo of stainless steel bench)
Good (photo of round light fixture with round steel pole Mesa – Countryside Park)

Cc: Attendees, Files 6888 – 200.2, 3, 4, 400.17, 400.20, 600.3

bethany home / grand canal
flood control project

Attendees of the July 19, 2001 PAAC Meeting:

ORGANIZATION	NAME	PHONE/FAX	E-MAIL
FCDMC	Scott Vogel	602-506-4771 / 602-506-8561	csv@mail.maricopa.gov
FCDMC	Dennis Holcomb	602-506-4074 / 602-506-4601	dbh@mail.maricopa.gov
FCDMC	Lucia de Cordre	602-506-2956 / 602-506-4601	lvd@mail.maricopa.gov
City of Glendale	Warren Smith	623-930-2827 / 623-931-9651	wsmith@ci.glendale.az.us
City of Glendale	Jennifer Sokol	623-930-2043 / 623-931-9651	jsokol@ci.glendale.az.us
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City of Phoenix	Ray Dovalina	602-262-4026 / 602-262-7322	rdovalin@ci.phoenix.az.us
City of Phoenix	Elayne Taylor-Tyler		etaylor1@ci.phoenix.az.us
DMJM+HARRIS	Jeff Minch	602-337-2540 / 602-337-2620	jeff.minch@dmjmharris.com
DMJM+HARRIS	Wade Gendreau	602-337-2565 / 602-337-2620	wade.gendreau@dmjmharris.com
DMJM+HARRIS	Bob Gladwin	602-337-2591 / 602-337-2620	bob.gladwin@dmjmharris.com
Jim Duncan	SRP	602-236-5380	jcduncan@srpnet.com
Mike Zimmerman	SRP	602-236-0860	mszimmer@srpnet.com
Glendale Parks & Recreation Commission	John Kolodziej		

HYDROLOGY

DMJM HARRIS

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Phoenix, Arizona 85016-4302
Tel: (602) 337-2777
Fax: (602) 337-2624

MEMORANDUM

To:	**Jeff R. Minch, P.E.**	Date:	**Tuesday, July 2, 2002**
From:	**Alan B. Morrice, P.E.**	Subject:	**Bethany Home Outfall Channel - Phase II Hydrologic Analysis**

I. INTRODUCTION

Since the completion of the Bethany Home / Grand Canal Flood Control Project (BH/GC FCP) Pre-Design Study, several hydrologic parameters and issues had to be examined, refined, and verified before proceeding through the next design phase of the project. The pre-design study utilized somewhat worst case scenario flow rates for the evaluation of alternatives for each individual segment due to the level of uncertainty at that time. For this and subsequent phases of design, the range of hydrologic variables must be reduced and the hydrologic (HEC-1) model, with corresponding design flows, refined and integrated into one complete and encompassing design element. The three main components of this hydrologic analysis effort have focused on the Maryvale Detention Basin (MDB), the 91st Avenue Detention Basin (91ADB), and the continued compliance with the Intergovernmental Agreement (IGA) between the Flood Control District of Maricopa County (FCDMC) and the Arizona Department of Transportation (ADOT). Numerous design refinements have occurred throughout this phase of design that has precipitated hydrologic model updates. The following summarizes those updates.

II. SUNSET DETENTION BASIN UPDATE

As a part of this phase of design, some refinements have occurred along the entire length of the BH/GC FCP to various degrees. At the Sunset Detention Basin (SDB) which is at the upstream end of the project, some minor refinements have occurred from the Pre-Design Study. Due to modifications associated with the final design of downstream segments, and the preliminary nature of the Pre-Design Study, the outlet structure for the SDB (8' x 7' RCB) was updated. For consistency, and to achieve as comprehensive a hydrologic analysis as reasonably possible, the stage-discharge relationship the SDB in the HEC-1 model was updated to reflect this new information. Based upon the updated model output, the SDB will attenuate the inflow of 784 cfs to 400 cfs. Of the total outflow, approximately 55 cfs will discharge into an existing storm drain system in Indian School Road and the remaining 345 cfs will discharge into the BH/GTC FCP conveyance system. Based upon the hydrologic model, at peak discharge, the SDB will have a water surface elevation of approximately 1096.45 with a storage volume of 46.53 acre-feet.

III. MARYVALE DETENTION BASIN UPDATE

For the pre-design hydrologic analysis, the topographic mapping and digital terrain model (dtm) from the Area Drainage Master Study (ADMS) was utilized to hydrologically model the MDB. The new topographic mapping and corresponding dtm associated with this design phase was used to recreate and refine this important

project facility. The basin outlet structure, although very similar to the pre-design facility, was adjusted to reflect current design grades and elevations. The revised HY8 output for this (2-8'x7' RCB) was then used for the updated stage-discharge relationship input into the hydrologic model. The tailwater condition of having a higher peak flow at the culvert outlet was simulated by inputting into HY8 an accordingly smaller channel bottom width. For the stage-storage portion of the refined hydrologic model, basically three alternatives with varied limits of construction were evaluated. They included:

1. The same encroachment into SRP right of way (ROW) as with pre-design on the southwest side of the MDB, and on the northeast side, match existing curb grades 10 feet south of street ROW.

2. No encroachment into SRP ROW on the southwest side of the MDB, and on the northeast side, match existing curb grades at approximately the street ROW.

3. No encroachment into SRP ROW on the southwest side of the MDB, and on the northeast side, match existing curb grades 10 feet south of street ROW.

None of these alternatives have specifically accounted for variations in side slope or other grade modifications added to facilitate the basin's multiple uses such as for open space or recreation. Generally, the third alternative was developed to provide the 10 feet of buffer, so to speak, solely for that purpose. The storage modeled can be used as a measuring stick or limiting value for final design as it relates to multi-use features that may encroach into the MDB required storage volume. When the final grading and landscape plans for the MDB are prepared, the final storage values should be compared against the modeled values and adjustments made accordingly so that proper hydrologic function is maintained. Based upon this storage assumption, the peak inflow of 1,580 cfs was attenuated by the MDB to provide a 1,141 cfs outflow. The 100-year water surface elevation is 1091.53 with a corresponding storage volume of approximately 58.62 acre-feet.

IV. 91ST AVENUE DETENTION BASIN

Similar to the Maryvale Detention Basin, the 91st Avenue Detention Basin had to be updated with the use of the revised topographic mapping. Additional effort was involved with this basin, however, since the pre-design study model had only a diversion element to simulate a surge type basin design whereas a reservoir routing would be needed to refine the design. The pre-design study had estimated that a detention volume of approximately 26.7 acre-feet would be required. Continuing with this surge type of design and a side channel spillway, only about 0.3 feet of head could be used to divert runoff into the basin for storage. Due to complications of design under the range of potential storm event conditions, economic considerations, and the desire for a more aesthetic multi-use corridor, other detention alternatives were investigated.

One detention alternative investigated was to try and configure the basin so that it would function as an on-line facility yet not require as much storage as most on-line basin configurations would. After one or two trial iterations, with this unique configuration, this concept was eliminated due to the required volume not reasonably being obtainable within the available right of way.

The next detention alternative analyzed was targeted at maximizing multi-use aspects and involved an off-line detention basin design which attenuates all of the runoff anticipated to flow south in sub-basin 10-21, as depicted in the ADMS as well as subsequent hydrologic models. This was confirmed through field reconnaissance to be a realistic yet conservative approach hydrologically. To realisticly model the detention basin, the timing of the peak outflow had to be compared to that of the BH/GC FCP hydrograph. Based upon the hydrologic (HEC-1) model output, tailwater conditions corresponding to the BH/GC FCP peak flow rate of 2,846 cfs was considered as a constant tailwater (elevation 1066.40) for the detention basin stage-discharge relationship. This would provide for reasonable, yet still conservative, results. Numerous basin configurations

and outlet structures were modeled until all of the requirements of the IGA, surrounding topographic conditions and optimum aesthetic opportunities were realized. The final configuration involves a 36 inch diameter reinforced concrete pipe (with a square edge headwall) that discharges into the BH/GC FCP channel at approximately station 76+43. Also, at the request of the City of Glendale to facilitate the basin drainage, inlets were added to two storm drain lines. These required a further refinement to the detention basin's stage-discharge relationship in the hydrologic model. Per the final model output, the 100-year peak inflow of 176 cfs (D1021S) is attenuated by the off-line detention basin to a peak outflow rate of 88 cfs while utilizing approximately 20.55 ac.-ft. of storage volume. The corresponding water surface elevation for the detention basin is approximately 1068.49. As can be seen on the proposed plans, this detention configuration optimizes hydrologic/hydraulic performance with open space and recreational use opportunities.

V. SUMMARY OF RESULTS

In achieving the detention configurations described above, the specific basis or criteria for satisfaction of the inter-governmental agreement (IGA) was investigated. This was done to ensure that the requirements of the IGA continued to be adhered to while at the same time pushing basin configurations to the limit, so to speak, in arriving at the most beneficial hydrologic alternative. The IGA generally states that the design flow to the New River is to be 2,200 cfs over the existing conditions. Based upon comparison of the hydrologic (HEC-1) models with and without the Agua Fria Freeway, 100AFBH.oh1 and 100AF1.oh1 respectively, the difference in peak runoff at the New River (C8-21W) is approximately 2,200 cfs. The before freeway condition corresponds to a peak flow of approximately 2,450 cfs (2,452). Therefore, based upon the IGA, the maximum future condition peak flow of the BH/GC FCP channel must be equal to or less than 4,650 cfs at the New River. The proposed hydrologic model (BGC-CS95.out) depicts a peak flow rate at the confluence with the New River (C8-21W) of 4,579 cfs.

Attached is a Hydrologic Summary Table that presents the peak flow rates along the Bethany Home / Grand Canal Flood Control Project at various locations. The flow rates are identified by location as well as by hydrologic model concentration point. Also attached, is a schematic that illustrates the proposed hydrologic model flow rates along the BH/GC FCP as well as at various inflow locations. One area of interest is the 100-year peak flow rates at junctures with main roadway corridors within this phase. These include 91st Avenue (236 cfs), 83rd Avenue (180 cfs) and Bethany Home Road (1,334 cfs). An excerpt from the Output Summary Table, pertaining to the BH/GC FCP, from the hydrologic model (BGC-CS95.out) is also enclosed for your use.

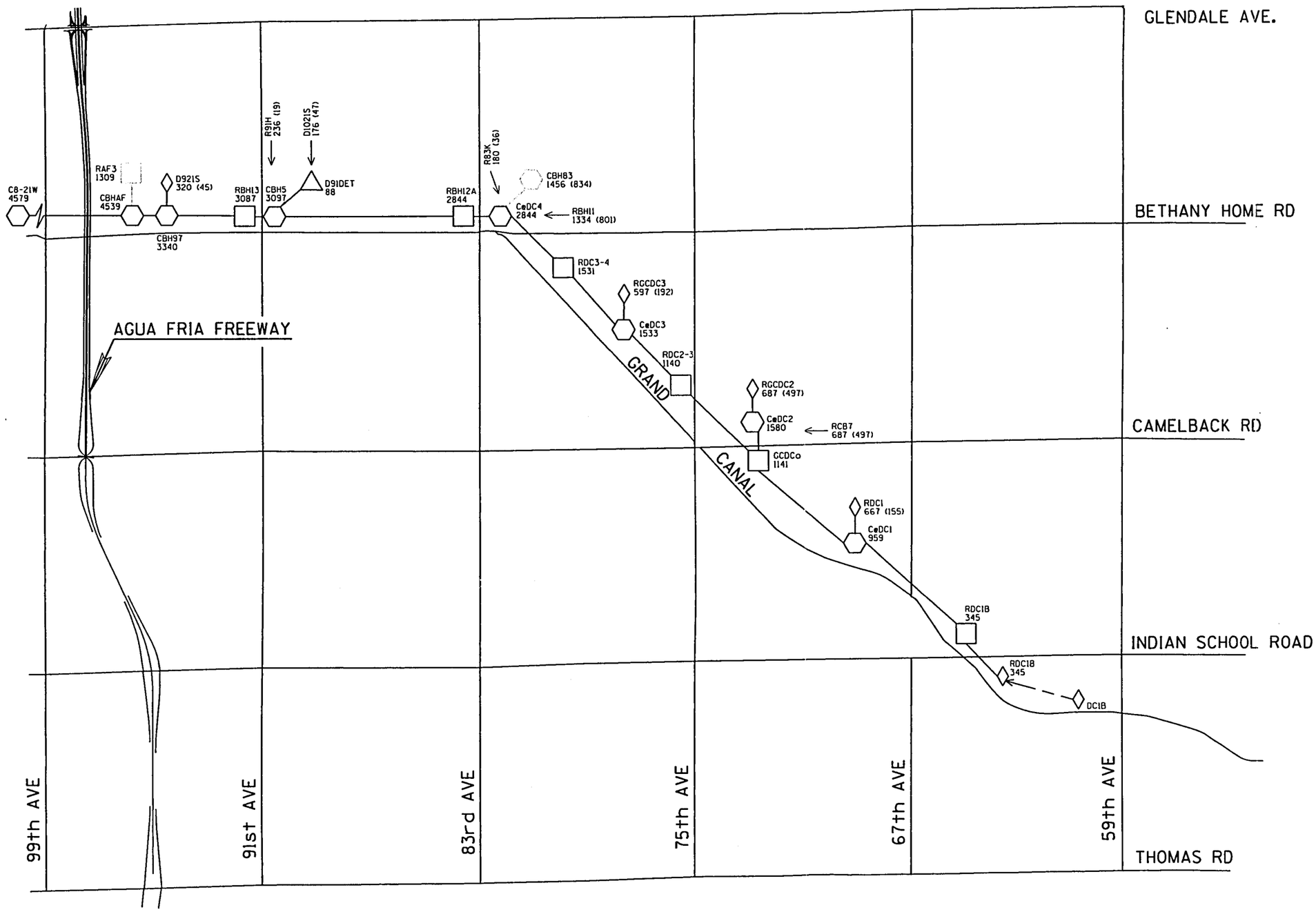
Hydrologic Summary Table

Bethany Home / Grand Canal Flood Control Project

Phase II - 100 % Design

July 10, 2002

Location	Concentration Point	Discharge Rate (cfs)
Bethany Home / Grand Canal Outfall Channel (BGC-CS95.out, 100-year):		
New River Confluence	C8-21W	4579
Agua Fria Freeway	CBHAF	4539
97th Ave. to 91st Ave.	CBH97	3340
91st Ave. to Grand Canal	CBH5	3097
87th Ave. to 83rd Ave.	C@DC4	2844
83rd Avenue	C@DC4	2844
79th Avenue	C@DC3	1533
Maryvale Basin Outflow	GCDCo	1141
Maryvale Basin Inflow	C@DC2	1580
Indian School Road	RDC1B	345
Camelback Road Storm Drain System (BGC0c.out, 10-year):		
59th Avenue	CCB59	159
63rd Avenue ±	SCB3W	313
67th Avenue	CCB67	375
71st Avenue ±	SCB4W	498
75th Avenue	CCB75	498

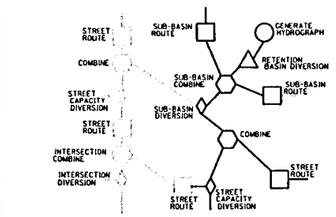


FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME/GRAND CANAL FLOOD CONTROL PROJECT

FCD CONTRACT #

LEGEND

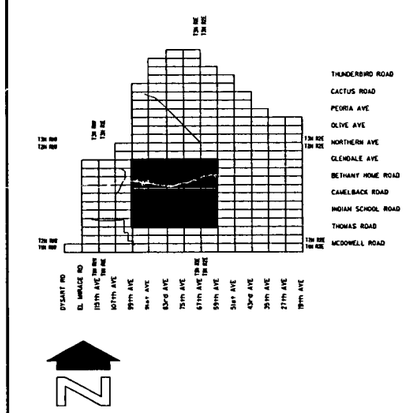


NOTE: BOLD Is Rerun Portion,
GRAY SCALE Is from Original Model.

PROPOSED AGUA FREEWAY ALIGNMENT

D102IS — ELEMENT DESCRIPTOR
176 (47)
10 YEAR PEAK FLOW (cfs)
100 YEAR PEAK FLOW (cfs)

INDEX MAP



DESIGN FLOW DIAGRAM

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME OUTFALL CHANNEL, PHASE II
SR 101L TO 83RD AVENUE
PCN NO. 620 03 32

PRELIMINARY **100%** Review NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	DBL	07-02
DRAWN	CPG	07-02
CHECKED	JRM	07-02

DMJM HARRIS
2777 E. CAMELBACK ROAD SUITE 200
PHOENIX, AZ. 85016-4302 (602) 337-2777

DRAWING NO. | DESIGN FLOW DIAGRAM | SHEET OF 1 of 1

n:\6888\Prod\Exhibit\88dex01.dgn 07/01/2002

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	RBH11	1334.	13.25	898.	291.	100.	34.87		
+	HYDROGRAPH AT	D83GA	91.	13.00	30.	8.	3.	30.20		
+	ROUTED TO	R83J	81.	14.50	30.	8.	3.	30.20		
+	HYDROGRAPH AT	D1121W	190.	13.33	100.	27.	9.	34.87		
+	2 COMBINED AT	C83E	264.	13.25	128.	34.	11.	34.87		
+	DIVERSION TO	S83FW	83.	13.25	39.	10.	3.	34.87		
+	HYDROGRAPH AT	S83FS	181.	13.25	88.	24.	8.	34.87		
+	ROUTED TO	R83K	180.	13.42	88.	24.	8.	34.87		
+	2 COMBINED AT	CBH83	1456.	13.25	942.	303.	104.	50.50		
+	HYDROGRAPH AT	RDC1B	345.	13.83	100.	25.	8.	34.10		
+	ROUTED TO	RDC1B	344.	13.92	100.	25.	8.	34.10		
+	HYDROGRAPH AT	RDC1	667.	13.67	226.	63.	21.	40.90		
+	2 COMBINED AT	C@DC1	959.	13.67	314.	85.	28.	46.55		

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	RGCDC2	687.	13.25	299.	93.	31.	37.08		
+	2 COMBINED AT	C@DC2	1580.	13.67	607.	176.	59.	46.55		
+	ROUTED TO	GCDCo	1141.	14.25	607.	176.	59.	46.55		
+	ROUTED TO	RDC2-3	1140.	14.33	607.	176.	59.	46.55		
+	HYDROGRAPH AT	RGCDC3	597.	13.33	224.	61.	20.	41.03		
+	2 COMBINED AT	C@DC3	1533.	13.75	812.	232.	78.	50.50		
+	ROUTED TO	RDC3-4	1531.	13.75	812.	232.	78.	50.50		
+	2 COMBINED AT	C@DC4	2844.	13.50	1748.	534.	181.	50.50		
+	DIVERSION TO	D83BH	0.	13.50	0.	0.	0.	50.50		
+	HYDROGRAPH AT	DBH83	2844.	13.50	1748.	534.	181.	50.50		
+	ROUTED TO	RBH12A	2844.	13.50	1748.	534.	181.	50.50		
+	ROUTED TO	RBH12B	2835.	13.67	1745.	534.	181.	50.50		

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	RBH12C	2831.	13.75	1744.	534.	181.	50.50		
+	HYDROGRAPH AT	SGA8S	126.	13.00	47.	12.	4.	34.46		
+	ROUTED TO	R1021S	119.	13.33	47.	12.	4.	34.46		
+	HYDROGRAPH AT	10-21	586.	12.58	160.	45.	15.	.98		
+	DIVERSION TO	D1021R	410.	12.58	81.	21.	7.	.98		
+	HYDROGRAPH AT	RET10	312.	13.50	84.	24.	8.	.98		
+	HYDROGRAPH AT	S83FW	83.	13.25	39.	10.	3.	34.87		
+	ROUTED TO	R1021W	77.	13.58	39.	10.	3.	34.87		
+	3 COMBINED AT	C10-21	309.	13.83	144.	39.	13.	43.32		
+	DIVERSION TO	D1021W	133.	13.83	62.	17.	6.	43.32		
+	HYDROGRAPH AT	D1021S	176.	13.83	82.	22.	7.	43.32		
+	ROUTED TO	D91det	88.	15.25	63.	20.	7.	43.32		
+	HYDROGRAPH AT	D91GA	327.	13.17	145.	36.	12.	34.46		

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	R91G	320.	13.33	145.	36.	12.	34.46		
+	HYDROGRAPH AT	D1021W	133.	13.83	62.	17.	6.	43.32		
+	2 COMBINED AT	C91D	421.	13.33	200.	51.	17.	43.32		
+	DIVERSION TO	S91DW	180.	13.33	85.	21.	7.	43.32		
+	HYDROGRAPH AT	S91DS	241.	13.33	115.	30.	10.	43.32		
+	ROUTED TO	R91H	236.	13.50	114.	30.	10.	43.32		
+	3 COMBINED AT	CBH5	3096.	13.75	1913.	582.	198.	50.50		
+	DIVERSION TO	SBH7S	0.	13.58	0.	0.	0.	50.50		
+	HYDROGRAPH AT	SBH7W	3096.	13.75	1913.	582.	198.	50.50		
+	DIVERSION TO	D91BH	0.	.00	0.	0.	0.	50.50		
+	HYDROGRAPH AT	DBH91	3096.	13.75	1913.	582.	198.	50.50		
+	ROUTED TO	RBH13	3087.	13.92	1908.	582.	198.	50.50		

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	SGA9S	170.	13.25	69.	17.	6.	35.26		
+	ROUTED TO	R921S	165.	13.58	69.	17.	6.	35.26		
+	HYDROGRAPH AT	9-21E	360.	12.67	106.	27.	9.	.85		
+	HYDROGRAPH AT	S91DW	180.	13.33	85.	21.	7.	43.32		
+	ROUTED TO	R921W	177.	13.58	85.	21.	7.	43.32		
+	3 COMBINED AT	C9-21	524.	13.50	237.	60.	20.	44.97		
+	DIVERSION TO	D921W	205.	13.50	92.	23.	8.	44.97		
+	HYDROGRAPH AT	D921S	320.	13.50	145.	37.	12.	44.97		
+	2 COMBINED AT	CBH97	3340.	13.83	2035.	617.	209.	50.90		
+	HYDROGRAPH AT	DGAAFS	1146.	13.33	755.	299.	121.	35.26		
+	ROUTED TO	RAF2	1143.	13.42	755.	299.	121.	35.26		
+	HYDROGRAPH AT	D921W	205.	13.50	92.	23.	8.	44.97		
+	2 COMBINED AT	CAFA	1310.	13.42	825.	317.	127.	46.23		

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	RAF3	1309.	13.50	824.	317.	127.	46.23		
+	2 COMBINED AT	CBHAF	4539.	13.67	2852.	915.	336.	50.90		
+	HYDROGRAPH AT	9-21W	31.	12.83	13.	4.	1.	.11		
+	DIVERSION TO	S99AW	31.	12.83	13.	4.	1.	.11		
+	HYDROGRAPH AT	S99AS	0.	12.42	0.	0.	0.	.11		
+	ROUTED TO	R99C	0.	12.92	0.	0.	0.	.11		
+	2 COMBINED AT	CBH6	4539.	13.67	2852.	915.	336.	52.34		
+	DIVERSION TO	D99BH	0.	.00	0.	0.	0.	52.34		
+	HYDROGRAPH AT	DBH99	4524.	13.67	2840.	911.	335.	52.34		
+	ROUTED TO	RBH14	4527.	13.75	2840.	911.	335.	52.34		
+	HYDROGRAPH AT	8-21E	216.	12.58	55.	14.	5.	.51		
+	HYDROGRAPH AT	S99AW	31.	12.83	13.	4.	1.	.11		

RUNOFF SUMMARY

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

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	R821EW	30.	13.25	13.	4.	1.	.11		
+	2 COMBINED AT	C8-21E	216.	12.58	66.	17.	6.	46.01		
+	DIVERSION TO	D821EW	105.	12.67	32.	8.	3.	46.01		
+	HYDROGRAPH AT	D821ES	82.	12.67	25.	6.	2.	46.01		
+	2 COMBINED AT	CBH7	4559.	13.75	2852.	916.	336.	53.19		
+	HYDROGRAPH AT	8-21W	173.	12.42	34.	9.	3.	.27		
+	2 COMBINED AT	C8-21W	4579.	13.75	2864.	923.	339.	53.47		
+	HYDROGRAPH AT	D821EW	105.	12.67	32.	8.	3.	46.01		
+	ROUTED TO	RES8N	0.	19.08	0.	0.	0.	46.01		
+	3 COMBINED AT	NULL5	8909.	13.58	5183.	1622.	578.	1.00		
+	2 COMBINED AT	NULL5A	17483.	13.58	9858.	3092.	1105.	1.00		

*** NORMAL END OF HEC-1 ***

PROJECT GEOMETRY

```
INTERGRAPH OUTPUT FILE
i f 0 /cogo/bhoc/cntrlqc.ics
*
* Bethany Home Outfall Channel
* FCD Contract No. 98-46, PCN 620 03 32
* Coordinate Geometry QA/QC - JRM
* FILE: CNTRLQC.ICS
* 8/7/01
*
# BHOC Ground  Control ICS file #
# Created 7/09/01 by BJC #
# filename=n:\6888\design\civ\inroads\cntrl.ics #
# a p !newalign
del c   (100-143)
        0 point(s) deleted
del c   (1200-1205)
        0 point(s) deleted
del f   [9100 8300 9999]
        0 alignment(s) deleted
#       Points 100-106 received from Aztec on 6/28/01 #
* s       121     920845.9433     596974.3094     1072.44 * BC/HH - W 1/4 COR SEC 10
*         125     918250.5823     596975.654      1068.37 * BC/FLUSH - SW COR SEC 10
*         123     915609.2505     596956.1072     1059.77 * BC/HH - W 1/4 COR SEC 15
*         128     912967.1476     596937.0092     1056.48 * BC/HH - SW COR SEC 15
*         124     915589.9545     602256.0208     1080.74 * BC/HH - E 1/4 COR SEC 15
*         122     920850.0367     602277.6398     1088.83 * BC/HH - E 1/4 COR SEC 10
*         129     923439.0802     596973.5596     1078.75 * PK Strattlers - NW COR SEC 10
s       1200 920845.9433 596974.3094 1072.44 * BC/HH - W 1/4 COR. SEC. 10 T. 2 N., R. 1 E.
      1200     920845.9433     596974.3094       1072.4400 default
        1201 918250.5823 596975.6540 1068.37 * BC/FLUSH - SW COR. SEC. 10 T. 2 N., R. 1 E.
      1201     918250.5823     596975.6540       1068.3700 default
        1202 915609.2505 596956.1072 1059.77 * BC/HH - W 1/4 COR. SEC. 15 T. 2 N., R. 1 E.
      1202     915609.2505     596956.1072       1059.7700 default
        1203 912967.1476 596937.0092 1056.48 * BC/HH - SW COR. SEC. 15 T. 2 N., R. 1 E.
      1203     912967.1476     596937.0092       1056.4800 default
        1204 915589.9545 602256.0208 1080.74 * BC/HH - E 1/4 COR. SEC. 15 T. 2 N., R. 1 E.
      1204     915589.9545     602256.0208       1080.7400 default
        1205 920850.0367 602277.6398 1088.83 * BC/HH - E 1/4 COR. SEC. 10 T. 2 N., R. 1 E.
      1205     920850.0367     602277.6398       1088.8300 default
*
*       COLLINS/PINA RESULTS OF SURVEY (5/1/00)
*
s       101 918231.17  602274.29  1083.76  * NW COR SEC 14
       101     918231.1700     602274.2900       1083.7600 default
        103 918084.33  591686.37  1060.38  * NW COR SEC 16
       103     918084.3300     591686.3700       1060.3800 default
        105 918083.370 591729.860 1062.176 * ERM 1 - BC S. END OF E. SIDE GUARD RAIL, 99TH AV
       105     918083.3700     591729.8600       1062.1760 default
        102 918250.31  596975.69  0000.00  * NW COR SEC 15
       102     918250.3100     596975.6900          0.0000 default
        107 918249.40  597026.61  1069.053 * ERM 2 - BC ON SW COR RADIAL GATE #2-22
       107     918249.4000     597026.6100       1069.0530 default
        114 918218.00  602365.57  1088.75  * ERM 3 - BC ON SW COR RADIAL GATE #2-21
       114     918218.0000     602365.5700       1088.7500 default
        100 918272.60  607493.34  0000.00  * BC/HH NE COR SEC 14
       100     918272.6000     607493.3400          0.0000 default
        104 915639.33  607488.03  0000.00  * BC/HH E 1/4 COR SEC 14
       104     915639.3300     607488.0300          0.0000 default
#       Collins-Pina measured N=918250.31, E=596975.69, Elev=0.00 #
#       Points 107-123 received from Collins-Pina. #
#       Converted from grid to ground coordinates on 6/06/01. #
* s         101 918231.1493 602274.2894 1083.76 * NW COR SEC 14
*         127 918272.5781 607493.3433 0.00000 * NE COR SEC 14
*         131 915788.8954 612792.1177 0.00000 * E 1/4 COR SEC 13
*         132 915826.3964 617916.9780 0.00000 * E 1/4 COR SEC 18
*         133 913186.7759 617896.4717 0.00000 * SE COR SEC 18
*         134 913153.5801 615244.7697 0.00000 * S 1/4 COR SEC 18
*         135 913122.5243 612774.7296 0.00000 * SE COR SEC 13
*         136 913062.9941 610129.0663 0.00000 * S 1/4 COR SEC 13
*         137 913004.8947 607482.9069 0.00000 * SW COR SEC 13
```

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*        138 912976.8926 604863.3359 0.00000 * S 1/4 COR SEC 14
*        139 910476.3635 612757.1374 0.00000 * W 1/4 COR SEC 19
*        140 910628.9418 612758.1639 0.00000 * E 1/4 COR SEC 24
*        141 907830.6001 612739.0840 0.00000 * SW COR SEC 19
*        142 907866.4497 615211.2523 0.00000 * S 1/4 COR SEC 19
*        143 905229.6723 615210.3571 0.00000 * C 1/4 SEC 30
*
* Translate AZTEC data to CPE Record Survey
*
I D     (1201 102)
    From       To          Direction     Distance  Slope Dist.  Elev. Diff.
-----------------------------------------------------------------------------
    1201      102   S  7^31'52.44" E       0.2747    1068.3700   -1068.3700
L DI    102 121 (A 1201 1200) (D 1201 1200)
       121     920845.6710     596974.3454          0.0000 default
        102 123 (A 1201 1202) (D 1201 1202)
       123     915608.9782     596956.1432          0.0000 default
        1205 122 (A 1201 102) (D 1201 102)
       122     920849.7644     602277.6758       1088.8300 default
        1204 124 (A 1201 102) (D 1201 102)
       124     915589.6822     602256.0568       1080.7400 default
s f 9100 (123 102 121) 102 1000
        9100    ( 123 102 121  )
        9100    ( 123 102 121  )
    8300 (124 101 122) 101 1000
        8300    ( 124 101 122  )
        8300    ( 124 101 122  )
des a 9100
 POB     123          -16+41.4041             915608.9782  596956.1432
                                               2641.4041  N  0^25'26.41" E
  PI     102           10+00.0000             918250.3100  596975.6900
                                               2595.3613  N  0^01'46.86" W
 POE     121           35+95.3613             920845.6710  596974.3454
      8300
 POB     124          -16+41.5507             915589.6822  602256.0568
                                               2641.5507  N  0^23'43.75" E
  PI     101           10+00.0000             918231.1700  602274.2900
                                               2618.5966  N  0^04'26.70" E
 POE     122           36+18.5966             920849.7644  602277.6758
s f 9999 (103 102 101 100)
        9999    ( 103 102 101 100  )
        9999    ( 103 102 101 100  )
des a 9999
 POB     103            0+00.0000             918084.3300  591686.3700
                                               5291.9236  N 88^12'09.49" E
  PI     102           52+91.9236             918250.3100  596975.6900
                                               5298.6346  S 89^47'34.92" E
  PI     101          105+90.5582             918231.1700  602274.2900
                                               5219.2144  N 89^32'42.66" E
 POE     100          158+09.7726             918272.6000  607493.3400
* # Locate Channel Centerline intersection with section lines @ 91st and 83rd
* se a    9100
* s a o   [10000] 100 5546.44 5546.44
* se a    8300
* s a o   [10000] 100 11143.13 11143.13
* se a    9999
* s a o   [10000] 100 7688.50 7688.50
o f -1
```

```
Review Horizontal Alignment All
             Project Name: dl_drn
              Description: dl's working geometry
Horizontal Alignment Name: 10000
              Description: 100% BHOC Cst. CL
               Preference: default
                                          STATION      NORTHING       EASTING
Element: Linear
             POB (   10000)              10+00.18   918283.3350   592440.6860
              PI (   10001)              16+03.16   918319.6700   593042.5700
         Tangent Direction: N 86^32'43.1398" E
            Tangent Length:              602.9798

Element: Linear
              PI (   10001)              16+03.16   918319.6700   593042.5700
              PI (   10002)              17+41.06   918351.2790   593176.8030
         Tangent Direction: N 76^44'58.0722" E
            Tangent Length:              137.9044

Element: Linear
              PI (   10002)              17+41.06   918351.2790   593176.8030
              PC (   10003)              24+81.90   918379.0272   593917.1141
         Tangent Direction: N 87^51'12.4466" E
            Tangent Length:              740.8309

Element: Circular
              PC (   10003)              24+81.90   918379.0272   593917.1141
              CC (   10050)                         919378.3255   593879.6586
              PT (   10004)              25+86.87   918388.4534   594021.6207
                     Radius:             1000.0000
                      Delta:        6^00'53.4750" Left
  Degree of Curvature(Arc):         5^43'46.4806"
                     Length:              104.9790
                    Tangent:               52.5378
                      Chord:              104.9308
           Middle Ordinate:                 1.3773
                   External:                1.3792
         Tangent Direction: N 87^51'12.4466" E
          Radial Direction: S  2^08'47.5534" E
           Chord Direction: N 84^50'45.7091" E
          Radial Direction: S  8^09'41.0284" E
         Tangent Direction: N 81^50'18.9716" E

Element: Linear
              PT (   10004)              25+86.87   918388.4534   594021.6207
              PC (   10005)              26+77.50   918401.3194   594111.3330
         Tangent Direction: N 81^50'18.9716" E
            Tangent Length:               90.6302

Element: Circular
              PC (   10005)              26+77.50   918401.3194   594111.3330
              CC (   10051)                         917411.4473   594253.2950
              PT (   10006)              28+02.69   918411.2984   594236.0405
                     Radius:             1000.0000
                      Delta:        7^10'21.8487" Right
  Degree of Curvature(Arc):         5^43'46.4806"
                     Length:              125.1879
                    Tangent:               62.6758
                      Chord:              125.1061
           Middle Ordinate:                 1.9584
                   External:                1.9622
         Tangent Direction: N 81^50'18.9716" E
          Radial Direction: S  8^09'41.0284" E
           Chord Direction: N 85^25'29.8959" E
          Radial Direction: S  0^59'19.1797" E
         Tangent Direction: N 89^00'40.8203" E

Element: Linear
              PT (   10006)              28+02.69   918411.2984   594236.0405
              PC (   10007)              30+20.37   918415.0543   594453.6832
         Tangent Direction: N 89^00'40.8203" E
            Tangent Length:              217.6752
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Element: Circular
              PC (   10007)          30+20.37   918415.0543   594453.6832
              CC (   10052)                     917415.2032   594470.9378
              PT (   10008)          30+84.75   918414.0927   594518.0518
                    Radius:          1000.0000
                     Delta:      3^41'20.7501" Right
  Degree of Curvature(Arc):      5^43'46.4806"
                    Length:            64.3869
                   Tangent:            32.2046
                     Chord:            64.3758
           Middle Ordinate:             0.5182
                  External:             0.5184
         Tangent Direction: N 89^00'40.8203" E
          Radial Direction: S  0^59'19.1797" E
           Chord Direction: S 89^08'38.8047" E
          Radial Direction: S  2^42'01.5704" W
         Tangent Direction: S 87^17'58.4296" E

Element: Linear
              PT (   10008)          30+84.75   918414.0927   594518.0518
              PC (   10009)          32+32.20   918407.1460   594665.3335
         Tangent Direction: S 87^17'58.4296" E
            Tangent Length:          147.4454

Element: Circular
              PC (   10009)          32+32.20   918407.1460   594665.3335
              CC (   10053)                     920404.9250   594759.5616
              PT (   10010)          33+03.46   918405.0572   594736.5637
                    Radius:          2000.0000
                     Delta:      2^02'29.6926" Left
  Degree of Curvature(Arc):      2^51'53.2403"
                    Length:            71.2646
                   Tangent:            35.6361
                     Chord:            71.2609
           Middle Ordinate:             0.3174
                  External:             0.3175
         Tangent Direction: S 87^17'58.4296" E
          Radial Direction: S  2^42'01.5704" W
           Chord Direction: S 88^19'13.2759" E
          Radial Direction: S  0^39'31.8778" W
         Tangent Direction: S 89^20'28.1222" E

Element: Linear
              PT (   10010)          33+03.46   918405.0572   594736.5637
              PC (   10011)          41+65.77   918395.1416   595598.8120
         Tangent Direction: S 89^20'28.1222" E
            Tangent Length:          862.3052

Element: Circular
              PC (   10011)          41+65.77   918395.1416   595598.8120
              CC (   10054)                     921894.9102   595639.0582
              PT (   10012)          45+24.03   918409.3482   595956.6383
                    Radius:          3500.0000
                     Delta:      5^51'53.5400" Left
  Degree of Curvature(Arc):      1^38'13.2802"
                    Length:           358.2647
                   Tangent:           179.2889
                     Chord:           358.1083
           Middle Ordinate:             4.5831
                  External:             4.5891
         Tangent Direction: S 89^20'28.1222" E
          Radial Direction: S  0^39'31.8778" W
           Chord Direction: N 87^43'35.1078" E
          Radial Direction: S  5^12'21.6622" E
         Tangent Direction: N 84^47'38.3378" E

Element: Linear
              PT (   10012)          45+24.03   918409.3482   595956.6383
              PC (   10013)          47+65.68   918431.2746   596197.2891
         Tangent Direction: N 84^47'38.3378" E
            Tangent Length:          241.6476

Element: Circular
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            PC (   10013)          47+65.68   918431.2746   596197.2891
            CC (   10055)                     916439.5248   596378.7634
            PT (   10014)          50+61.15   918436.2913   596492.4462
                  Radius:         2000.0000
                   Delta:      8^27'52.3655" Right
  Degree of Curvature(Arc):      2^51'53.2403"
                  Length:          295.4684
                 Tangent:          148.0035
                   Chord:          295.1998
          Middle Ordinate:            5.4539
                 External:            5.4688
        Tangent Direction: N 84^47'38.3378" E
         Radial Direction: S  5^12'21.6622" E
          Chord Direction: N 89^01'34.5206" E
         Radial Direction: S  3^15'30.7034" W
        Tangent Direction: S 86^44'29.2966" E

Element: Linear
            PT (   10014)          50+61.15   918436.2913   596492.4462
            PC (   10015)          52+25.46   918426.9516   596656.4925
        Tangent Direction: S 86^44'29.2966" E
           Tangent Length:         164.3119

Element: Circular
            PC (   10015)          52+25.46   918426.9516   596656.4925
            CC (   10056)                     919425.3348   596713.3339
            PT (   10016)          52+84.12   918425.3364   596715.1189
                  Radius:         1000.0000
                   Delta:      3^21'38.8960" Left
  Degree of Curvature(Arc):      5^43'46.4806"
                  Length:           58.6571
                 Tangent:           29.3370
                   Chord:           58.6487
          Middle Ordinate:            0.4301
                 External:            0.4302
        Tangent Direction: S 86^44'29.2966" E
         Radial Direction: S  3^15'30.7034" W
          Chord Direction: S 88^25'18.7446" E
         Radial Direction: S  0^06'08.1926" E
        Tangent Direction: N 89^53'51.8074" E

Element: Linear
            PT (   10016)          52+84.12   918425.3364   596715.1189
            PI (   10017)          55+44.60   918425.8013   596975.5991
        Tangent Direction: N 89^53'51.8074" E
           Tangent Length:         260.4806

Element: Linear
            PI (   10017)          55+44.60   918425.8013   596975.5991
            PC (   10018)          60+21.36   918426.6524   597452.3610
        Tangent Direction: N 89^53'51.8074" E
           Tangent Length:         476.7626

Element: Circular
            PC (   10018)          60+21.36   918426.6524   597452.3610
            CC (   10057)                     916426.6556   597455.9311
            PT (   10019)          61+86.66   918420.1200   597617.4849
                  Radius:         2000.0000
                   Delta:      4^44'07.8034" Right
  Degree of Curvature(Arc):      2^51'53.2403"
                  Length:          165.3002
                 Tangent:           82.6972
                   Chord:          165.2531
          Middle Ordinate:            1.7075
                 External:            1.7090
        Tangent Direction: N 89^53'51.8074" E
         Radial Direction: S  0^06'08.1926" E
          Chord Direction: S 87^44'04.2909" E
         Radial Direction: S  4^37'59.6108" W
        Tangent Direction: S 85^22'00.3892" E

Element: Linear
            PT (   10019)          61+86.66   918420.1200   597617.4849
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            PC (   10020)          65+19.93   918393.1998   597949.6615
       Tangent Direction: S 85^22'00.3892" E
          Tangent Length:          333.2656

 lement: Circular
            PC (   10020)          65+19.93   918393.1998   597949.6615
            CC (   10058)                     920386.6642   598111.2154
            PT (   10021)          66+80.95   918386.6643   598110.5037
                  Radius:         2000.0000
                   Delta:     4^36'46.2159" Left
  Degree of Curvature(Arc):     2^51'53.2403"
                  Length:          161.0184
                 Tangent:           80.5527
                   Chord:          160.9749
          Middle Ordinate:            1.6202
                 External:            1.6215
       Tangent Direction: S 85^22'00.3892" E
        Radial Direction: S  4^37'59.6108" W
         Chord Direction: S 87^40'23.4971" E
        Radial Direction: S  0^01'13.3950" W
       Tangent Direction: S 89^58'46.6050" E

Element: Linear
            PT (   10021)          66+80.95   918386.6643   598110.5037
            PC (   10022)          75+28.43   918386.3628   598957.9904
       Tangent Direction: S 89^58'46.6050" E
          Tangent Length:          847.4867

Element: Circular
            PC (   10022)          75+28.43   918386.3628   598957.9904
            CC (   10059)                     918261.3628   598957.9459
            PT (   10023)          76+59.74   918323.4698   599066.4250
                  Radius:          125.0000
                   Delta:    60^11'14.6877" Right
  Degree of Curvature(Arc):    45^50'11.8450"
                  Length:          131.3086
                 Tangent:           72.4416
                   Chord:          125.3539
          Middle Ordinate:           16.8492
                 External:           19.4742
       Tangent Direction: S 89^58'46.6050" E
        Radial Direction: S  0^01'13.3950" W
         Chord Direction: S 59^53'09.2612" E
        Radial Direction: S 60^12'28.0827" W
       Tangent Direction: S 29^47'31.9173" E

Element: Linear
            PT (   10023)          76+59.74   918323.4698   599066.4250
            PI (   10024)          77+52.94   918242.5904   599112.7305
       Tangent Direction: S 29^47'31.9173" E
          Tangent Length:           93.1969

Element: Linear
            PI (   10024)          77+52.94   918242.5904   599112.7305
            PC (   10025)          80+66.76   917970.2445   599268.6552
       Tangent Direction: S 29^47'31.9173" E
          Tangent Length:          313.8230

Element: Circular
            PC (   10025)          80+66.76   917970.2445   599268.6552
            CC (   10060)                     918119.3012   599529.0052
            PT (   10026)          83+78.52   917819.3214   599525.5201
                  Radius:          300.0000
                   Delta:    59^32'31.9003" Left
  Degree of Curvature(Arc):    19^05'54.9354"
                  Length:          311.7622
                 Tangent:          171.6107
                   Chord:          297.9217
          Middle Ordinate:           39.5952
                 External:           45.6157
       Tangent Direction: S 29^47'31.9173" E
        Radial Direction: S 60^12'28.0827" W
         Chord Direction: S 59^33'47.8674" E
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          Radial Direction: S  0^39'56.1824" W
         Tangent Direction: S 89^20'03.8176" E

Element: Linear
              PT (   10026)           83+78.52   917819.3214   599525.5201
              PC (   10027)           87+61.90   917814.8678   599908.8716
         Tangent Direction: S 89^20'03.8176" E
            Tangent Length:           383.3774

Element: Circular
              PC (   10027)           87+61.90   917814.8678   599908.8716
              CC (   10061)                      918204.8415   599913.4022
              PT (   10028)           90+17.92   917893.1530   600147.8170
                    Radius:           390.0000
                     Delta:     37^36'42.1658" Left
  Degree of Curvature(Arc):     14^41'28.4119"
                    Length:           256.0148
                   Tangent:           132.8113
                     Chord:           251.4427
           Middle Ordinate:            20.8196
                  External:            21.9937
         Tangent Direction: S 89^20'03.8176" E
          Radial Direction: S  0^39'56.1824" W
           Chord Direction: N 71^51'35.0996" E
          Radial Direction: S 36^56'45.9833" E
         Tangent Direction: N 53^03'14.0167" E

Element: Linear
              PT (   10028)           90+17.92   917893.1530   600147.8170
              PC (   10029)           91+78.74   917989.8195   600276.3490
         Tangent Direction: N 53^03'14.0167" E
            Tangent Length:           160.8256

Element: Circular
              PC (   10029)           91+78.74   917989.8195   600276.3490
              CC (   10062)                      917590.2188   600576.8808
              PT (   10030)           95+54.85   918087.3383   600630.4743
                    Radius:           500.0000
                     Delta:     43^05'57.4657" Right
  Degree of Curvature(Arc):     11^27'32.9612"
                    Length:           376.1123
                   Tangent:           197.4559
                     Chord:           367.3073
           Middle Ordinate:            34.9502
                  External:            37.5768
         Tangent Direction: N 53^03'14.0167" E
          Radial Direction: S 36^56'45.9833" E
           Chord Direction: N 74^36'12.7495" E
          Radial Direction: S  6^09'11.4824" W
         Tangent Direction: S 83^50'48.5176" E

Element: Linear
              PT (   10030)           95+54.85   918087.3383   600630.4743
              PC (   10031)           97+51.36   918066.2757   600825.8454
         Tangent Direction: S 83^50'48.5176" E
            Tangent Length:           196.5032

Element: Circular
              PC (   10031)           97+51.36   918066.2757   600825.8454
              CC (   10063)                      918811.9548   600906.2358
              PT (   10032)           99+39.54   918069.6656   601013.5050
                    Radius:           750.0000
                     Delta:     14^22'34.1683" Left
  Degree of Curvature(Arc):      7^38'21.9742"
                    Length:           188.1835
                   Tangent:            94.5885
                     Chord:           187.6902
           Middle Ordinate:             5.8944
                  External:             5.9411
         Tangent Direction: S 83^50'48.5176" E
          Radial Direction: S  6^09'11.4824" W
           Chord Direction: N 88^57'54.3982" E
          Radial Direction: S  8^13'22.6859" E
```

```
        Tangent Direction: N 81^46'37.3141" E

Element: Linear
             PT (   10032)          99+39.54   918069.6656   601013.5050
             PC (   10033)         101+21.74   918095.7247   601193.8304
        Tangent Direction: N 81^46'37.3141" E
           Tangent Length:          182.1986

Element: Circular
             PC (   10033)         101+21.74   918095.7247   601193.8304
             CC (   10064)                     916858.5759   601372.6125
             PT (   10034)         104+24.20   918102.5225   601495.4821
                   Radius:         1250.0000
                    Delta:     13^51'50.4116" Right
  Degree of Curvature(Arc):      4^35'01.1845"
                   Length:          302.4656
                  Tangent:          151.9751
                    Chord:          301.7283
           Middle Ordinate:            9.1374
                 External:             9.2047
        Tangent Direction: N 81^46'37.3141" E
         Radial Direction: S  8^13'22.6859" E
          Chord Direction: N 88^42'32.5199" E
         Radial Direction: S  5^38'27.7257" W
        Tangent Direction: S 84^21'32.2743" E

Element: Linear
             PT (   10034)         104+24.20   918102.5225   601495.4821
             PC (   10035)         105+93.55   918085.8766   601664.0073
        Tangent Direction: S 84^21'32.2743" E
           Tangent Length:          169.3453

Element: Circular
             PC (   10035)         105+93.55   918085.8766   601664.0073
             CC (   10065)                     919329.8232   601786.8769
             PT (   10036)         107+10.61   918079.8376   601780.8717
                   Radius:         1250.0000
                    Delta:      5^21'56.7861" Left
  Degree of Curvature(Arc):      4^35'01.1845"
                   Length:          117.0630
                  Tangent:           58.5743
                    Chord:          117.0203
           Middle Ordinate:            1.3701
                 External:             1.3716
        Tangent Direction: S 84^21'32.2743" E
         Radial Direction: S  5^38'27.7257" W
          Chord Direction: S 87^02'30.6674" E
         Radial Direction: S  0^16'30.9395" W
        Tangent Direction: S 89^43'29.0605" E

Element: Linear
             PT (   10036)         107+10.61   918079.8376   601780.8717
             PI (   10037)         112+02.98   918077.4722   602273.2291
        Tangent Direction: S 89^43'29.0605" E
           Tangent Length:          492.3631

Element: Linear
             PI (   10037)         112+02.98   918077.4722   602273.2291
             PC (   10038)         119+98.89   918073.6485   603069.1345
        Tangent Direction: S 89^43'29.0605" E
           Tangent Length:          795.9146

Element: Circular
             PC (   10038)         119+98.89   918073.6485   603069.1345
             CC (   10066)                     917823.6513   603067.9335
             PT (   10039)         122+36.00   917968.4163   603271.7548
                   Radius:          250.0000
                    Delta:     54^20'25.0910" Right
  Degree of Curvature(Arc):     22^55'05.9225"
                   Length:          237.1043
                  Tangent:          128.3180
                    Chord:          228.3173
           Middle Ordinate:           27.5864
```

```
              External:            31.0080
     Tangent Direction: S 89^43'29.0605" E
      Radial Direction: S  0^16'30.9395" W
       Chord Direction: S 62^33'16.5149" E
      Radial Direction: S 54^36'56.0306" W
     Tangent Direction: S 35^23'03.9694" E

Element: Linear
          PT (   10039)          122+36.00   917968.4163   603271.7548
         POE (   10040)          124+02.15   917832.9560   603367.9660
     Tangent Direction: S 35^23'03.9694" E
        Tangent Length:           166.1508
```

```
############################
# BHOC 100% Profile Grade Line
# Created by DBL 9-28-01
# Revised by DBL 6-12-02
 ###########################

se a 10011

v s 10+00.00    1048.62
    16+03.16    1049.18
    17+41.06    1050.05
    55+92.20    1054.44
    56+33.35    1056.404
    78+19.20    1058.17
    78+28.71    1060.51
    122+83.92   1067.22
    122+98.16   1074.34
    123+76.56   1074.42

v e 123+76.56   1074.42 10011_PGL
```

```
Cogo Generated Coordinates
#
# Bethany Home Outfall Channel
# FCD Contract No. 98-46, PCN 620 03 32
# FILE: 83&91_h.ics
# design: cbb 11-12-01
#
# run cntrlqc.ics - section line control before
# run chan_60%.ics - channel centerline control before this file
del cord (8301-8399) # 83rd ave construction centerline
           2 point(s) deleted
         (9101-9199) # 91st ave construction centerline
           2 point(s) deleted
del fig [8310]  # 83rd ave construction centerline
           0 alignment(s) deleted
        [9110]  # 91st ave construction centerline
           0 alignment(s) deleted
a p !newalign
      Plotting height is     0.0000
      Active point feature/preference is newalign
      Active linear feature/preference is newalign
#######
# 83rd ave construction centerline
#
# hold end of bridge approach slabs to the same sta's as the monument line
#######
# set end points per 30% plan stations
l di 101 8301 (a101 124) (1000.00 -650.00) # sta 6+50 on ml
      8301     917881.1783     602271.8741       1083.7600 newalign
     101 8304 (a101 124) (1000.00 -979.00) # sta 9+79 on ml
      8304     918210.1705     602274.1450       1083.7600 newalign
# set channel centerline intersections with ml and cst cl
f f i 8305 8300 10000 101 10.00 0.00 # set cst cl 10' east of ml
      8305     918077.4241     602283.2290          0.0000 newalign
      8306 8300 10000 101 0.00 0.00  # intersection on ml
      8306     918077.4722     602273.2291          0.0000 newalign
# set end of the approach slabs for the bridge
l di 8305 8302 (a101 124) (75.00 +14.00) # assume bridge is centered on
channel
      8302     917988.4263     602282.6147          0.0000 newalign
     8305 8303 (a124 101) (75.00 +14.00)
      8303     918166.4220     602283.8433          0.0000 newalign
s f 8310 (8301 8302 8303 8304) 8303 935.3195
        8310    ( 8301 8302 8303 8304  )
f d [8310] *83rd ave cst centerline
  Figure ID    Figure Description
-----------------------------------------------------------------------
        8310   83rd ave cst centerline
se a 8300
            Horizontal alignment 8300 activated
            Beginning station is -16+41.5507
s a o [8310]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  8301       6+50.0000       6+49.5351    0.0000 1083.7600   5^43'08.1021"
  PI  8302       7+57.3195       7+57.3195   10.0000    0.0000  95^19'24.3561"
  PI  8303       9+35.3195       9+35.3195   10.0000    0.0000  90^00'00.0000"
 POE  8304       9+79.0000       9+80.1300    0.0000 1083.7600 -12^29'57.5564"
      (8305 8306)
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  8305       8+46.3195       0+00.0000   10.0000    0.0000   0^07'12.8065"
 POE  8306       8+46.2985       0+10.0000    0.0000    0.0000   0^16'30.9395"
se a 10000
            Horizontal alignment 10000 activated
            Beginning station is 10+00.0000
```

```
s a o (8305 8306)
                    Baseline      Centerline  Baseline              Centerline
Type                 Station        Station    Offset Elevation     Skew Angle
-----------------------------------------------------------------------------
 POB  8305     112+12.9815       0+00.0000   -0.0000    0.0000  90^16'30.9395"
 POE  8306     112+02.9815       0+10.0000    0.0000    0.0000 -89^43'29.0605"
se a 8310
            Horizontal alignment 8310 activated
            Beginning station is 6+49.5351
# store vertical
v s 6+49.54 1083.55
    8+46.32 1084.28 100
v e 9+80.13 1083.86 8310
Tangent:
                  POB            6+49.5400     1083.5500
                  PVC            7+96.3200     1084.0945
                       Grade:      0.3710%
                      Length:     146.7800
Symmetric Parabolic Curve:
                  PVC            7+96.3200     1084.0945
                  PVI            8+46.3200     1084.2800
                  PVT            8+96.3200     1084.1231
                VHIGH            8+50.4884     1084.1950
                      Length:     100.0000
             Entrance Grade:      0.3710%
                 Exit Grade:     -0.3139%
        R = ( g2 - g1 ) / L:      -0.6849
        K = 1 / ( g2 - g1 ):     146.0173
            Middle Ordinate:      -0.0856
Tangent:
                  PVT            8+96.3200     1084.1231
                  POE            9+80.1300     1083.8600
                       Grade:     -0.3139%
                      Length:      83.8100
# set centerline of access ramps is 6 + 4 south of approach slab.
# bridge is parallel with channel centerline.
#
# set points at the offset of the curved retaining wall = 54'-3 1/4" + 20' -
10"
#                                                          =75.104166'
di i 8321 8302 (a124 101) 8302 (a10036 10038) -75.104166 10.00 # west end
      8321     917978.7873     602207.4422          0.0000 newalign
     8322 8302 (a124 101) 8302 (a10036 10038) 75.104166 10.00  # east end
      8322     917978.0657     602357.6491          0.0000 newalign
s f 8320 (8321 8322)
        8320    ( 8321 8322  )
f d [8320] *83rd access ramp cl
  Figure ID    Figure Description
-----------------------------------------------------------------------
        8320   83rd access ramp cl
#######
# 91st ave construction centerline
#
# hold end of bridge approach slabs to the same sta's as the monument line
#######
# set end points per 30% plan stations
l di 102 9101 (a102 121) (1047.00 -1000.00) # sta 10+47 on ml
      9101     918297.3100     596975.6657          0.0000 newalign
     102 9104 (a102 121) (1325.00 -1000.00) # sta 13+25 on ml added 25' for
utility work
      9104     918575.3100     596975.5216          0.0000 newalign
# set channel centerline intersections with ml and cst cl
f f i 9105 9100 10000 102 -10.00 0.00 # set cst cl 10' west of ml
      9105     918425.7835     596965.5991          0.0000 newalign
      9106 9100 10000 102 0.00 0.00  # intersection on ml
      9106     918425.8013     596975.5991          0.0000 newalign
# set end of the approach slabs for the bridge
l di 9105 9103 (a102 121) (68.25 +14.00) # assume bridge is centered on
```

```
channel
      9103     918508.0335     596965.5565          0.0000 newalign
     9105 9102 (a121 102) (68.25 +14.00)
      9102     918343.5335     596965.6417          0.0000 newalign
# force end of approach slab station to match moument line station
s f 9110 (9101 9102 9103 9104) 9102 1093.2287
        9110    ( 9101 9102 9103 9104  )
f d [9110] *91st ave cst centerline
  Figure ID    Figure Description
-----------------------------------------------------------------------
        9110   91st ave cst centerline
se a 9100
            Horizontal alignment 9100 activated
            Beginning station is -16+41.4041
s a o [9110]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  9101      10+47.0000      10+45.9308    0.0000    0.0000 -12^14'08.1867"
  PI  9102      10+93.2287      10+93.2287  -10.0000    0.0000-102^12'21.3254"
  PI  9103      12+57.7287      12+57.7287  -10.0000    0.0000 -90^00'00.0000"
 POE  9104      13+25.0000      13+25.7392    0.0000    0.0000   8^25'31.8711"
      (9105 9106)
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  9105      11+75.4787       0+00.0000  -10.0000    0.0000   0^04'21.3313"
 POE  9106      11+75.4914       0+10.0000    0.0000    0.0000  89^53'51.8074"
se a 10000
            Horizontal alignment 10000 activated
            Beginning station is 10+00.0000
s a o (9105 9106)
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  9105      55+34.6048       0+00.0000    0.0000    0.0000  89^53'51.8074"
 POE  9106      55+44.6048       0+10.0000    0.0000    0.0000  89^53'51.8074"
se a 9110
            Horizontal alignment 9110 activated
            Beginning station is 10+45.9308
# store vertical
v s 10+45.93 1068.03
v e 13+25.74 1066.48 9110
Tangent:
                 POB            10+45.9300     1068.0300
                 POE            13+25.7400     1066.4800
                      Grade:     -0.5539%
                     Length:     279.8100
# set centerline of access ramps is 17'+ 6' + 4' north of approach slab.
# bridge is parallel with channel centerline.
#
# set points at the offset of the curved retaining wall = 54'-3 1/4" + 20' -
10"
#                                                        =75.104166'
di i 9121 9103 (a102 121) 9103 (a10016 10018) -75.104166 -27.00 # west end
      9121     918534.8994     596890.4384          0.0000 newalign
     9122 9103 (a102 121) 9103 (a10016 10018) 75.104166 -27.00  # east end
      9122     918535.1676     597040.6466          0.0000 newalign
s f 9120 (9121 9122)
        9120    ( 9121 9122  )
f d [9120] *91st access ramp cl
  Figure ID    Figure Description
-----------------------------------------------------------------------
        9120   91st access ramp cl
```

HYDRAULICS

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MEMORANDUM

To:	**Jeff R. Minch, P.E.**	Date:	**Monday, September 9, 2002**
From:	**Dave B. Lutzky, P.E.**	Subject:	**Bethany Home Outfall Channel Hydraulic Analysis**

I. Introduction

The following is a brief synopsis of the methods and procedures used to determine the hydraulic analysis if the Bethany Home Outfall Channel (BHOC).

II. Hydraulic Model

The hydraulic model was developed for the proposed channel using the U.S. Army Corps of Engineers HEC-RAS Computer program (Version 3.0). The channel analysis was extended to the downstream point of the system at the ADOT Channel/BHOC confluence. The ADOT Channel is an existing channel that outfalls into the New River. The design and hydraulic analysis of the existing ADOT Channel was preformed by BRW. Summary outputs for this model has been provided as an attachment to this memo.

The HEC-RAS cross-sections were created by cutting cross-sections from the channel DTM and importing them into the HEC-RAS program. The HEC-RAS cross-section numbers correspond to the stationing of the channel construction plans. Culvert and bridge crossings utilize the culvert/bridge routine found in HEC-RAS software. The downstream boundary for the channel was set to the upstream water surface elevation from the HEC-RAS model (ADOT Channel) provided by BRW. Flow changes were made at stations that correspond to the concentration point locations (see Hydrologic Summary Table in the Hydrology section of this report). . Freeboard throughout the channel varies anywhere from one foot to eight feet.

Impacts due to superelevation are minimal. Typically, if the rise is less than one-half foot, the normally determined channel freeboard should be adequate. No special treatment such as increased wall heights or invert banking is required. Radii for the channel was set so that it was at a minimum three times greater than the top width with the exception of the downstream outlet of the 87th Avenue culvert crossing. At this location the radius is approximately the same as the top width. However, there is approximately 5 feet of freeboard at this location.

III. Manning's Roughness Coefficient

Manning's roughness coefficients used for the BHOC were estimated using the U.S.G.S. Water Resource Division's Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona. The BHOC hydraulic model was divided into segments where characteristics were similar or representative of that segment. Sections were chosen within each segment so that Manning's roughness calculations would be slightly conservative. The Manning's roughness coefficients

were calculated based on Table 2 (see attached) the following characteristics were evaluated: Channel Base Condition, Degree of Irregularity, Effects of Obstruction, Vegitation, Variations in Cross-section and the Degree of Meandering. Manning's 'n' values calculations for these segments are provided with this memo.

IV. Boundary Conditions

The downstream starting water surface-elevation for the BHOC HEC-RAS model was obtained from the BRW HEC-RAS model (Agua Fria Freeway). The DMJM+HARRIS model station 14+04.5 is equal to the BRW model station 139+50. The BRW model is based on the 100-year design frequency for the ADOT channel and 10-year storm frequency for the New River. The project invert elevation at this location is 1048.68 (DMJM+HARRIS) = 1048.21 BRW (HEC-RAS). Therefore, a ΔElev of +0.47' was added to the BRW water-surface elevation for the starting water-surface elevation in the DMJM+HARRIS model.

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 17+41 to Sta 20+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.002
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.002
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.029**

Note: Use n=0.030 minimum for grass-lined channel.

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 20+00 to Sta 32+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.004
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.003
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.032**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 32+00 to Sta 44+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	0.001
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.002
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.002
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.030**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 44+00 to Sta 54+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.003
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.005
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.033**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 56+40 to Sta 74+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	0.001
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.002
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.002
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.030**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 74+00 to Sta 76+76

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	0.002
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.002
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.004
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.002
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.030**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 78+29 to Sta 80+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.002
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.002
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.029**

Note: Use n=0.030 minimum for grass-lined channel.

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 80+00 to Sta 84+00

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	0.002
Minor (0.005 - 0.015)	
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	0.005
Medium (0.010 - 0.025)	
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.002
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.029**

Note: Use n=0.030 minimum for grass-lined channel.

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 84+00 to Sta 111+35

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	0.002
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	
Minor (0.005 - 0.015)	0.010
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	
Medium (0.010 - 0.025)	0.010
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.003
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.045**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 112+81 to Sta 116+14

Mannings n Computations	
Base Condition	0.020
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	0.002
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	
Minor (0.005 - 0.015)	0.010
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	
Medium (0.010 - 0.025)	0.010
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.003
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.045**

BHOC Project - Phase 2

Mannings Roughness Calculations

Sta 116+14 to Sta 117+55

Mannings n Computations	
Base Condition	0.040
Degree of Irregularity	
Smooth (0.0)	0.000
Minor (0.001 - 0.005)	0.002
Moderate (0.006 - 0.010)	
Severe (0.011 - 0.020)	
Effects of Obstruction	
Negligible (0.0 - 0.004)	
Minor (0.005 - 0.015)	0.002
Appreciable (0.020 - 0.030)	
Severe (0.040 - 0.060)	
Vegitation	
Small (0.002 - 0.010)	
Medium (0.010 - 0.025)	0.010
Large (0.025 - 0.050)	
Very Large (0.050 - 0.100)	
Variations in Channel Cross Section	
Gradual (0.0)	
Moderate Alternating (0.001 - 0.005)	0.001
Appreciable Alternating (0.010 - 0.015)	
Degree of Meandering	
Minor (1.0)	X
Appreciable (1.15)	
Severe (1.3)	
Recommended n =	**0.055**

A common method of selecting the roughness coefficient, *n*, is to first select a base value of *n* for the bed material (table 1). The base values of *n* are for a straight uniform channel of a given bed material. Cross-section irregularities, channel alignment, obstructions, vegetation, and other factors that increase roughness are accounted for by adding increments of roughness to the base value of *n*. Ranges of adjustments for the factors that may add to channel roughness are shown in table 2.

Many alluvial channels in Maricopa County have bed material that moves during floodflow. In addition to the changing channel geometry of these channels, the roughness coefficient may change during floodflow because of the changing form of the channel bed in parts of the channel cross section (Davidian, 1984). Bedforms, such as dunes, antidunes, and plane bed have been observed during large floods. Within a few minutes, dunes can appear, disappear, and reappear at different locations across a large stream channel. The Manning roughness coefficient can double or triple when the bedform changes from plane to dunes. A method of defining reliable values of Manning's *n* for unstable alluvial channels is not available. A plane bedform is common during large floods, and for this report, plane-bed conditions are assumed where the roughness coefficient is related to the size of the channel material and not the form of the channel bed. Plane-bed conditions were assumed for nearly all indirect measurements of peak discharge where the slope-area method was used.

Table 1.--*Base values of Manning's n for stable channels*

[Modified from Aldridge and Garrett, 1973, table 1]

Channel material	Size of bed material		Base *n* values	
	Millimeters	Inches	Benson and Dalrymple (1967)[1]	Chow (1959)[2]
Concrete.....	-------	--------	0.012-0.018	0.011
Rock cut.....	-------	--------	----------	.025
Firm soil.....	-------	--------	.025- .032	.020
Coarse sand.....	1-2	--------	.026- .035	-----
Fine gravel.....	-------	--------	----------	.024
Gravel.....	2-64	0.08-2.5	.028- .035	-----
Coarse gravel.....	-------	--------	----------	.028
Cobble.....	64-256	2.5-10.0	.030- .050	-----
Boulder.....	>256	>10.0	.040- .070	-----

[1]Straight uniform channel.
[2]Smoothest channel attainable in indicated material.

Table 2.--*Adjustment factors for the determination of overall Manning's n values*

[Modified from Chow, 1959]

Channel conditions	Manning's n adjustment[1]	Example
Degree of irregularity:		
Smooth	0.000	Smoothest channel attainable in given bed material.
Minor	.001- .005	Channels with slightly eroded or scoured side slopes.
Moderate	.006- .010	Channels with moderately sloughed or eroded side slopes.
Severe	.011- .020	Channels with badly sloughed banks; unshaped, jagged, and irregular surfaces of channels in rock.
Effects of obstruction[2]:		
Negligible	.000- .004	A few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	.005- .015	Obstructions occupy 5 to 15 percent of the cross-sectional area and the spacing between obstructions is such that the sphere of influence around one obstruction does not extend to the sphere of influence around another obstruction. Smaller adjustments are used for curved smooth-surfaced objects than are used for sharp-edged angular objects.
Appreciable	.020- .030	Obstructions occupy from 15 to 50 percent of the cross-sectional area or the space between obstructions is small enough to cause the effects of several obstructions to be additive, thereby blocking an equivalent part of a cross section.
Severe	.040- .060	Obstructions occupy more than 50 percent of the cross-sectional area or the space between obstructions is small enough to cause turbulence across most of the cross section.
Vegetation:		
Small	.002- .010	Dense growths of flexible turf grass, such as Bermuda, or weeds where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow weed, or saltcedar where the average depth of flow is at least three times the height of the vegetation.
Medium	.010- .025	Grass or weeds where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemmy grass, weeds, or tree seedlings where the average depth of flow is from two to three times the height of the vegetation; moderately dense brush, similar to 1- to 2-year-old saltcedar in the dormant season, along the banks and no significant vegetation along the channel bottoms where the hydraulic radius exceeds 2 feet.
Large	.025- .050	Turf grass or weeds where the average depth to flow is about equal to the height of vegetation; small trees intergrown with some weeds and brush where the hydraulic radius exceeds 2 feet.

See footnotes at end of table.

Table 2.--*Adjustment factors for the determination of overall Manning's n values*--Continued

Channel conditions	Manning's n adjustment[1]	Example
Vegetation—Continued:		
Very large	.050- .100	Turf grass or weeds where the average depth of flow is less than half the height of vegetation; small bushy trees intergrown with weeds along side slopes of dense cattails growing along channel bottom; trees intergrown with weeds and brush.
Variations in channel cross section:		
Gradual	.000	Size and shape of cross sections change gradually.
Alternating	.001- .005	Large and small cross sections alternate occasionally, or the main flow occasionally shifts from side to side owing to changes in cross-sectional shape.
Alternating	.010- .015	Large and small cross sections alternate frequently, or the main flow frequently shifts from side to side owing to changes in cross-sectional shape.
Degree of meadering[3]:		
Minor	1.00	Ratio of the meander length to the straight length of the channel reach is 1.0 to 1.2.
Appreciable	1.15	Ratio of the meader length to the straight length of channel is 1.2 to 1.5.
Severe	1.30	Ratio of the meander length to the straight length of channel is greater than 1.5.

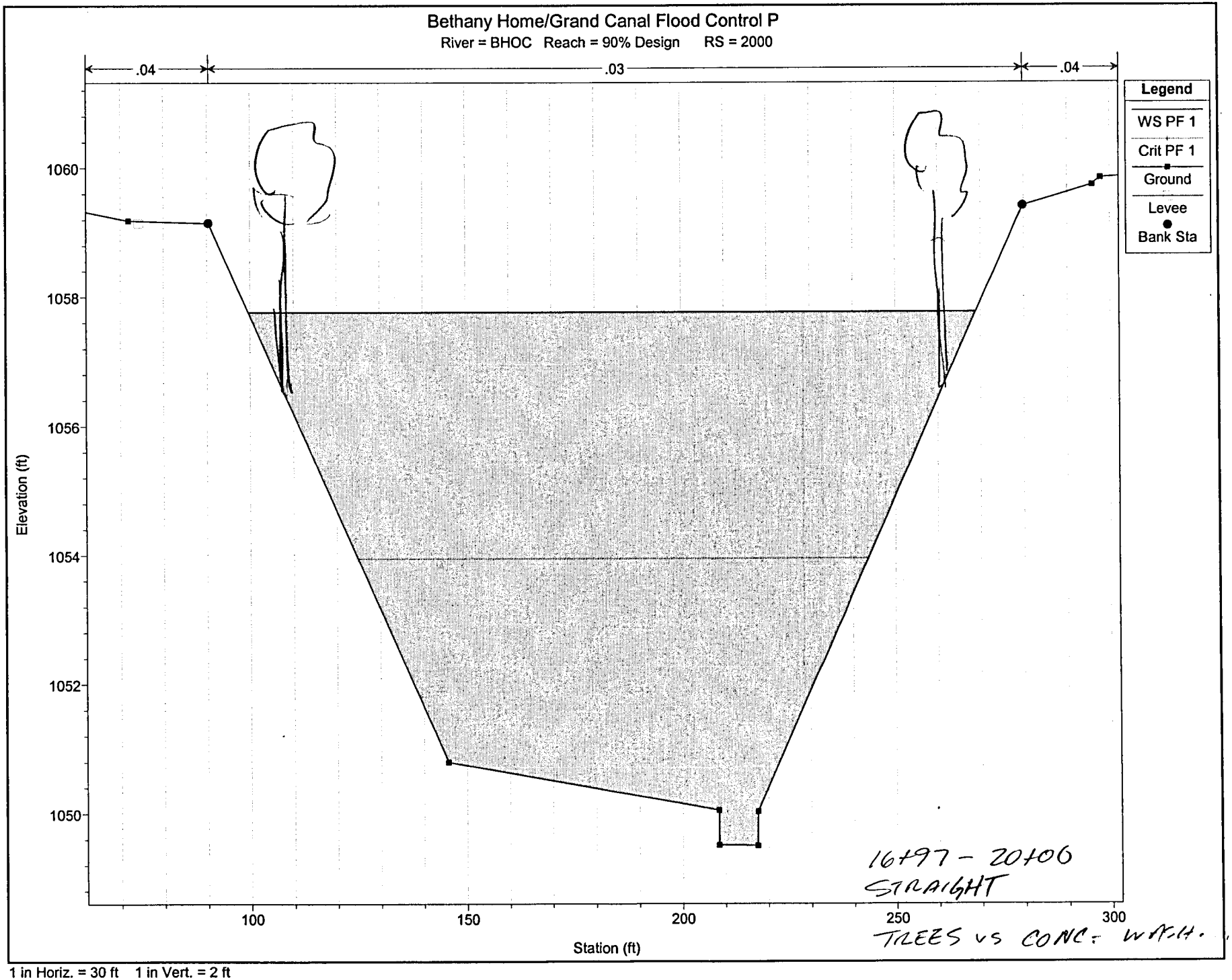
[1]Adjustments for degree of irregularity, variations in cross section, effect of obstructions, and vegetation are added to the base n value (table 1) before multiplying by the adjustment for meander.

[2]Conditions considered in other steps must not be reevaluated or duplicated in this section.

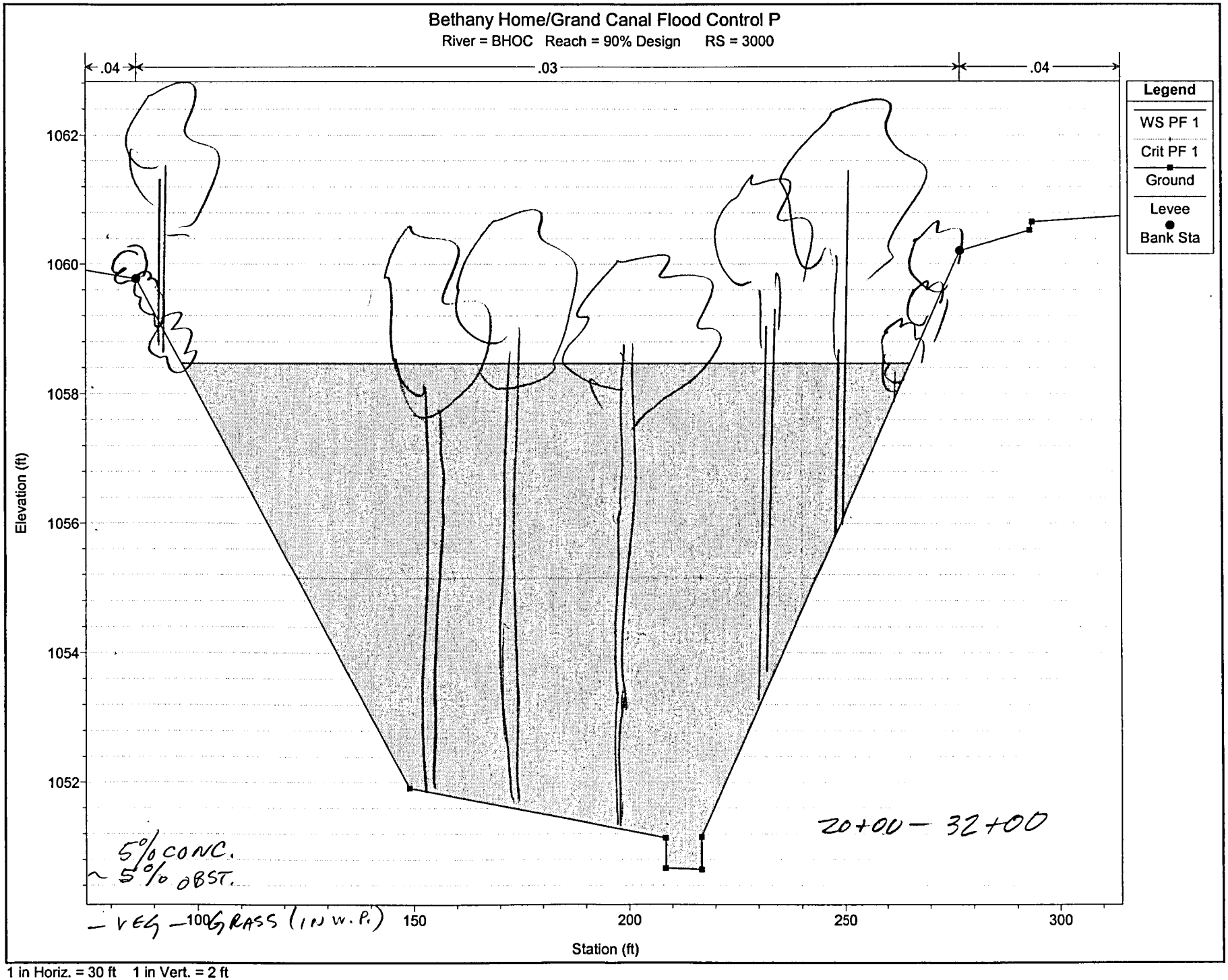
[3]Adjustment values apply to flow confined in the channel and do not apply where downvalley flow crosses meanders. The adjustment is a multiplier.

For floodflows in sand channels with moveable beds, roughness mainly is a function of the size of the bed material as shown in the following table (Benson and Dalrymple, 1967, p. 22).

Median grain size, in millimeters	Manning's *n*	Median grain size, in millimeters	Manning's *n*
0.2	0.012	0.6	.023
.3	.017	.8	.025
.4	.020	1.0	.026
.5	.022		



1 in Horiz. = 30 ft 1 in Vert. = 2 ft



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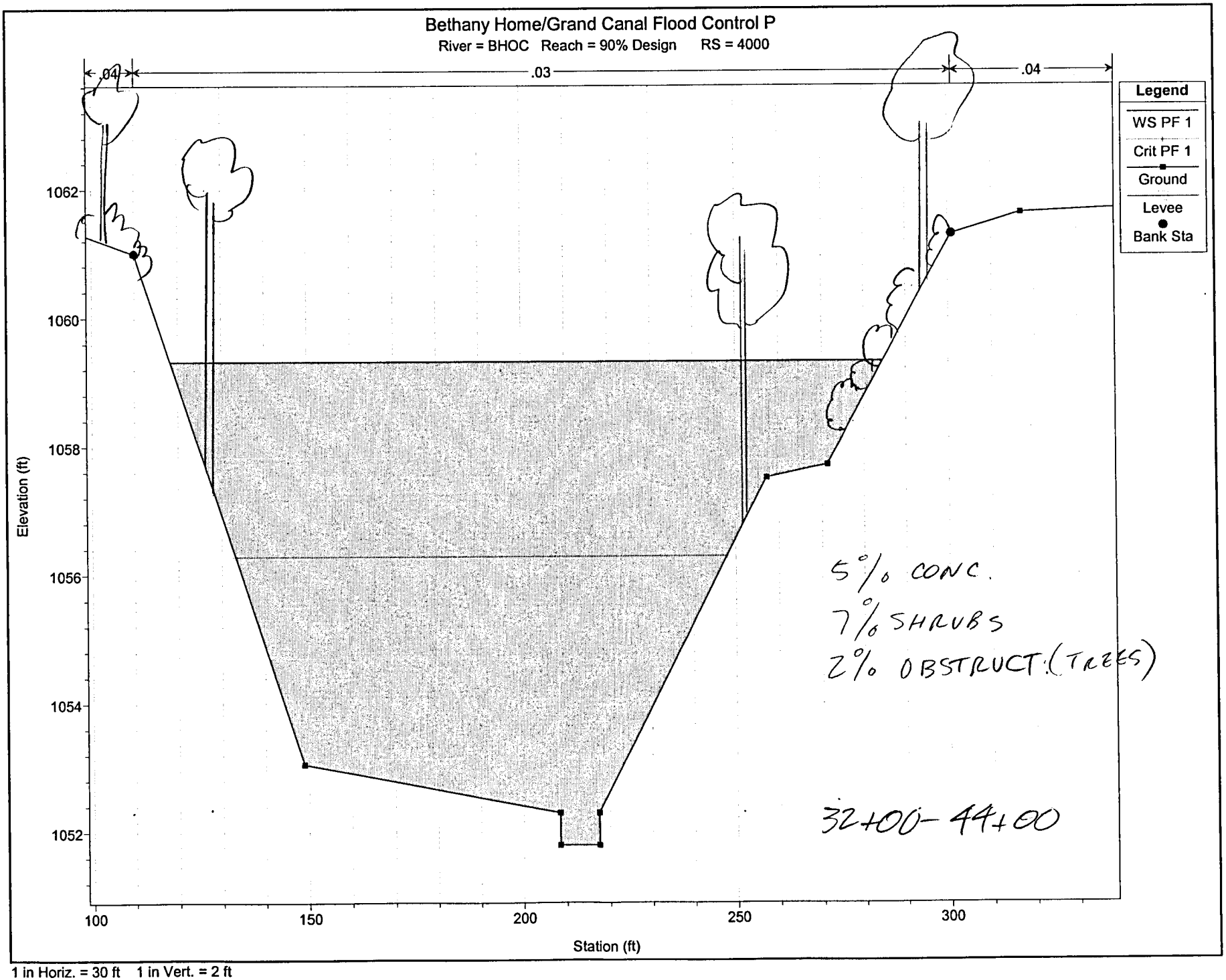

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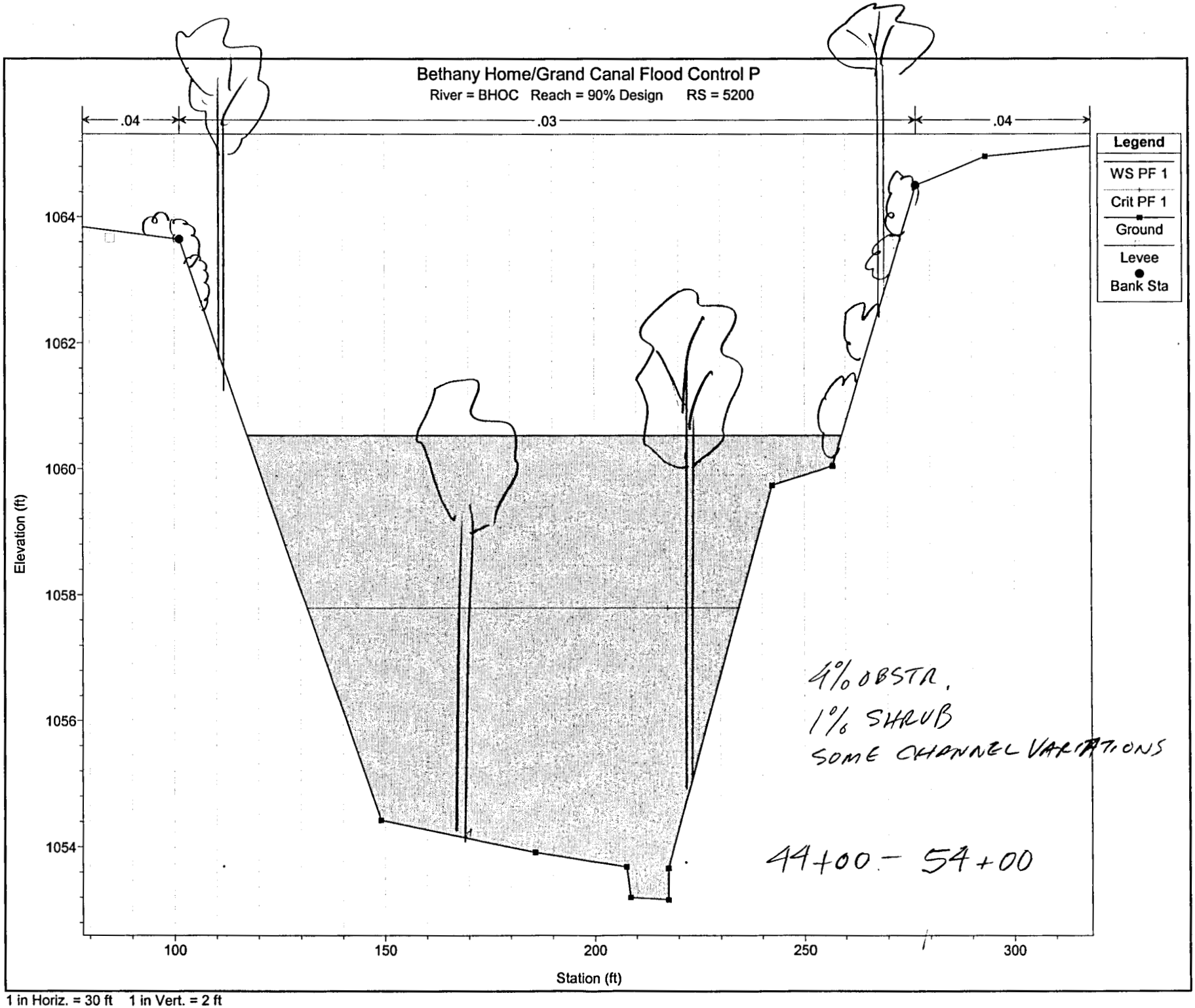

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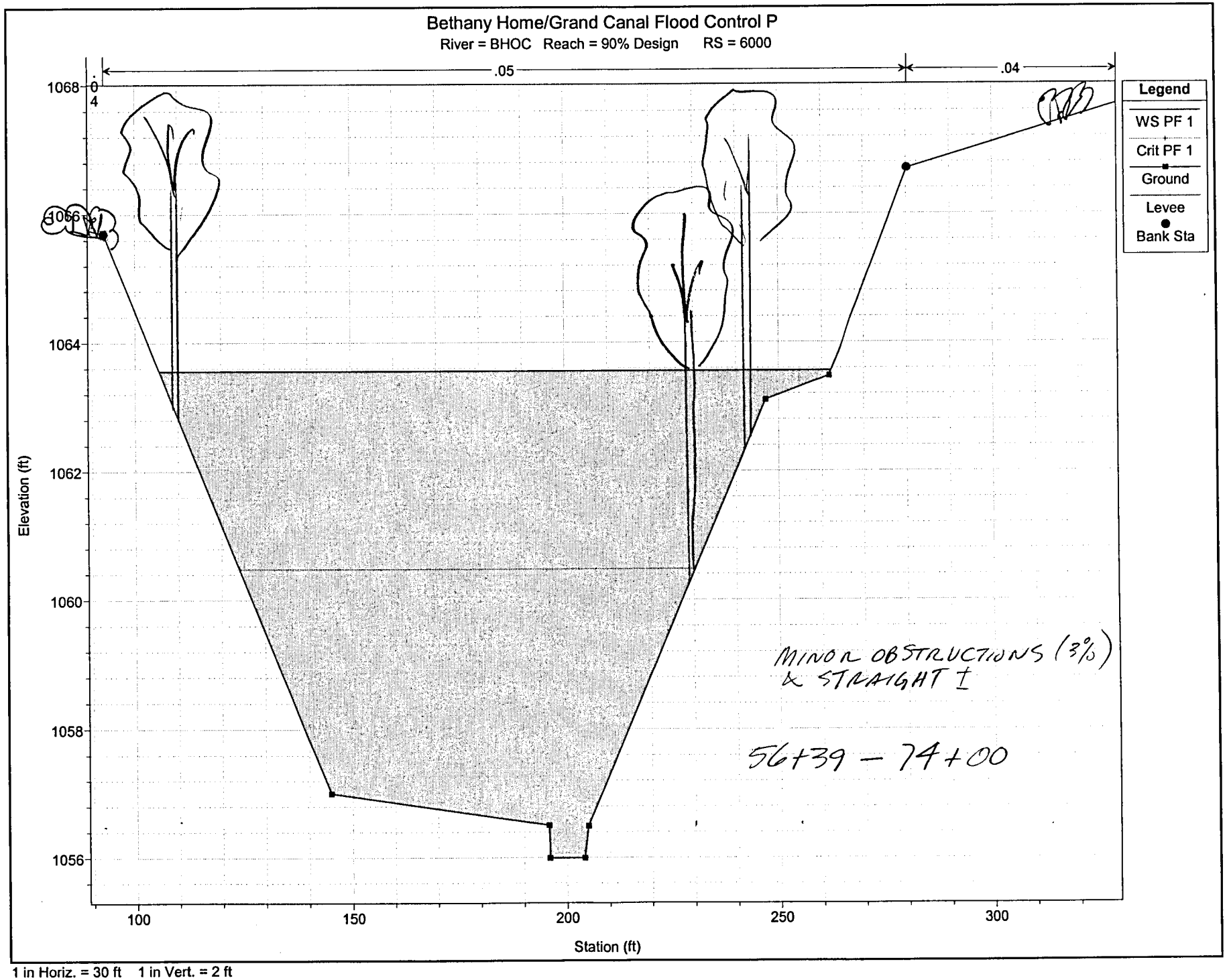

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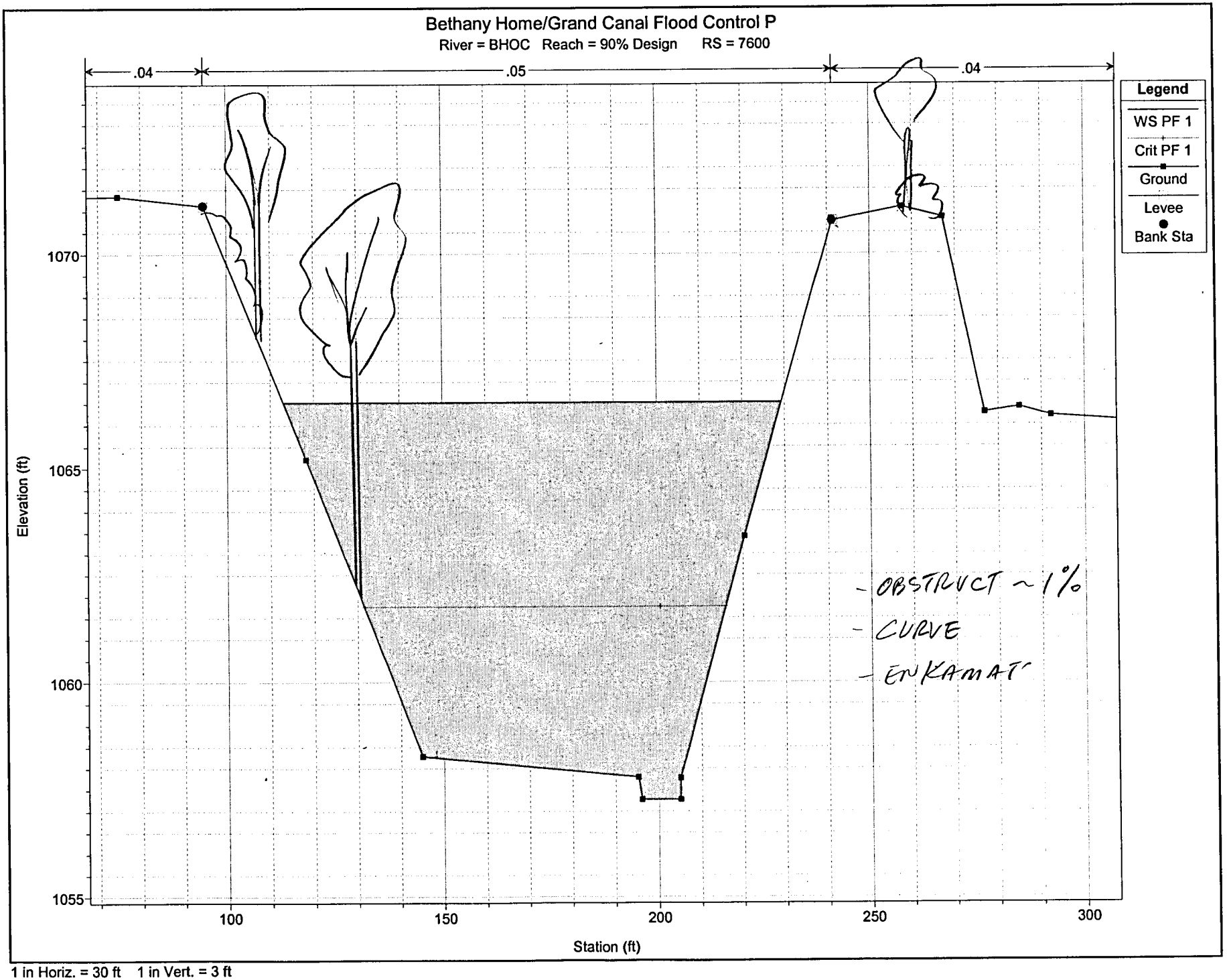
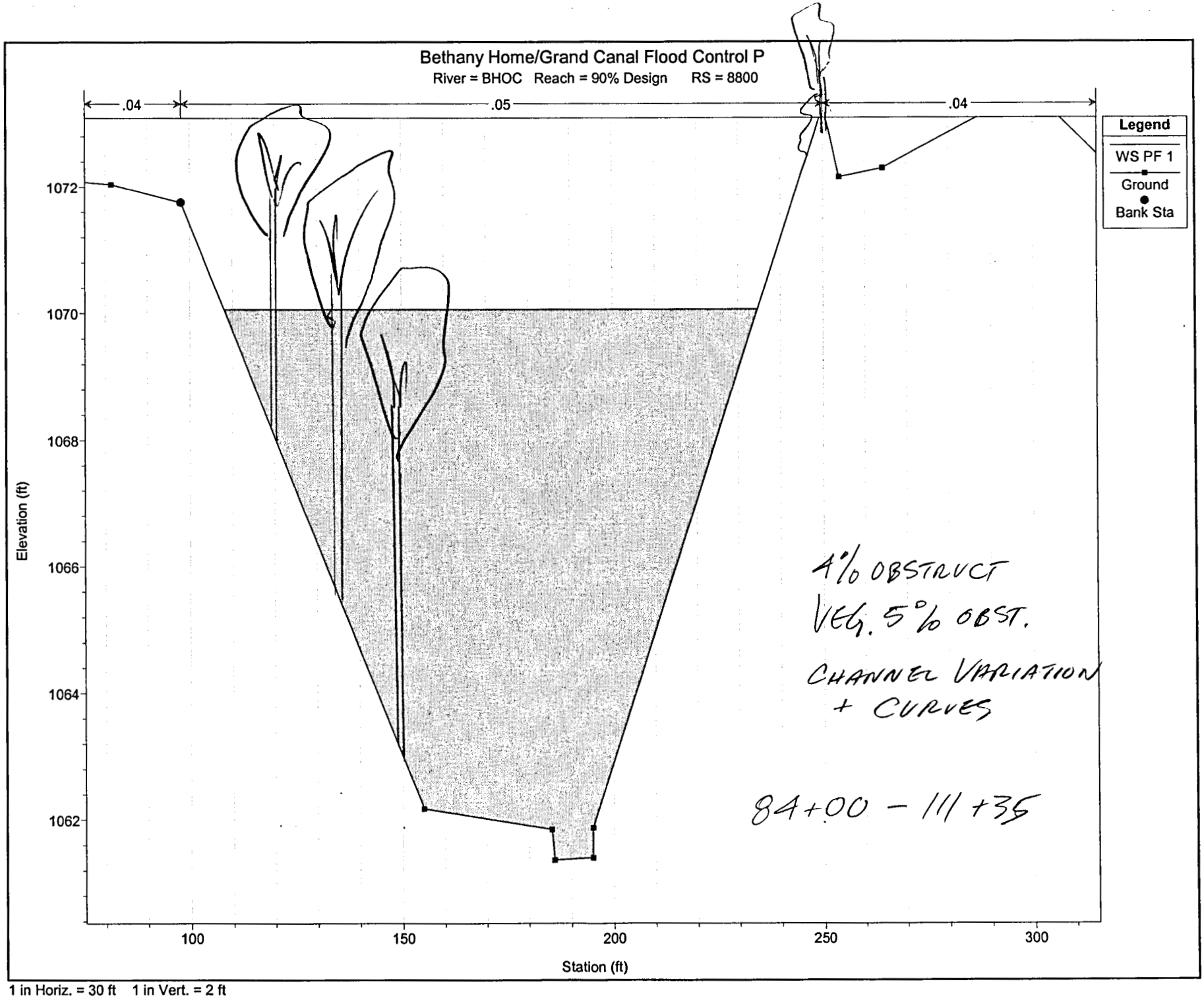


1 in Horiz. = 30 ft 1 in Vert. = 3 ft



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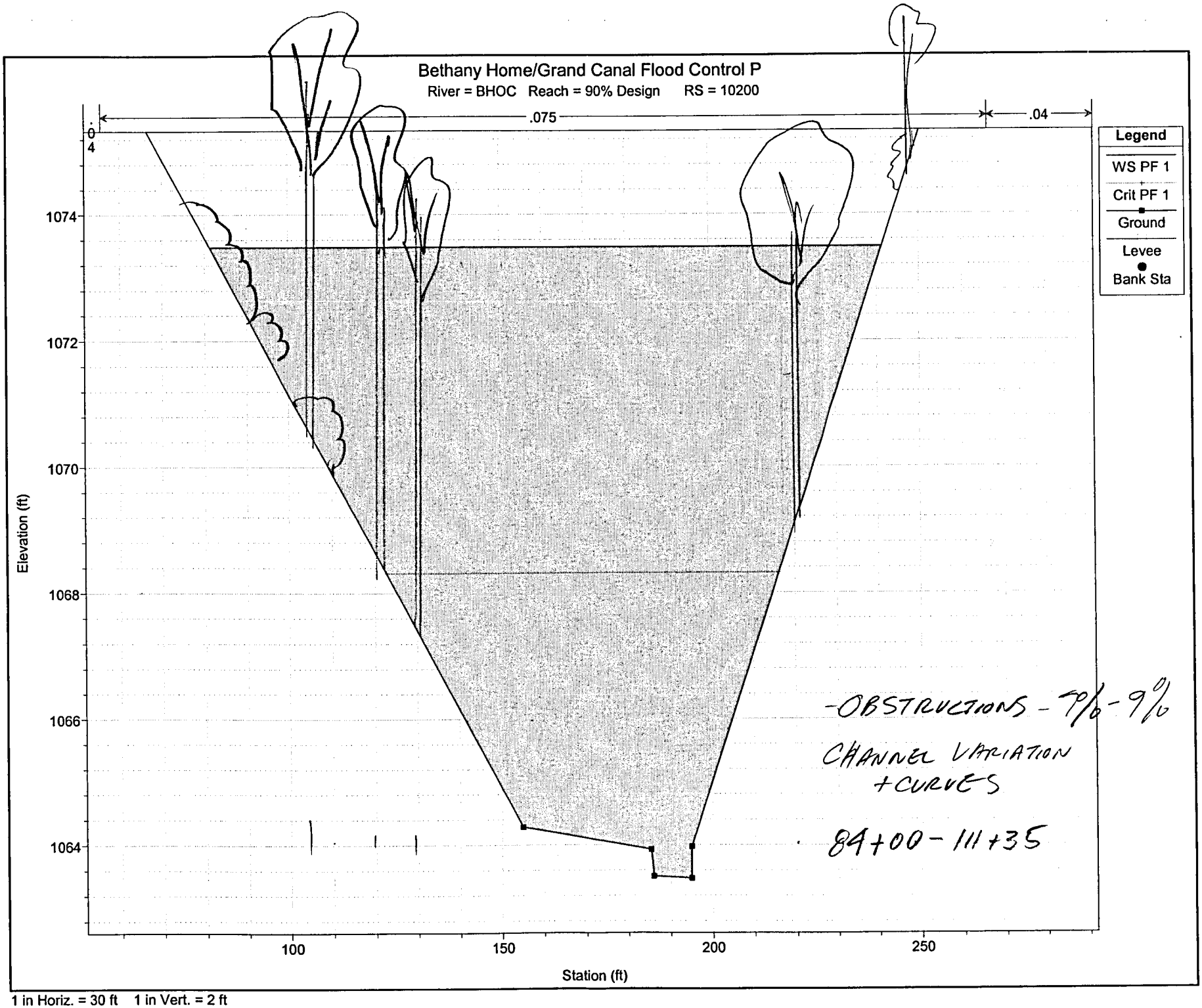
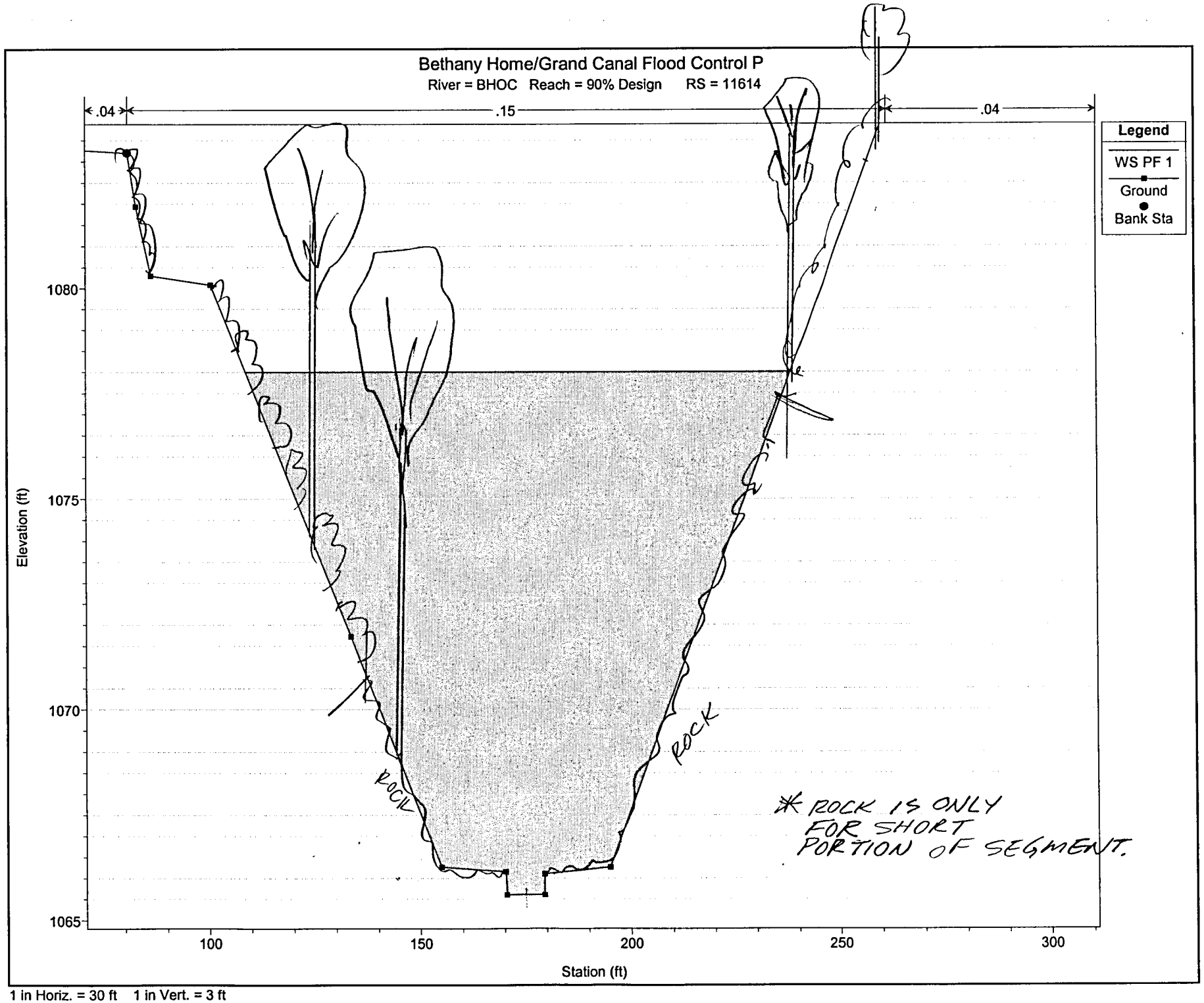
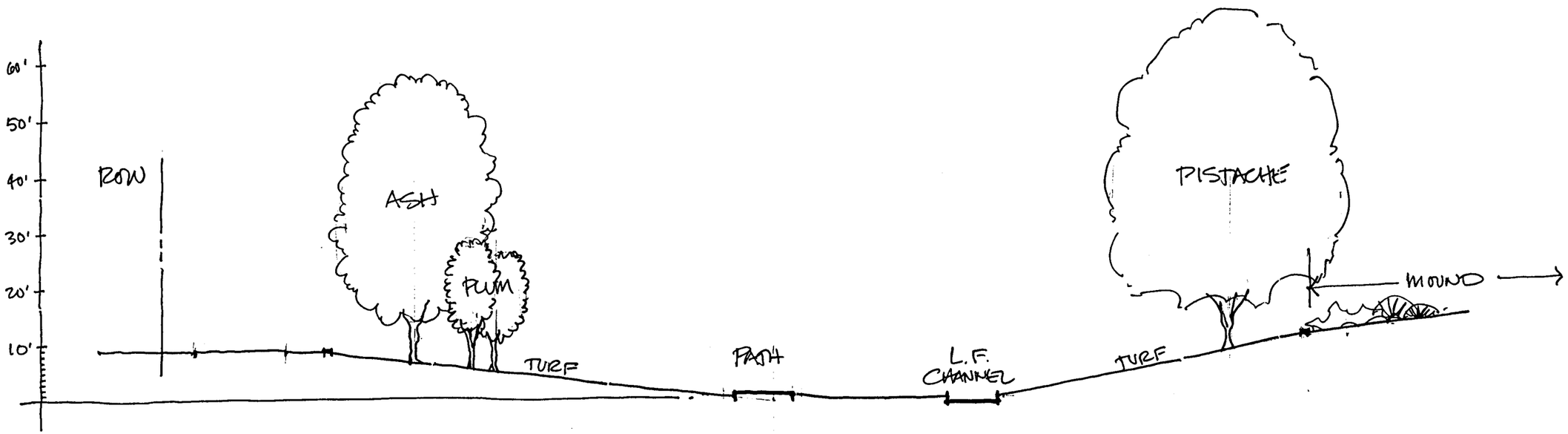


1 in Horiz. = 30 ft 1 in Vert. = 2 ft



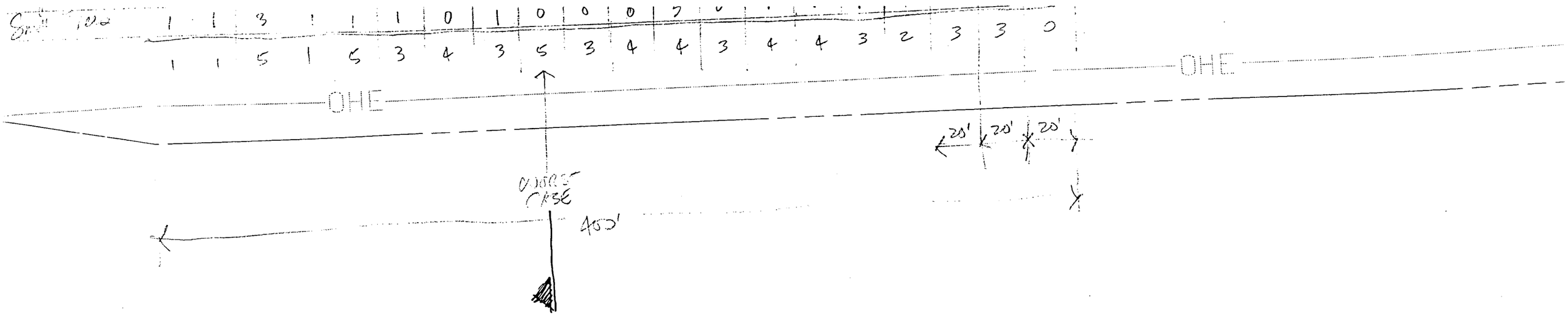
1 in Horiz. = 30 ft 1 in Vert. = 3 ft

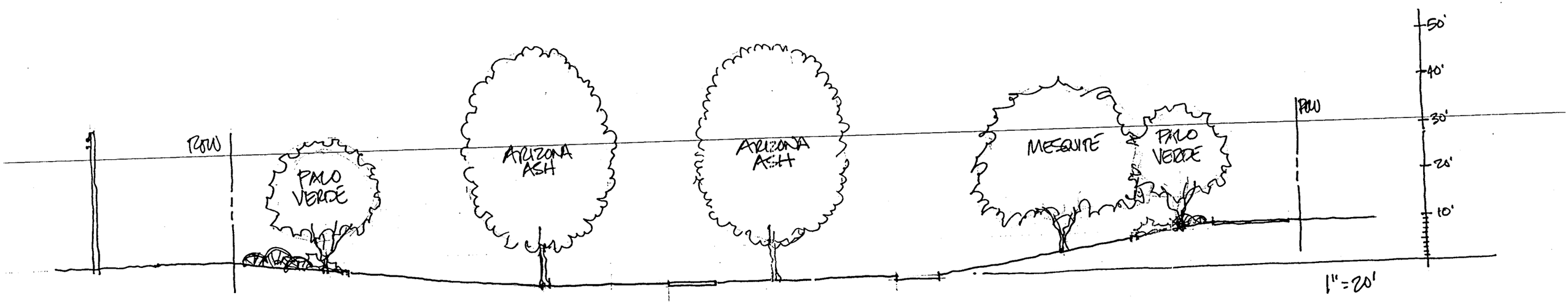


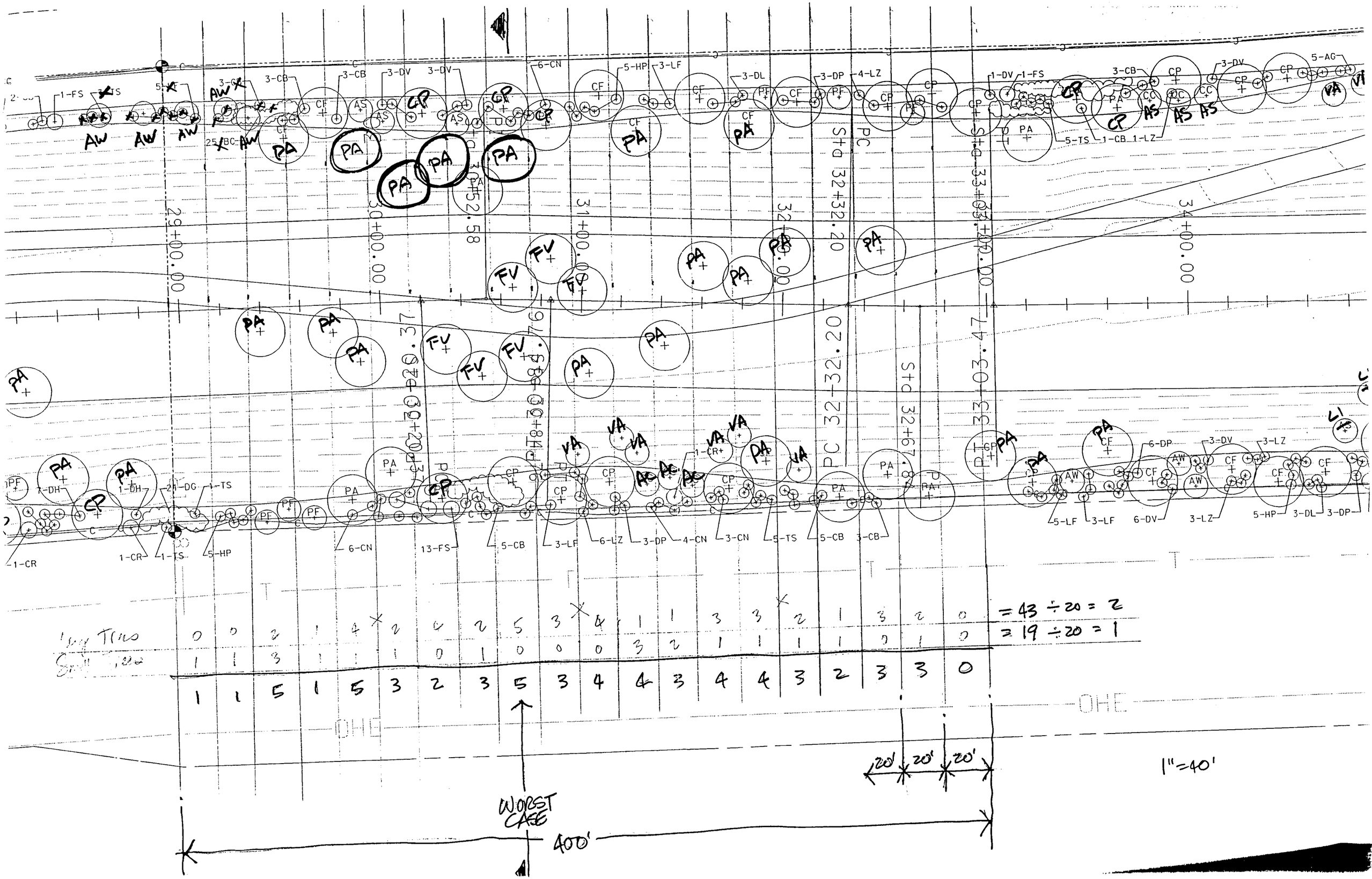
STA 90+70 ±
WELBORN AREA

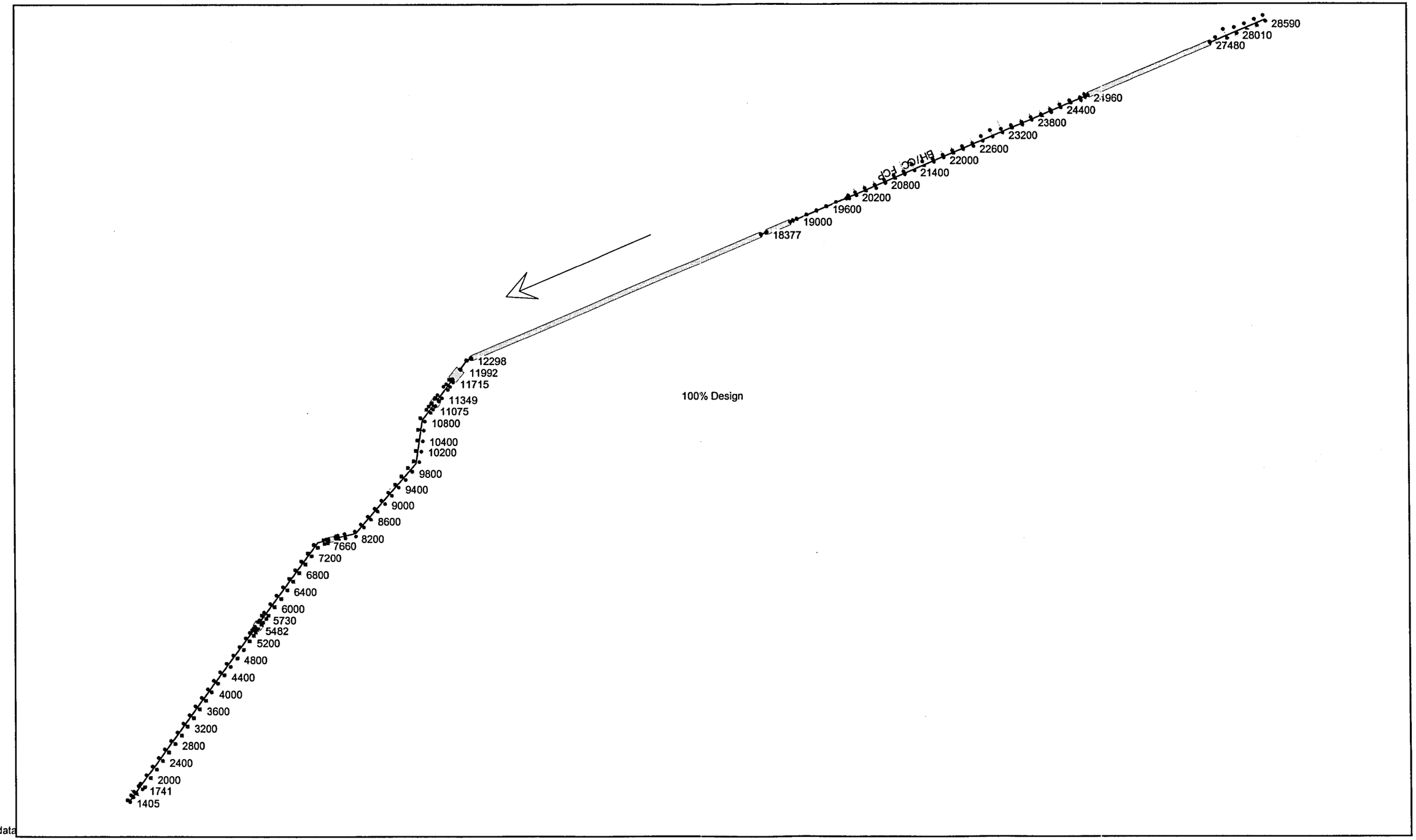
SCALE 1" = 20'

= 43 ÷ 24 = 1.8 = 2
= 11 ÷ 24 = 0.4 = 1
average
WORST CASE
3167

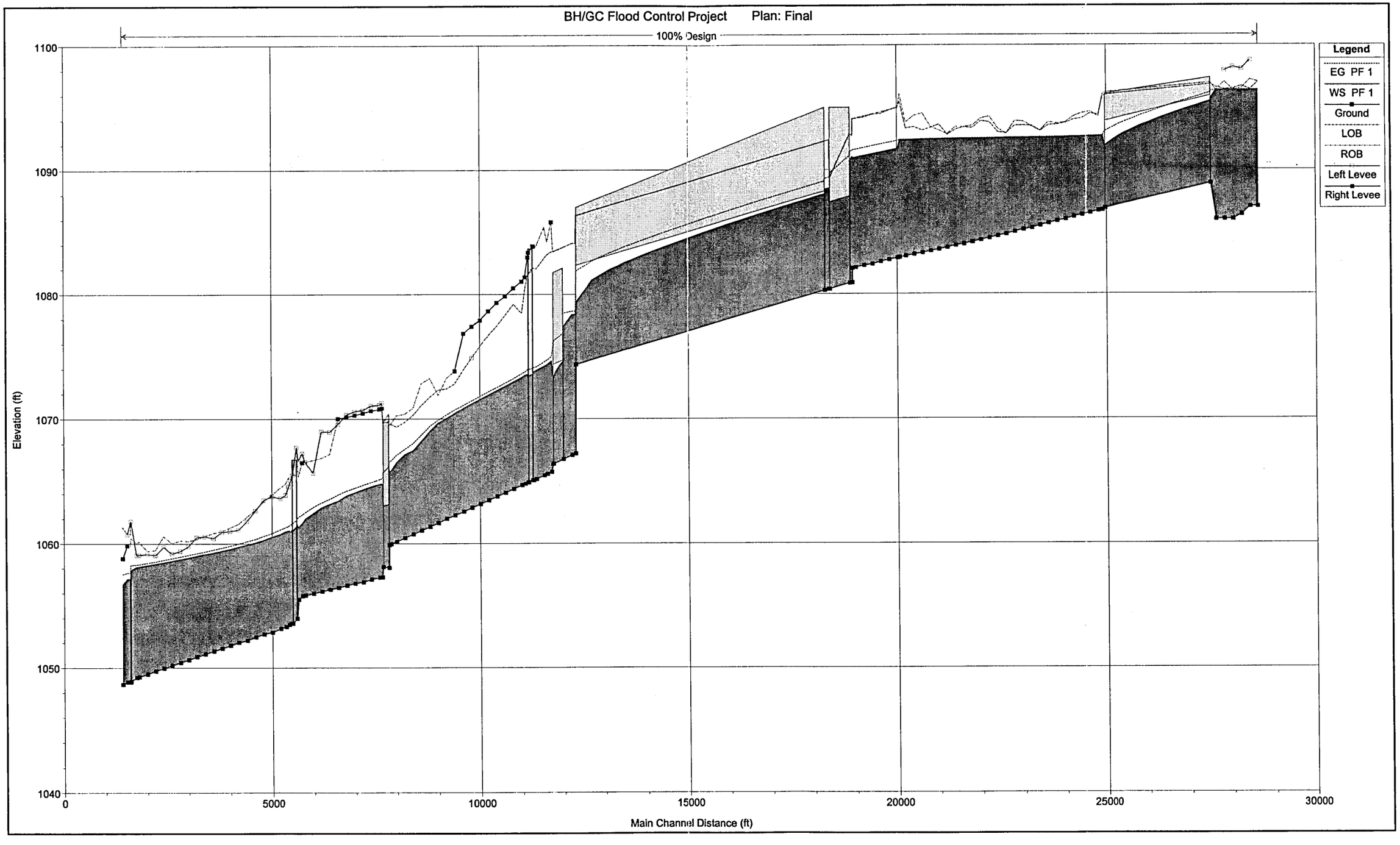

1 1 3 1 1 1 0 1 0 0 0
1 1 5 1 5 3 4 3 5 3 4 4 3 4 4 3 2 3 3 0
OHE
OHE
20' 20' 20'
WORST CASE
400'


ROW
PALO VERDE
ARIZONA ASH
ARIZONA ASH
MESQUITE
PALO VERDE
ROW
50'
40'
30'
20'
10'
1" = 20'


29+00.00
30+00.00
31+00.00
32+00.00
33+00.00
34+00.00
30+52.58
30+20.37
30+84.76
31+45.62
32+32.20
32+67.18
33+03.47
Sta 32+32.20
PC
Sta 32+67.18
Sta 33+03.47
1-FS
5-TS
3-CB
3-DV
6-CN
5-HP
3-LF
3-DL
3-DP
4-LZ
1-DV
5-AG
1-CB
1-LZ
1-DH
1-DG
1-CR
13-FS
5-CB
6-LZ
4-CN
3-CN
1-CR+
6-DP
3-LZ
5-LF
6-DV
OHE
Lay Time
Sort Time
= 43 ÷ 20 = 2
= 19 ÷ 20 = 1
1 1 5 1 5 3 2 3 5 3 4 4 3 4 4 3 2 3 3 0
20' 20' 20'
WORST CASE
400'
1"=40'



Partial GIS data

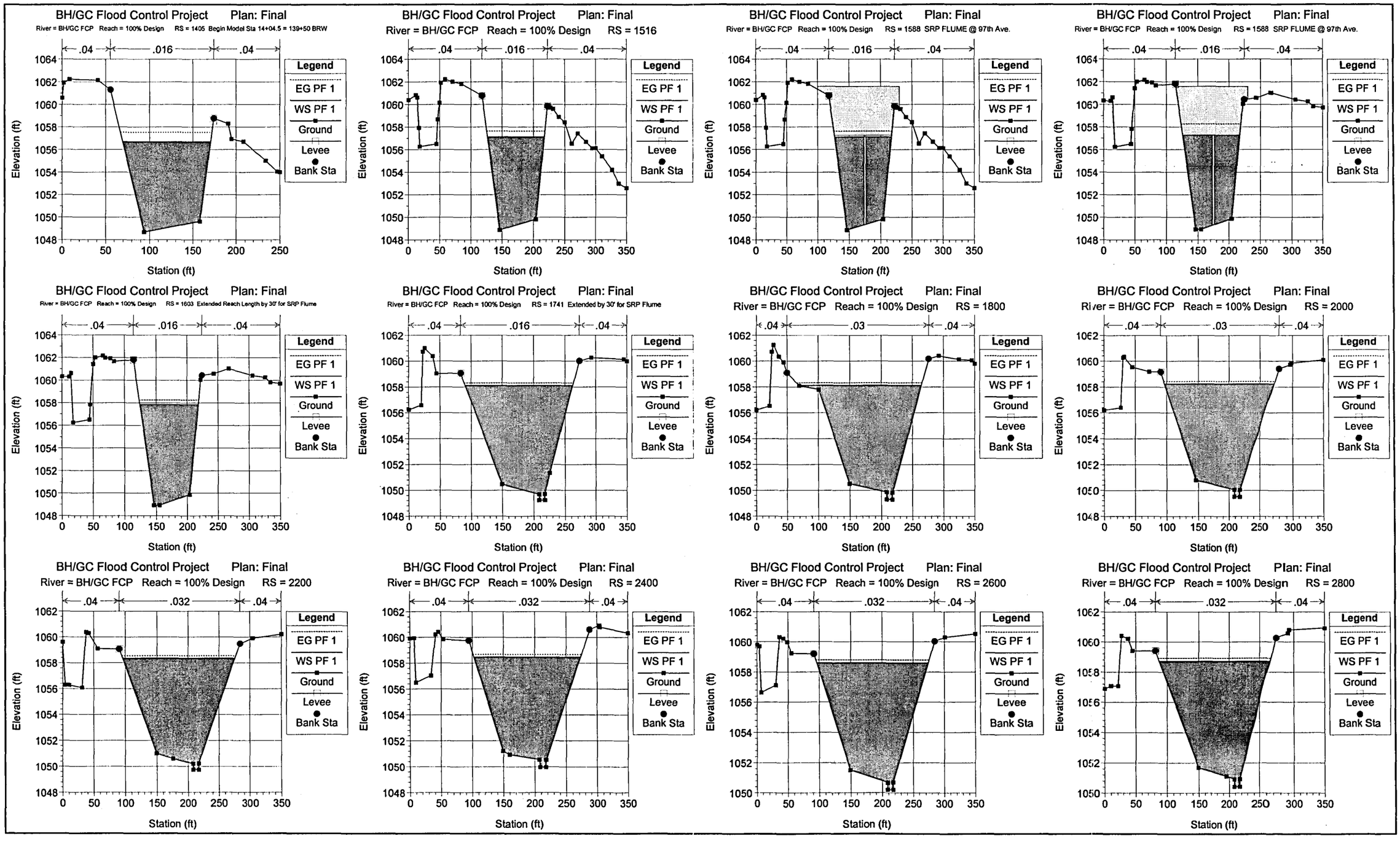

BH/GC Flood Control Project Plan: Final
100% Design
Legend
EG PF 1
WS PF 1
Ground
LOB
ROB
Left Levee
Right Levee
Elevation (ft)
1100
1090
1080
1070
1060
1050
1040
0
5000
10000
15000
20000
25000
30000
Main Channel Distance (ft)

HEC-RAS Plan: 100% River: BH/GC FCP Reach: 100% Design Profile: PF 1

Reach	River Sta	Q Total	Mann Wtd Chnl	Min Ch El	W.S. Elev	L. Freeboard	R. Freeboard	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)		(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
100% Design	1405	4579.00	0.016	1048.68	1056.69	4.61	2.07	0.000567	7.31	626.64	101.26	0.52
100% Design	1518	3340.00	0.016	1048.87	1057.12	3.65	2.73	0.000340	5.74	581.43	91.02	0.40
100% Design	1588	Bridge										
100% Design	1603	3340.00	0.016	1048.92	1057.85	3.96	2.58	0.000246	5.14	650.13	94.33	0.34
100% Design	1741	3340.00	0.016	1049.23	1058.12	0.94	1.89	0.000140	3.45	967.22	171.82	0.26
100% Design	1800	3340.00	0.030	1049.28	1058.13	0.97	2.04	0.000628	3.53	946.64	195.42	0.28
100% Design	2000	3340.00	0.030	1049.50	1058.25	0.90	1.16	0.000487	3.41	979.49	175.81	0.25
100% Design	2200	3340.00	0.032	1049.74	1058.36	0.70	1.12	0.000584	3.43	972.35	179.82	0.26
100% Design	2400	3340.00	0.032	1049.97	1058.47	1.27	2.13	0.000643	3.62	923.80	170.18	0.27
100% Design	2600	3340.00	0.032	1050.19	1058.60	0.59	1.42	0.000658	3.57	935.62	178.28	0.27
100% Design	2800	3340.00	0.032	1050.42	1058.73	0.68	1.53	0.000694	3.63	919.24	177.67	0.28
100% Design	3000	3340.00	0.032	1050.64	1058.86	0.92	1.36	0.000742	3.73	895.34	174.75	0.29
100% Design	3200	3340.00	0.032	1050.88	1058.99	1.52	1.39	0.000781	3.79	880.24	170.92	0.29
100% Design	3400	3340.00	0.030	1051.10	1059.14	1.45	1.47	0.000653	3.72	897.91	176.04	0.29
100% Design	3600	3340.00	0.030	1051.33	1059.27	1.16	1.57	0.000802	3.94	847.28	178.17	0.32
100% Design	3800	3340.00	0.030	1051.56	1059.42	1.51	1.57	0.000768	4.00	835.34	166.35	0.31
100% Design	4000	3340.00	0.030	1051.79	1059.57	1.43	1.72	0.000869	4.11	811.76	169.57	0.33
100% Design	4200	3340.00	0.030	1052.02	1059.75	1.36	1.83	0.000801	4.01	832.48	170.03	0.32
100% Design	4400	3340.00	0.030	1052.20	1059.91	1.89	2.24	0.000870	4.19	797.43	162.12	0.33
100% Design	4600	3340.00	0.033	1052.47	1060.08	2.56	2.62	0.001091	4.29	779.27	157.35	0.34
100% Design	4800	3340.00	0.033	1052.70	1060.30	3.20	3.10	0.001219	4.50	742.68	151.40	0.36
100% Design	5000	3340.00	0.033	1052.85	1060.54	3.26	3.38	0.001182	4.44	752.81	152.99	0.35
100% Design	5200	3340.00	0.033	1053.16	1060.77	2.87	3.73	0.001453	4.83	690.87	144.15	0.39
100% Design	5330	3340.00	0.033	1053.30	1060.99	2.91	3.81	0.001157	4.56	732.88	140.70	0.35
100% Design	5400	3340.00	0.033	1053.46	1061.04	3.57	4.27	0.001346	4.97	672.51	126.55	0.38
100% Design	5450	3340.00	0.030	1053.57	1060.97	4.11	4.40	0.001783	6.19	540.01	103.74	0.48
100% Design	5482	3097.00	0.016	1053.57	1061.16	4.29	4.38	0.000358	5.34	580.17	106.58	0.40
100% Design	5591	Bridge										
100% Design	5592	3097.00	0.016	1053.97	1061.58	6.13	6.01	0.000329	5.20	596.11	106.74	0.39
100% Design	5633	3097.00	0.016	1055.49	1061.32	5.33	4.08	0.001009	7.31	423.54	106.87	0.65
100% Design	5730	3097.00	0.030	1055.77	1061.63	5.62	4.84	0.003080	6.68	463.58	120.83	0.60
100% Design	5800	3097.00	0.030	1055.83	1061.98	4.56	4.57	0.002260	5.87	527.62	132.26	0.52
100% Design	6000	3097.00	0.030	1055.99	1062.45	3.24	4.25	0.001918	5.62	550.91	130.64	0.48
100% Design	6200	3097.00	0.030	1056.15	1062.90	6.10	3.98	0.001477	4.99	621.03	144.94	0.42
100% Design	6400	3097.00	0.030	1056.31	1063.18	5.78	4.02	0.001474	5.12	604.45	134.83	0.43
100% Design	6600	3097.00	0.030	1056.44	1063.43	6.17	6.54	0.001668	5.69	544.22	113.39	0.46
100% Design	6800	2844.00	0.030	1056.63	1063.84	6.46	6.29	0.001207	4.97	571.68	114.24	0.39
100% Design	7000	2844.00	0.030	1056.79	1064.09	6.51	6.20	0.001172	4.94	576.22	113.87	0.39
100% Design	7200	2844.00	0.030	1056.90	1064.33	6.37	6.12	0.001112	4.84	587.80	114.95	0.38
100% Design	7400	2844.00	0.030	1057.11	1064.57	6.46	6.04	0.001074	4.78	595.30	115.63	0.37
100% Design	7600	2844.00	0.030	1057.27	1064.76	6.36	6.00	0.001164	5.09	558.99	104.33	0.39
100% Design	7660	2844.00	0.030	1057.29	1064.79	6.48	6.03	0.001270	5.43	524.07	94.21	0.41
100% Design	7676.4	2844.00	0.030	1058.11	1064.66	5.05	5.05	0.001918	6.72	423.41	64.62	0.46
100% Design	7815	Culvert										
100% Design	7816.7	2844.00	0.016	1058.05	1066.00	3.74	4.41	0.000301	5.54	513.36	64.61	0.35
100% Design	7828.7	2844.00	0.016	1059.89	1065.76	3.73	3.79	0.001113	7.26	391.99	107.68	0.67
100% Design	7872	2844.00	0.030	1059.96	1065.86	3.71	3.77	0.003833	7.20	394.92	108.02	0.66
100% Design	8000	2844.00	0.030	1060.16	1066.51	2.85	3.75	0.002842	6.21	458.18	125.56	0.57
100% Design	8200	2844.00	0.030	1060.46	1067.16	2.58	3.22	0.001787	5.17	550.34	140.63	0.46
100% Design	8400	2844.00	0.030	1060.76	1067.47	2.82	3.40	0.002681	6.15	462.31	122.73	0.56
100% Design	8600	2844.00	0.045	1061.06	1068.23	2.87	4.61	0.003992	5.59	508.59	114.15	0.47
100% Design	8800	2844.00	0.045	1061.36	1069.01	2.74	4.24	0.003145	5.18	548.67	115.25	0.42
100% Design	9000	2844.00	0.045	1061.66	1069.67	2.66	2.24	0.001833	3.98	713.69	149.12	0.32
100% Design	9200	2844.00	0.045	1062.00	1070.04	2.38	3.23	0.002070	4.24	670.12	139.82	0.34
100% Design	9400	2844.00	0.045	1062.27	1070.44	2.38	3.41	0.002069	4.29	662.51	134.97	0.34
100% Design	9600	2844.00	0.045	1062.57	1070.87	3.09	5.99	0.001754	3.96	717.71	146.25	0.32
100% Design	9800	2844.00	0.045	1062.87	1071.21	3.69	6.23	0.001808	4.05	702.09	141.08	0.32
100% Design	10000	2844.00	0.045	1063.17	1071.57	4.29	6.41	0.001743	4.01	709.99	141.49	0.32
100% Design	10200	2844.00	0.045	1063.47	1071.92	4.77	6.69	0.001745	4.02	706.80	139.99	0.32
100% Design	10400	2844.00	0.045	1063.77	1072.27	5.19	7.03	0.001762	4.06	700.39	137.43	0.32
100% Design	10600	2844.00	0.045	1064.07	1072.62	5.68	7.25	0.001771	4.11	691.17	133.64	0.32
100% Design	10800	2844.00	0.045	1064.38	1072.97	6.23	7.48	0.001866	4.17	682.60	134.49	0.33
100% Design	11000	2844.00	0.045	1064.68	1073.32	5.16	7.73	0.001966	4.43	641.54	119.32	0.34
100% Design	11075	2844.00	0.045	1064.79	1073.50	6.90	7.99	0.001676	4.13	688.75	127.14	0.31
100% Design	11144	2844.00	0.045	1064.89	1073.55	7.96	9.43	0.002438	5.04	564.83	101.45	0.38
100% Design	11160	2844.00	0.016	1064.92	1073.56	8.02	9.78	0.000313	5.08	560.14	100.94	0.38
100% Design	11265	Bridge										
100% Design	11266	2844.00	0.016	1065.08	1073.74	8.42	10.15	0.000287	4.93	576.87	101.73	0.36
100% Design	11281	2844.00	0.016	1065.10	1073.75	8.36	10.15	0.000288	4.92	578.37	102.26	0.36
100% Design	11349	2844.00	0.045	1065.19	1073.88	8.15	9.97	0.001845	4.31	659.78	122.25	0.33
100% Design	11542	2844.00	0.045	1065.49	1074.23	8.66	11.18	0.002079	4.69	606.48	107.75	0.35
100% Design	11614	2844.00	0.045	1065.60	1074.36	8.84	9.88	0.002222	4.89	582.10	101.74	0.36
100% Design	11715	2844.00	0.055	1065.75	1074.64	8.79	11.20	0.003118	4.78	594.60	102.51	0.35
100% Design	11755	2844.00	0.055	1066.40	1073.40	10.06	10.02	0.027106	12.77	222.78	31.81	0.85
100% Design	11991	Culvert										
100% Design	11992	2844.00	0.016	1066.78	1077.37	6.41	6.41	0.000702	8.44	336.92	31.85	0.46
100% Design	12200	1533.00	0.016	1067.10	1078.36	5.73	5.74	0.000169	4.25	360.54	32.03	0.22
100% Design	12284	1533.00	0.016	1067.22	1078.36	5.74	5.86	0.000175	4.31	355.37	31.96	0.23
100% Design	12298	1533.00	0.016	1074.34	1079.21	7.13	7.14	0.003411	12.53	122.34	25.11	1.00
100% Design	18260	Culvert										
100% Design	18261	1533.00	0.016	1080.27	1088.42	3.84	3.84	0.000771	7.49	204.78	25.12	0.46
100% Design	18361	1533.00	0.016	1080.37	1088.50	3.87	3.87	0.000781	7.52	203.85	25.12	0.47
100% Design	18377	1141.00	0.016	1080.38	1088.34	1.02	1.02	0.001293	8.54	133.63	16.80	0.53

HEC-RAS Plan: 100% River: BH/GC ECP Reach: 100% Design Profile: PF 1 (Continued)

Reach	River Sta	Q Total	Mann Wtd Chnl	Min Ch El	W.S. Elev	L. Freeboard	R. Freeboard	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)		(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
100% Design	18859	Culvert										
100% Design	18860	1141.00	0.016	1080.86	1090.72	2.14	2.18	0.000734	6.89	165.49	16.79	0.39
100% Design	18918	959.00	0.016	1080.90	1091.02	1.66	1.90	0.000486	5.65	169.74	16.80	0.31
100% Design	18920	959.00	0.016	1082.06	1090.92	3.15	3.15	0.000688	6.45	148.61	16.79	0.38
100% Design	19000	959.00	0.016	1082.12	1090.98	3.12	3.15	0.000689	6.46	148.52	16.79	0.38
100% Design	19200	959.00	0.016	1082.28	1091.11	3.09	3.18	0.000695	6.48	148.05	16.79	0.38
100% Design	19400	959.00	0.016	1082.40	1091.25	3.19	3.20	0.000696	6.48	148.04	16.79	0.38
100% Design	19600	959.00	0.016	1082.60	1091.38	3.11	3.22	0.000705	6.51	147.29	16.79	0.39
100% Design	19800	959.00	0.016	1082.76	1091.52	3.24	3.28	0.000710	6.53	146.86	16.80	0.39
100% Design	20000	959.00	0.016	1082.90	1091.67	3.33	3.26	0.000687	6.46	148.50	17.08	0.39
100% Design	20051	959.00	0.016	1082.95	1092.32	3.14	3.70	0.000043	1.89	507.42	90.56	0.14
100% Design	20200	959.00	0.030	1083.04	1092.36	0.94	1.44	0.000067	1.33	718.86	118.57	0.10
100% Design	20400	830.00	0.030	1083.18	1092.39	1.01	1.94	0.000059	1.24	673.68	136.69	0.09
100% Design	20600	830.00	0.030	1083.30	1092.40	0.73	2.11	0.000060	1.22	679.36	117.52	0.09
100% Design	20800	830.00	0.030	1083.45	1092.42	0.94	0.98	0.000058	1.21	686.11	117.52	0.09
100% Design	21000	830.00	0.030	1083.59	1092.43	1.17	0.70	0.000060	1.25	665.75	111.70	0.09
100% Design	21200	830.00	0.030	1083.73	1092.45	0.34	0.39	0.000065	1.29	643.83	108.93	0.09
100% Design	21400	700.00	0.030	1083.90	1092.47	0.74	0.95	0.000008	0.48	1472.67	223.50	0.03
100% Design	21600	700.00	0.030	1084.02	1092.48	0.91	0.92	0.000011	0.59	1190.34	176.78	0.04
100% Design	21800	700.00	0.030	1084.18	1092.48	0.85	1.04	0.000053	1.14	616.28	107.65	0.08
100% Design	22000	700.00	0.030	1084.34	1092.48	1.41	1.60	0.000072	1.29	542.98	99.24	0.10
100% Design	22200	700.00	0.030	1084.50	1092.50	1.30	1.76	0.000063	1.22	574.40	103.78	0.09
100% Design	22400	700.00	0.030	1084.66	1092.51	0.49	0.76	0.000061	1.19	586.05	106.09	0.09
100% Design	22600	700.00	0.030	1084.80	1092.52	0.38	0.34	0.000060	1.18	593.68	107.81	0.09
100% Design	22800	700.00	0.030	1085.00	1092.54	0.97	1.36	0.000016	0.67	1048.62	170.32	0.05
100% Design	23000	700.00	0.030	1085.17	1092.55	0.98	1.30	0.000006	0.43	1618.74	250.43	0.03
100% Design	23200	700.00	0.030	1085.30	1092.55	0.94	0.88	0.000053	1.06	659.84	128.73	0.08
100% Design	23400	700.00	0.030	1085.50	1092.55	0.54	0.56	0.000078	1.29	541.87	105.08	0.10
100% Design	23600	700.00	0.030	1085.68	1092.56	0.99	1.25	0.000088	1.35	517.81	102.71	0.11
100% Design	23800	700.00	0.030	1085.85	1092.57	1.03	1.11	0.000098	1.41	497.98	101.23	0.11
100% Design	24000	700.00	0.030	1086.00	1092.59	1.15	1.21	0.000098	1.40	501.61	102.54	0.11
100% Design	24200	700.00	0.030	1086.20	1092.60	1.41	1.66	0.000113	1.48	474.48	99.81	0.12
100% Design	24400	700.00	0.030	1086.35	1092.62	1.49	1.90	0.000122	1.51	463.00	98.94	0.12
100% Design	24600	700.00	0.030	1086.51	1092.64	1.86	2.00	0.000137	1.58	442.54	96.77	0.13
100% Design	24800	700.00	0.030	1086.68	1092.66	1.72	1.58	0.000147	1.62	433.34	96.53	0.13
100% Design	24900	345.00	0.030	1086.74	1092.70	3.10	3.30	0.000041	0.84	408.58	92.31	0.07
100% Design	24960	345.00	0.013	1086.88	1091.92	4.07	4.27	0.001903	8.53	40.45	8.04	0.67
100% Design	27479	Culvert										
100% Design	27480	345.00	0.013	1088.90	1095.66	1.14	1.28	0.000873	6.30	54.78	8.21	0.43
100% Design	27610	345.00	0.030	1086.00	1096.34	0.23	-0.02	0.000002	0.23	1491.14	214.59	0.02
100% Design	27810	345.00	0.030	1086.00	1096.34	0.05	0.66	0.000000	0.12	2834.20	366.28	0.01
100% Design	28010	345.00	0.030	1086.00	1096.34	0.11	0.06	0.000001	0.18	1898.20	254.94	0.01
100% Design	28210	345.00	0.030	1086.38	1096.34	0.33	0.13	0.000001	0.19	1851.12	254.19	0.01
100% Design	28410	345.00	0.030	1087.00	1096.34	0.06	0.83	0.000001	0.20	1750.66	256.52	0.01
100% Design	28590	345.00	0.030	1087.00	1096.34	0.62	0.66	0.000002	0.22	1585.54	231.88	0.01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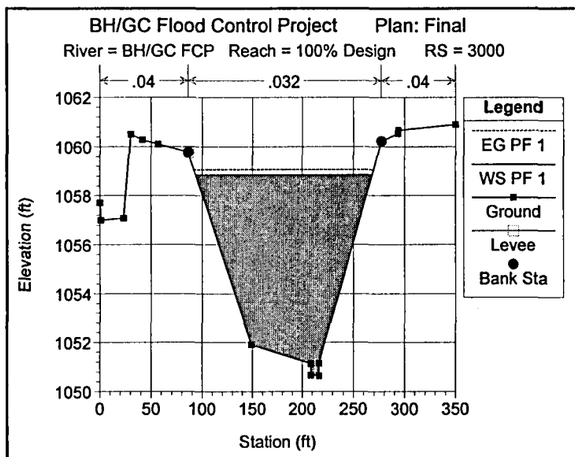
River = BH/GC FCP Reach = 100% Design RS = 1405 Begin Model Sta 14+04.5 = 139+50 BRW
River = BH/GC FCP Reach = 100% Design RS = 1516
River = BH/GC FCP Reach = 100% Design RS = 1588 SRP FLUME @ 97th Ave.
River = BH/GC FCP Reach = 100% Design RS = 1588 SRP FLUME @ 97th Ave.
River = BH/GC FCP Reach = 100% Design RS = 1603 Extended Reach Length by 30' for SRP Flume
River = BH/GC FCP Reach = 100% Design RS = 1741 Extended by 30' for SRP Flume
River = BH/GC FCP Reach = 100% Design RS = 1800
River = BH/GC FCP Reach = 100% Design RS = 2000
River = BH/GC FCP Reach = 100% Design RS = 2200
River = BH/GC FCP Reach = 100% Design RS = 2400
River = BH/GC FCP Reach = 100% Design RS = 2600
River = BH/GC FCP Reach = 100% Design RS = 2800
.04
.016
.03
.032
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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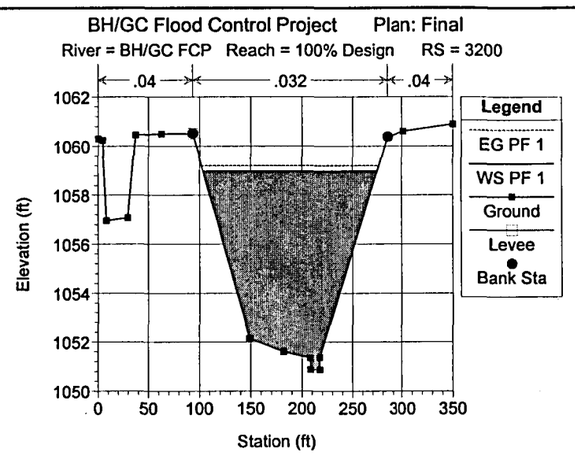
River = BH/GC FCP Reach = 100% Design RS = 3000
.04 .032 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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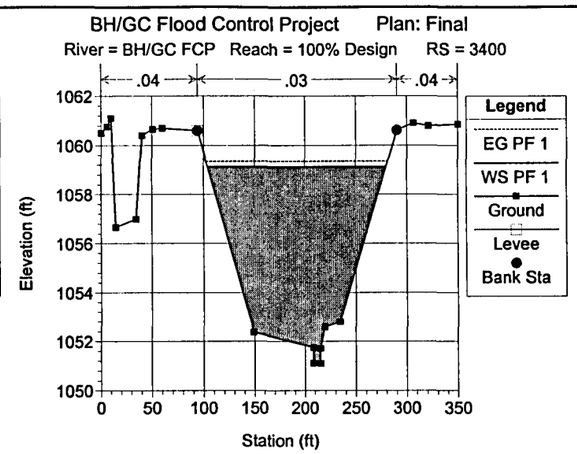
River = BH/GC FCP Reach = 100% Design RS = 3200
.04 .032 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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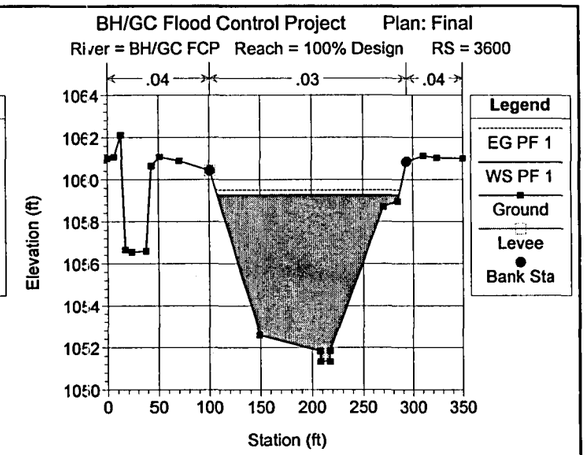
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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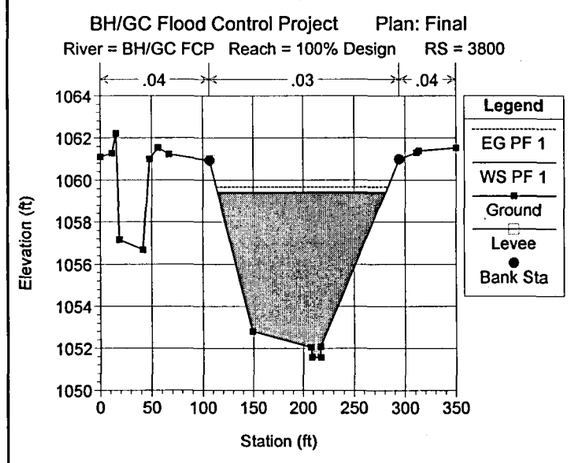
River = BH/GC FCP Reach = 100% Design RS = 3600
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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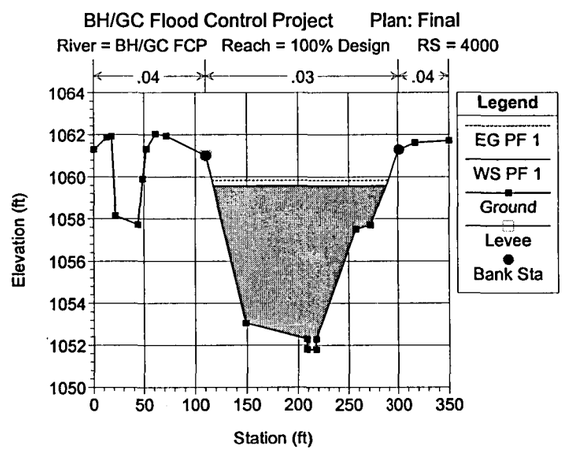
River = BH/GC FCP Reach = 100% Design RS = 3800
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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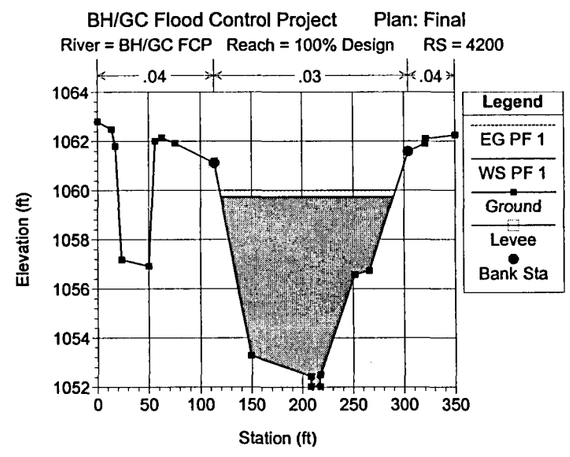
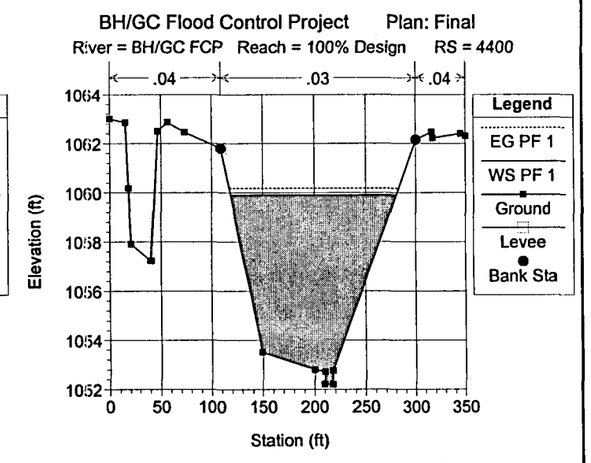
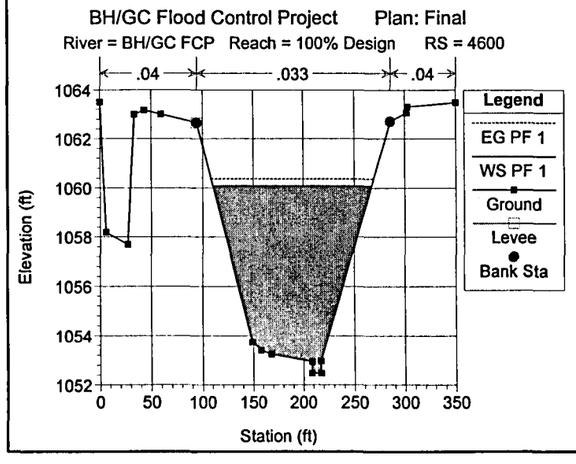
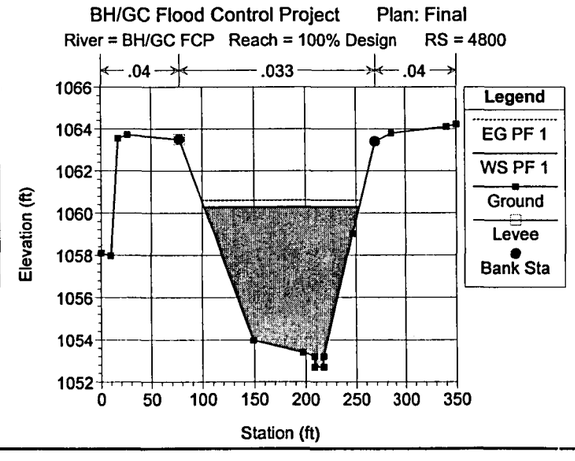
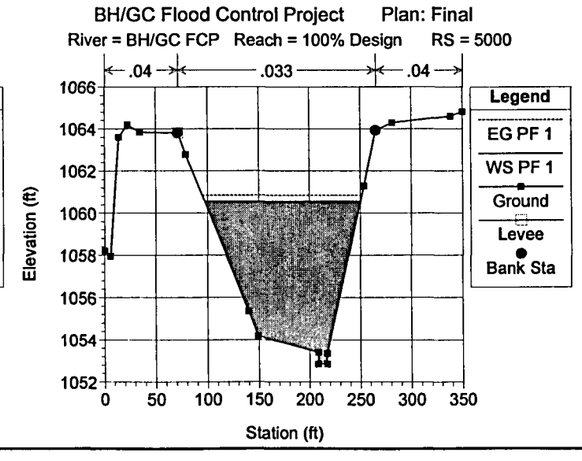
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

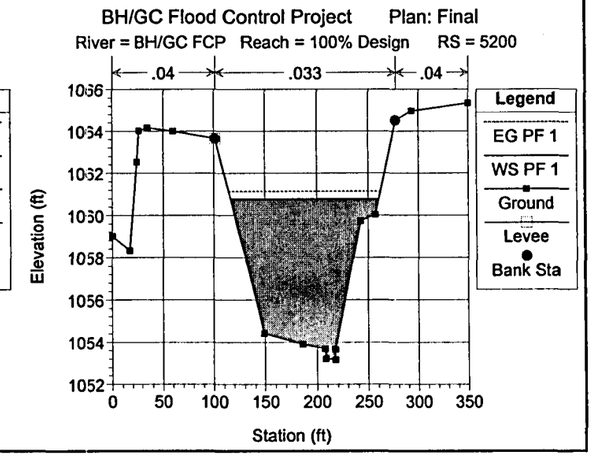

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 4200
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

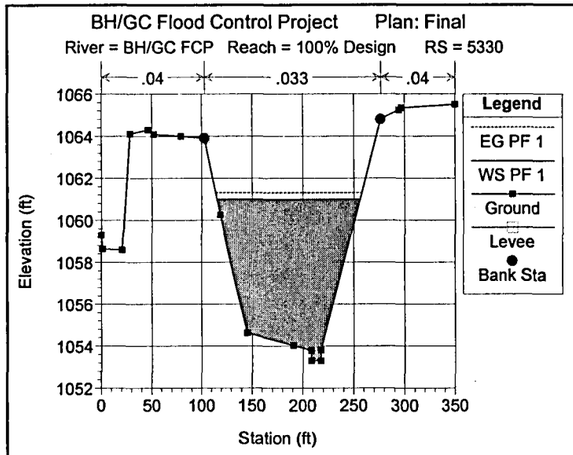

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 4400
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 4600
.04 .033 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 4800
.04 .033 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5000
.04 .033 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5200
.04 .033 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5330
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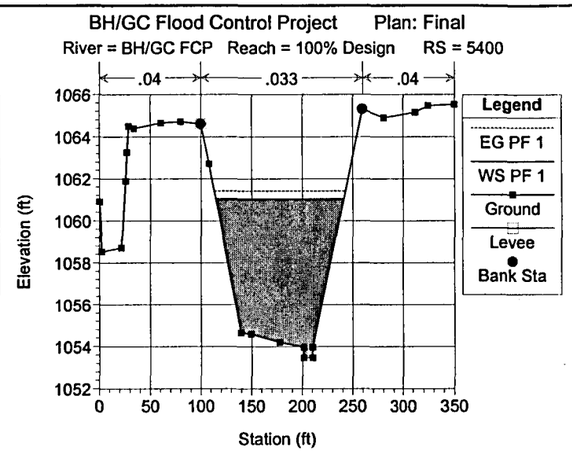
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5400
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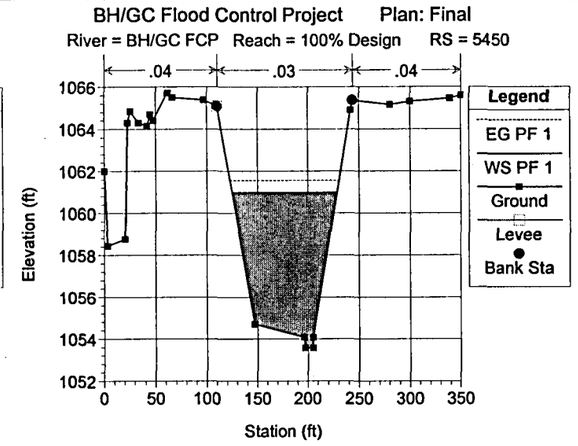
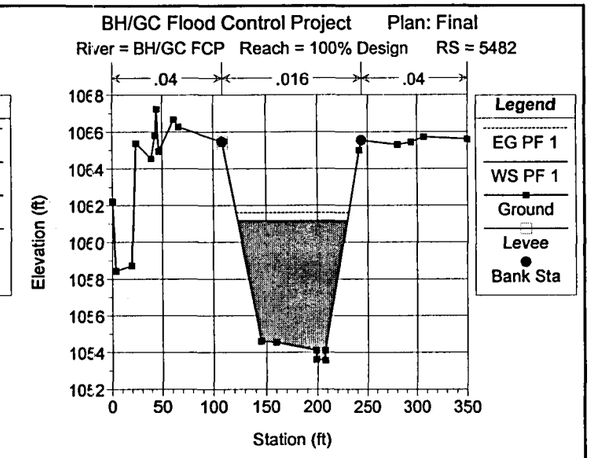
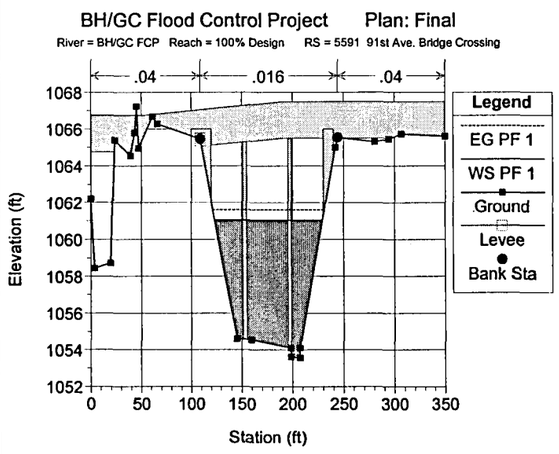
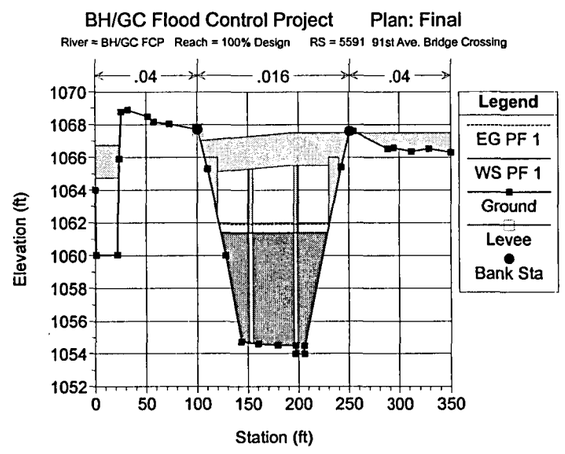
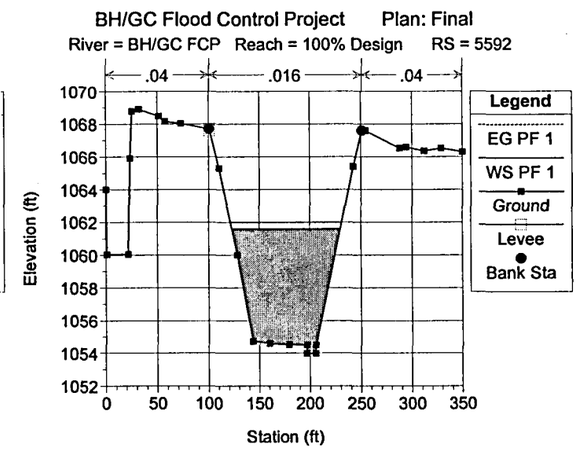
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

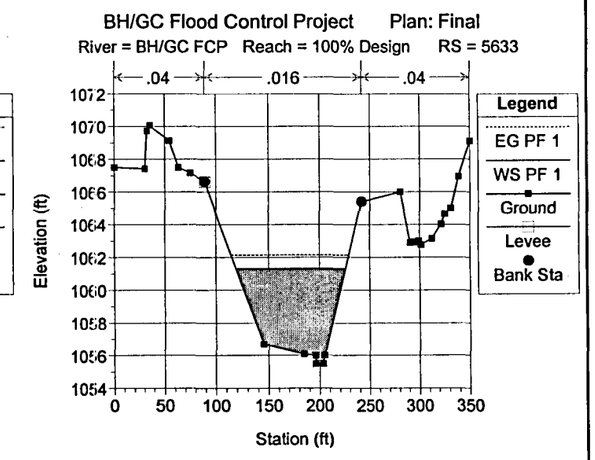

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5450
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

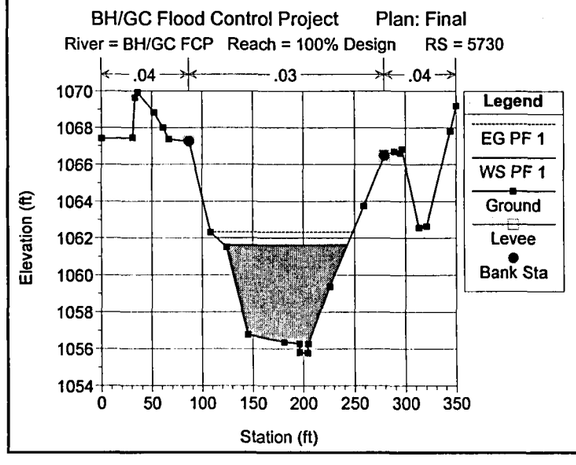

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5482
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

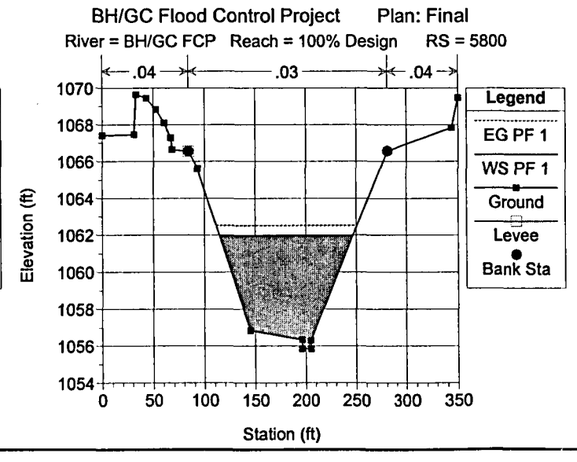

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5591 91st Ave. Bridge Crossing
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

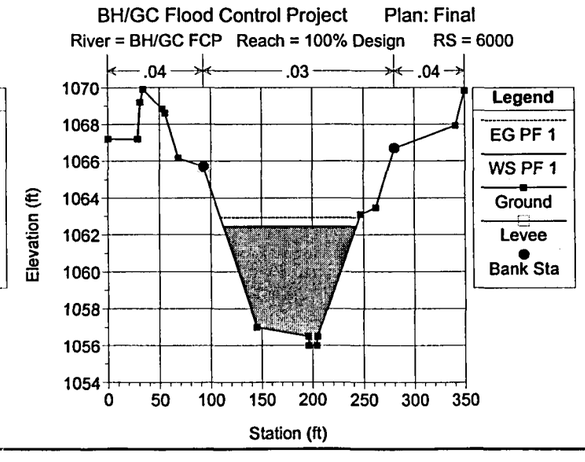

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5591 91st Ave. Bridge Crossing
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

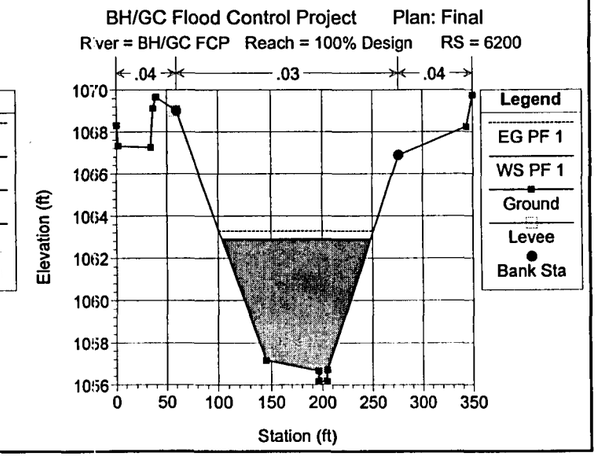

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5592
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

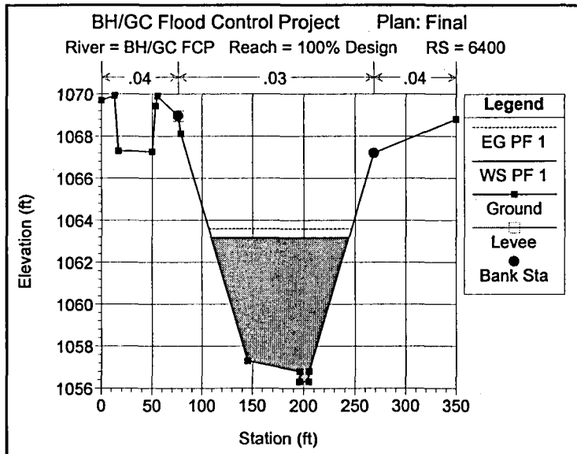

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5633
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

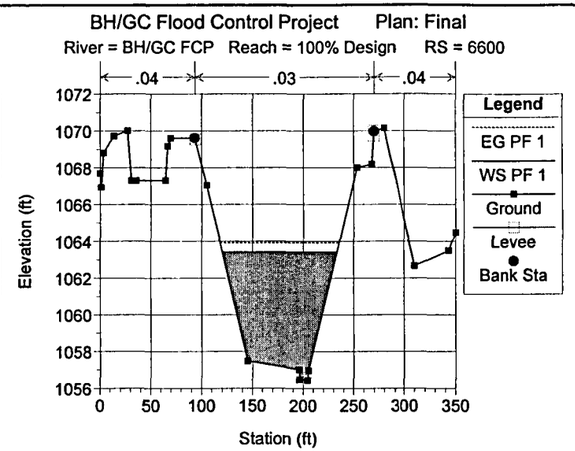

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5730
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

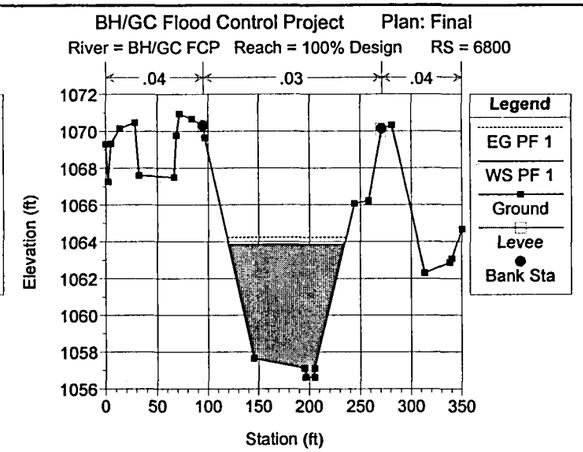

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 5800
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

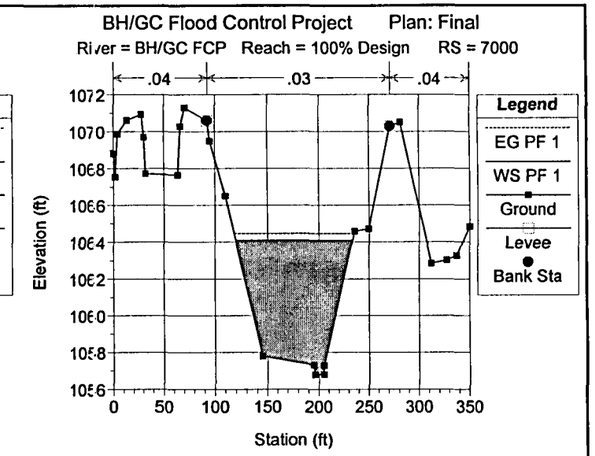

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 6000
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

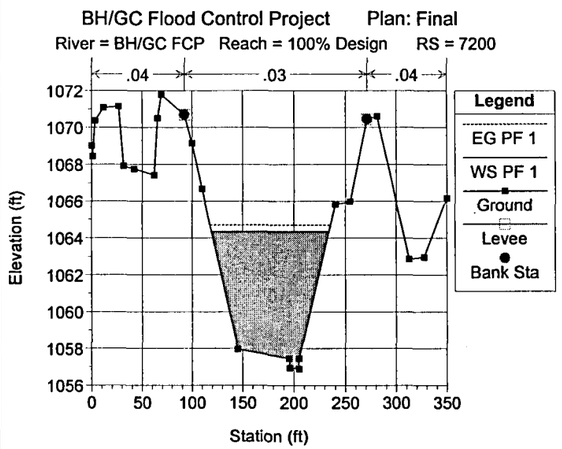

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 6200
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

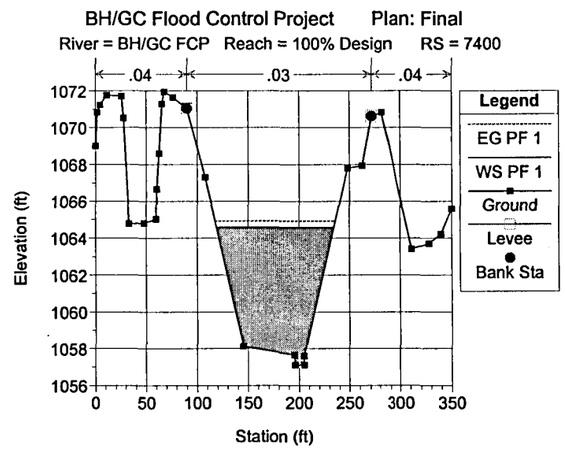

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 6400
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

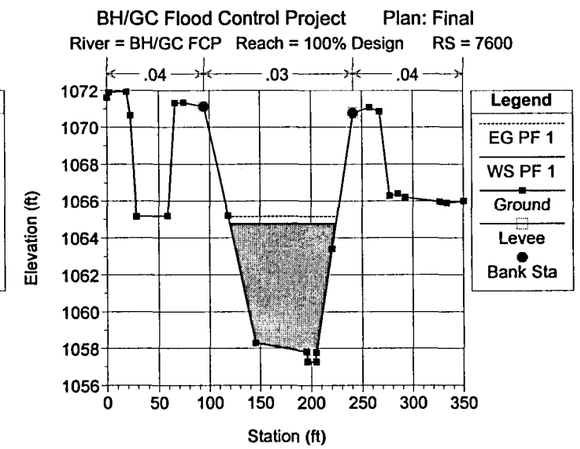

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 6600
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

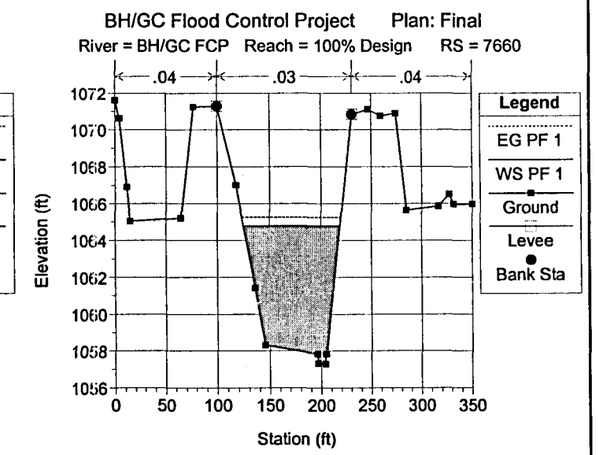

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 6800
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

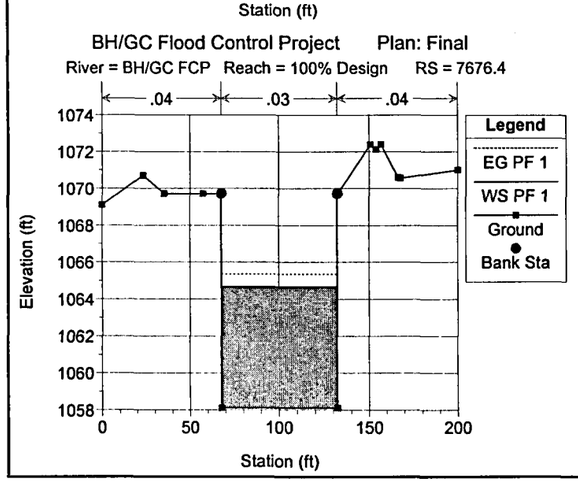

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7000
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

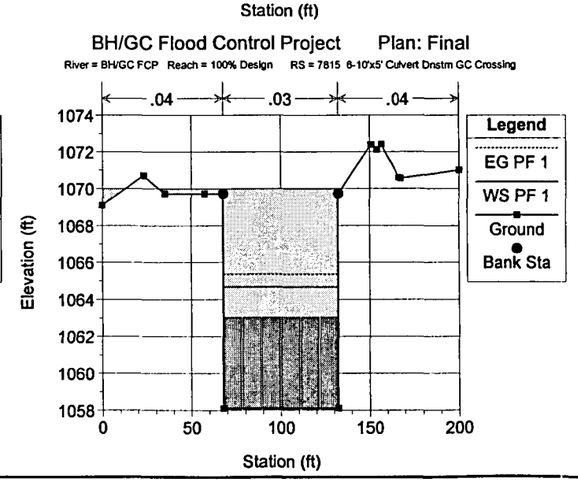

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7200
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

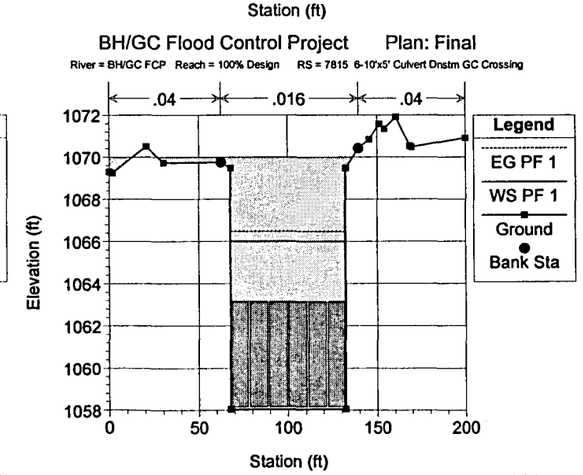

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7400
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

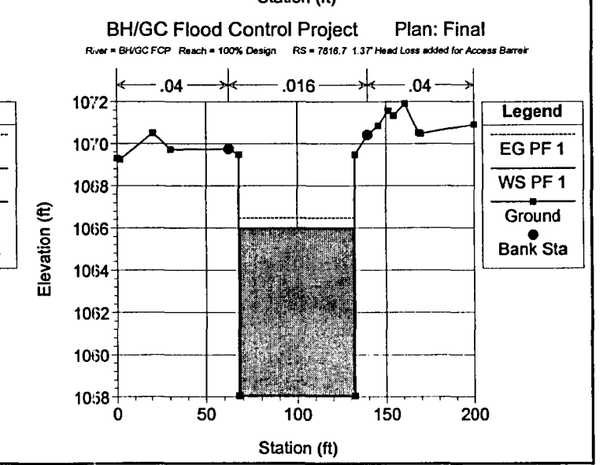

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7600
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

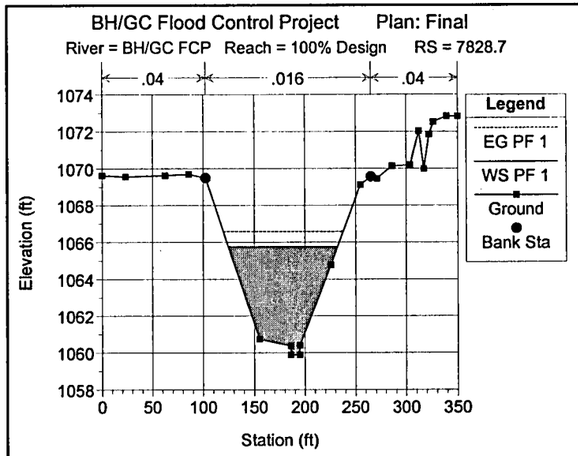

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7660
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta

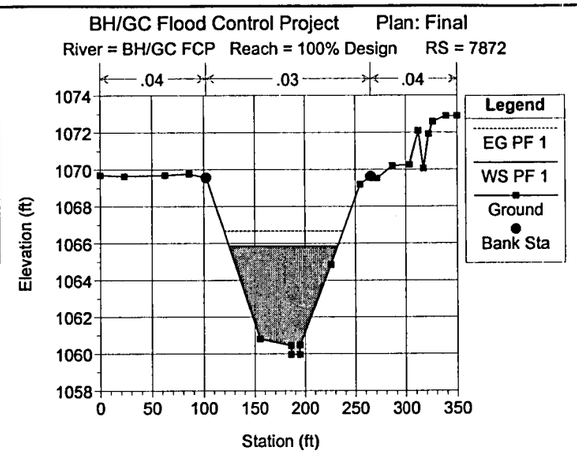

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7676.4
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

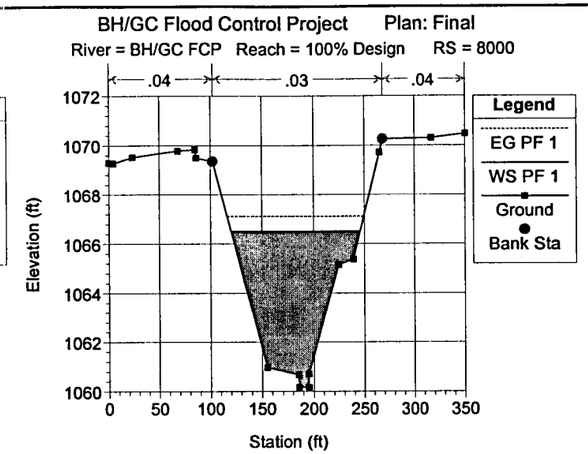

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7815 6-10'x5' Culvert Dnstm GC Crossing
.04 .03 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

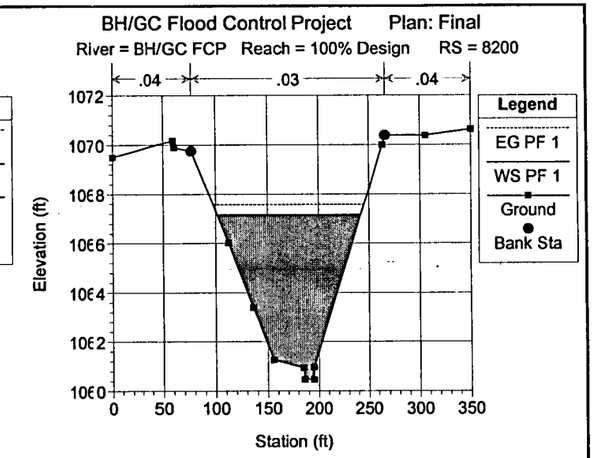

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7815 6-10'x5' Culvert Dnstm GC Crossing
.04 .016 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

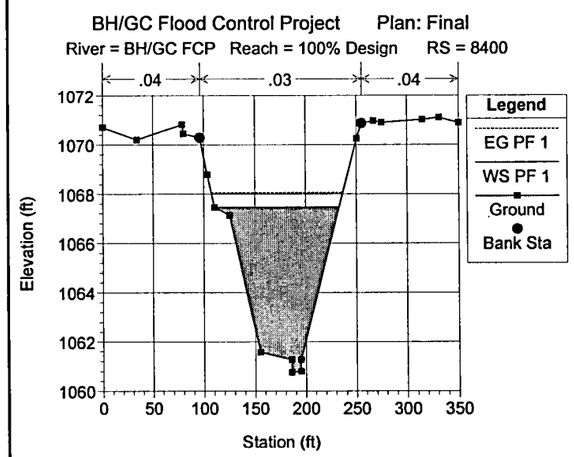

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7816.7 1.37' Head Loss added for Access Barrier
.04 .016 .04
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

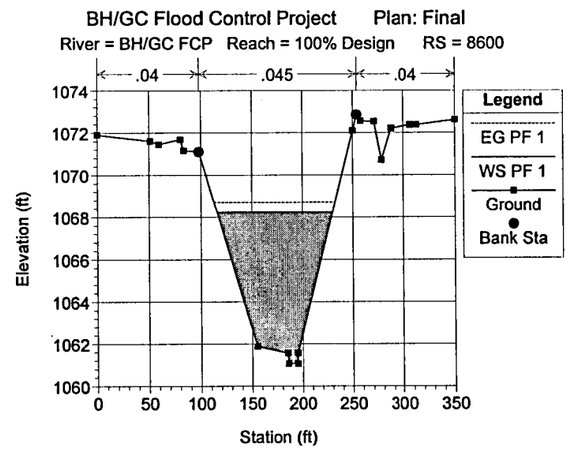

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7828.7
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

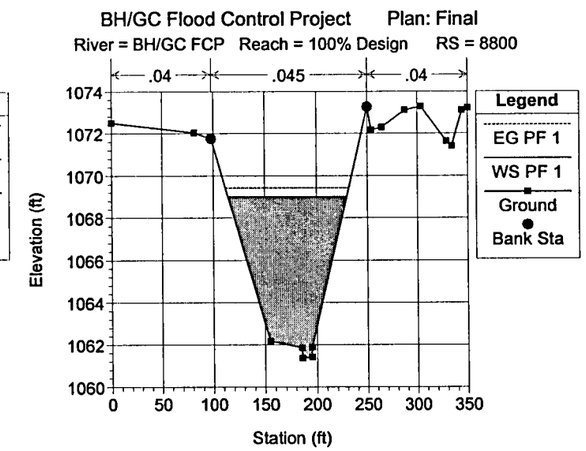

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 7872
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

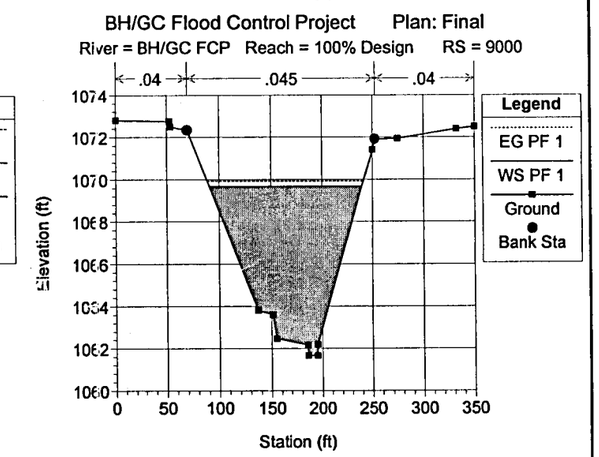

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 8000
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

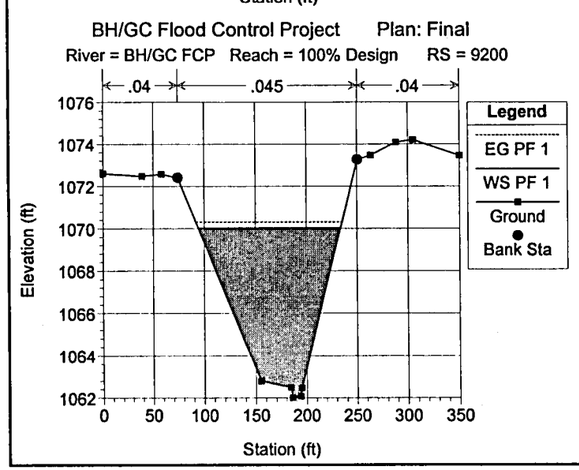

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 8200
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

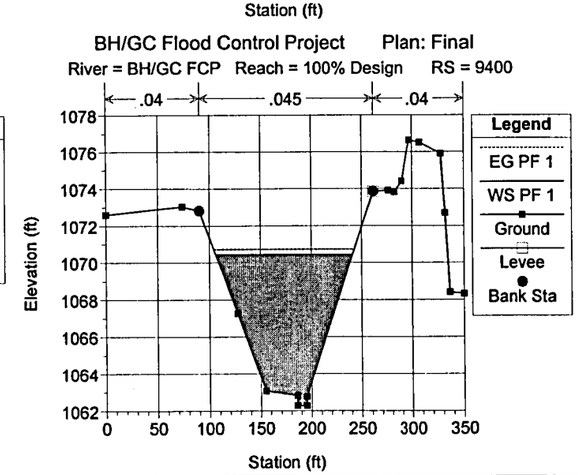

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 8400
.04 .03 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

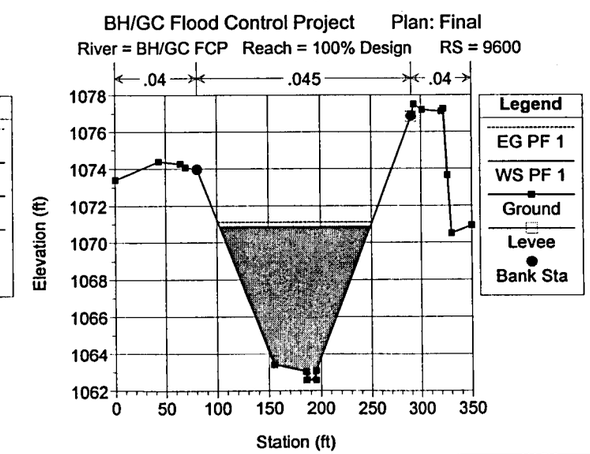

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 8600
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

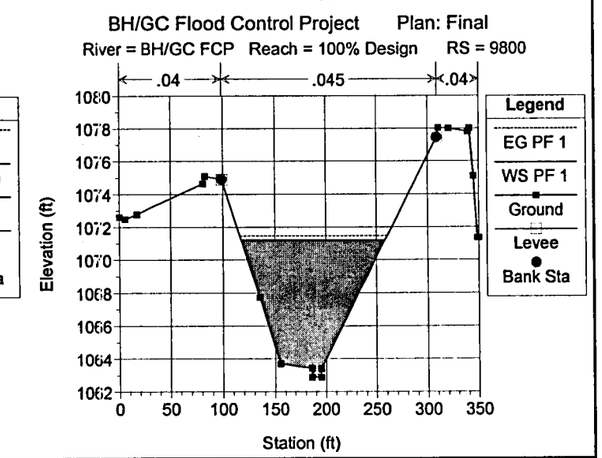

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 8800
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

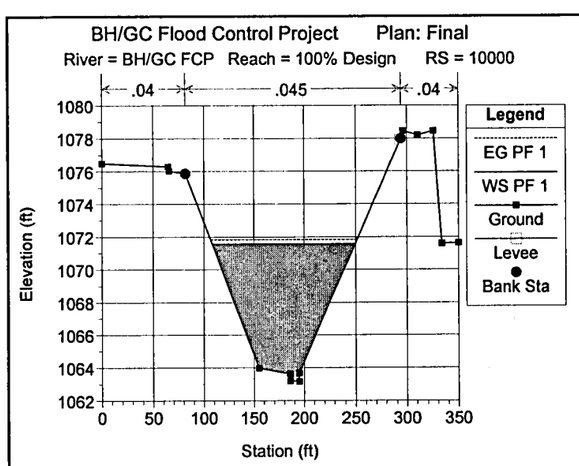

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 9000
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

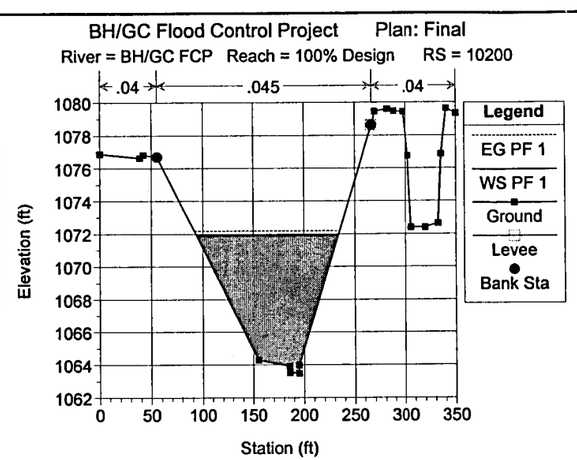

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 9200
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

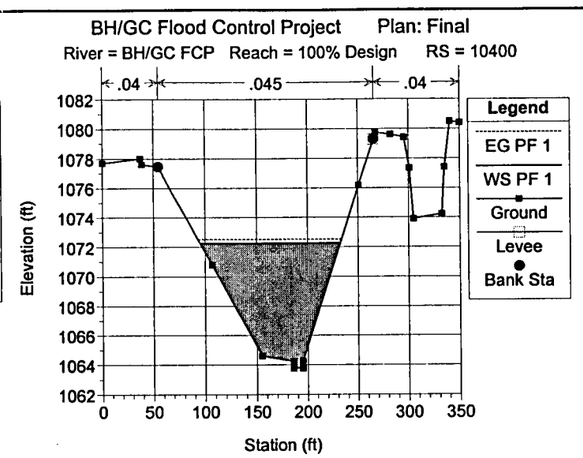

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 9400
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

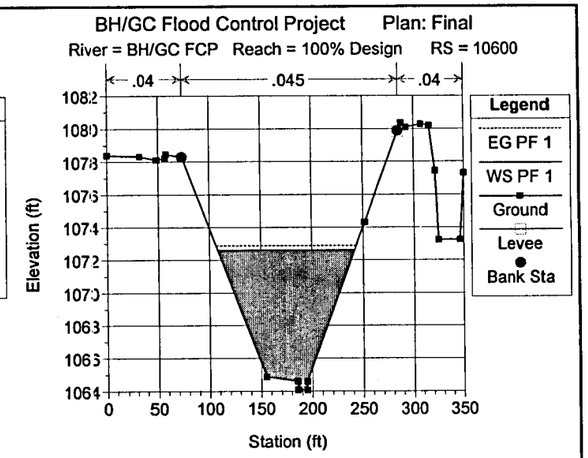

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 9600
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

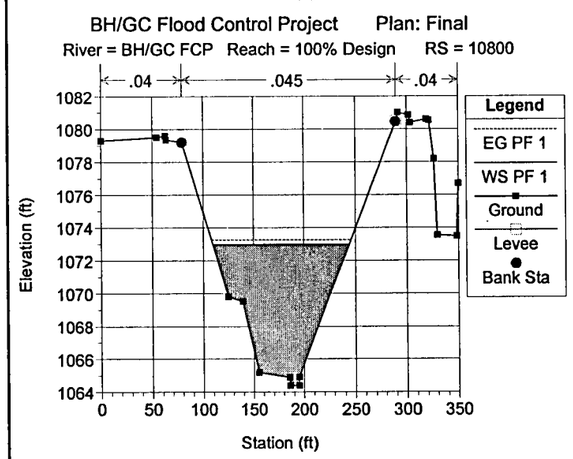

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 9800
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

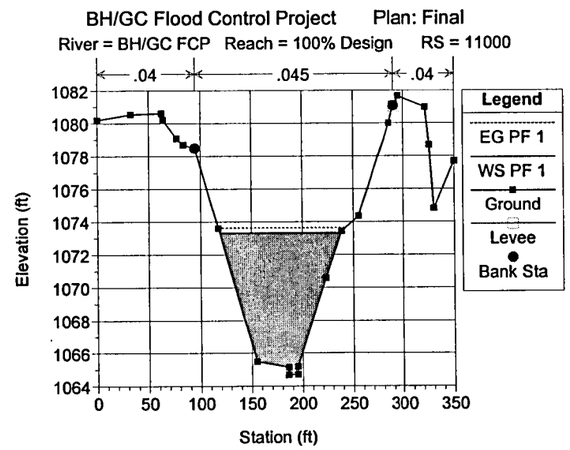

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 10000
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

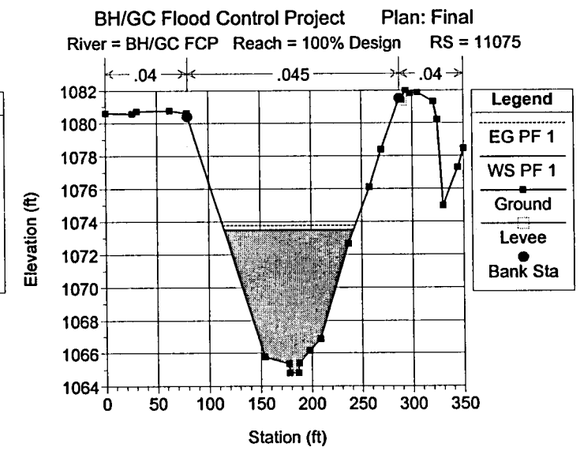

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 10200
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

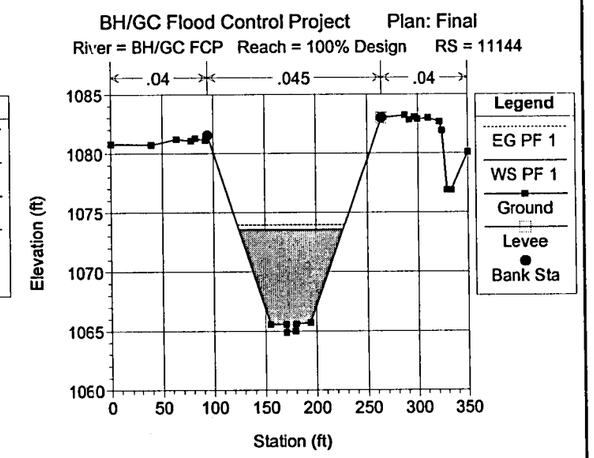

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 10400
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

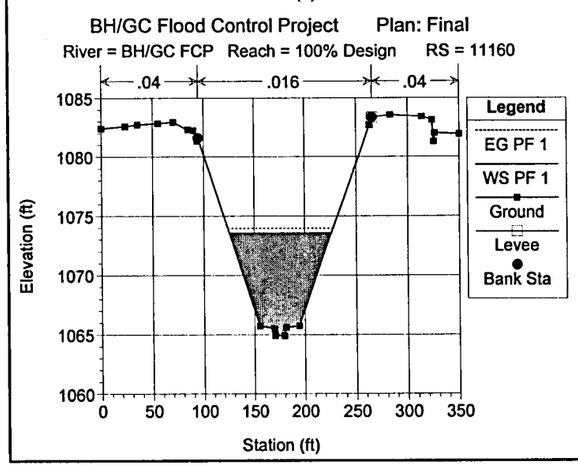

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 10600
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

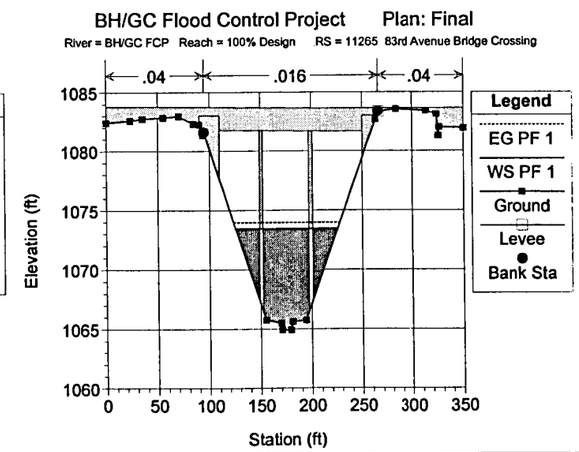

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 10800
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

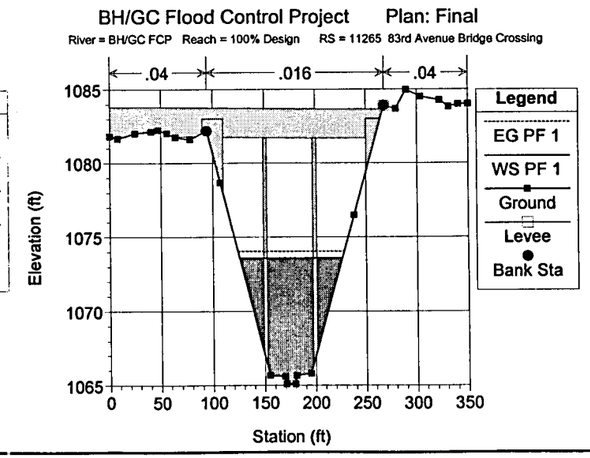

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11000
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

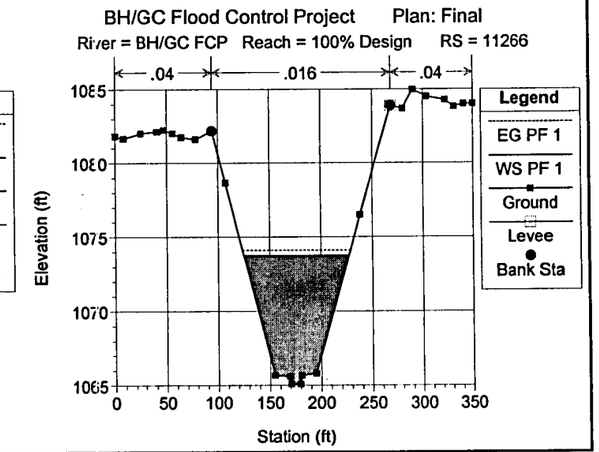

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11075
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

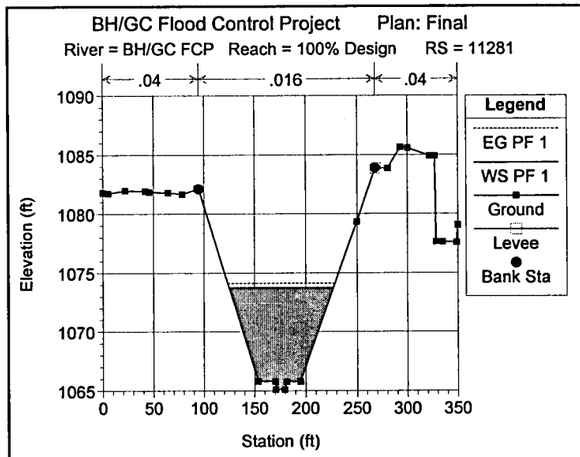

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11144
.04 .045 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

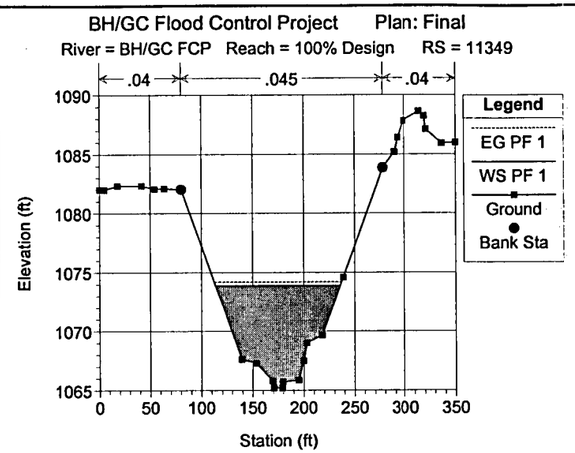

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11160
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

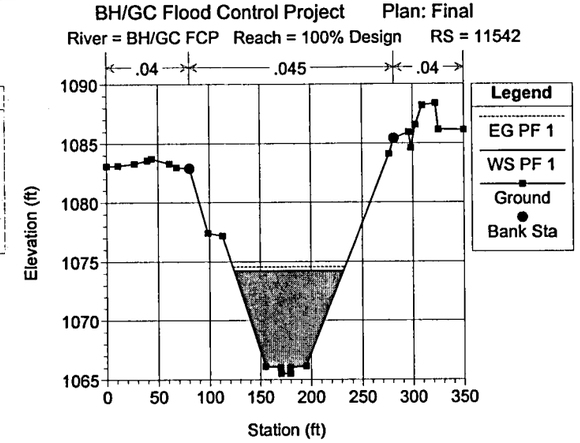

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11265 83rd Avenue Bridge Crossing
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

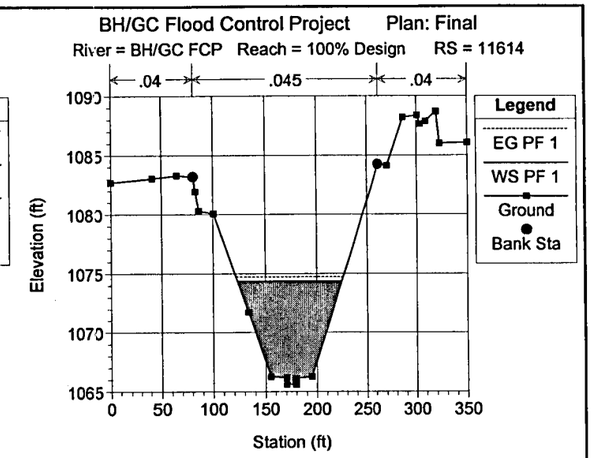

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11265 83rd Avenue Bridge Crossing
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11266
.04 .016 .04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11281
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11349
.04
.045
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11542
.04
.045
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11614
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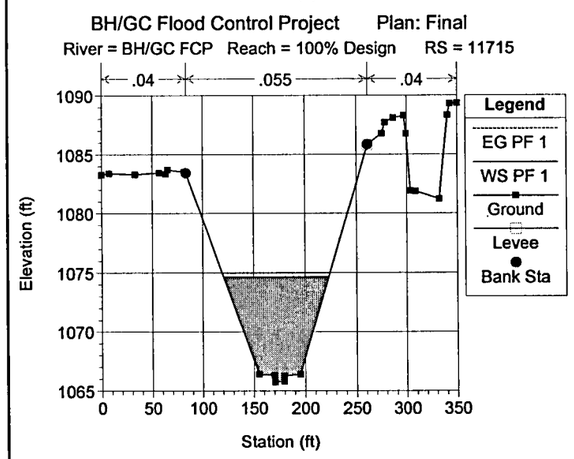
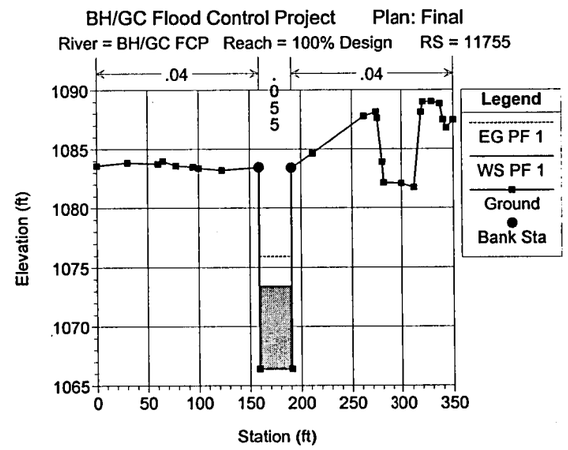
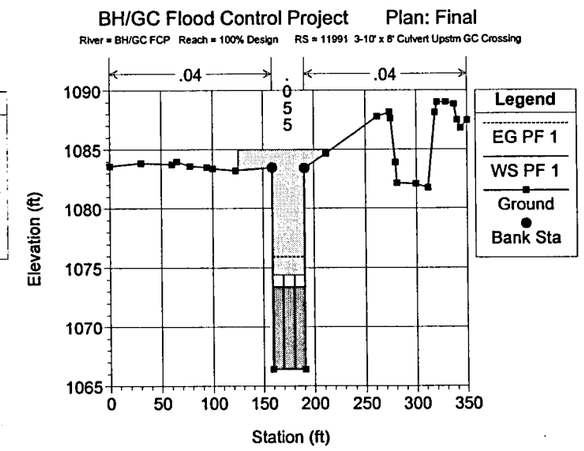
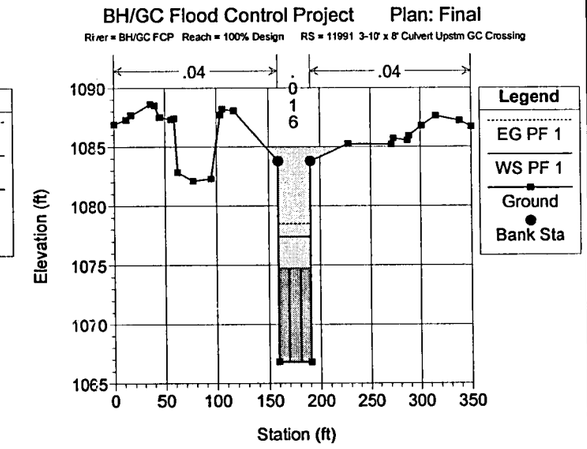
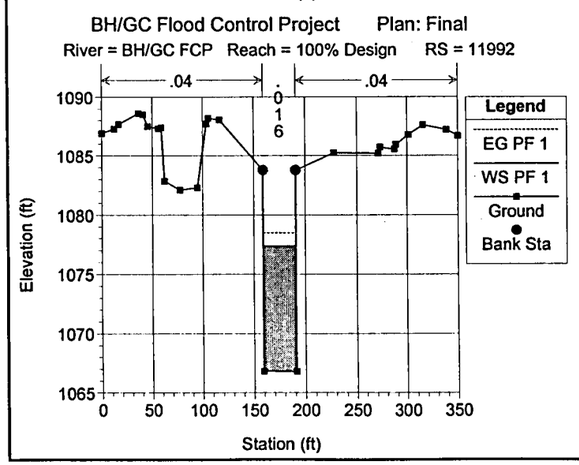
.045
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

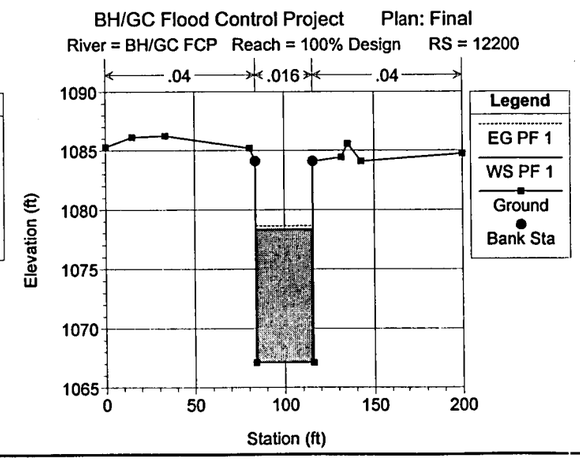

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11715
.04
.055
.04
Legend
EG PF 1
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

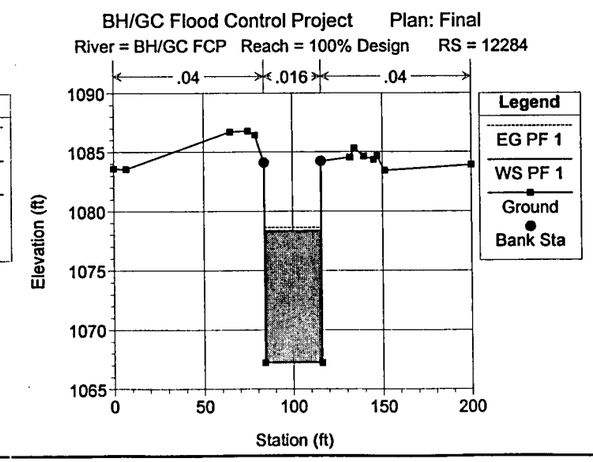

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11755
.04
.055
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

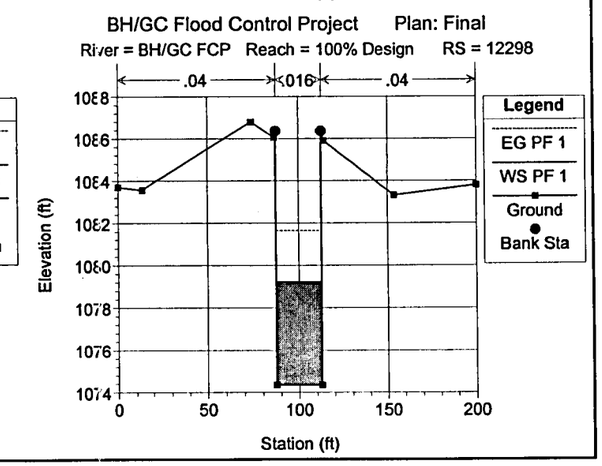

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11991 3-10' x 8' Culvert Upstm GC Crossing
.04
.055
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

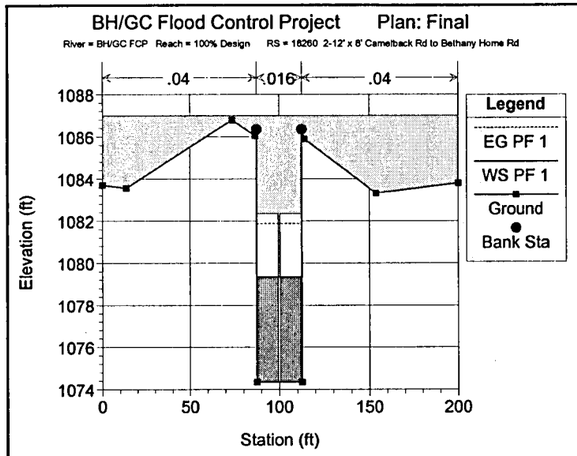

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11991 3-10' x 8' Culvert Upstm GC Crossing
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

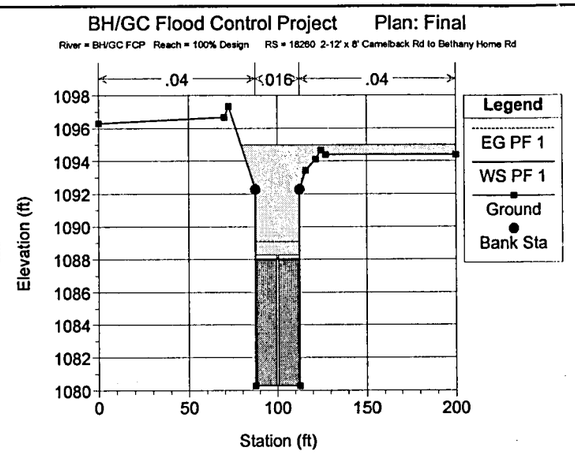

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 11992
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

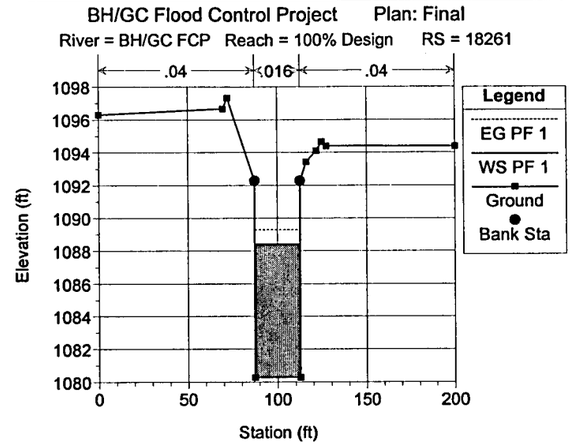

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 12200
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

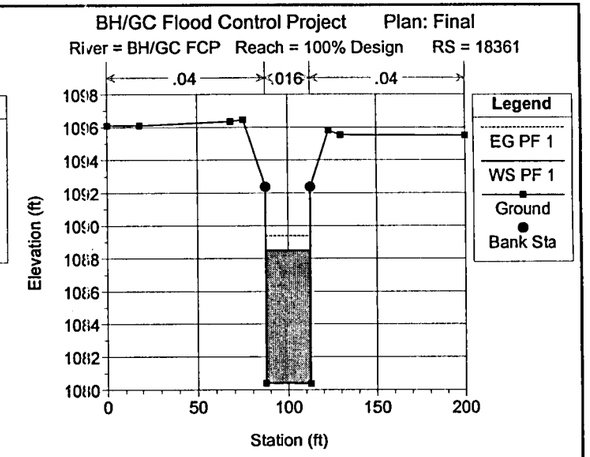

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 12284
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

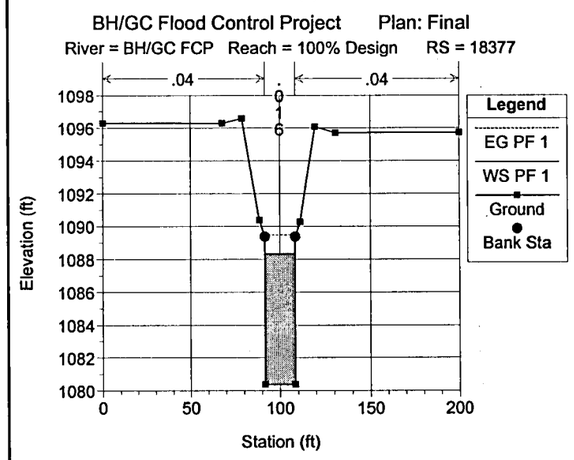

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 12298
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

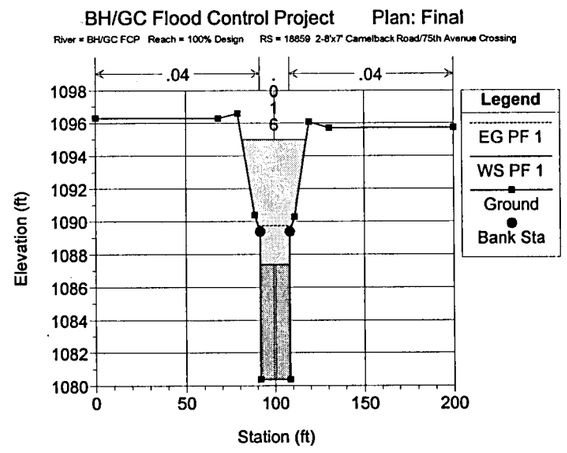

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18260 2-12' x 6' Camelback Rd to Bethany Home Rd
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

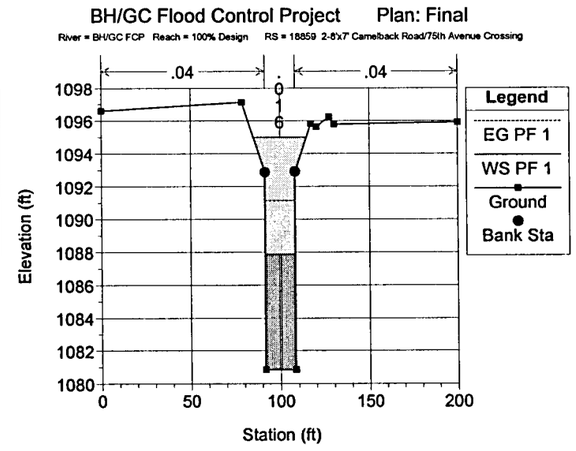

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18260 2-12' x 6' Camelback Rd to Bethany Home Rd
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

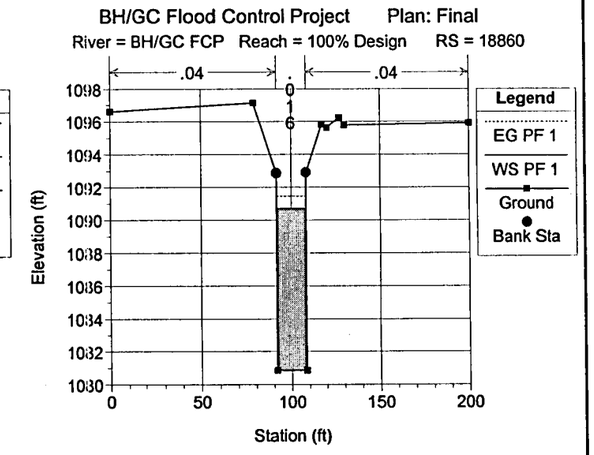

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18261
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

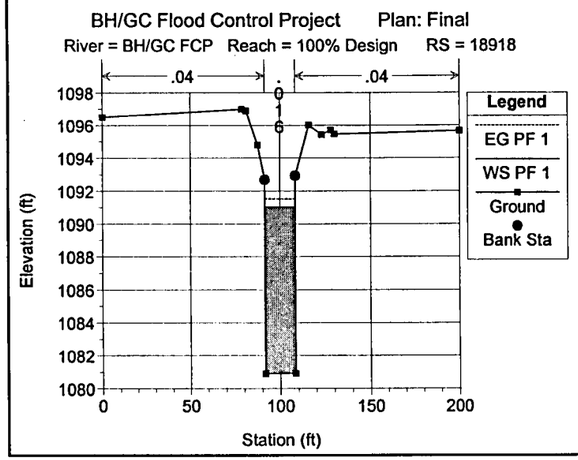

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18361
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

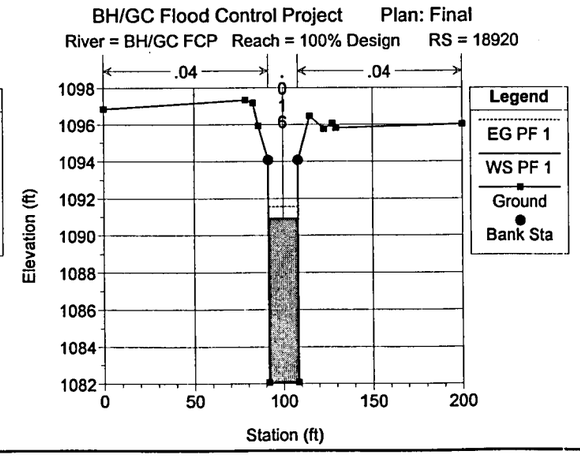

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18377
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

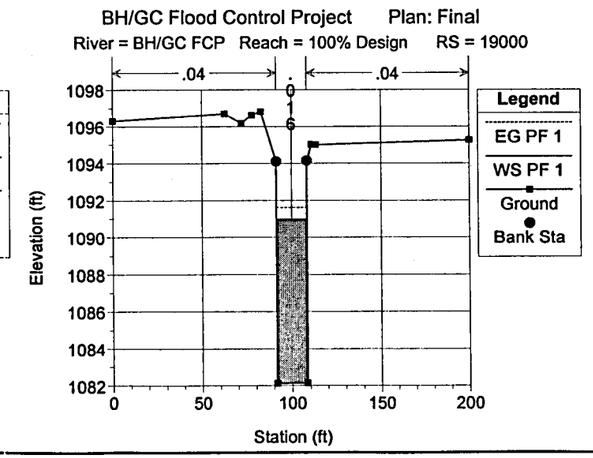

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18859 2-8'x7' Camelback Road/75th Avenue Crossing
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

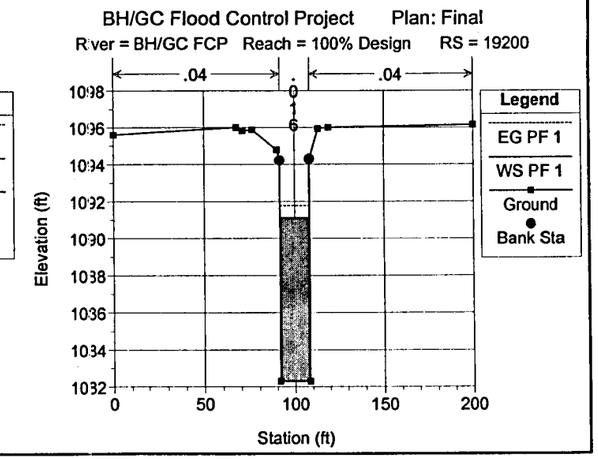

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18859 2-8'x7' Camelback Road/75th Avenue Crossing
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

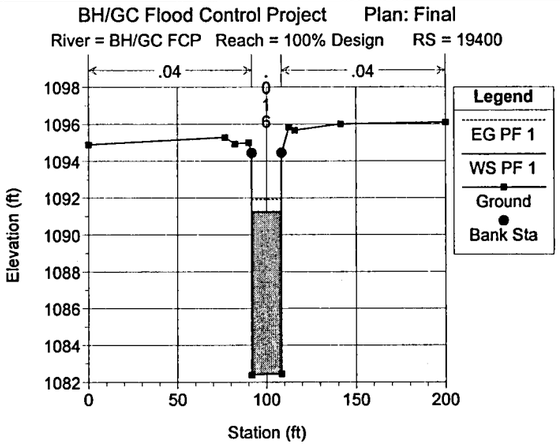

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18860
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

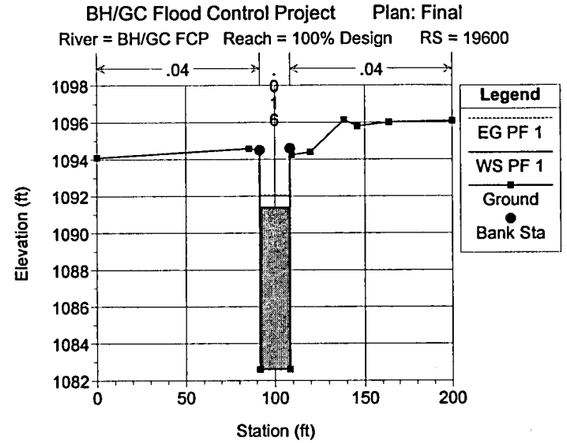

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18918
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

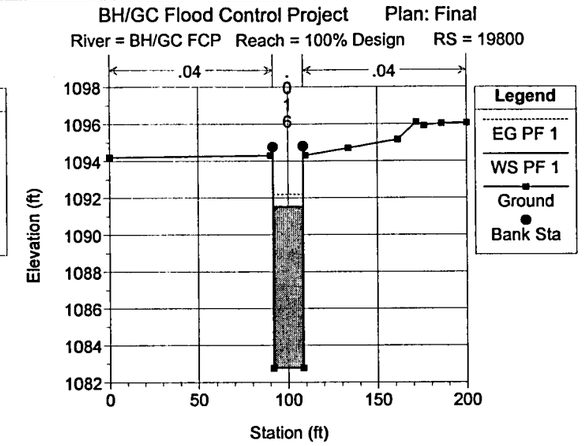

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 18920
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

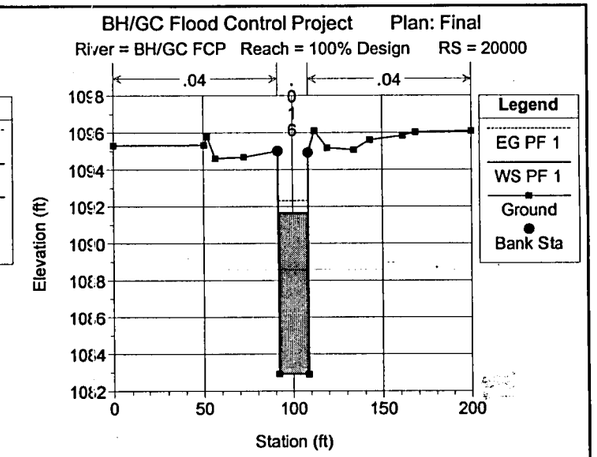

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 19000
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

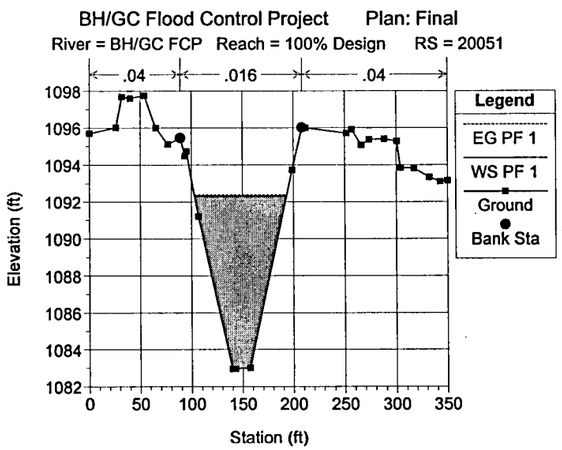

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 19200
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

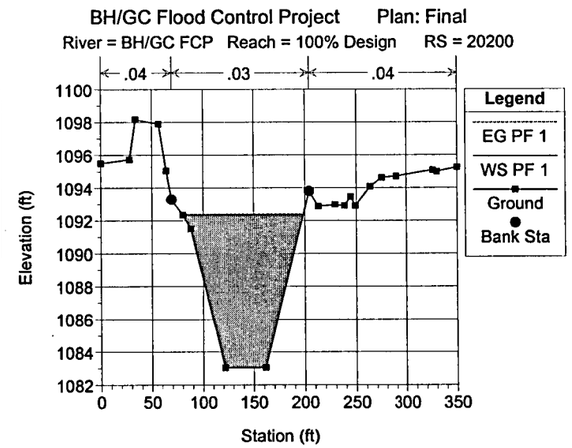

BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 19400
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 19600
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 19800
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 20000
.04
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


BH/GC Flood Control Project Plan: Final
River = BH/GC FCP Reach = 100% Design RS = 20051
.04
.016
.04
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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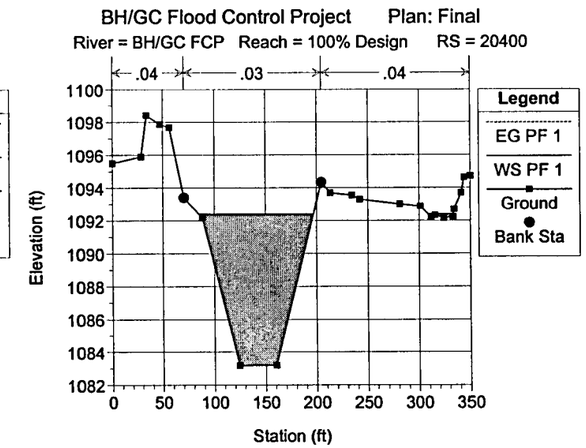
Bank Sta
Elevation (ft)
Station (ft)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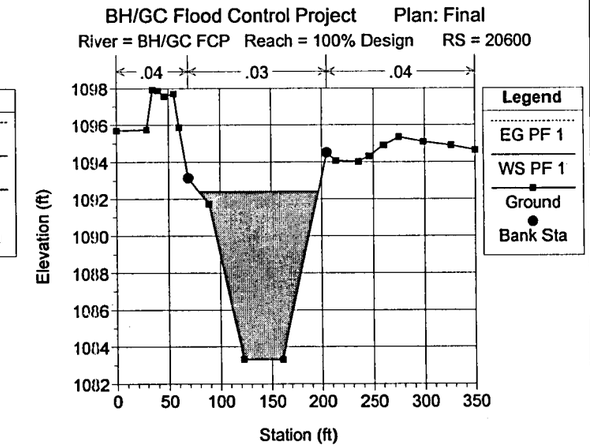
Bank Sta
Elevation (ft)
Station (ft)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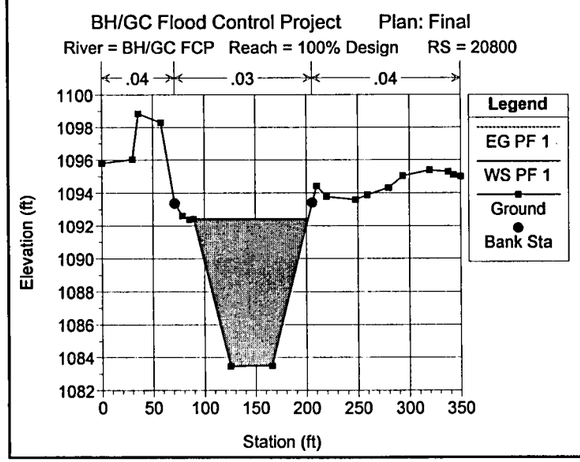
Bank Sta
Elevation (ft)
Station (ft)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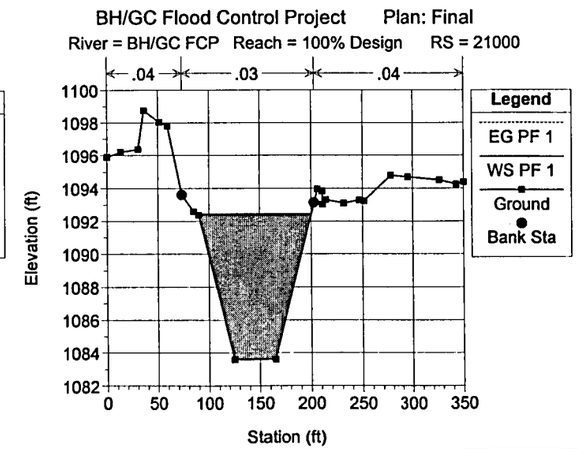
Station (ft)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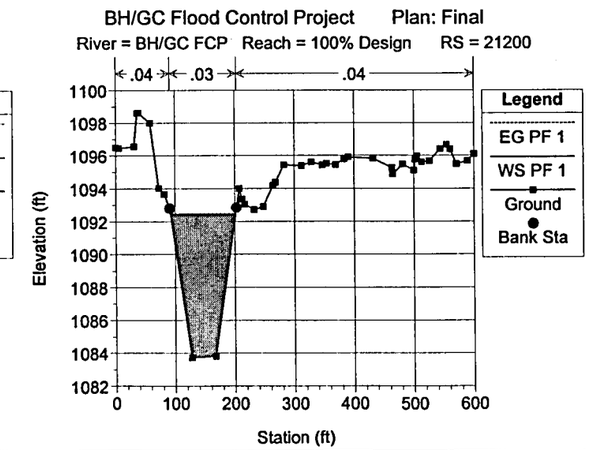
Bank Sta
Elevation (ft)
Station (ft)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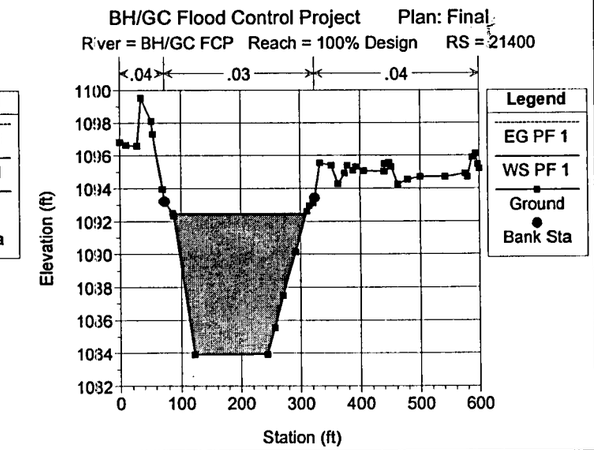
Bank Sta
Elevation (ft)
Station (ft)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Bank Sta
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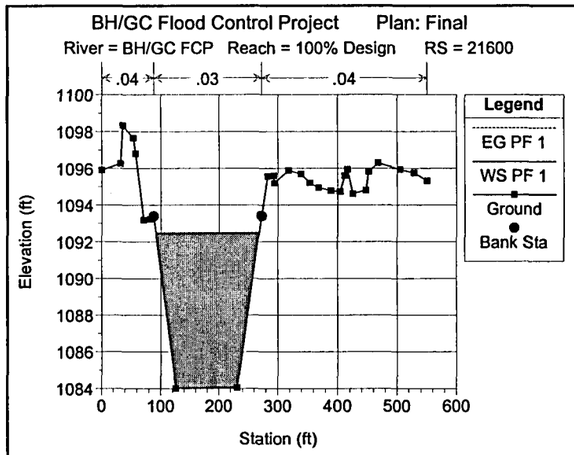
Station (ft)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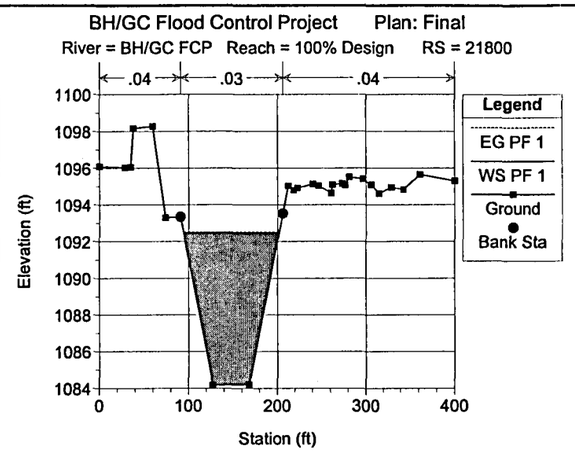
Elevation (ft)
Station (ft)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Legend
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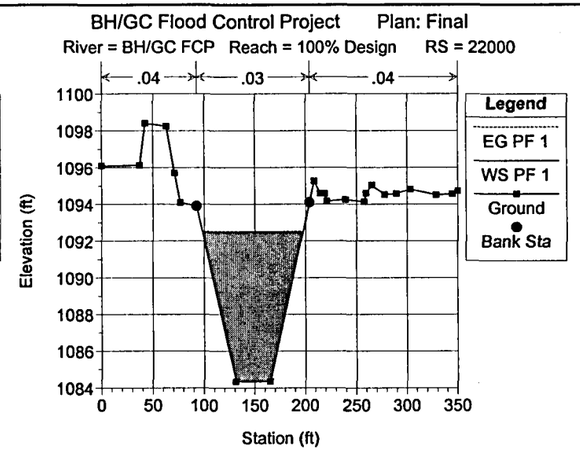
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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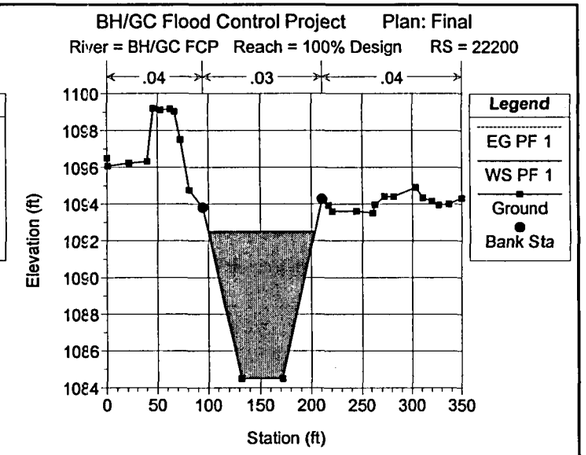
Elevation (ft)
Station (ft)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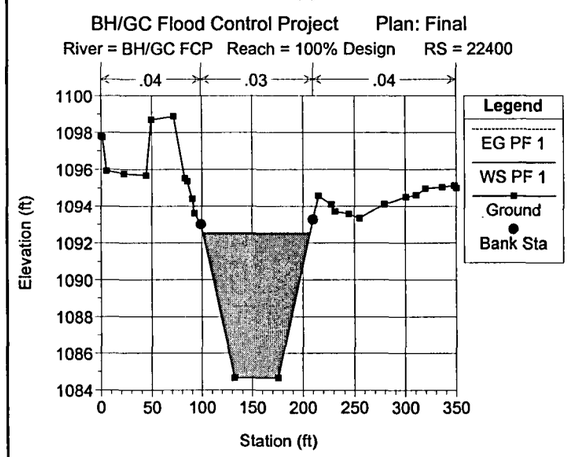
Elevation (ft)
Station (ft)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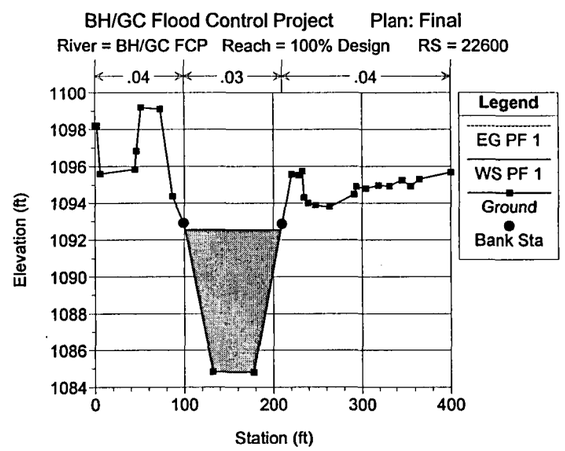
Bank Sta
Elevation (ft)
Station (ft)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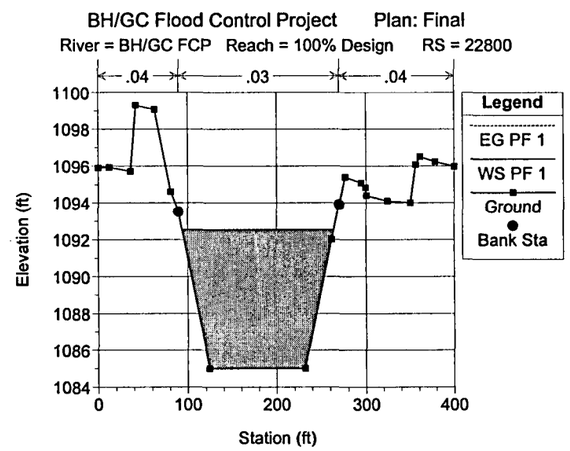
Station (ft)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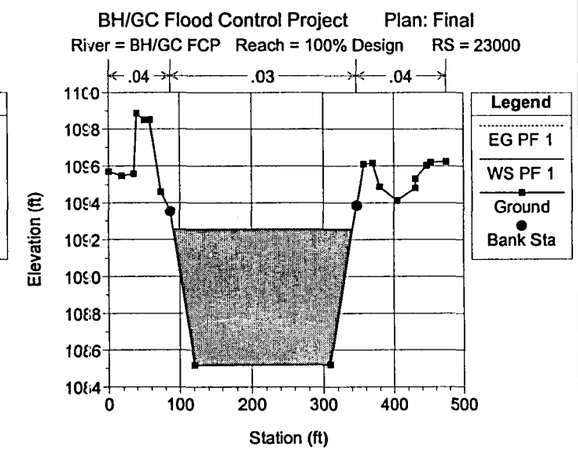
Station (ft)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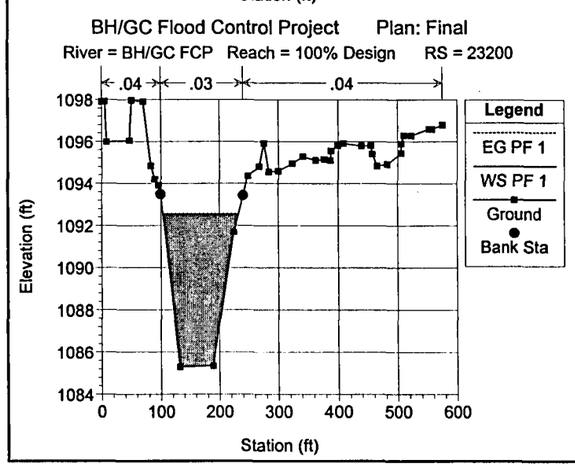
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Bank Sta
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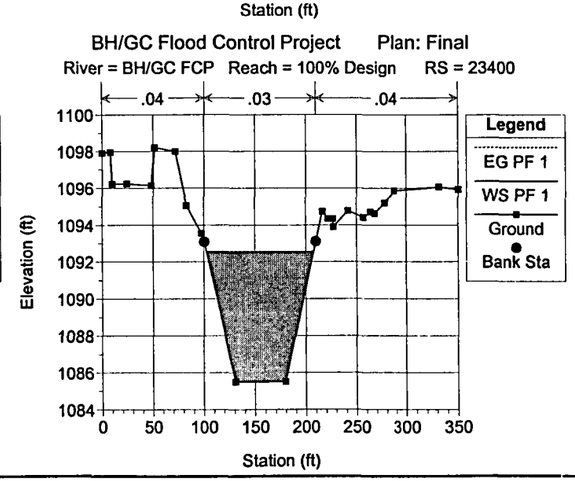
Station (ft)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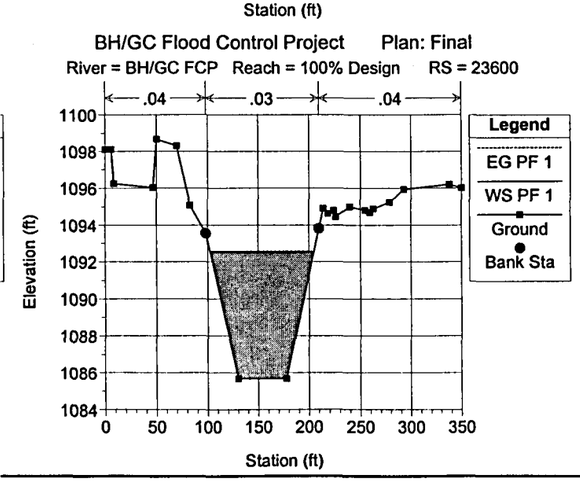
Bank Sta
Elevation (ft)
Station (ft)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Legend
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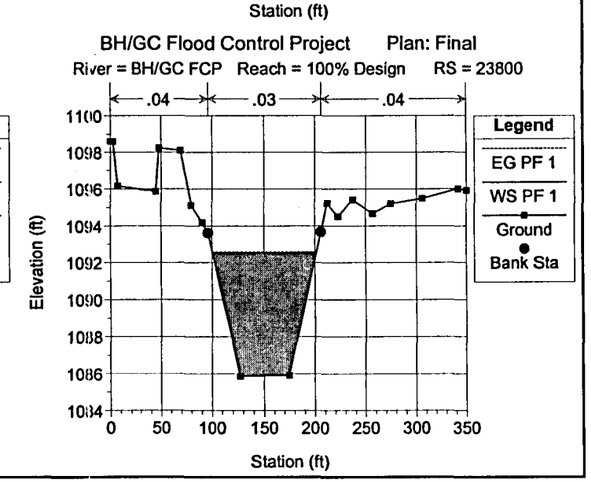
Bank Sta
Elevation (ft)
Station (ft)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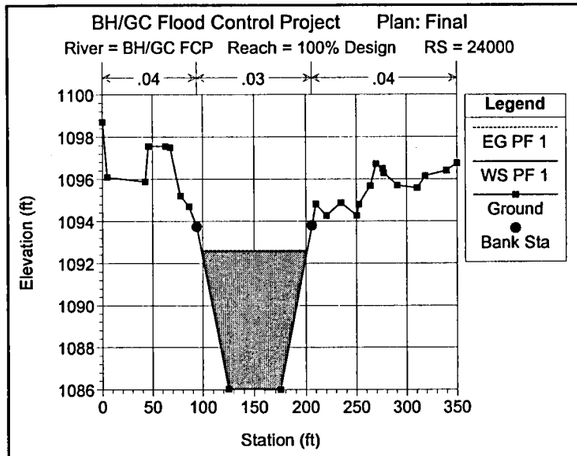
Bank Sta
Elevation (ft)
Station (ft)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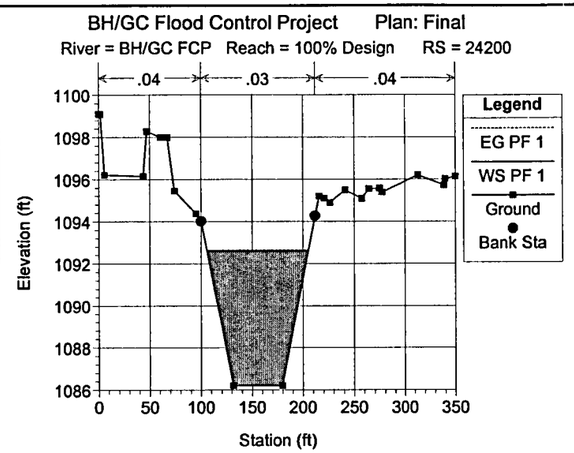
Elevation (ft)
Station (ft)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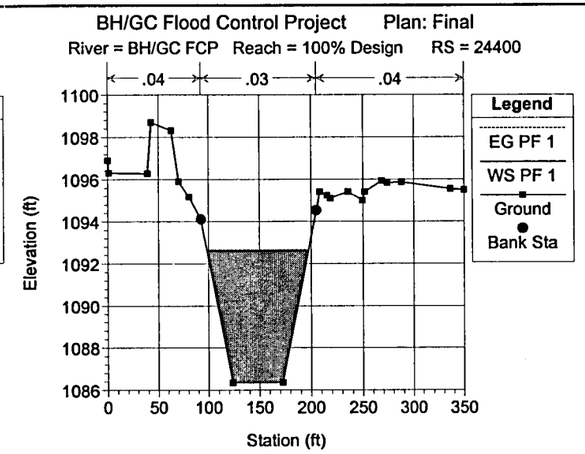
Bank Sta
Elevation (ft)
Station (ft)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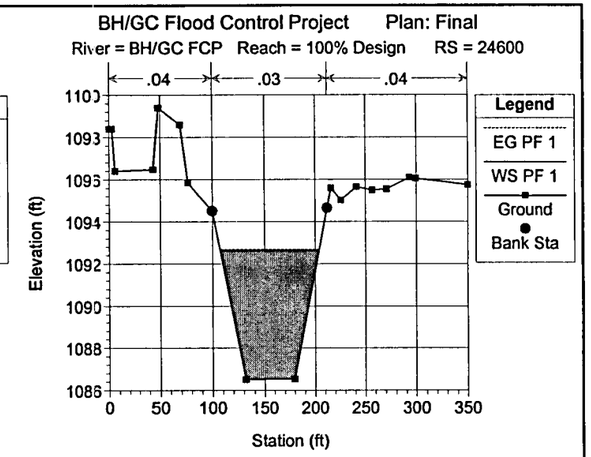
Bank Sta
Elevation (ft)
Station (ft)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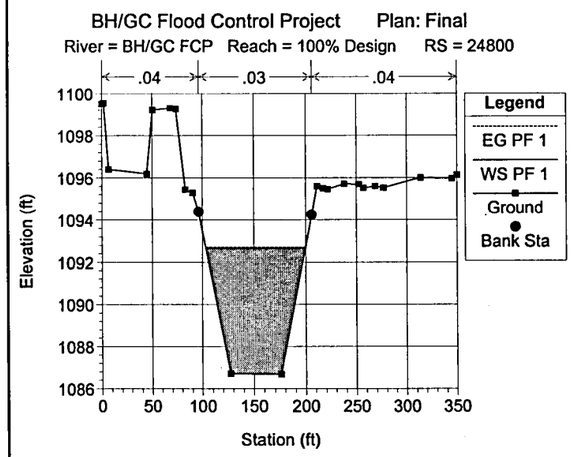
Station (ft)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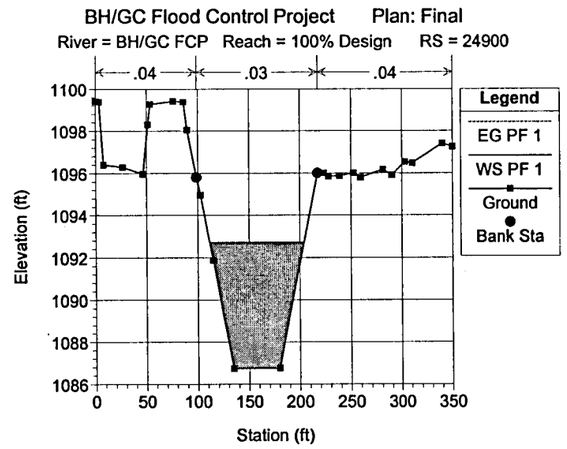
Elevation (ft)
Station (ft)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Elevation (ft)
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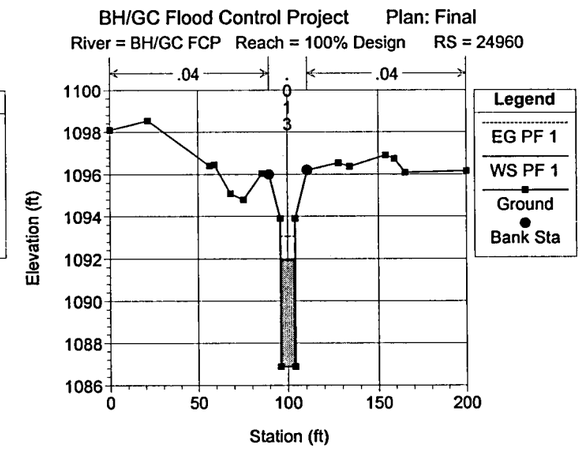
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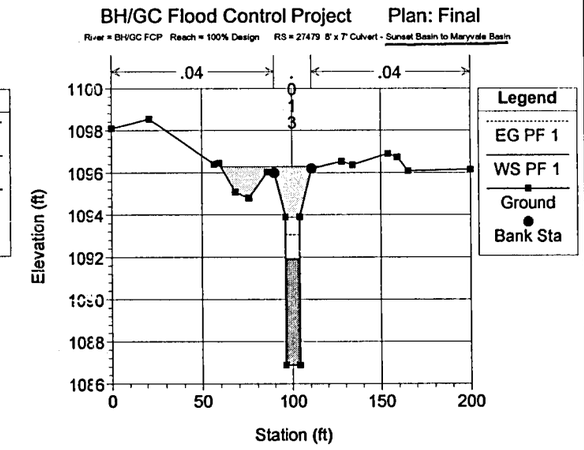
Bank Sta
Elevation (ft)
Station (ft)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.04 .04
Legend
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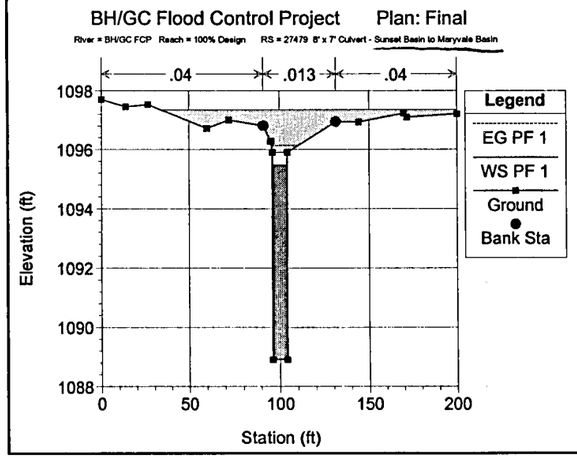
Ground
Bank Sta
Elevation (ft)
Station (ft)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Legend
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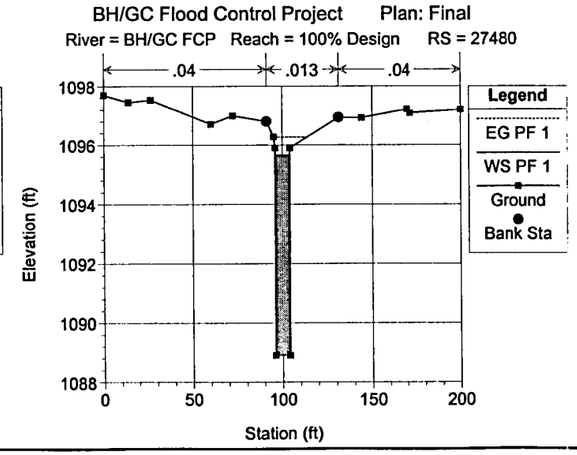
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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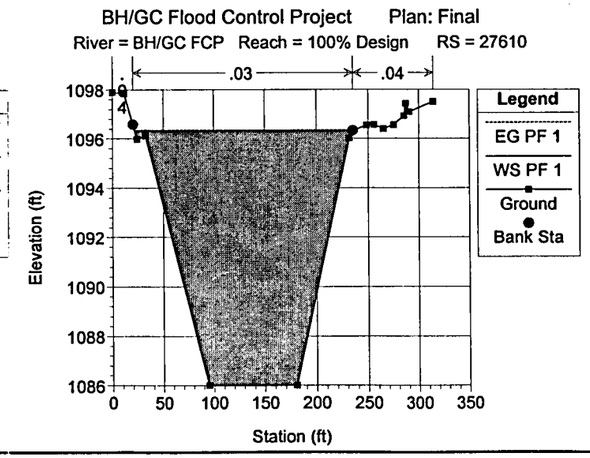
Bank Sta
Elevation (ft)
Station (ft)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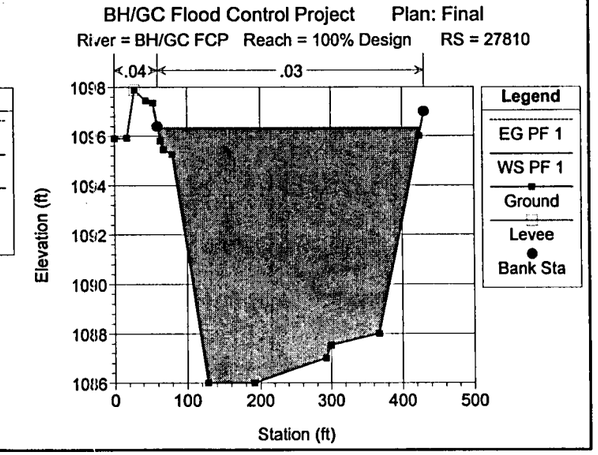
Elevation (ft)
Station (ft)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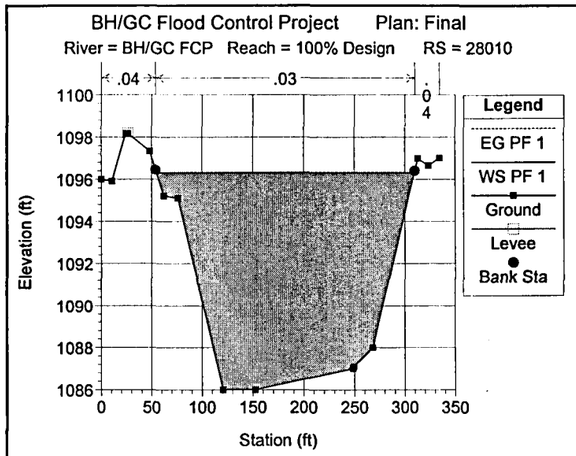
Levee
Bank Sta
Elevation (ft)
Station (ft)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.04
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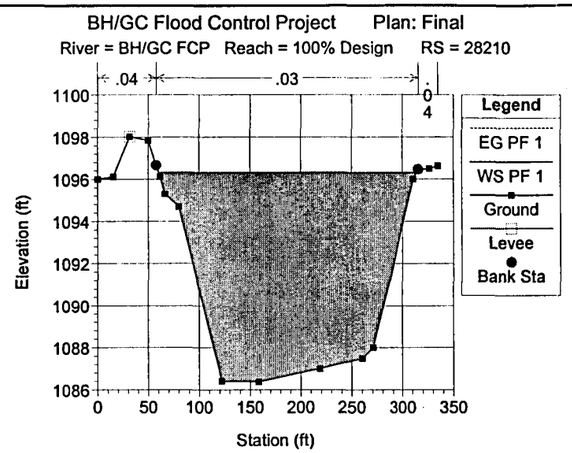
Levee
Bank Sta
Elevation (ft)
Station (ft)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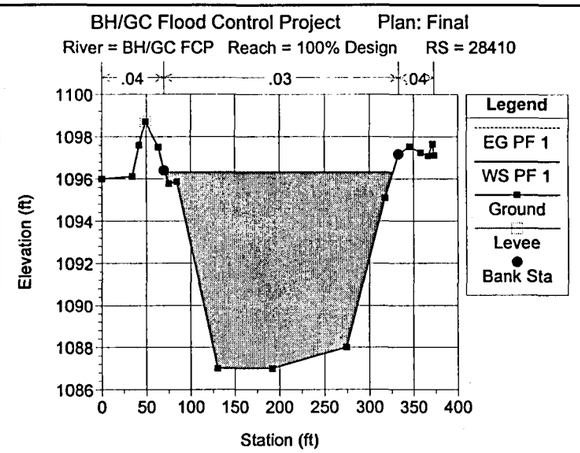
Levee
Bank Sta
Elevation (ft)
Station (ft)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.04
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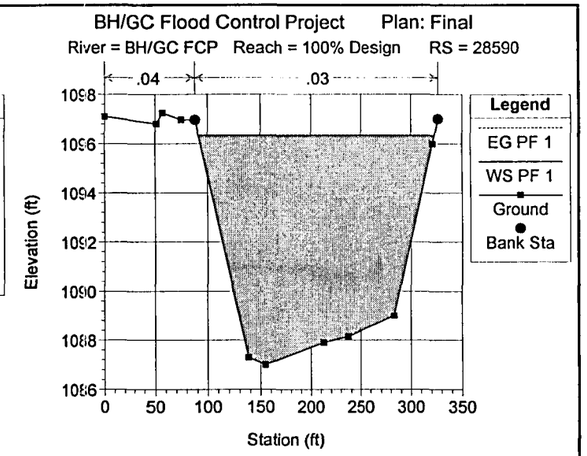
Levee
Bank Sta
Elevation (ft)
Station (ft)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.03
Legend
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Ground
Bank Sta
Elevation (ft)
Station (ft)

EROSION CONTROL MEASURES

DMJM HARRIS

MEMORANDUM

To: **Jeff Minch** Date: **Monday, March 11, 2002**

From: **Kaan Tuncok** Subject: **BHOC Erosion Control Measures**

The erosion control measures evaluated for use along the proposed channel system include;
(1) Enkamat Turf Reinforcement Matting (TRM),
(2) Conlock I Articulated Concrete Blocks (ACB), and
(3) Riprap Basin

The proposed conditions hydraulic model was used to evaluate the type and application limit of the specific erosion control measure. The results are summarized in the following table.

Table 1 – Summary of Erosion Control Measures

Structure	Application Limits		Type of Erosion Control Measure
	Downstream Limit	Upstream Limit	
83rd Avenue Bridge			Enkamat[1]
Upstream Face	112+80.82	112+99.00	
Downstream Face	111+11.50	111+34.83	
91st Avenue Bridge			Enkamat[1]
Upstream Face	56+38.50	58+00.00	
Downstream Face	54+00.00	54+50.00	
6-10'x5' RCBC			Enkamat[1]
Upstream Face	78+24.50	80+20.00	
Downstream Face	73+88.00	76+85.00	
3-10'x8' RCBC			Riprap Basin
Downstream Face	116+55.00	117+55.00	
Spillways			Conlock I[2]

1. Enkamat 7020 by Colbond Geosynthetics or equivalent.
2. Conlock I 800-07 by Hydropave LP or equivalent along the spillway face and toe.

(1) Enkamat TRM
The type of Enkamat and its application limits were identified using the following guidelines:

a) Type
As shown in the hand computations the hydraulic forces (i.e., maximum channel velocity and boundary shear stress) were evaluated to achieve a stable channel design. The type of Enkamat TRM chosen for application was based on the permissible velocity and maximum shear stress.

b) Application Limits
Since the proposed Enkamat TRM will tie into the proposed soil cover (Bermuda grass), Enkamat TRM was extended far enough upstream and downstream to maintain the permissible velocity of Bermuda grass.

As documented in the Flood Control District Maricopa County (FCDMC) Hydraulics Manual (Volume II, 1996), the permissible velocity of bermuda grass is a function of the following two factors:

i) Slope range: As shown on plans, the channel bottom slope along the proposed BHOC system is less than 5 percent.
ii) Erosion characteristics of the soil: As documented in DMJM+HARRIS' Geotechnical Investigation Report (2001), the soils encountered in the vicinity of the proposed 83rd Avenue and 91st Avenue bridges and the 6-10'x5' RCBC (upper 15

to 20 feet) typically consist of finer grained medium plasticity clays. These soils should posses sufficient cohesion to be classified as "erosion resistant" for the hydraulic parameters observed in the vicinity of these proposed structures.

Based on the slope range and the erosion characteristics, the permissible velocity of bermuda grass is 6 ft/s. Therefore, Enkamat is extended upstream and downstream of the proposed structures where the maximum channel velocity is 6.0 ft/s. The upstream and downstream application limits are summarized in Table 1.

(2) Riprap Basin
As shown in the hand computations, the hydraulic conditions at the outlet of the 3-10'x8' RCBC may warrant the use of a riprap basin. The length of riprap basin and the required riprap size (D_{50} rock size) were computed using the guidelines presented in the Federal Highway Administration Hydraulic Engineering Circular No. 14 (HEC 14), Hydraulic Design of Energy Dissipators for Culverts and Channels.

The recommended D_{50} riprap size along the riprap basin is 18 inches.

(3) Conlock I ACB
The type of Conlock ACB chosen for application was based on the factor of safety against sliding and overturning. The design was based on a minimum factor of safety of 1.5.

The erosion control measures evaluated for this project include:

(1) Enkamat Turf Reinforcement Matting (TRM), and

(2) Conlock I and Conlock II Articulated Concrete Blocks (ACB)

As shown in the following pages,

- Enkamat is proposed in the vicinity of proposed bridges

(ie, 83rd Avenue and 91st Avenue bridges) and the 6-10' x 5' RCBC, and

- Conlock is proposed in the vicinity of the 3-10' x 8' RCBC and along the spillways.

The applications of these erosion control measures are provided in the following pages. The hydraulic tests and guidelines provided by the manufacturers and other hydraulic criteria documented in several hydraulic text-books were used in the computations.

The guidelines documented by the manufacturers (ie, hydraulic tests) are provided at the end of the hand computations.

The longitudinal extend and type of erosion control measures, in the vicinity of the proposed structures, are also summarized at the end of the hand computations.

(1) ENKAMAT TRM :

Among alternative erosion protection treatments, a fiber matrix system (Enkamat) was chosen for further evaluation. The application of these systems upstream and downstream of the proposed bridge crossings (ie, 83rd Avenue and 91st Avenue) and the 6-10' x 5' RCBC are analyzed.

To achieve stable channel design, the hydraulic forces (ie, maximum channel velocity and boundary shear stress) will be evaluated.

Boundary shear stress

The average boundary shear stress is the tractive force per unit of wetted area and can be calculated as:

$$\tau_0 = \gamma_w \; R \; S_e \quad \left(\text{the maximum shear stress, } (\tau_0)_{max} = \gamma \; y \; S_e \right)$$

y = flow depth

where:

τ_0 = mean boundary shear stress, lb/ft^2

γ_w = unit weight of water, 62.4 lb/ft^3

R = hydraulic radius = $\dfrac{\text{Area}}{\text{Top width}}$, ft

S_e = slope of the energy grade line

The boundary shear stress varies ~~within a river reach~~ as a consequence of the non-uniform distribution of velocity in the cross section. The local boundary shear stress that will be used in design can be calculated as follows:

DMJM HARRIS	PROJECT: BHOC, Phase II	JOB NO. 6888	SHEET 2 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT: Application of Enkamat		CHECKED BY VRM	DATE 2/10/02

$$\tau_b = K_a * \tau_o$$

Where

K_a = associated local boundary shear stress adjustment factor.

At the proposed bridge / culvert locations where Enkamat might be applied, the average boundary shear stress can be computed as:

Location	y (a) (ft)	R (a) (ft)	S_e (a) (ft/ft)	τ_o (lb/ft²)	$(\tau_o)_{max}$ (lb/ft²)
d/s face of 91st Av Bridge	6.83	4.80	0.00056	0.17	0.24
u/s face of 91st Av Bridge	6.95	5.01	0.00048	0.15	0.21
d/s face of 6-10' x 5' culvert	6.48	5.40	0.00057	0.19	0.23
u/s face of 6-10' x 5' culvert	7.91	6.35	0.00031	0.12	0.15
d/s face of 83rd Av Bridge	7.26	4.66	0.00066	0.19	0.30
u/s face of 83rd Av Bridge	7.47	4.87	0.00054	0.16	0.25
d/s face of 3-10' x 8' culvert	6.29	4.51	0.01109	3.12	4.35
u/s face of 3-10' x 8' culvert	10.60	6.36	0.00070	0.28	0.46

To compute the local boundary shear stress, the guidelines in "Sizing Riprap for the Protection of Approach Embankments and Spur Dikes and Limiting the Depth of Scour at Bridge Piers and Abutments," by Simons, Li & Assoc. (SLA, 1989) for ADOT, were used. (Report No: FHWA-AZ 89-260)

(a) See the hydraulic summary table

The following two correction factors were used to adjust τ_0:

(i) At the bridge section (Channel bed adjustment factor)

The following equation provides the boundary shear stress adjustment factor for a bridge section:

$$K_{bc} = F_1 * \left(A + 2g \frac{h_d}{V_a^2} \right)$$

Where

F_1 = component of the adjustment factor (see Chart 11 in FHWA-AZ 89-260)

A = velocity head coefficient ($A = 1.1$ recommended for symmetric channels)

h_d = total water-surface drop through the bridge, ft

V_a = mean velocity of approach flow, ft/s.

g = gravitational acceleration, 32.2 ft/s^2

The correction factor and the associated τ_{max} for the 91st and 83rd Av. bridges can be computed as follows:

Location	$(\tau_0)_{max}$ (1)	h_d	L (2)	F_1	A	V_a	K_{bc}	τ_b (3)
91st Av bridge	0.24	0.21	106	0.98	1.1	7.09 (4)	1.29	0.31
	0.17	0.50	106	0.98	1.1			
83rd Av bridge	0.30	0.02	104	1.0	1.1	5.86 (5)	1.13	0.34

(1) maximum boundary shear stress (see page 2)

(2) width of the bridge

(3) local boundary shear stress used at bridge locations.

(4) Average of Sections 5592 – 5800

(5) Average at Sections 11266 – 11542

(ii) Bend adjustment factor

A channel bend causes an increase in local boundary shear stress. The adjustment factor is calculated as follows:

$$K_r = 3.16 * \left(\frac{R_c}{T}\right)^{-0.5} \quad \text{for } \frac{R_c}{T} < 10$$

$$K_r = 1.0 \quad \text{for } \frac{R_c}{T} \geq 10$$

where

R_c = centerline radius of the bend, ft

T = flow topwidth at upstream end of the bend, ft

A bend adjustment factor is required at the outlet of 6-10' x 5' RCBC. Using the R_c of the bend and the hydraulic properties at section 7686

R_c = ~~165~~ 125 ft $\quad T = 64.6$ ft $\Rightarrow \frac{R_c}{T} = 2.9$ 1.9

Therefore, $K_r = 3.16\ (2.9)^{-0.5} = 1.86$ 2.3

The local boundary shear stress at the 6-10' x 5' RCBC outlet is

$\tau_b = K_r * (\tau_0)_{max} = 1.86 * 0.23 = 0.43$ lb/ft^2 ✓

2.3 (0.19) = 0.43

DMJM HARRIS	PROJECT: BHOC, Phase II	JOB NO. 6888	SHEET 5 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT: Application of Enkamat		CHECKED BY JRM	DATE 2/10/02

To evaluate the applicability of the Enkamat Turf Reinforcement Mat, the following two performance properties, permissible shear stress and permissible velocity, were computed

(a) Permissible Shear Stress

The technical data associated with a variety of Enkamat products (i.e, 7000-, 7200-, and 7900-series) are provided in the following page.

As shown in this table the minimum and maximum permissible shear stresses (τ_p) are 6.0 lb/ft^2 and 8.0 lb/ft^2, respectively.

As recommended in the SLA (1989) report, a factor of safety is applied to τ_p to compute the design shear stresses (τ_d) that will be used in the design of erosion control measures.

The recommended safety factors for the bridges and culverts are 1.60 and 1.25, respectively.

Therefore, the design shear stresses that will be used for the application of the Enkamat products are summarized as follows:

$$\tau_d = (\tau_p) \;/\; (\text{Factor of Safety})$$

Structure	τ_p (1)	Factor of Safety	τ_d
Bridge	6 lb/ft^2	1.60	3.75 lb/ft^2
Culvert	6 lb/ft^2	1.25	4.80 lb/ft^2

(1) The minimum available shear stress as supported by the Enkamat TRM (50-hr vegetated values are used).

→ To complete the evaluation of the shear stress, the local boundary shear stress (τ_b) will be compared to the design shear stress (τ_d)

→ If $\tau_b < \tau_d$, the application of Enkamat is appropriate wrt to the shear stress criteria.

DMJM HARRIS	PROJECT: BHOC, Phase II	JOB NO. 6888	SHEET 6 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT: Application of Enkamat		CHECKED BY JRM	DATE 2/10/02

Location	τ_b	τ_d	Application of Enkamat[1]
91st Av Bridge	0.31	3.75	Adequate (Use Enkamat 7020[3])
6-10' x 5' culvert	0.43	4.80	Adequate (Use Enkamat 7020[3])
83rd Av Bridge	0.34	3.75	Adequate (Use Enkamat 7020[3])
3-10' x 8' culvert	4.35	4.80	Adequate[2]

(1) Applicability of the Enkamat wrt shear stress.

(2) Application of Enkamat is not adequate wrt permissible velocity. (see the summary at the end of this page)

(3) The upstream and downstream limits are documented in p. 21-24

(b) Permissible Velocity

→ Similar to the permissible shear stress, permissible velocity values are documented in the technical data summary table.

→ To evaluate the application of Enkamat, V_p values are compared to the maximum channel velocities (V_{max}) at the outlet of the culvert and the u/s and d/s faces of the bridge.

If $V_{max} < V_p$, the application of Enkamat is appropriate wrt to the velocity criteria.

Location	V_{max} (ft/s)	V_p[1] (ft/s)	Application of Enkamat
91st Av bridge, d/s face	6.3	14.0	Adequate
91st Av bridge u/s face	6.0	14.0	Adequate
6-10' x 5' culvert outlet	6.8	14.0	Adequate
83rd Av bridge, d/s face	6.6	14.0	Adequate
83rd Av bridge, u/s face	6.2	14.0	Adequate
3-10' x 8' culvert outlet	14.2	14.0	NOT Adequate ✓

(1) 50-hour vegetated values

Enkamat® 7020

COLBOND
GEOSYNTHETICS

Description

Enkamat 7020 is a three-dimensional turf reinforcement mat (TRM) made of heavy nylon monofilaments fused at their intersections. Ninety-five percent of the geomatrix is open and available for soil and root interaction with filaments.

Recommended Applications

- *Slopes*
- *Turf Reinforcement*
- *Landfill Closures*
- *Channels*
- *Ponds*
- *Weathered Embankments*

7020 TECHNICAL DATA			
PROPERTY	TEST METHOD	UNIT	TYPICAL VALUE
Color	Visual		Black
Mass/Unit Area	ASTM D 5261	oz/yd^2	12.0
Thickness	ASTM D 5199	inches	0.7
Tensile Strength	ASTM D 5035 mod.		
Machine (Roll) Direction		lb./ft.	240.0
Cross Machine Direction		lb./ft.	145.0
Area Holding Capacity	Calculated	in^3/yd^2	850
Porosity	Calculated	%	>95
UV Stability	ASTM G53, ASTM D1682 mod.	%	80
Performance Data			
Permissible Velocity			
7020 alone, direct measurement	Independent Testing(1)	ft./sec.	20.0
30 minute, vegetated	Independent Testing(1)	ft./sec.	19.0
50 hour, vegetated	Independent Testing(1)	ft./sec.	14.0
Permissible Shear stress			
7020 alone, direct measurement	Independent Testing(1)	$lb./ft.^2$	11.2
30 minute, vegetated	Independent Testing(1)	$lb./ft.^2$	10.0
50 hour, vegetated	Independent Testing(1)	$lb./ft.^2$	8.0

1) Test Data developed through Independent Laboratory - available upon request.

(2) CONLOCK ACB

The application of Conlock ACB, as erosion control measures, at the culvert outlets and along the spillways are tested. The specific type of the Conlock unit is chosen by testing the factor of safety against sliding and overturning.

(a) Stability against sliding : The guidelines presented in the Erosion Control Manuals are used to check the stability of a single block against sliding at the culvert outlet and the spillways.

(i) 3 - 10' x 8' culvert

As shown on pages 2 and 6, the maximum boundary shear stress, $(\tau_o)_{max}$, at the culvert outlet is 0.23 lb/ft^2, and the local boundary, τ_b, is 0.43 lb/ft^2.

To check the stability of the blocks w.r.t to sliding, τ_b is compared to the resistive slip shear traction (τ_{st}). τ_{st} is expressed as:

$$\tau_{st} = f_c \left(W \left(1 - \sin\alpha \right) \right)$$

where :

f_c = static friction at block / fabric interface

W = submerged weight of block (lb/ft^2)

α = channel bottom slope (in degrees)

Since CONLOCK II 4VM-30 block has the greatest percent open area (26% - 28.3%) and exhibits the lowest weight per ft^2, it will be used for preliminary computations.

As documented in the Hydropave Erosion System Manuals (1999 and 2001)

$f_c = 0.65$

$W = (21.2 \text{ lb}) / (1.20 \text{ ft}^2) = 17.67 \text{ lb/ft}^2$

Table 1. Conlock Hydraulic Data

CONLOCK II BLOCK DATA													
Block Class	Weight	Cov.	Weight	Weight submerged	L	W	H	n	Moment Arms l1	l2	l3	l4	Tc
	(lb)	(ft^2)	(lb/ft^2)	(lb)	(in)	(in)	(in)		(ft)	(ft)	(ft)	(ft)	(lb/ft^2)
4NVM-05	43.2	1.04	41.6	23.3	16.7	12.0	4.0	0.022	0.167	0.780	0.267	0.780	11.48
4NVM-10	43.2	1.10	39.4	23.3	16.7	12.0	4.0	0.024	0.167	0.780	0.267	0.780	11.48
4NVM-20	43.2	1.20	36.1	23.3	16.7	12.0	4.0	0.026	0.167	0.780	0.267	0.780	11.48
6NVM-05	65.4	1.04	62.9	35.2	16.7	12.0	6.0	0.022	0.250	0.780	0.400	0.780	14.79
6NVM-l0	65.4	1.10	59.5	35.2	16.7	12.0	6.0	0.024	0.250	0.780	0.400	0.780	14.79
6NVM-20	65.4	1.20	54.5	35.2	16.7	12.0	6.0	0.026	0.250	0.780	0.400	0.780	14.79
8NVM-05	86.5	1.04	83.2	46.5	16.7	12.0	8.0	0.022	0.333	0.780	0.533	0.780	17.03
8NVM-10	86.5	1.10	78.6	46.5	16.7	12.0	8.0	0.025	0.333	0.780	0.533	0.780	17.03
8NVM-20	86.5	1.20	72.1	46.5	16.7	12.0	8.0	0.027	0.333	0.780	0.533	0.780	17.03
4VM-10	39.3	1.04	37.8	21.2	16.7	12.0	4.0	0.026	0.167	0.780	0.267	0.780	10.44
4VM-20	39.3	1.10	35.7	21.2	16.7	12.0	4.0	0.028	0.167	0.780	0.267	0.780	10.44
*4VM30	39.3	1.20	32.8	21.2	16.7	12.0	4.0	0.030	0.167	0.780	0.267	0.780	10.44
6VM-10	59.2	1.04	56.9	31.8	16.7	12.0	6.0	0.026	0.250	0.780	0.400	0.780	13.38
6VM-20	59.2	1.10	53.8	31.8	16.7	12.0	6.0	0.028	0.250	0.780	0.400	0.780	13.38
6VM-30	59.2	1.20	49.3	31.8	16.7	12.0	6.0	0.030	0.250	0.780	0.400	0.780	13.38
8VM-10	78.7	1.04	75.7	42.3	16.7	12.0	8.0	0.027	0.333	0.780	0.533	0.780	15.49
8VM-20	78.7	1.10	71.5	42.3	16.7	12.0	8.0	0.029	0.333	0.780	0.533	0.780	15.49
8VM-30	78.7	1.20	65.6	42.3	16.7	12.0	8.0	0.031	0.333	0.780	0.533	0.780	15.49

CONLOCK I BLOCK DATA													
Block Class	Weight	Cov.	Weight	Weight submerged	L	W	H	n	Moment Arms l1	l2	l3	l4	Tc
	(lb)	(ft^2)	(lb/ft^2)	(lb)	(in)	(in)	(in)		(ft)	(ft)	(ft)	(ft)	(lb/ft^2)
400-02	42.4	1.0	42.4	22.8	16.0	12.0	4.0	0.022	0.167	0.833	0.267	0.833	25.43
400-07	39.5	1.0	39.5	21.2	16.0	12.0	4.0	0.023	0.167	0.833	0.267	0.833	23.67
400~17*	35.2	1.0	35.2	18.9	16.0	12.0	4.0	0.028	0.167	0.833	0.267	0.833	21.12
400-24	32.3	1.0	32.3	17.3	16.0	12.0	4.0	0.030	0.167	0.833	0.267	0.833	19.35
600-02	62.6	1.0	63.6	33.7	16.0	12.0	6.0	0.023	0.250	0.833	0.400	0.833	32.01
600-07	58.6	1.0	59.3	31.5	16.0	12.0	6.0	0.024	0.250	0.833	0.400	0.833	29.94
600-17	51.8	1.0	52.8	27.9	16.0	12.0	6.0	0.029	0.250	0.833	0.400	0.833	26.50
600-24	47.7	1.0	47.7	25.6	16.0	12.0	6.0	0.030	0.250	0.833	0.400	0.833	24.37
800-02	83.5	1.0	84.8	44.9	16.0	12.0	8.0	0.023	0.333	0.833	0.533	0.833	37.18
800-07	76.6	1.0	79.0	41.2	16.0	12.0	8.0	0.024	0.333	0.833	0.533	0.833	34.09
800-17	69.1	1.0	70.4	37.2	16.0	12.0	8.0	0.029	0.333	0.833	0.533	0.833	30.77
800-24	63.3	1.0	63.3	34.0	16.0	12.0	8.0	0.031	0.333	0.833	0.533	0.833	28.16

* Flume Tested

Using the channel bottom slope in the vicinity of the proposed culvert,

$S_0 = 0.001507$ ft/ft ($\alpha = \tan^{-1}(0.001507) = 0.086°$), τ_{st} can be computed as:

$$\tau_{st} = 0.65\left(17.67\left(1 - \sin(0.086)\right)\right) = 11.48 \text{ lb/ft}^2$$

For design purposes a safety factor (wrt sliding) of 2.0 will be used in the computations. Therefore, the design shear stress can be computed as:

$$\tau_d = \tau_{st} / 2.0 = 5.74 \text{ lb/ft}^2$$

Since $\tau_b < \tau_d$, application of CONLOCK II 4VM-30 is adequate ✓ wrt <u>sliding</u>.

(ii) Spillways Slope = 6:1 $\Rightarrow$ $\theta = 9.5°$

Use 4VM-30 (CONLOCK II) $S = 0.1667$ ft/ft

$\tau_{st} = 0.65\,(17.67\,(1 - \sin(9.5))) = 9.60$ lb/ft^2

$\tau_d = \tau_{st} / 2.0 = 9.60 / 2 = 4.80$ lb/ft^2

$\tau_0 = \gamma\, y^{(1)} S^{(2)} = 62.4 * 1.0 * 0.1667 = 10.4$ lb/ft^2

Since $\tau_0 > \tau_d$ application of CONLOCK II 4VM-30 is not adequate.

Use 800-07 (CONLOCK I)

$\tau_{st} = 0.65\,(41.20^{(3)}(1 - \sin(9.5))) = 22.36$ lb/ft^2

$\tau_d = 11.18$ lb/ft^2

since $\tau_0 < \tau_d$ application of 800-07 is adequate.

Assumptions:

(1) Flow depth is 1 ft at the spillway crest

(2) Spillway is at a 6:1 slope ($S \approx 0.1667$ ft/ft)

(3) Submerged weight of the individual block = (41.2 lb)/(1 ft^2) = 41.2 lb/ft^2

(b) Stability against overturning

As defined in the Hydropave Engineering & Technical Manual (2001) the stability of a single concrete block on a sloping face wrt to overturning can be computed as follows:

$$\ell_2 W_A \cos\theta = \ell_1 W_A \sin\theta \cos\beta + \ell_3 F_D \cos\delta + \ell_4 F_L$$

Where:

W_A = submerged weight of the block (lb/ft^2)

ℓ_1 and ℓ_2 = moment arms of the weight of the block (side - and longitudinal-slope)

F_D = drag force on the block

F_L = lift force on the block

ℓ_3 and ℓ_4 = moment arms of the lift and drag forces on the block

θ = side slope angle relative to the horizontal plane

λ = angle between the horizontal and the velocity vector measured in the plane of the side slope.

δ = angle between the drag force and particle movement direction = $90 - \beta - \lambda$

β = angle between the block movement direction and the vertical plane.

The factor safety, SF, for the block is defined as the ratio of moments resisting motion to those tending to rotate the block out of its resting position. The factor of safety can be expressed as:

$$SF = \frac{\ell_2 W_A \cos\theta}{\ell_1 W_A \sin\theta \cos\beta + \ell_3 F_D \cos\delta + \ell_4 F_L} \quad \ldots\ldots \quad (1)$$

For the special case of:

- Canlocks applied to the main channel bed instead of the side slopes, the SF can be computed by interpreting some of the parameters as follows:

$\theta =$ channel bottom slope

$\lambda = 90^\circ$

$\beta = \delta = 0^\circ \qquad (\delta = 90 - \beta - 90 = 0^\circ)$

Then the safety factor simplifies to;

$$SF = \frac{\ell_2 W_A \cos\theta}{\ell_1 W_A \sin\theta + \ell_3 F_D + \ell_4 F_L} \quad \ldots\ldots \quad (2)$$

Numerical tests indicate that the drag force on the block can be computed as follows:

$$F_D = C\,(\Delta z\, w\, \rho\, V^2)$$

Where

$\Delta z =$ projection height (assume 1 inches = 0.083 ft)

$w =$ width of projection

$C =$ momentum transfer coefficient (assumed equal to 0.5)

$\rho =$ fluid density (1.94 slug/ft^3)

$V =$ velocity (ft/s.)

When the additional forces of projecting blocks are considered, the factor of safety equation becomes:

$$SF = \frac{\cos\theta\left(\frac{\ell_2}{\ell_1}\right)}{\eta'\left(\frac{\ell_2}{\ell_1}\right) + \sin\theta\cos\beta + \frac{\ell_3 F_D \cos\delta + \ell_4 F_L}{\ell_1 W_A}} \quad \ldots\ldots (3)$$

For the special case of conlocks applied to the main channel bed instead of the side slopes, the factor of safety can be computed as:

$$SF = \frac{\cos\theta\left(\frac{\ell_2}{\ell_1}\right)}{\eta'\left(\frac{\ell_2}{\ell_1}\right) + \sin\theta + \frac{\ell_3 F_D + \ell_4 F_L}{\ell_1 W_A}} \quad \ldots\ldots (4)$$

where:

$$\eta' = \left\{\frac{\frac{M}{N} + \sin(\lambda+\beta)}{\frac{M}{N} + 1}\right\}\eta$$

$$\frac{M}{N} = \frac{\ell_4 F_L}{\ell_3 F_D}$$

$$\eta = \frac{\tau_o}{\tau_c}$$

τ_o = shear stress acting on the channel

τ_c = critical shear stress when failure occurs.

(i) 3-10' x 8' RCBC

First, test the applicability of CONLOCK II 4VM-30;

$$F_D = 0.5\left(0.083\,(1.0)\,(1.94)\,(11.8^{(1)})^2\right) = 11.2 \text{ N}$$

Assume that $F_D = F_L$ (2)

$$S = 0.1507\% = 0.001507 \text{ ft/ft}$$

$$\therefore \tan\theta = 0.001507 \Rightarrow \theta = 0.086^\circ$$

$$\eta = \frac{\tau_o}{\tau_c} = \frac{4.35}{10.44} = 0.417$$

As shown on p. 6, $\tau_o = 4.35$ lb/ft^2

Using the guidelines in the Hydropave Erosion Control Manual (2001) for 4VM-30, $\tau_c = 10.44$ lb/ft^2

$$\frac{M}{N} = \frac{\ell_4}{\ell_3} = 2.92$$

$$\eta' = \left\{\frac{2.92+1}{2.92+1}\right\} 0.417 = 0.417$$

$$SF = \frac{\cos(0.086)\left(\frac{0.78}{0.167}\right)}{0.417\left(\frac{0.78}{0.167}\right) + \sin(0.086) + \frac{(0.267 * 16.3) + (0.78 * 16.3)}{0.167 * 17.67}} = 0.60$$

Assumptions:

(1) Based on the following hydraulic conditions; TW water-surface elevation = 1074 ft.

(2) Assume that the additional lift due to the vertical displacement is equal to the additional drag.

Since SF < 1.5, the application of CONLOCK II 4VM-30 is not adequate, therefore, test the applicability of 6VM-30;

$$\eta = \frac{4.35}{13.38} = 0.325$$

$$\eta' = 0.325$$

$$SF = \frac{(\cos(0.086))\left(\frac{0.78}{0.25}\right)}{0.325\left(\frac{0.78}{0.25}\right) + \sin(0.086) + \frac{(0.4 * 11.2) + (0.78 * 11.2)}{0.25 * 26.5}} = \underline{\underline{1.03}}$$

Since SF < 1.5, test the applicability of 8VM-30;

$$\eta = \frac{4.35}{15.49} = 0.28 \qquad \eta' = 0.28$$

$$SF = \frac{(\cos(0.086))\left(\frac{0.78}{0.333}\right)}{0.28\left(\frac{0.78}{0.333}\right) + \sin(0.086) + \frac{(0.533 * 11.2) + (0.78 * 11.2)}{0.333 * 35.25}} = \underline{\underline{1.23}}$$

Since SF < 1.5, the application of CONLOCK II is <u>not adequate</u> at the outlet of 3 - 10' x 8' culvert

DMJM HARRIS	PROJECT: BHOC, Phase II	JOB NO. 6888	SHEET 15 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT: Application of Conlock		CHECKED BY JRM	DATE 2/10/02

As an alternative erosion control measure, application of Conlock I will be tested at the culvert outlet. First, 400-17 will be applied as follows;

$$\eta = \frac{\tau_o}{\tau_c} = \frac{4.35}{21.12} = 0.206 \qquad \eta' = 0.206$$

$$SF = \frac{(\cos(0.086))\left(\frac{0.833}{0.167}\right)}{0.206\left(\frac{0.833}{0.167}\right) + \sin(0.086) + \frac{(0.267 * 11.2) + (0.833 * 11.2)}{0.167 * 18.9}} = 1.01$$

Since SF < 1.5, application of 600-17 will be tested;

$$\eta = \frac{\tau_o}{\tau_c} = \frac{4.35}{26.50} = 0.164 \qquad \eta' = 0.164$$

$$SF = \frac{(\cos(0.086))\left(\frac{0.833}{0.25}\right)}{0.164\left(\frac{0.833}{0.25}\right) + \sin(0.086) + \frac{(0.4 * 11.2) + (0.833 * 11.2)}{0.25 * 27.9}} = 1.32$$

Since SF < 1.5, application of 800-24 will be tested;

$$\eta = \frac{4.35}{28.16} = 0.154 \quad \eta' = 0.128$$

$$SF = \frac{(\cos(0.086))\left(\frac{0.833}{0.333}\right)}{0.154\left(\frac{0.833}{0.333}\right) + \sin(0.086) + \frac{(0.533 * 11.2 + 0.833 * 11.2)}{0.333 * 34.0}} = 1.44$$

Since SF < 1.5, application of 800-17 will be tested;

$$\eta = \frac{4.35}{30.77} = 0.141 \qquad \eta' = 0.141$$

$$SF = \frac{\left(\cos(0.086)\right)\left(\frac{0.833}{0.333}\right)}{0.141\left(\frac{0.833}{0.333}\right) + \sin(0.086) + \frac{(0.533 * 11.2 + 0.833 * 11.2)}{0.333 * 37.2}} = 1.57$$

Since SF = 1.57 > 1.5, application of 800-17 is adequate ✓
(POTENTIAL ALTERNATIVE)

The application of CONLOCK I (800-17) will also be tested wrt sliding.

$$\tau_{st} = 0.65\left(37.2\left(1 - \sin(0.086)\right)\right) = 24.14 \text{ lb/ft}^2$$

$$\tau_d = \tau_{st} / 2 = 12.07 \text{ lb/ft}^2$$

Since $\tau_b = 4.35 < \tau_d$, application of CONLOCK I (800-17) is adequate wrt sliding as well. ✓

NOTE: Since the local hydraulic conditions at the outlet of the 3-10' x 8' culvert may destabilize[1] the conlocks, especially in the long-term for extended time frames, a riprap energy dissipator will be used as an erosion control measure. The design of this basin is presented at the end of the hand computations.

(1) POTENTIAL FOR HYDRAULIC JUMP AT CULVERT OUTLET

(ii) Spillways : Since the conlocks are applied along the sloping face of the retention basin, the expressions derived for channels with side-slopes are used to compute the Safety Factor.

First, test the applizability of CONLOCK II 4VM-30;

$$\beta = \tan^{-1} \frac{\cos \lambda}{\left(\frac{\frac{M}{N}+1}{\eta} \quad \frac{\ell_1}{\ell_2} \right) \sin \theta + \sin \lambda} \qquad \eta = \frac{\tau_o}{\tau_c}$$

Channel bottom slope , $S = 1\% = 0.001 \Rightarrow \lambda = 0.057^\circ$

Side slope , $6:1 = 0.1667$ ft/ft $\Rightarrow \theta = 9.46^\circ$

Assume a trapezoidal spillway section with

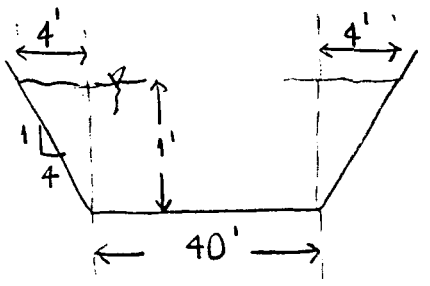
side slope: 4:1

Length : 40 ft

C ; 3.0

H : 1 ft

$$Q = C L H^{3/2} = 3.0 \ (40) \ (1)^{3/2} = 120 \text{ cfs.}$$



$$A = \frac{(40+48)}{2} * 1 = 44 \text{ ft}^2$$

$$Q = V * A \Rightarrow V = \frac{120}{44} = 2.73 \text{ ft/s.}$$

$$F_D = 0.5 \left(0.083 \ (1.0) \ (1.94) \ (2.73^2) \right) = 0.6 \text{ N}$$

$$\eta = \frac{\tau_o}{\tau_c} = \frac{10.4}{10.44} = 0.996$$

$$\beta = \tan^{-1}\left[\frac{\cos 0.057}{\left(\frac{\frac{0.78}{0.267}+1}{0.996} * \frac{0.167}{0.78}\right)\sin(9.46) + \sin(0.057)}\right] = 82.06$$

$$\delta = 90 - \beta - \lambda = 90 - 82.06 - 0.057 = 7.883$$

$$\eta' = \left(\frac{\frac{0.78}{0.267} + \sin(0.057 + 82.06)}{\left(\frac{0.78}{0.267} + 1\right)}\right) 0.996 = 0.994$$

$$SF = \frac{\cos(9.46)\left(\frac{0.78}{0.167}\right)}{0.994\left(\frac{0.78}{0.167}\right) + \sin(9.46)\cos(82.06) + \frac{0.267 * 0.6 * \cos(7.883) + 0.78 * 0.6}{0.167 * 17.67}}$$

$$= 0.95$$

Since $SF < 1.5$, application of 4VM-30 is <u>not</u> <u>adequate</u>.

Use 8 VM-30

$$F_D = 0.5\left(0.083(1.0)(1.94)(2.73)^2\right) = 0.6$$

$$\eta = \frac{\tau_0}{\tau_c} = \frac{10.4}{15.49} = 0.67$$

$$\beta = \tan^{-1}\left(\frac{\cos 0.057}{\left(\frac{\frac{0.78}{0.533}+1}{0.67} * \frac{0.333}{0.78}\right)\sin 9.46 + \sin 0.057}\right) = 75.5^\circ$$

$$\delta = 90 - \beta - \lambda = 90 - 75.5 - 0.057 = 14.44$$

$$\eta' = \left\{\frac{\left(\frac{0.78}{0.533}\right) + \sin(0.057 + 75.5)}{\left(\frac{0.78}{0.533}+1\right)}\right\} 0.67 = 0.66$$

$$SF = \left(\frac{\cos(9.46)\left(\frac{0.78}{0.333}\right)}{0.66\left(\frac{0.78}{0.333}\right) + \sin(9.46)\cos(75.5) + \frac{0.533(0.6)\cos(14.44) + 0.78 * 0.6}{0.333 * 35.25}}\right)$$

$$= 1.28$$

Since SF < 1.5, application of 8VM-30 is not adequate along the spillways. Therefore, an alternative conlock application (CONLOCK I 800-07) will be tested.

Use 800-07

$$\eta = \frac{10.4}{34.09} = 0.305$$

$$\beta = 61.05^\circ$$

$$\delta = 90 - 61.05 - 0.057 = 28.89$$

$$\eta' = 0.29$$

$$SF = 2.51$$

since SF > 1.5, application of 800-07 is adequate at the spillways.

As shown on p.9, the application of 800-07 is adequate wrt sliding as well.

Therefore, apply CONLOCK I 800-07 along the spillways. ⟸

Longitudinal Extend of Enkamat :

The erosion control measures in the vicinity of the proposed culverts and bridges will be finalized using the guidelines in "Design of Roadside Channels with Flexible Linings," (HEC-15, 1988) and "Performance of Flexible Ditch Linings," (FHWA/RD-86/114, 1985) by the FHWA, and the Hydraulics Manual of the FDCMC (Volume II, 1996).

The longitudinal extend of the Enkamat will be based on the permissible velocity and shear stress of the "grass lining". Enkamat will be applied upstream and downstream of the proposed structures, up to segments of the channel system where the maximum velocity and shear stress are below the permissible velocity and permissible shear stress of "bermuda grass", the type of grass recommended along the BHOC.

(1) As documented by the FCOMC, the permissible velocity of bermuda grass at a slope range of 0-5% for erosion resistant and easily eroded soils are 6.0 ft/s and 4.5 ft/s, respectively.

Since the characteristic soil type in the vicinity of the proposed structures is fine-grained, silty to sandy clay, and are generally moderately firm to firm within the upper five to eight feet (becoming firmer with depth), the soil conditions along the BHOC is considered as erosion resistant. Therefore, the application limits of Enkamat, wrt to the velocity, will be checked using the permissible velocity of 6.0 ft/s for the bermuda grass.

(2) As documented by the FHWA (1988), the permissible shear stress for bermuda grass (Class B Retardance as shown in Table 1) is 2.1 lb/ft^2 (shown in Table 2).

(1) Application limits wrt permissible velocity

The upstream and downstream application limits of the Enkamat can be summarized as follows:

Structure	Downstream limit	Upstream limit	Type of Enkamat
83rd Av Bridge			
u/s face	112+80.82 (b)	112+99.00 (a)	ENKAMAT 7020
d/s face	111+11.50 (a)	111+34.83 (b)	ENKAMAT 7020
91st Av Bridge			
u/s face	56+38.35 (b)	58+00.00 (a)	ENKAMAT 7020
d/s face	54+00.00 (a)	54+50.00 (b)	ENKAMAT 7020
6-10'x5' Culvert			
u/s face	78+24.50 (b)	80+20.00 (a)	ENKAMAT 7020
d/s face	73+88.00 (c)	76+85.00 (b)	ENKAMAT 7020

(a) As shown in the hydraulic summary table, maximum channel velocity at this station is less than the permissible velocity, 6.0 ft/s.

(b) As shown in the plans "End of Concrete Lining"

(c) See the hand computations in the following page

As recommended in HEC-15 (FHWA, 1988), the total length of the Enkamat lining around the bend segment of the channel is the sum of the length in the bend plus the length required for downstream protection.

The downstream distance is found using Chart 11 in HEC-15 as follows;

Given: $n = 0.03$

$R = 5.22$ (average hydraulic radius downstream of the culvert outlet sections 7400 - 7686)

Find L_p, the downstream distance using the following equation

$$\frac{L_p}{R} = 0.604 \left(\frac{R^{1/6}}{n} \right)$$

$$L_p = 0.604 \left(\frac{5.22^{1/6}}{0.03} \right) 5.22 \Rightarrow L_p = 138.5 \text{ ft.}$$

Use $L_p = 140.0$ ft.

As shown on the plans, the downstream limit of the bend is Station 75+28.44. Therefore, the downstream limit of the Enkamat is 73+88.44 (Design Recommendation is 73+88.00).

This approach results in a more conservative Enkamat lining length and therefore will be the basis of design.

Longitudinal Extend of Riprap Basin:

As an alternative to CONLOCK, the application of Riprap Basin is tested at the outlet of the 3-10' x 8' RCBC.

The guidelines in HEC-11 and HEC-14 are used to design the dimensions of the riprap basin.

Design discharge = 2846 cfs [design Q per barrel = 949 cfs]

Tailwater depth = 7.6 ft.

Normal flow depth at the culvert outlet, y_0

→ $y_0 = 6.3$ ft (based on the HEC-RAS analysis)

→ Use the guideline in HEC-14 (Fig III-9)

Culvert span, B = 10 ft

Culvert height, D = 8 ft

$$\frac{Q}{B D^{1.5}} = \frac{949}{(10)(8)^{1.5}} = 4.2$$

$$\frac{TW}{D} = \frac{7.6}{8} = 0.95$$

Use Fig. III-9 → $\frac{y_0}{D} = 0.97$

$$y_0 = 7.8 \text{ ft.}$$

For design computations use $y_0 = 6.3$ ft.

Assume normal flow depth (y_0) = brink depth (y_c) = 6.3 ft.

$$V_0 = \frac{Q}{A} = \frac{949}{(10)(6.3)} = 15.1 \text{ ft/s.}$$

$$F_r = \frac{V_0}{\sqrt{g y_e}} = \frac{15.1}{\sqrt{(32.2)(6.3)}} = 1.06$$

$$\frac{TW}{y_e} = \frac{7.6}{6.3} = 1.2 \Rightarrow \text{High tailwater depth}$$

Therefore use Fig. XI-3 to compute the length

To compute the equivalent diameter, D_e

$$\text{Area} = (B)(y_e) = \frac{\pi D_e^2}{4} = 63 \text{ ft}^2 \Rightarrow D_e = 8.96 \text{ ft.} \sim 9.0 \text{ ft.}$$

$\frac{L}{D_e}$	$L^{(a)}$ (ft)	$V_L/V_0^{(b)}$	V_L (ft/s)
10	90	0.59	8.91
15	135	0.39	5.89

As shown in this table at a length of 135 ft downstream of the culvert outlet, the velocity is 5.89 ft/s, which is less than the permissible velocity of bermuda grass, 6 ft/s.

Therefore, a 135 ft long riprap basin is recommended at the culvert outlet.

DMJM HARRIS	PROJECT:	JOB NO. 6888	SHEET 26 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT:		CHECKED BY JRM	DATE 3/9/02

Based on the hydraulic conditions in the vicinity of the 3 - 10' x 8' RCBC, tailwater depth (TW) = 7.6 ft , Q = 2846 cfs , [Q per barrel = 949 cfs]

$$\frac{TW}{D} = \frac{7.6}{8} = 0.95$$

$$\frac{Q}{BD^{3/2}} = \frac{949}{(10)(8)^{3/2}} = 4.2$$

Using Fig III-9 in HEC-14

$$\frac{y_o}{D} = 0.97 \Rightarrow y_o = 7.76 \text{ ft.}$$

Assume $y_o = y_e = 7.76$ ft.

$$V_o = \frac{Q}{A} = \frac{949}{(10)(7.76)} = 12.23 \text{ ft/s}$$

$$F_r = \frac{V_o}{\sqrt{g y_e}} = \frac{12.23}{\sqrt{(32.2)(7.76)}} = 0.77$$

As shown in Fig. X1-2, for $F_r = 0.77$, the 2 options for the $\frac{d_{50}}{y_e}$ range;

(1) $0.1 \leq \frac{d_{50}}{y_e} \leq 0.2$

(2) $0.21 \leq \frac{d_{50}}{y_e} \leq 0.3$

DMJM HARRIS	PROJECT:	JOB NO. 6888	SHEET 27 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT:		CHECKED BY JRM	DATE 3/19/02

(1) For $0.1 \leq \frac{d_{50}}{y_e} \leq 0.2$

→ Try $\frac{d_{50}}{y_e} = 0.1 \rightarrow d_{50} = 0.78$ ft.

From Fig. X1-2, $\frac{h_s}{y_e} = 0.74 \rightarrow h_s = 5.74$ ft.

$\frac{h_s}{d_{50}} = 7.36$

USE: 18" D_{50}

→ Try $\frac{d_{50}}{y_e} = 0.2 \Rightarrow d_{50} = 1.55$ ft. $= 18.6"$

Fig X1-2, $\frac{h_s}{y_e} = 0.74 \rightarrow h_s = 5.74$ ft

$\frac{h_s}{d_{50}} = 3.7$

$2 < \frac{h_s}{d_{50}} < 4$

O.K. ✓

(2) For $0.21 \leq \frac{d_{50}}{y_e} \leq 0.3$

→ Try $\frac{d_{50}}{y_e} = 0.21 \Rightarrow d_{50} = 1.63$ ft.

Fig. X1-2, $\frac{h_s}{y_e} = 0.1 \rightarrow h_s = 0.776$

$\frac{h_s}{d_{50}} = 0.48$

→ Try $\frac{d_{50}}{y_e} = 0.3 \rightarrow d_{50} = 2.33$ ft.

Fig. X1-2, $\frac{h_s}{y_e} = 0.1 \rightarrow h_s = 0.776$

$\frac{h_s}{d_{50}} = 0.33$

DMJM HARRIS	PROJECT:	JOB NO. 6888	SHEET 28 of 28
		DESIGNED BY IKT	DATE 1/30/02
SUBJECT:		CHECKED BY JRM	DATE 3/9/02

Using the guidelines in HEC-14;

$L_s = \min\left[10(h_s),\ 3(B)\right] = 30$ ft.

$10\ h_s = 10(5.74) = 57.4$ ft

$3(B) = 3(10) = 30$ ft

FROM HEC-RAS HYDRAULIC MODEL: (83rd AVE CULVERT)
AVG. TOPWIDTH VARIES 92 TO 98' → USE 100' D/S OF CULVERT
CULVERT TOPWIDTH ≈ 32'
Δ T_W ⇒ FULL VALLEY SECTION (HEC-RAS)

$$\begin{array}{r} 100' \\ -\ 32' \\ \hline 2\ \big|\ 68' \end{array}$$

34' @ 3:1 Expansion ⟹ 102' TO FULL VALLEY SECTION
≈ 100' AND ACCURATE HYDRAULIC CONDITIONS IN HEC-RAS

OUTLET OF CULVERT STA. 117+55
− 1 00
D/S RIPRAP LIMITS = 116+55 ± AVG VELOCITY ≤ 6 fps ± OK

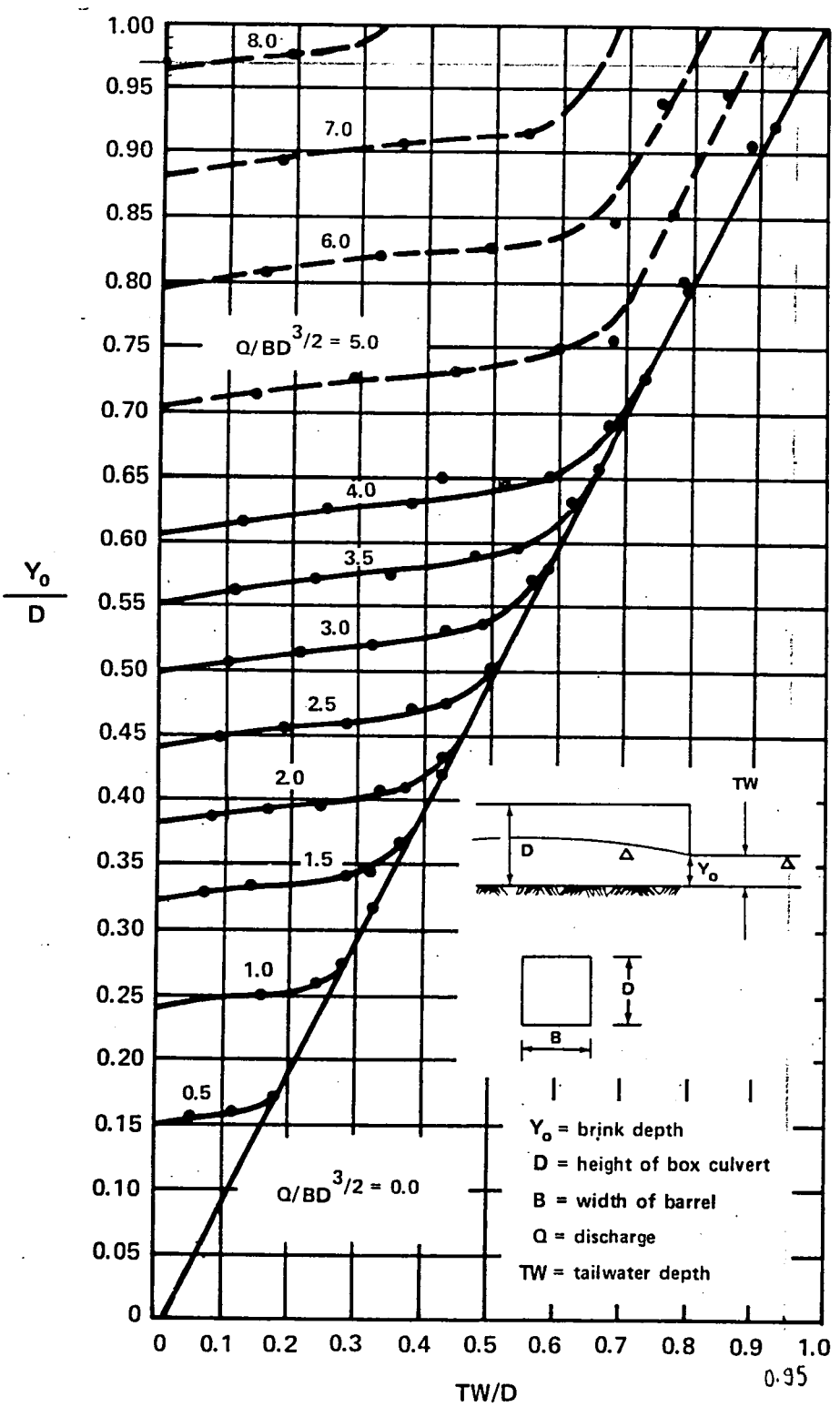


Figure III-9 Dimensionless Rating Curves for the Outlets of Rectangulars Culverts on Horizontal and Mild Slopes from Reference III-2

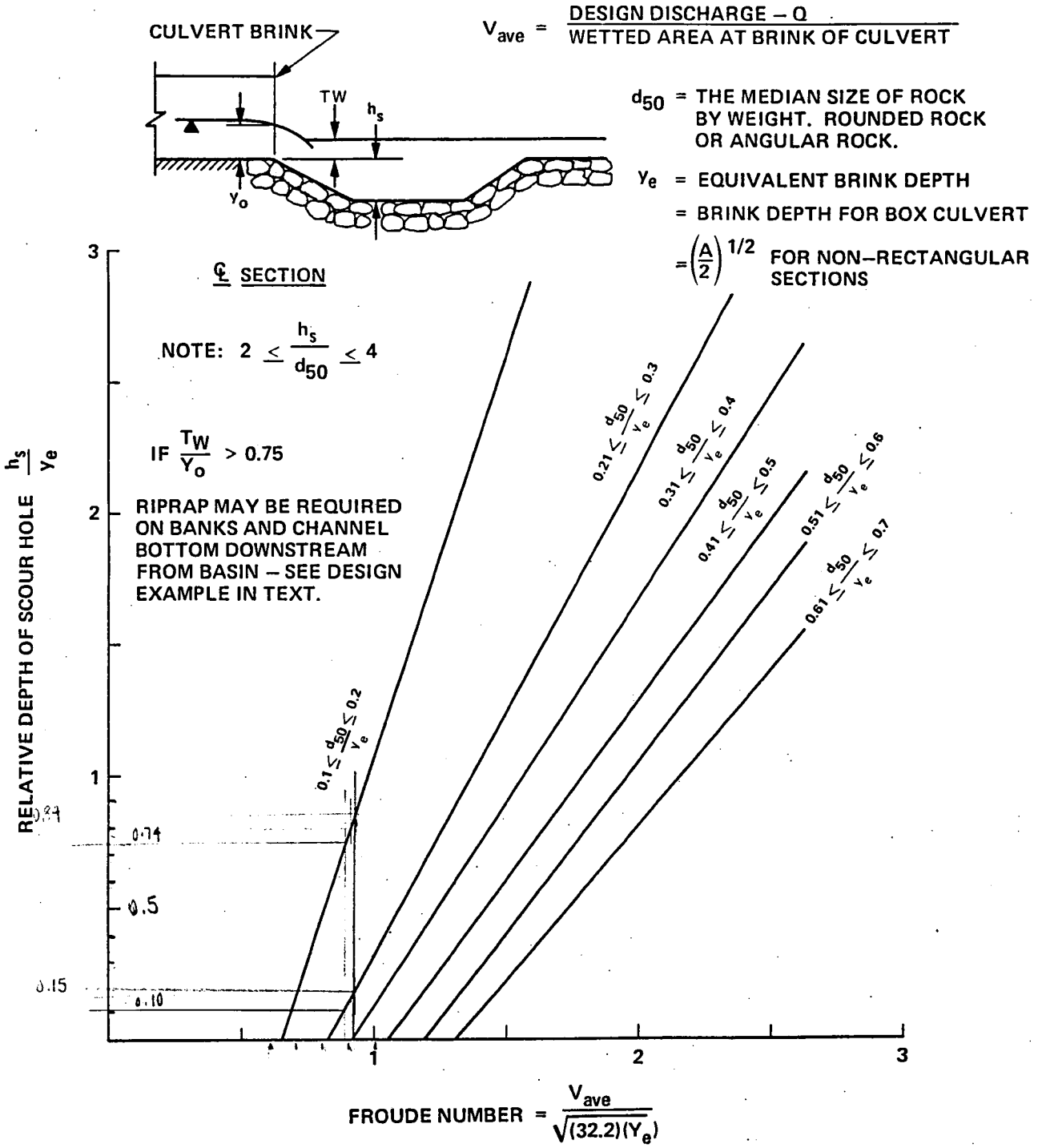


FIGURE X1–2. RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

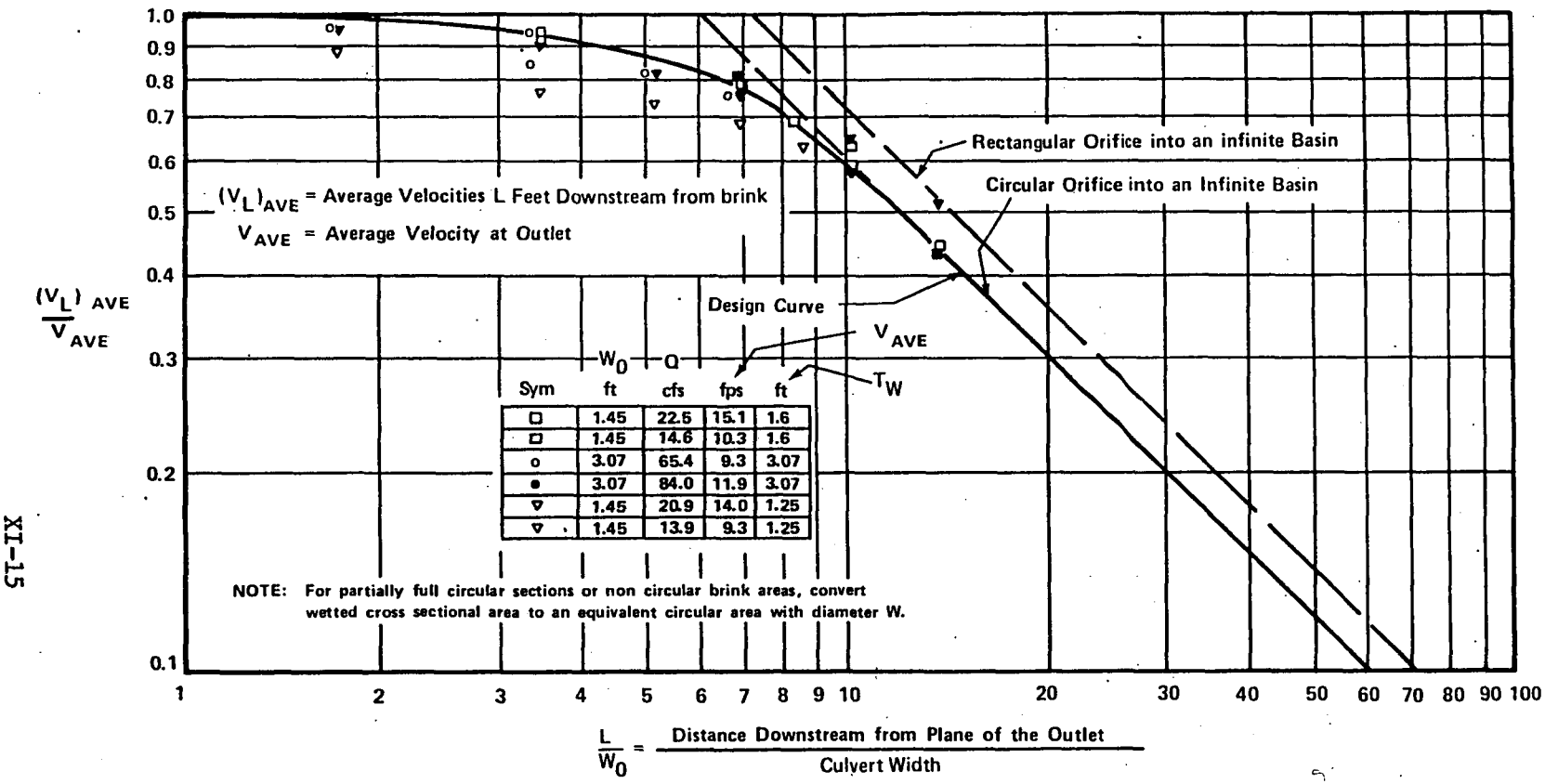


Figure XI - 3 Distribution of Centerline Velocity for Flow from Submerged Outlets from Reference XI - 2. to be used for Predicting Channel Velocities Downstream from Culvert Outlet where High Tailwater prevails. Velocities obtained from the use of this Chart can be used with Figure 2 of HEC No. 11 for sizing riprap (DO not use Figure 1 HEC No. 11, use Mean Velocity Values)

INVENTORY OF CONFLICTING UTILITIES

And Sewer Relocation Concept Costs

UTILITY POTHOLE DATA

TESTHOLE DATA SUMMARY

TBE GROUP, INC.

REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE ARIZONA U.S.A. Date Signed 8-6-01

PREPARED BY:
TBE Group, Inc.
2236 W. Shangri-La Rd.
Phoenix, AZ 85029
(602) 749-8550

DATE: August 3, 2001
PROJECT NAME: Bethany Home Outfall Channel - 91st Ave./ 83rd Ave.
PROJECT NO: N/A
CONTRACT NO: N/A

All Data is English

TBE Project Number: AZ-005-001-01

TH#	Street	Coordinates		Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type, Outside Diameter and Comments	Depth of Cover
		Northing	Easting							
1	83rd Avenue	918327.05	602248.56	12" AC Water	08/02/01	1083.71	1078.45	N/A	13" Concrete	5.26'
2	83rd Avenue	918200.98	602249.59	12" AC Water	08/02/01	xxx	xxx	xxx	Excavated at Request Site 13' Deep and 3' Wide- No Utility Found	xxx
3	83rd Avenue	917867.65	602272.54	12" AC Water	08/02/01	1083.56	1078.60	N/A	13" Concrete	4.96'
4	83rd Avenue	918162.75	602281.67	21" VCP Sanitary Sewer	08/02/01	1083.67	1073.51	N/A	21.5" VCP	10.16'
5	83rd Avenue	917963.48	602280.33	21" VCP Sanitary Sewer	08/02/01	1083.50	1072.86	N/A	22" Concrete	10.64'
6	83rd Avenue	918203.59	602235.63	36" Irrigation	08/02/01	1084.08	1081.54	N/A	43" Concrete	2.54'
7	83rd Avenue	918205.07	602336.05	36" Irrigation	08/02/01	1084.41	1082.65	N/A	43" Concrete	1.76'
8	83rd Avenue	918194.44	602234.50	Power	08/02/01	1083.78	1081.94	N/A	(2) 3" Plastic Conduits Laid 4" Wide	1.84'
9	83rd Avenue	918194.24	602309.94	Power	08/02/01	1083.85	1081.85	N/A	1.75" Plastic Conduit	2.00'
				Additional Utility			1081.91	N/A	+/- 36" Concrete Pipe - Running North of and Parallel to Electric Requested	1.94'
10	91st Avenue	918200.72	596965.38	12" AC Water	07/30/01	xxx	xxx	xxx	Excavated at Request Site to 5.5' Deep - No Utility Found/ Soil Very Hard with Large Chunks of Asphalt & Debris Limiting Maneuverability	xxx
11	91st Avenue	918283.85	596944.36	Power	07/27/01	1067.87	1064.43	N/A	1.5" Plastic Conduit	3.44'
12	91st Avenue	918279.66	597019.69	Power	07/25/01	1068.58	1064.83	N/A	1.5" Plastic Conduit	3.75'
13	91st Avenue	918287.04	596933.48	Irrigation	07/27/01	1066.73	1062.38	N/A	+/- 15" Concrete	4.35'
14	91st Avenue	918311.82	597011.59	Irrigation	07/25/01	1068.23	1063.96	N/A	9.58' Wide Slurry	4.27'

TESTHOLE DATA SUMMARY

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A.
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Date Signed 8-6-01
ARIZONA U.S.A.

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2236 W. Shangri-La Rd.
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CONTRACT NO: N/A

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TBE Project Number: AZ-005-001-01

TH#	Street	Coordinates		Anticipated Utility	Date	Ground Elevation	Top Elevation	Bottom Elevation	Material Type, Outside Diameter and Comments	Depth of Cover
		Northing	Easting							
15	91st Avenue	918298.74	596960.13	Water	07/27/01	xxx	xxx	xxx	Excavated at Request Site to 13' Deep - No Utility Found/ Encountered Asphalt Chunks & Rock	xxx
					07/28/01	xxx	xxx	xxx	Excavated Across from TH Site #16 to 13' Deep - No Utility Found	xxx
16	91st Avenue	918302.70	597002.45	Water	07/26/01	1067.82	1062.32	N/A	13" Concrete	5.50'
17	91st Avenue	918558.20	596955.49	12" AC Water	07/27/01	1066.66	1061.51	N/A	15" Asbestos Cement	5.15'
18	91st Avenue	918388.90	596998.95	Sanitary Sewer	07/20/01	1067.32	1055.18	N/A	23" VCP	12.14'
19	91st Avenue	918216.29	596948.55	72" RGRCP Irrigation	07/25/01	1068.06	1066.93	N/A	72" Concrete	1.13'
20	91st Avenue	918227.78	597019.77	72" RGRCP Irrigation	07/30/01	1067.81	1066.81	N/A	72" Concrete	1.00'
21	91st Avenue	918221.21	596948.61	Power	07/27/01	1067.75	1065.51	N/A	(2) 2.5" Plastic Conduits Laid 10" Wide	2.24'
22	91st Avenue	918232.26	597021.61	Power	07/30/01	1067.86	1064.62	N/A	(2) 2.5" Plastic Conduits Laid 8" Wide	3.24'
23	91st Avenue	918535.71	596995.20	Sanitary Sewer	07/30/01	1066.51	1055.97	N/A	23" VCP	10.54'

CULVERT AND MANHOLE SUMMARY

TBE GROUP, INC.

REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 8-6-01 ARIZONA U.S.A.

PREPARED BY:
TBE Group, Inc.
2236 W. Shangri-La Rd.
Phoenix, AZ 85029
(602) 749-8550

DATE: August 3, 2001
PROJECT NAME: Bethany Home Outfall Channel - 91st Ave./ 83rd Ave.
PROJECT NO: N/A
CONTRACT NO: N/A

All Data is English

TBE Project Number: AZ-005-001-01

REQ#	Street	Coordinates		Anticipated Utility	Date	MH Rim Elevation	Top Elevation	Invert Elevation	Material Type, Size, Pipe Direction and Comments	Depth of Cover
		Northing	Easting							
1	83rd Avenue	918340.32	602315.01	SSMH	07/24/01	1084.04	N/A	1075.22	8" VCP - East	8.82'
								1075.19	8" VCP - Southwest	8.85'
2	83rd Avenue	918287.85	602258.10	SSMH	07/24/01	1083.60	N/A	1074.70	8" VCP - Northeast	8.90'
								1072.94	12" VCP - East (Dry)	10.66'
								1072.26	24" VCP - North	11.34'
								1072.26	24" VCP - South	11.34'
								1073.28	6" VCP - Northwest	10.32'
3	83rd Avenue	918214.54	602256.82	SSMH	07/24/01	1083.58	N/A	1071.73	24" VCP - North	11.85'
								1071.63	24" VCP - East	11.95'
4	83rd Avenue	917808.61	602279.05	SSMH	07/24/01	1083.27	N/A	1070.65	24" VCP - North	12.62'
								1070.62	24" VCP - South	12.65'
5	91st Avenue	918746.47	596995.04	SSMH	07/24/01	1066.61	N/A	1055.11	6" VCP - East	11.50'
								1054.88	24" VCP - South	11.73'
								1054.86	24" VCP - North	11.75'
6	91st Avenue	918457.84	596995.64	SSMH	07/24/01	1066.94	N/A	1053.64	24" VCP - North	13.30'
								1053.64	24" VCP - South	13.30'
Basin-1	91st Avenue	918590.15	596948.79	C.B. E-Side Access Rim	07/24/01	1066.95	N/A	1061.75	24" RCP - East	5.20'
								1061.70	24" RCP - North	5.25'
								1061.65	Bottom of Box	5.30'
Basin-2	91st Avenue	918584.21	597009.18	C.B. W-Side Access Rim	07/24/01	1066.59	N/A	1058.19	24" RCP - East	8.40'
								1059.14	24" RCP - West	7.45'
								1058.79	Bottom of Box	7.80'

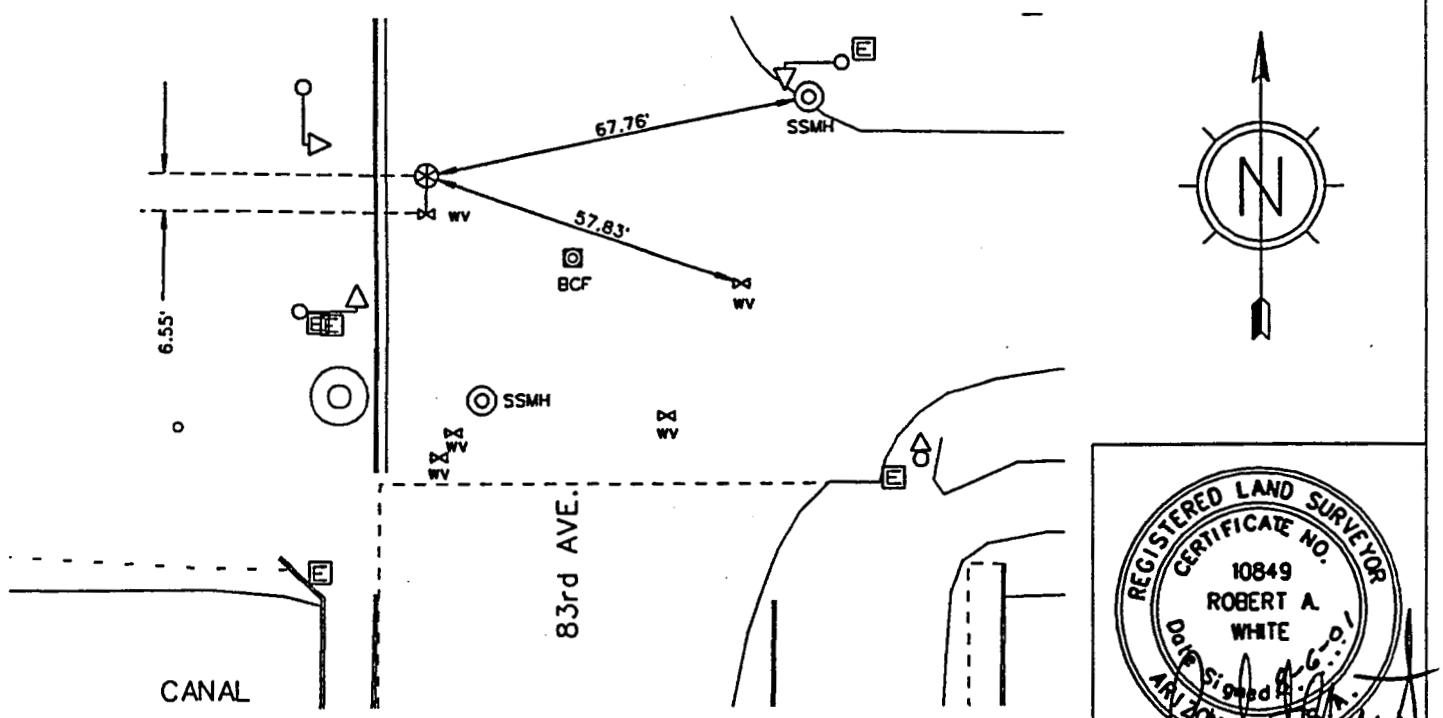
TESTHOLE DATA REPORT

TEST HOLE NO. 1
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ S. LIRA
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE.
NORTH SIDE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



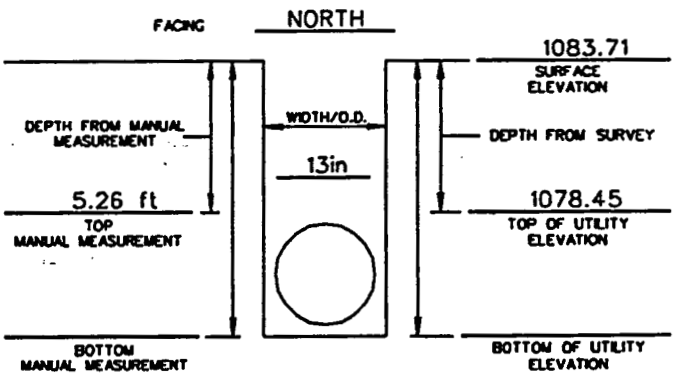
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918327.05 EAST 602248.56
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE 6in ASPHALT SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 13" CONCRETE WATER LINE
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

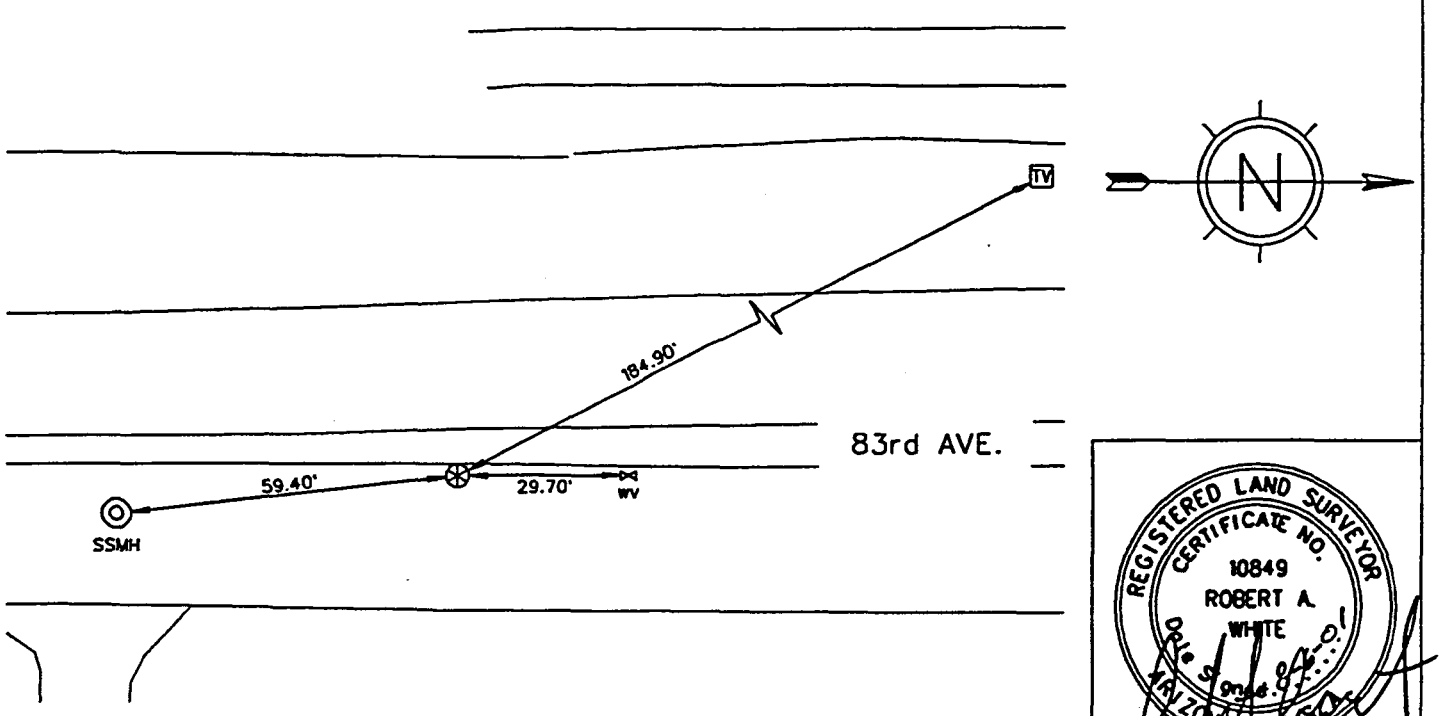
TESTHOLE DATA REPORT

TEST HOLE NO. 3
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ S. LIRA
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE.
SOUTH OF THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



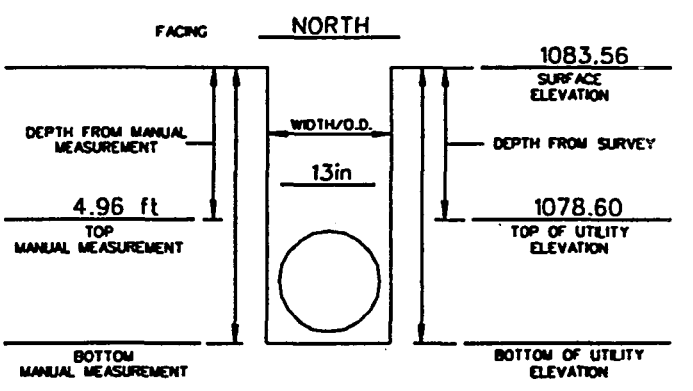
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 917867.65 EAST 602272.54
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE 4in ASPHALT SOIL CONDITION HARD DIRT
O.D./MATERIAL/TYPE 13" CONCRETE WATER LINE
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

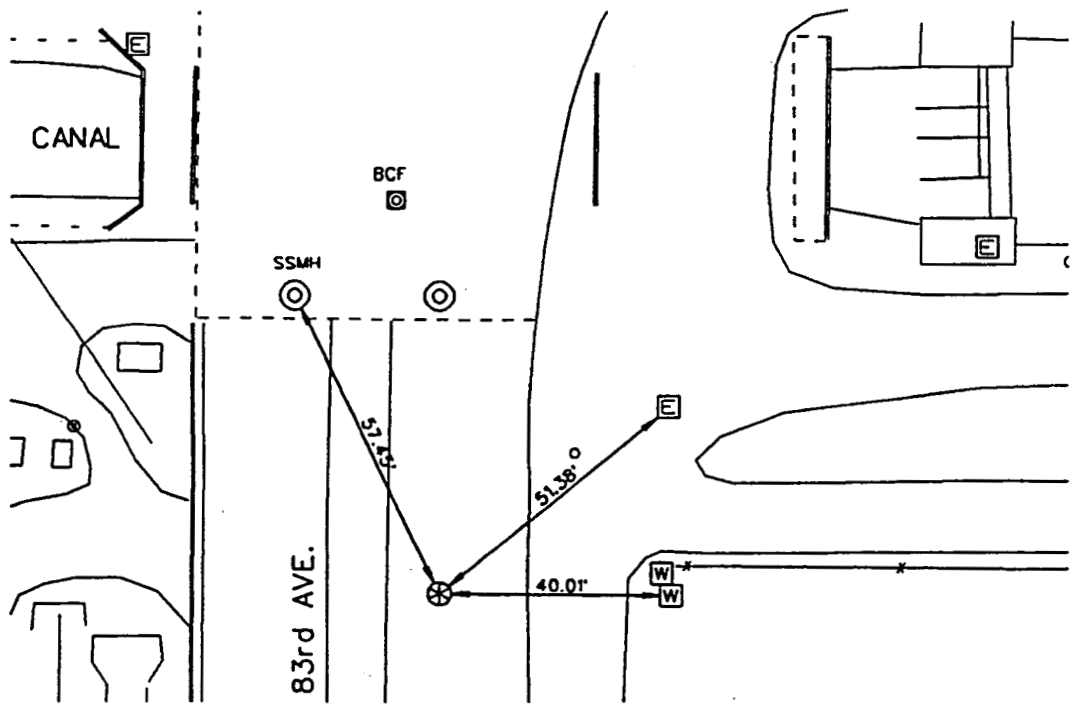
TESTHOLE DATA REPORT

TEST HOLE NO. 4
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ T.P./ S.L.
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE. AND THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE ARIZONA U.S.A.
Date Signed 8-9-01

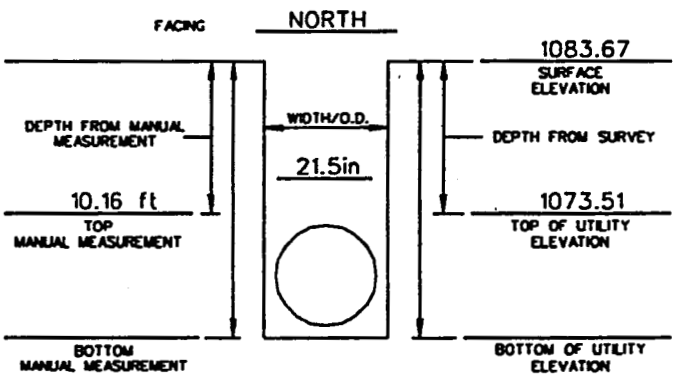
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR GREEN

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918162.75 EAST 602281.67
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE 6in ASPHALT SOIL CONDITION SOFT, ROCKY
O.D./MATERIAL/TYPE 21.5" VCP SANITARY SEWER
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

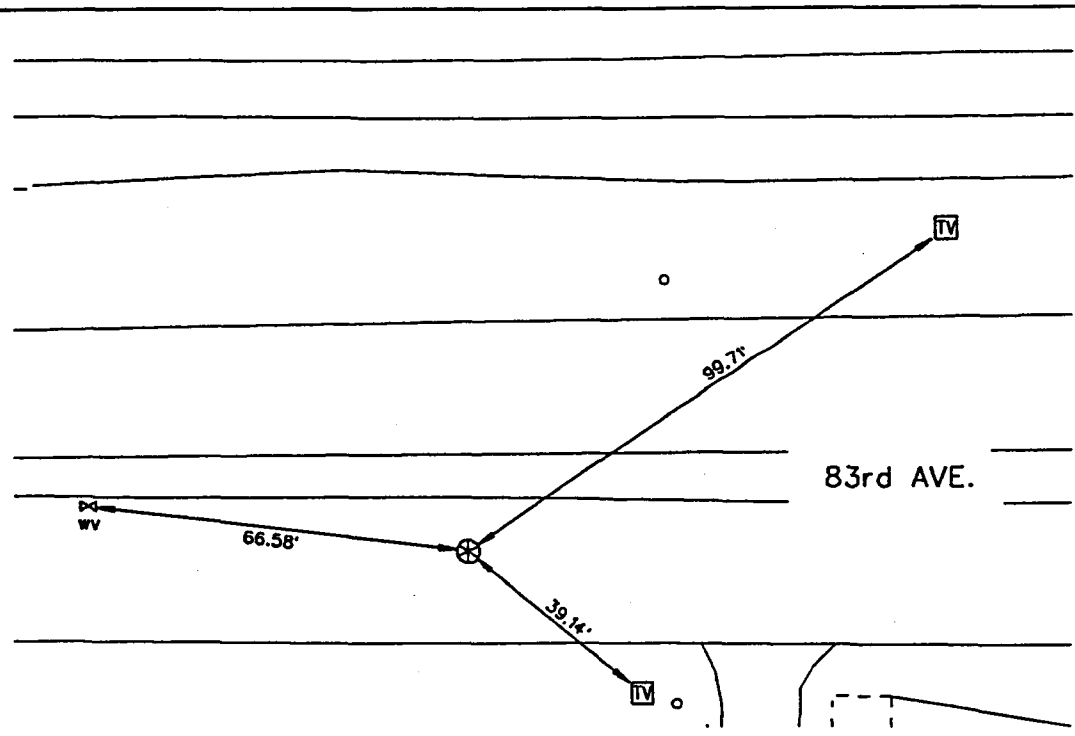
TESTHOLE DATA REPORT

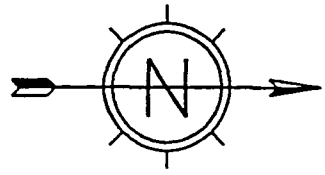
TEST HOLE NO. 5
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ T.P./ S.L.
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE.
SOUTH OF THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE





REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A.
WHITE
Date Signed 8/7/01
ARIZONA, U.S.A.

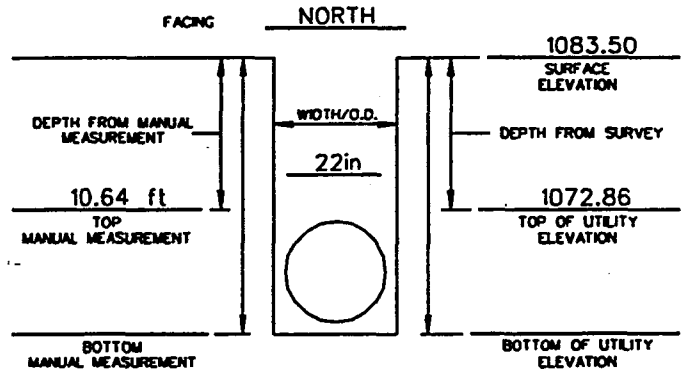
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR GREEN

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 917963.48 EAST 602280.33
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE 4in ASPHALT SOIL CONDITION HARD DIRT
O.D./MATERIAL/TYPE 22" CONCRETE SANITARY SEWER
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

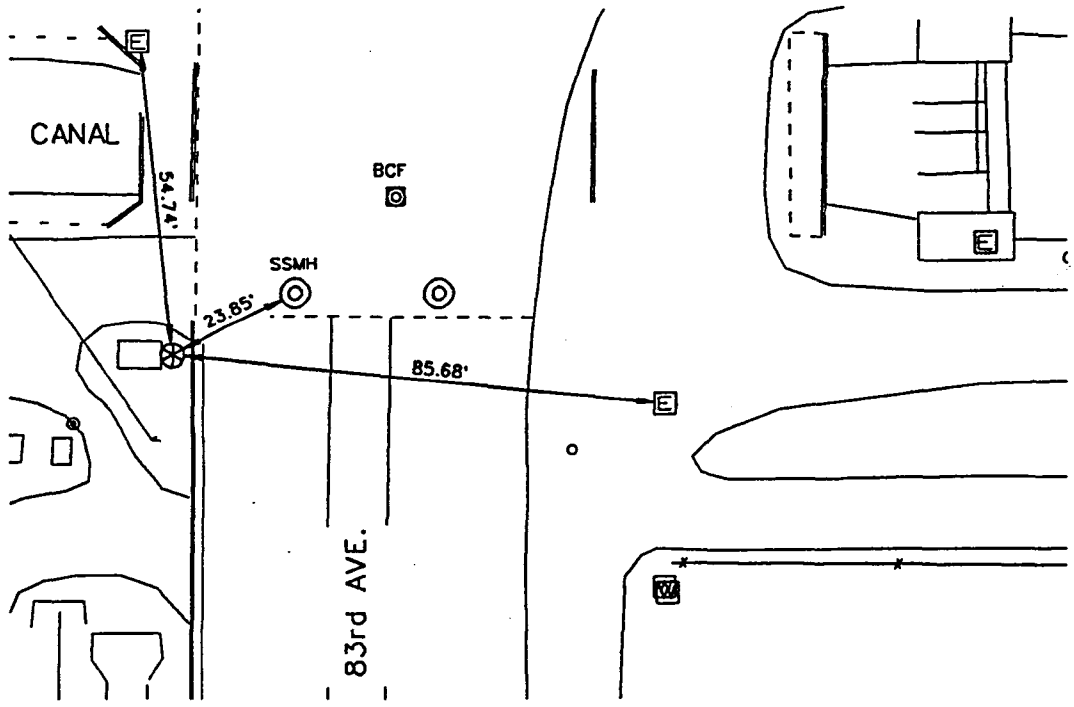
TESTHOLE DATA REPORT

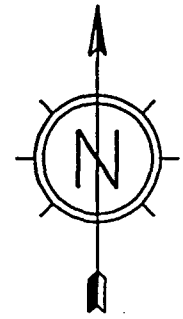
TEST HOLE NO. 6
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW T. POST/ G. GALLEGOS
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE. AND THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE





REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A.
WHITE
Date Signed
ARIZONA, U.S.A.

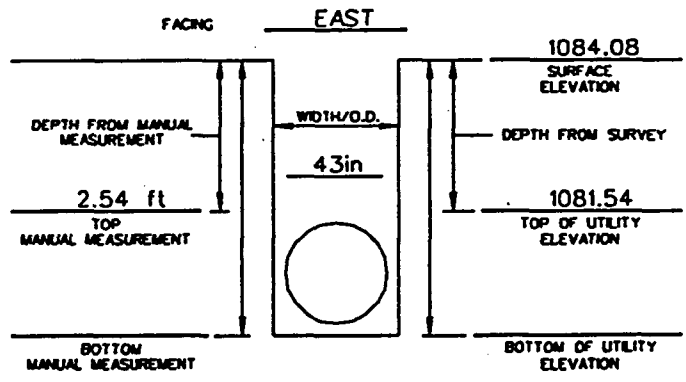
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918203.59 EAST 602235.63
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 43" CONCRETE IRRIGATION LINE
REMARKS: ADJUSTED T.H. +/- 14.9' N & 3.6' E TO PIPE LOCATION.

PREPARED BY: BAT CHECKED BY: TSB

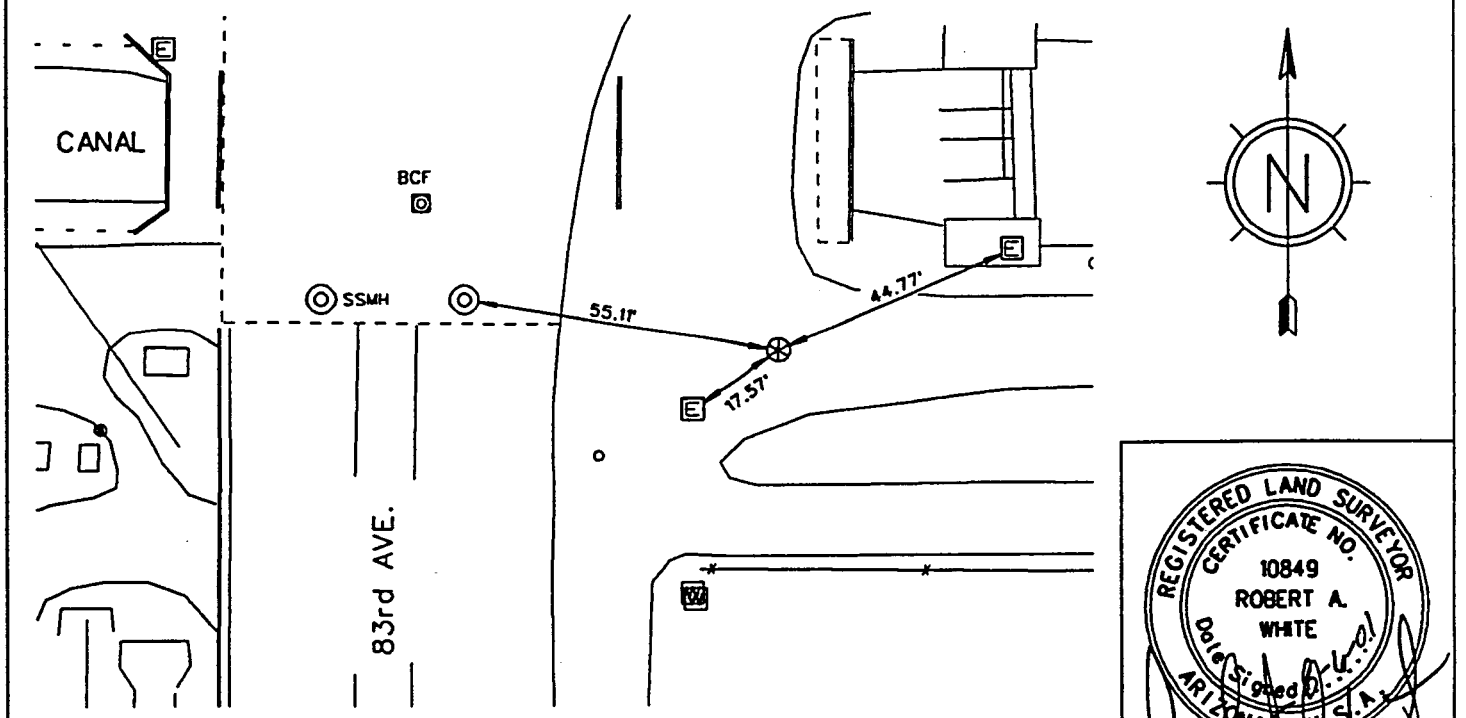
TESTHOLE DATA REPORT

TEST HOLE NO. 7
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ S. LIRA
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE. AND THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 8-6-01 ARIZONA U.S.A.

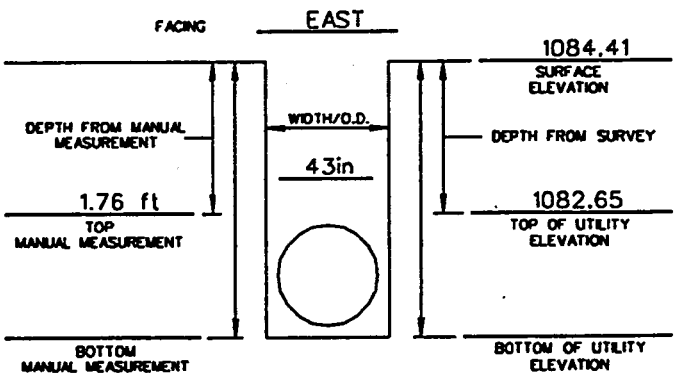
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N-918297.45, E-602764.71

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918205.07 EAST 602336.05
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT DIRT
O.D./MATERIAL/TYPE 43" CONCRETE IRRIGATION LINE
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

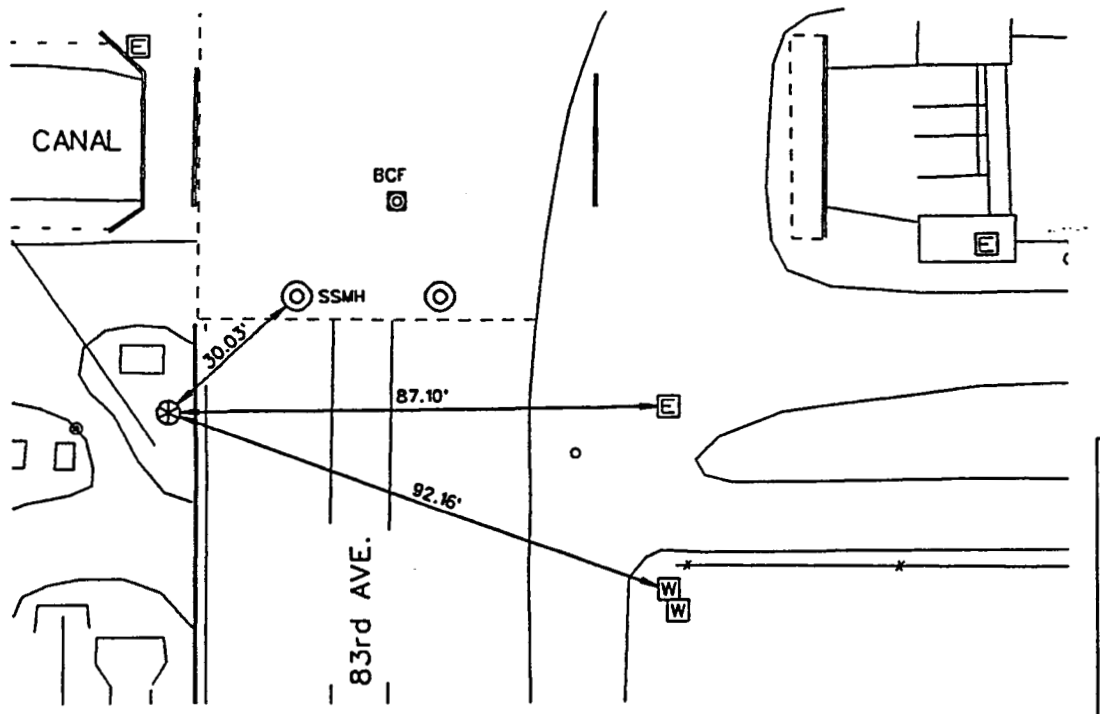
TESTHOLE DATA REPORT

TEST HOLE NO. 8
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ G. GALLEGOS
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE. AND THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



ALL H & V MEASURMENTS ENGLISH

REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 8/6/01 ARIZONA U.S.A.

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR RED

CROSS SECTION - NOT TO SCALE

FACING EAST

1083.78 SURFACE ELEVATION

DEPTH FROM MANUAL MEASUREMENT 1.84 ft TOP MANUAL MEASUREMENT

WIDTH/O.D. 4.0in

DEPTH FROM SURVEY 1081.94 TOP OF UTILITY ELEVATION

BOTTOM MANUAL MEASUREMENT

BOTTOM OF UTILITY ELEVATION

TESTHOLE COORDINATES NORTH 918194.44 EAST 602234.50
TESTHOLE STATION _____ OFFSET _____ ' ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE (2) 3" PLASTIC CONDUITS LAID 4" WIDE - ELECTRIC
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

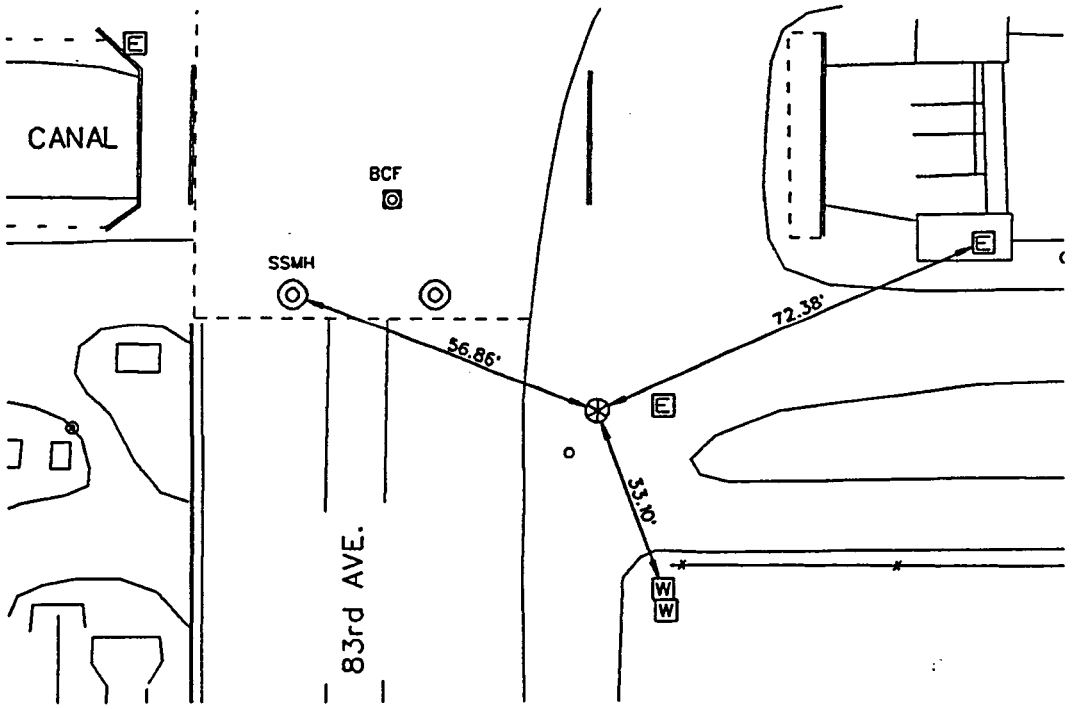
TESTHOLE DATA REPORT

TEST HOLE NO. 9
DATE DUG 8/2/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road Phoenix, Arizona 85029
(602) 749-8550 FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ S. LIRA
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 83rd AVE. AND THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed ARIZONA U.S.A.

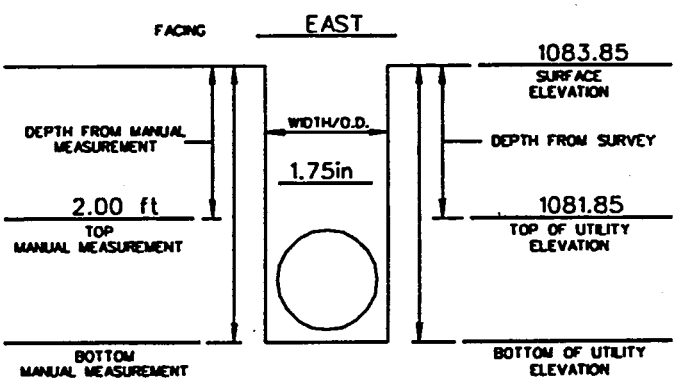
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1086.09
B.M. DESCRIPTION BCF AND PANAL
N=918297.45, E=602764.71

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR RED

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918194.24 EAST 602309.94
TESTHOLE STATION _____ OFFSET _____ ℄ 83rd AVENUE
STREET NAME

PAVING THICKNESS & TYPE 2in ASPHALT SOIL CONDITION SOFT DIRT
O.D./MATERIAL/TYPE 1.75" PLASTIC CONDUIT - ELECTRIC
REMARKS: ALSO FOUND CONCRETE PIPE RUNNING TO THE NORTH OF AND PARALLEL TO ELECTRIC REQUESTED.
FULL O.D. NOT OBTAINED : +/- 36", DEPTH= 1.94'
ELEVATION TOP = 1081.91

PREPARED BY: BAT CHECKED BY: TSB

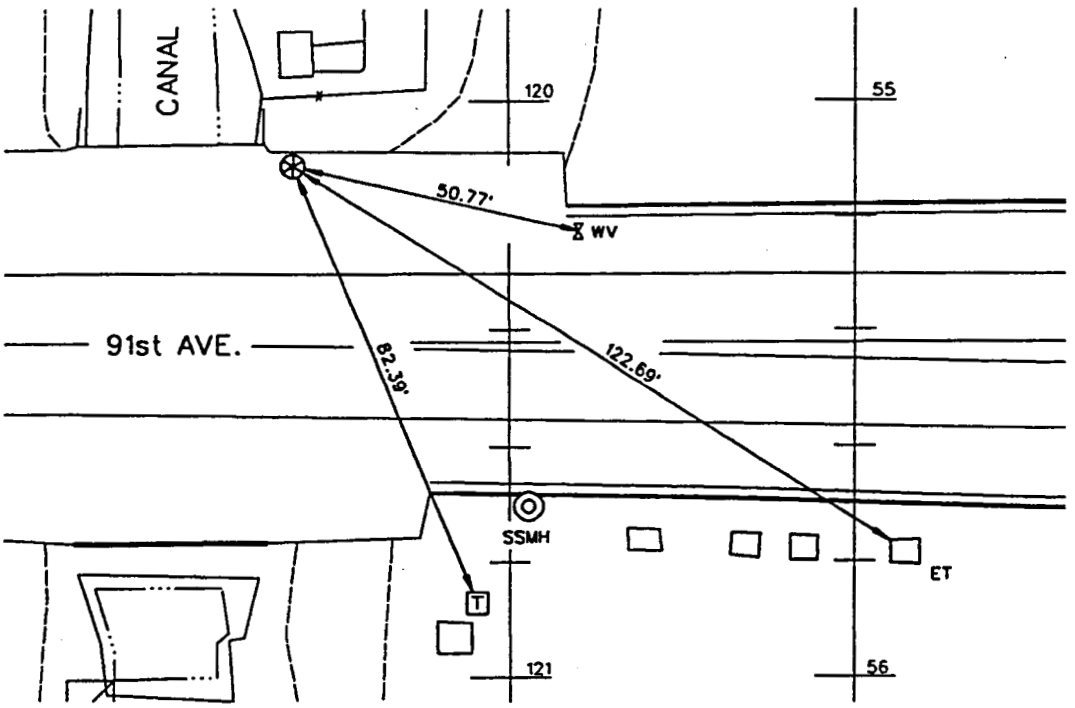
TESTHOLE DATA REPORT

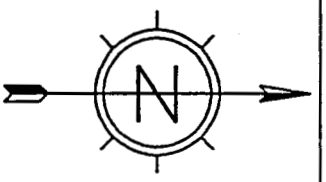
TEST HOLE NO. 11
DATE DUG 7/27/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE





REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 7-6-01 ARIZONA, U.S.A.

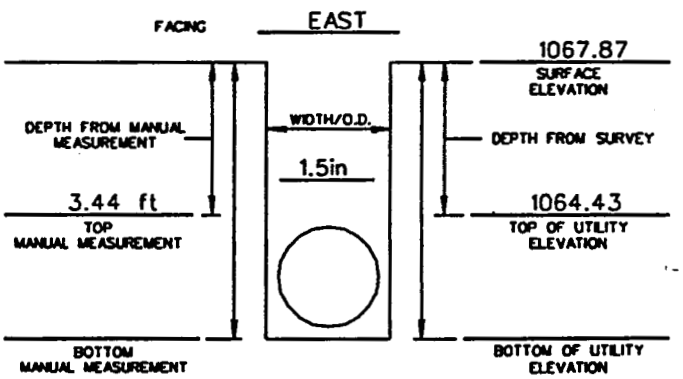
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR RED

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918283.85 EAST 596944.36
TESTHOLE STATION _____ OFFSET _____ ' ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE * 13in SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 1.5" PLASTIC CONDUIT FOR ELECTRIC
REMARKS: * 2in ASPHALT OVER 11in CONCRETE

PREPARED BY: BAT CHECKED BY: TSB

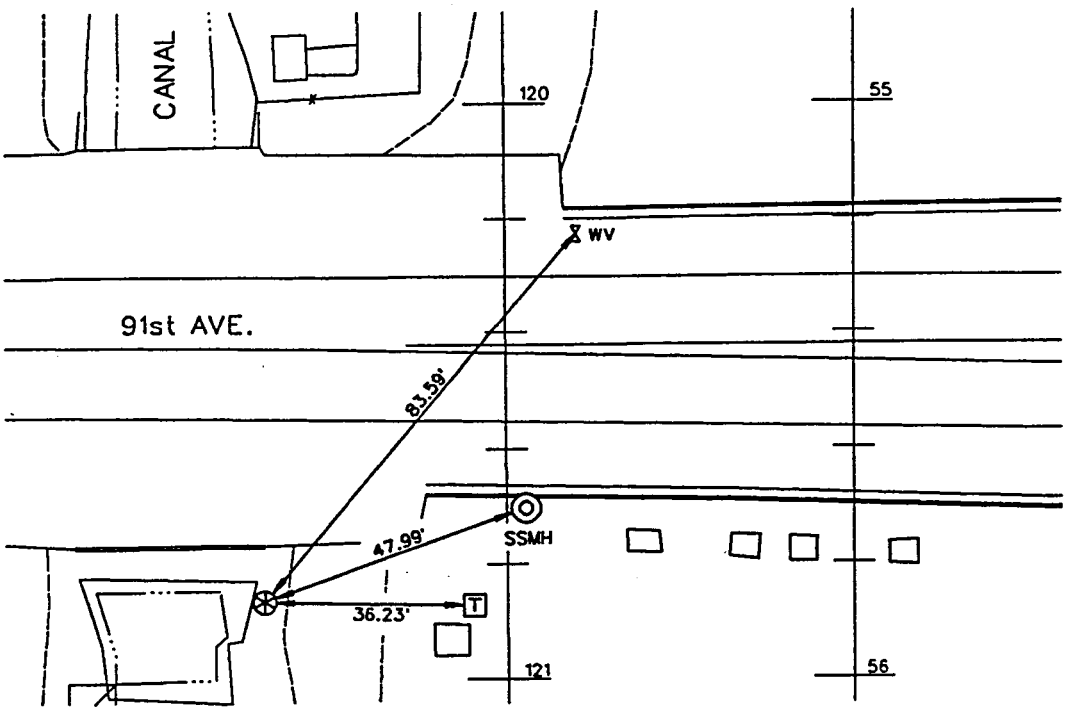
TESTHOLE DATA REPORT

TEST HOLE NO. 12
DATE DUG 7/25/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



ALL H & V MEASURMENTS ENGLISH

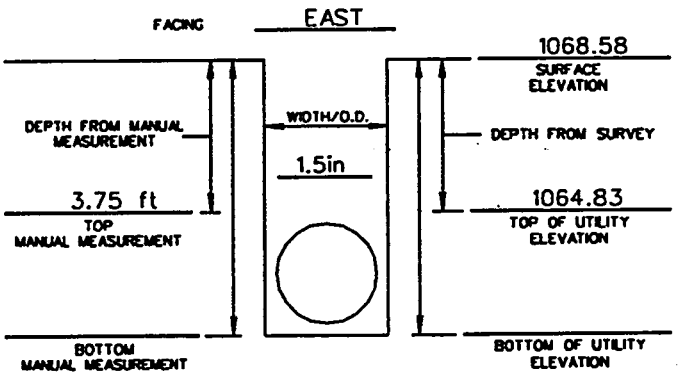
REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 8-16-01 ARIZONA, U.S.A.

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR RED

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918279.66 EAST 597019.69
TESTHOLE STATION _____ OFFSET _____ ' ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 1.5" PLASTIC CONDUIT FOR ELECTRIC
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

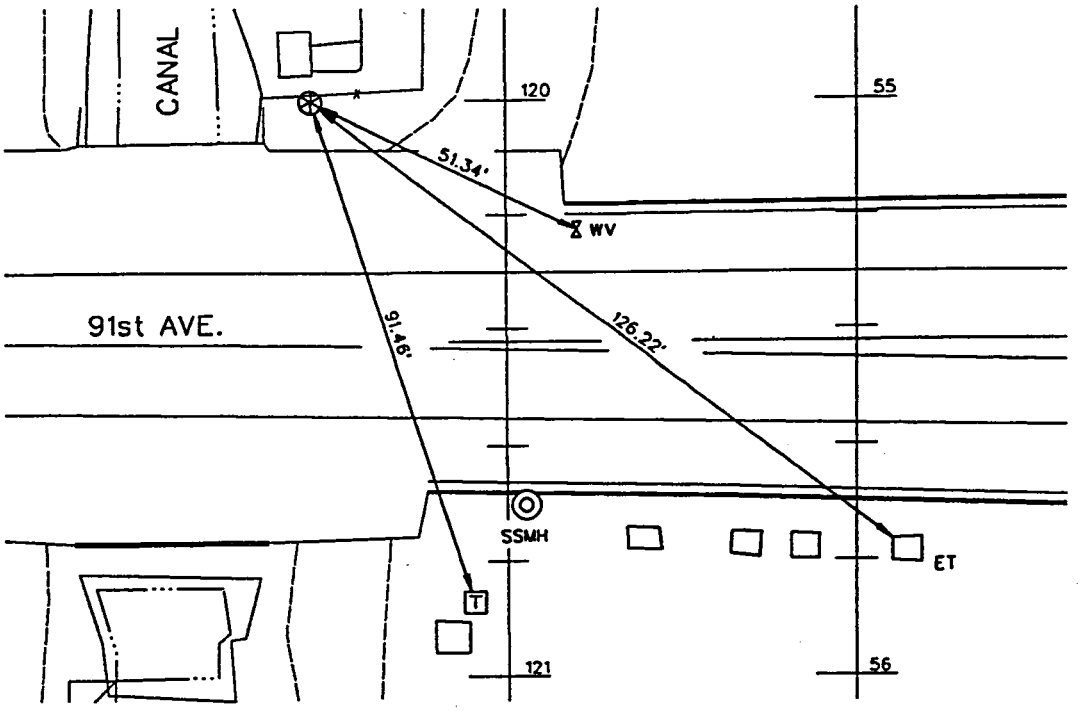
TESTHOLE DATA REPORT

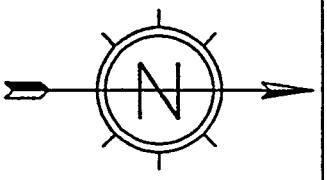
TEST HOLE NO. 13
DATE DUG 7/27/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

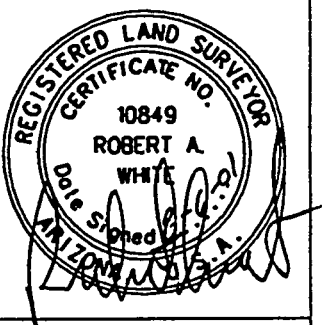
TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE







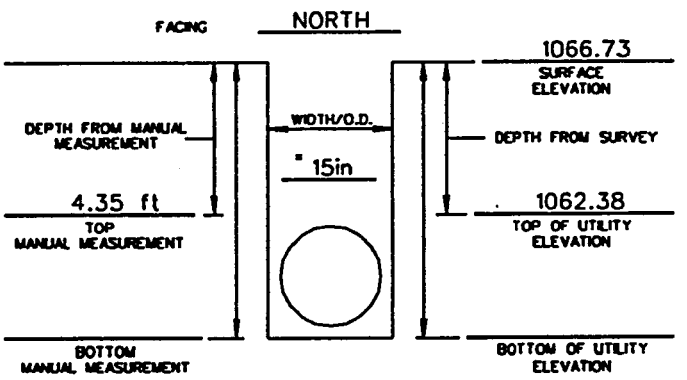
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918287.04 EAST 596933.48
TESTHOLE STATION _____ OFFSET _____ ' ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE +/- 15" CONCRETE - IRRIGATION
REMARKS: " PIPE COVERED WITH CONCRETE OVERPOUR - UNABLE TO OBTAIN TRUE O.D.
ADJUSTED T.H. 7.6' NORTH TO CENTER OF IRRIGATION LINE.

PREPARED BY: BAT CHECKED BY: TSB

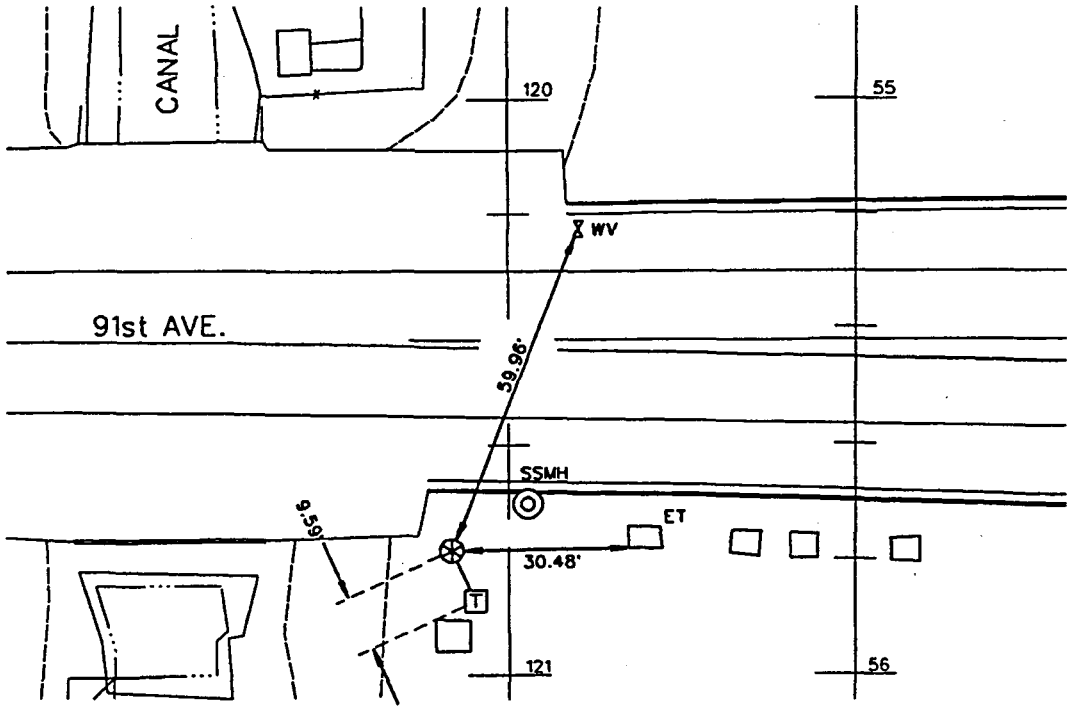
TESTHOLE DATA REPORT

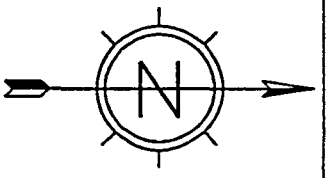
TEST HOLE NO. 14
DATE DUG 7/25/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

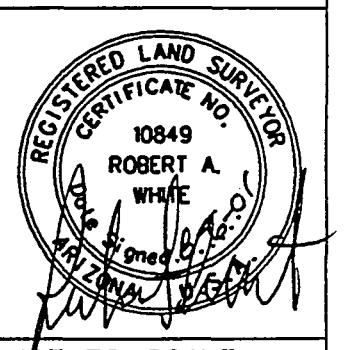
TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE







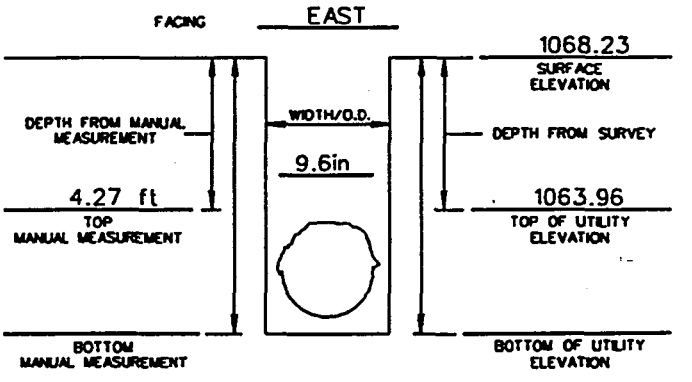
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918311.82 EAST 597011.59
TESTHOLE STATION _____ OFFSET _____ ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SAND, SMALL ROCK
O.D./MATERIAL/TYPE 9.58' WIDE CONCRETE/ SLURRY - IRRIGATION
REMARKS: HUGE MASS OF CONC./ SLURRY "OVERPOUR" - UNABLE TO EXPOSE BOTTOM IN T.H. DUE TO WIDTH.

PREPARED BY: BAT CHECKED BY: TSB

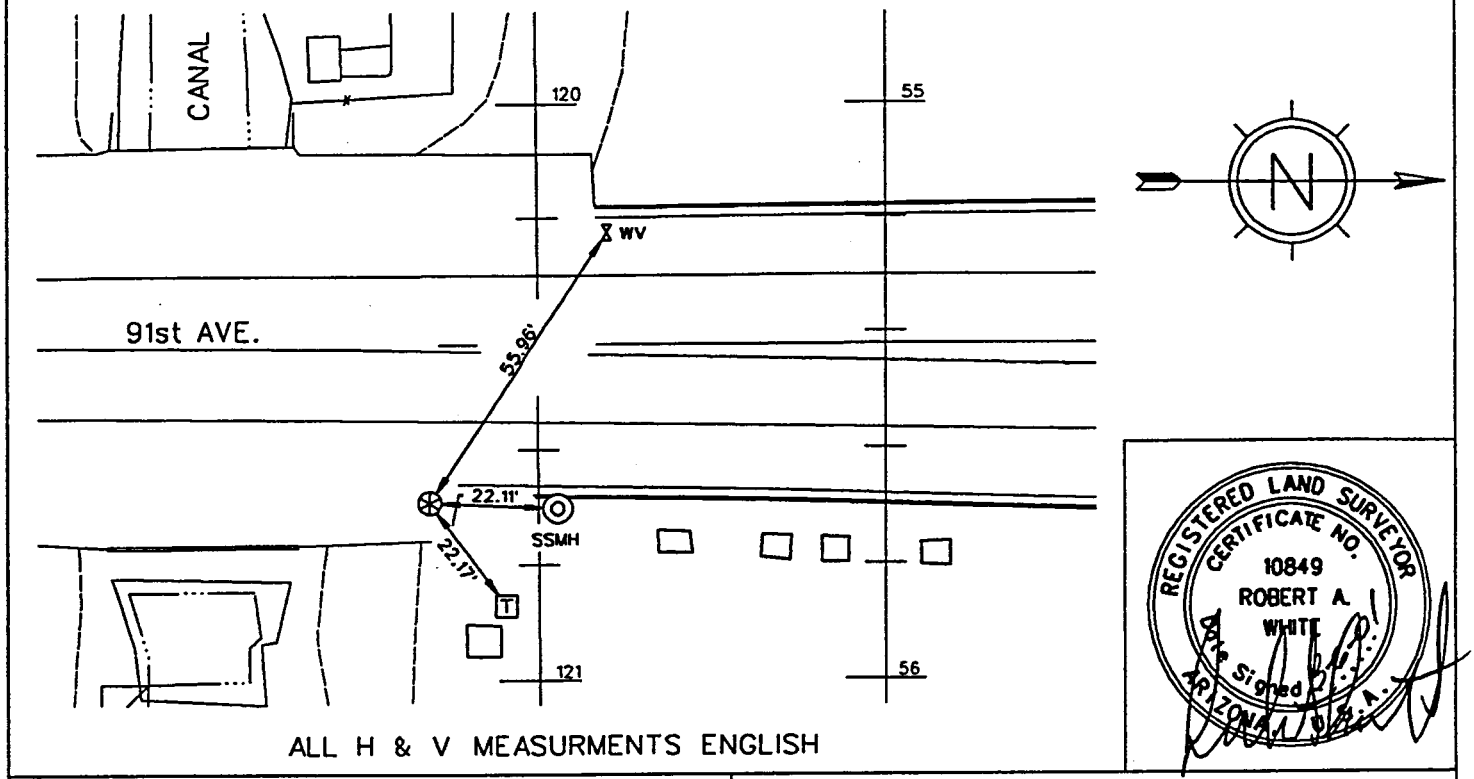
TESTHOLE DATA REPORT

TEST HOLE NO. 16
DATE DUG 7/26/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ S. LIRA
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



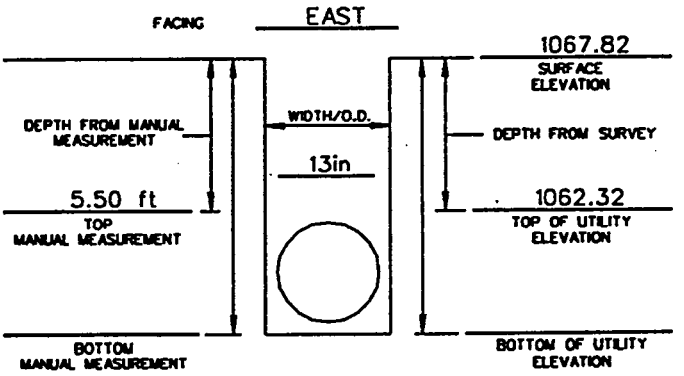
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918302.70 EAST 597002.45
TESTHOLE STATION _____ OFFSET _____ ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE " 14in SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 13" CONCRETE WATER LINE
REMARKS: " 2in ASPHALT OVER 12in CONCRETE
ADJUSTED T.H. 4' NORTH TO WATER LINE LOCATION.

PREPARED BY: BAT CHECKED BY: TSB

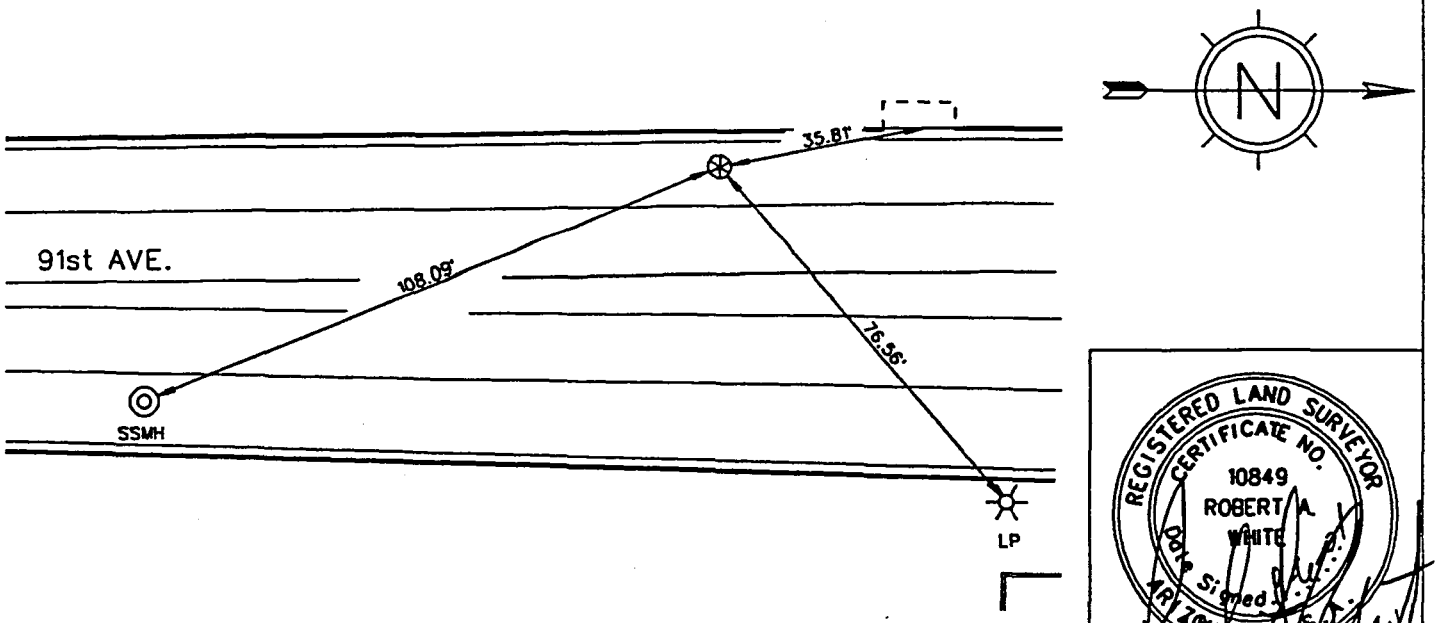
TESTHOLE DATA REPORT

TEST HOLE NO. 17
DATE DUG 7/27/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. JUST NORTH OF THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A. WHITE
Date Signed
ARIZONA U.S.A.

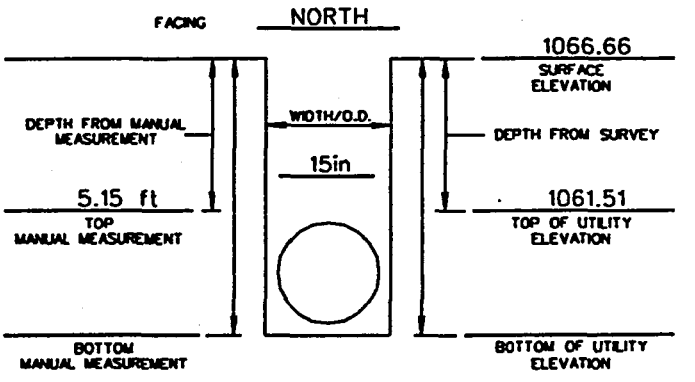
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918558.20 EAST 596955.49
TESTHOLE STATION _____ OFFSET _____ ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE 8in ASPHALT SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 15" ASBESTOS CEMENT WATER LINE
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

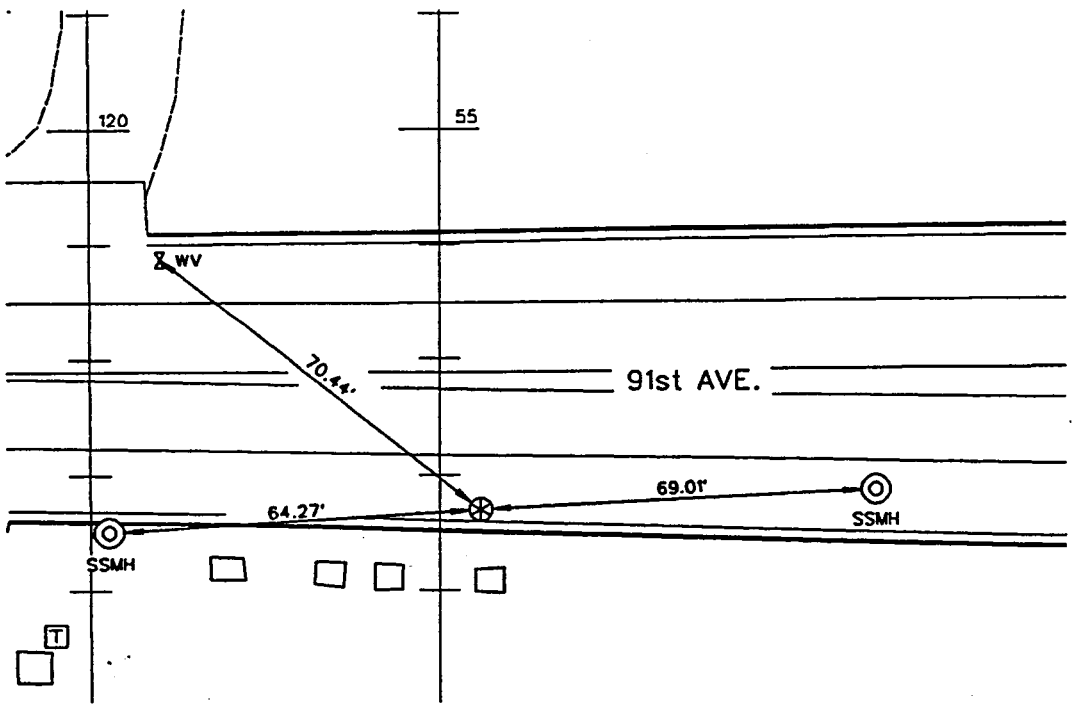
TESTHOLE DATA REPORT

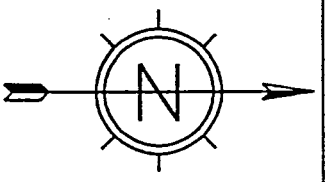
TEST HOLE NO. 18
DATE DUG 7/20/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. JUST NORTH OF THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE





REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 8-6-01 ARIZONA U.S.A.

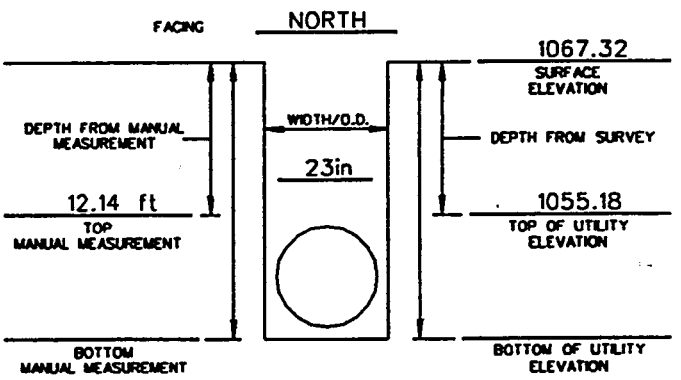
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

P.K.NAIL SET AT ℄ UTILITY
RIBBON COLOR GREEN

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918388.90 EAST 596998.95
TESTHOLE STATION _____ OFFSET _____ ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE 7in ASPHALT SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 23" VCP SANITARY SEWER
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

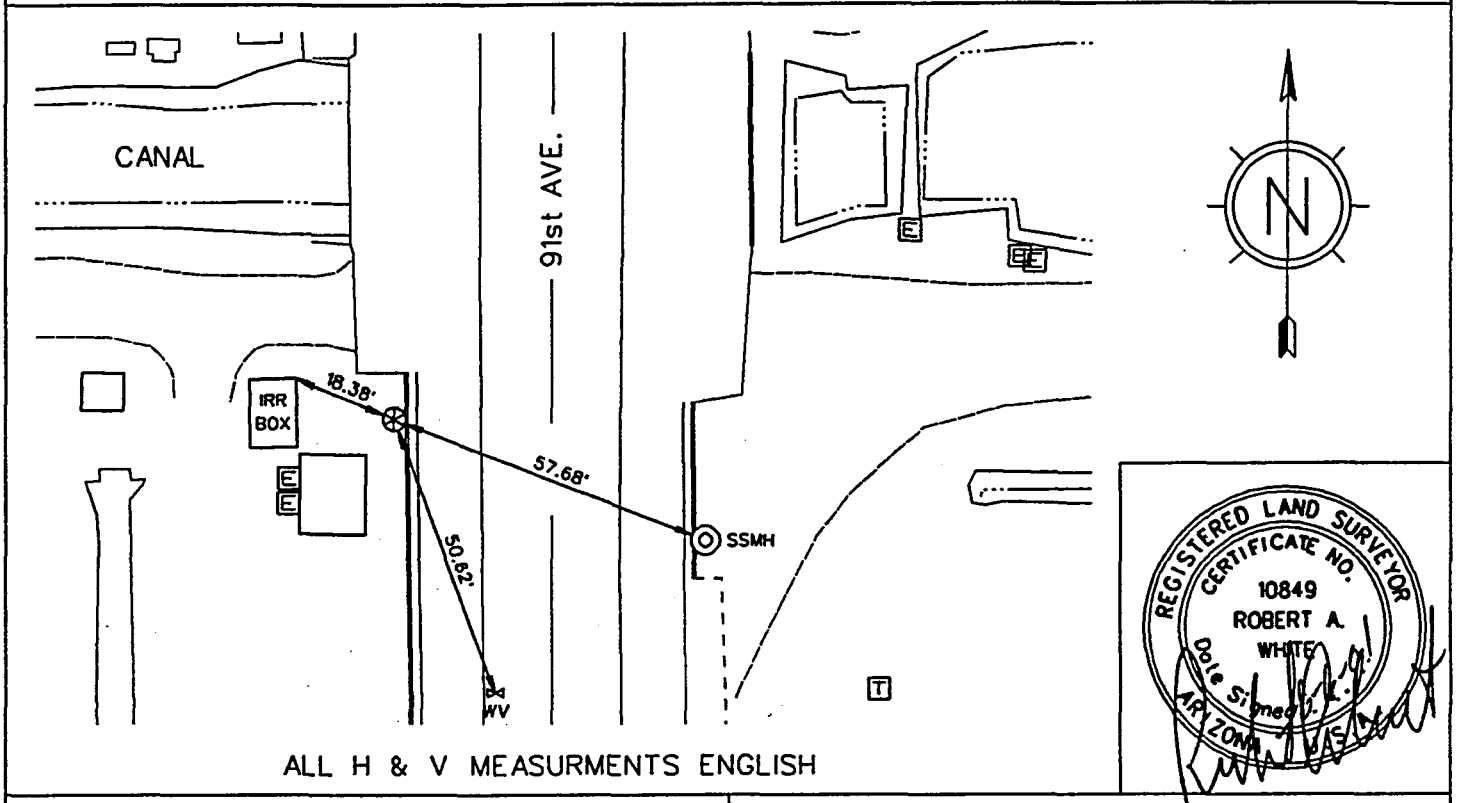
TESTHOLE DATA REPORT

TEST HOLE NO. 19
DATE DUG 7/25/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 211

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW J. PESAKOVIC/ S. LIRA
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



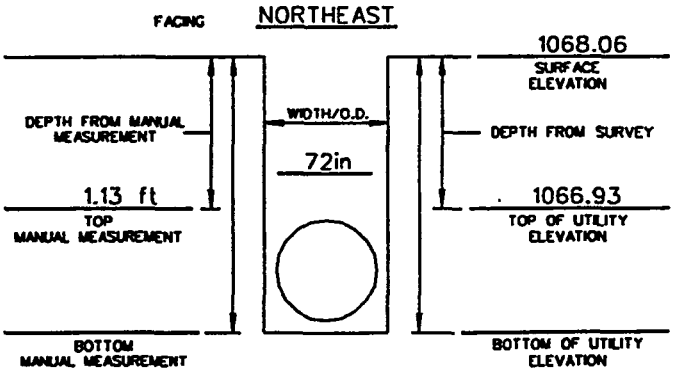
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918216.29 EAST 596948.55
TESTHOLE STATION _____ OFFSET _____ ' ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE +/- 72" CONCRETE IRRIGATION LINE
REMARKS: UNABLE TO OBTAIN TRUE O.D. DUE TO CONCRETE/ SLURRY "OVERPOUR" ON PIPE IN T.H.

PREPARED BY: BAT CHECKED BY: TSB

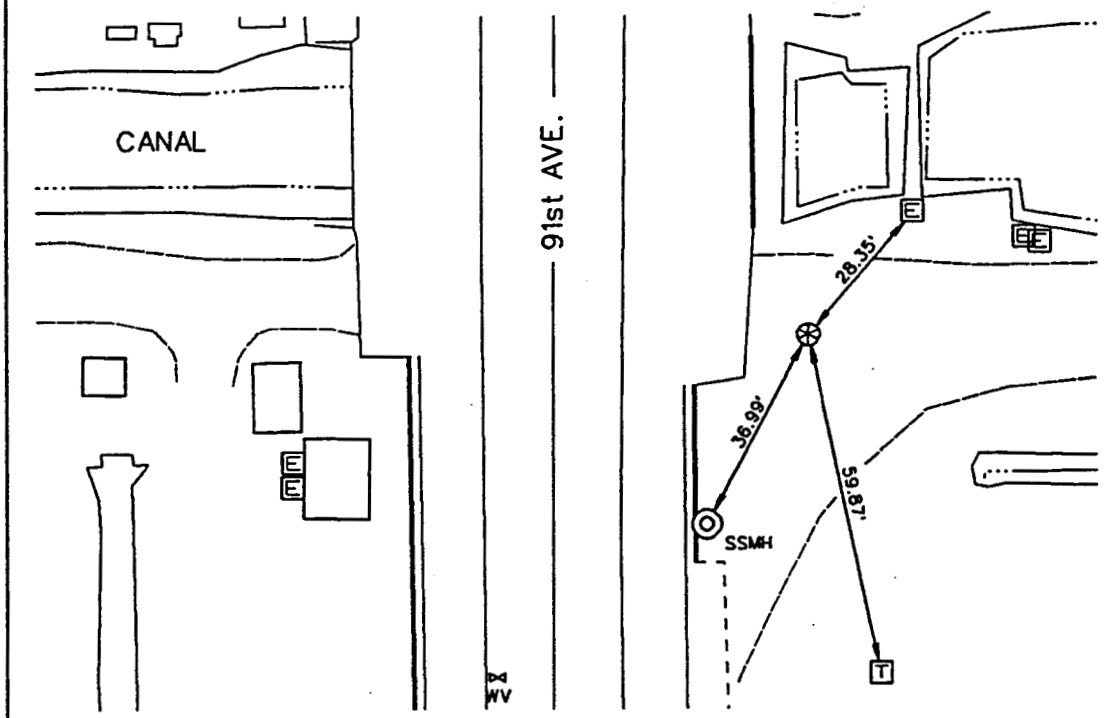
TESTHOLE DATA REPORT

TEST HOLE NO. 20
DATE DUG 7/30/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



ALL H & V MEASURMENTS ENGLISH

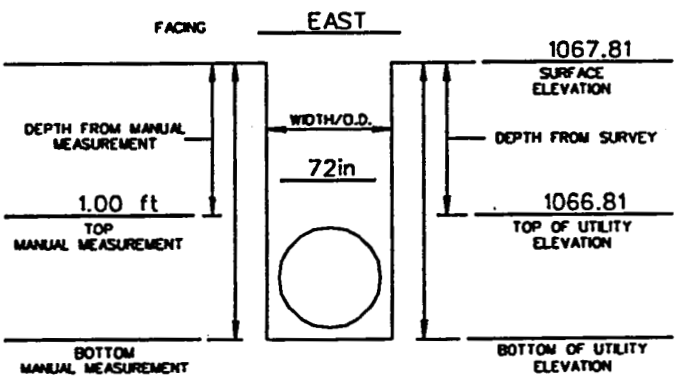
REGISTERED LAND SURVEYOR CERTIFICATE NO. 10849 ROBERT A. WHITE Date Signed 8-1-01 ARIZONA U.S.A.

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR BLUE

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918227.78 EAST 597019.77
TESTHOLE STATION _____ OFFSET _____ ' ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION HARD, MOIST
O.D./MATERIAL/TYPE 72" CONCRETE IRRIGATION LINE
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

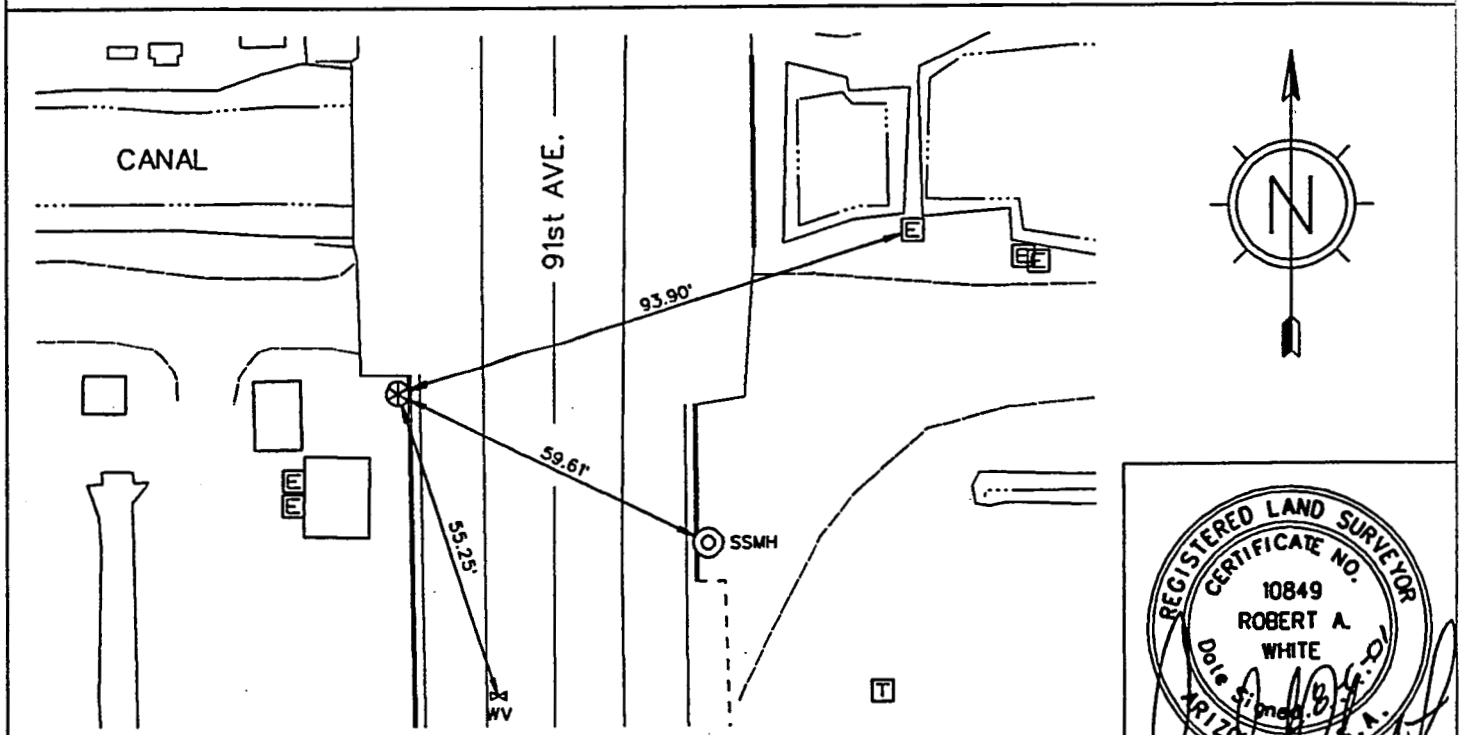
TESTHOLE DATA REPORT

TEST HOLE NO. 21
DATE DUG 7/27/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A.
WHITE
Date Signed 8-7-01
ARIZONA, U.S.A.

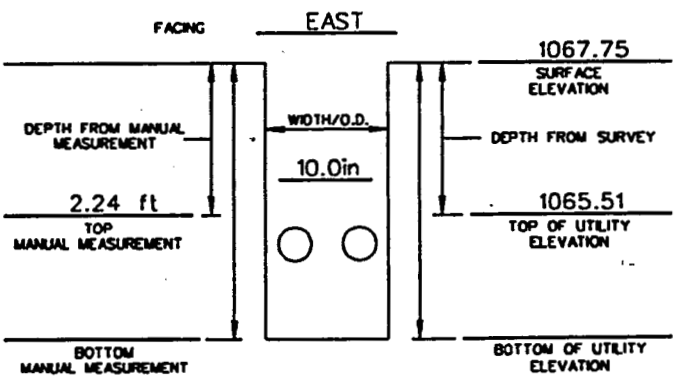
ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR RED

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918221.21 EAST 596948.61
TESTHOLE STATION _____ OFFSET _____ ' ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE (2) 2.5" PLASTIC CONDUITS LAID 10" WIDE - ELECTRIC
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

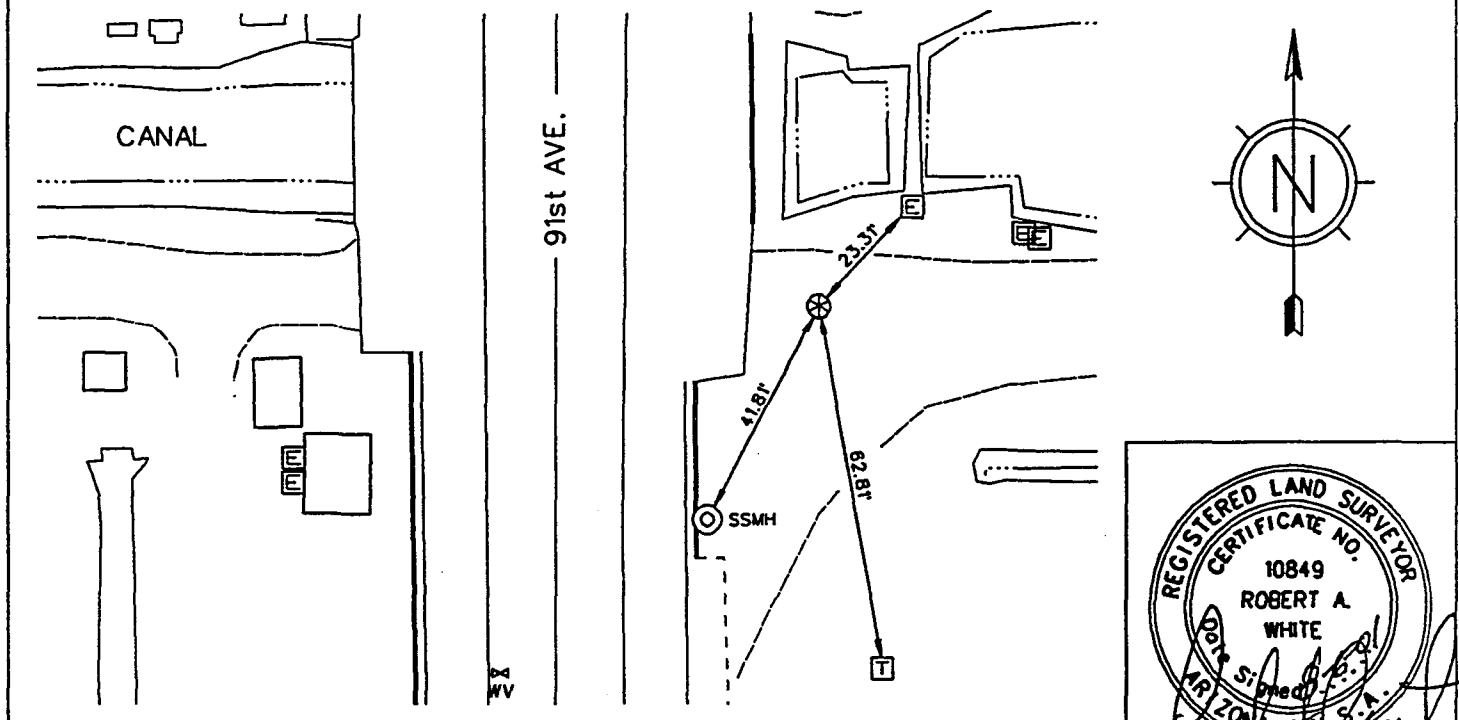
TESTHOLE DATA REPORT

TEST HOLE NO. 22
DATE DUG 7/30/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road (602) 749-8550
Phoenix, Arizona 85029 FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. AT THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A.
WHITE
Date Signed 8-6-01
ARIZONA U.S.A.

ALL H & V MEASURMENTS ENGLISH

BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

STEEL PIN SET AT ℄ UTILITY
RIBBON COLOR RED

CROSS SECTION - NOT TO SCALE

FACING EAST

		1067.86 SURFACE ELEVATION
DEPTH FROM MANUAL MEASUREMENT	WIDTH/O.D. 8.0in	DEPTH FROM SURVEY
3.24 ft TOP MANUAL MEASUREMENT		1064.62 TOP OF UTILITY ELEVATION
BOTTOM MANUAL MEASUREMENT		BOTTOM OF UTILITY ELEVATION

TESTHOLE COORDINATES NORTH 918232.26 EAST 597021.61
TESTHOLE STATION _____ OFFSET _____ ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE N/A SOIL CONDITION HARD, SAND & ROCK
O.D./MATERIAL/TYPE (2) 2.5" PLASTIC CONDUITS LAID 8" WIDE - ELECTRIC
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

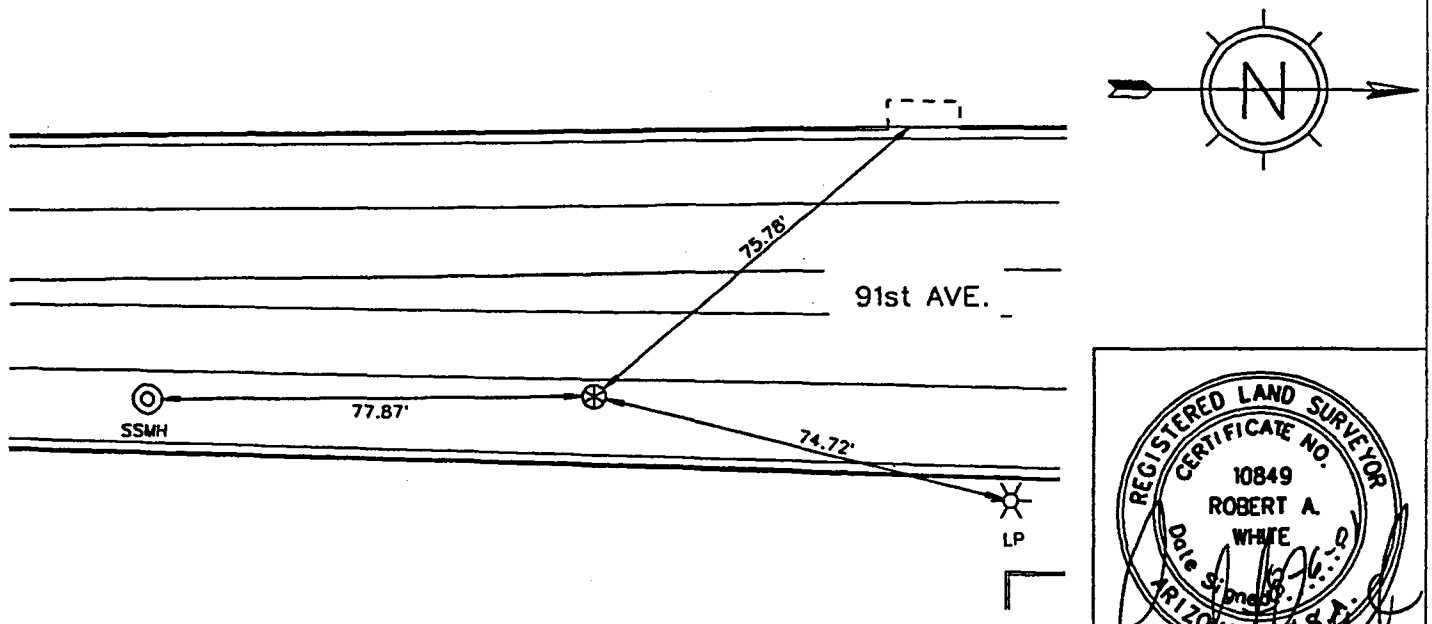
TESTHOLE DATA REPORT

TEST HOLE NO. 23
DATE DUG 7/30/01
CLIENT PROJECT NO. -------
TBE PROJECT NO. AZ-005-001-01
TBE TRUCK NO. 212

TBE GROUP, INC.
2236 W. Shangri-la Road
Phoenix, Arizona 85029
(602) 749-8550
FAX (602) 749-8551

SUE CREW T. POST/ P. ABRUZZESE
CITY/COUNTY GLENDALE/ MARICOPA
GENERAL LOCATION 91ST AVE. JUST NORTH OF THE GRAND CANAL

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR
CERTIFICATE NO.
10849
ROBERT A.
WHITE
Date Signed 8-16-01
ARIZONA U.S.A.

ALL H & V MEASURMENTS ENGLISH

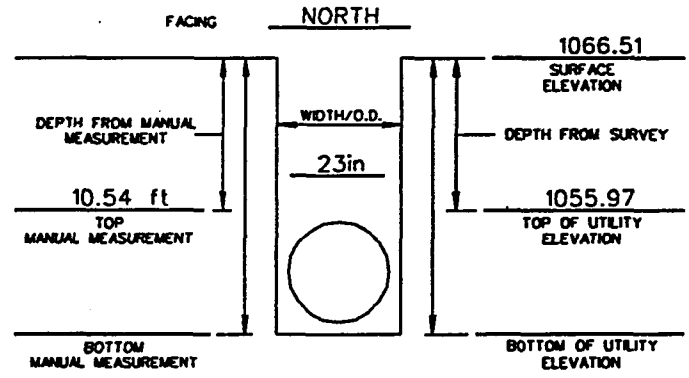
BENCHMARK

B.M. ELEVATION 1067.09
B.M. DESCRIPTION PK NAIL AND PANAL
N: 918742.06, E: 596975.34

P.K.NAIL SET AT ℄ UTILITY

RIBBON COLOR GREEN

CROSS SECTION - NOT TO SCALE



TESTHOLE COORDINATES NORTH 918535.71 EAST 596995.20
TESTHOLE STATION _____ OFFSET _____ ℄ 91ST AVENUE
STREET NAME

PAVING THICKNESS & TYPE 8in ASPHALT SOIL CONDITION SOFT, MOIST
O.D./MATERIAL/TYPE 23" VCP SANITARY SEWER
REMARKS:

PREPARED BY: BAT CHECKED BY: TSB

DMJM+HARRIS

2777 East Camelback Road
Suite 200
Phoenix, Arizona 85016-4302

Tel: (602) 337-2777
Fax: (602) 337-2620

July 16, 2001

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

ATTN: Mr. C. Scott Vogel, P.E.
Senior Project Manager
Planning and Project Management Division

RE: Contract FCD 98-46
Bethany Home Outfall Channel, Phase II
Final Design Cost Proposal

SUBJECT: Utility Potholing

Dear Scott:

Enclosed for your review is the DMJM+HARRIS request for additional funding for optional utility potholing associated with the Design of Reach A of the Bethany Home Outfall Channel - Phase II. DMJM +HARRIS will identify the pothole locations, review with the FCDMC utility coordinator and locate all potholes in plan and profile on the construction drawings.

In support of this effort, DMJM+HARRIS requests $13,289.70 in optional funding. The remaining value of the optional potholing task would be $3,790.00 as negotiated for this phase of the contract. If you have any questions concerning this proposal, please do not hesitate to call me at (602) 337-2540.

Sincerely,

DMJM+HARRIS

Jeffrey R. Minch

Jeffrey R. Minch, P.E.
Project Manager

Attachments

Cc: MSS, SMO, MET

CONSULTANT/SUBCONSULTANT COST PROPOSAL SUMMARY

CONSULTANT/SUBCONSULTANT: DMJM Arizona, Inc.

PROJECT NAME: Bethany Home Outfall Channel, Phase II - OPTIONAL ITEMS

CONTRACT NO.: FCD 98-46

OPTIONAL NO.: 16 - Utility Potholes

DATE: July 15, 2001

DIRECT LABOR

Classifications	Manhours	FY '00 Hourly Rates	Labor Costs
Project Principal	0	$ 62.31	$ -
Project Manager	2	$ 40.91	$ 81.82
Discipline Manager	0	$ 44.52	$ -
Sr. Project Engineer	0	$ 37.92	$ -
Project Engineer	8	$ 32.49	$ 259.92
Landscape Architect	0	$ 37.26	$ -
Engineer/Designer	0	$ 22.71	$ -
Landscape Designer	0	$ 21.00	$ -
CAD/Technician	0	$ 18.89	$ -
Clerical/Administration	0	$ 15.91	$ -
Total Hours:	10	Total Labor:	$ 341.74

OVERHEAD @ 142.9% of Labor: $ 488.35

Subtotal: $ 830.09

DIRECT AND OUTSIDE EXPENSES

Subtotal: $ 100.00

SUBCONSULTANTS

Name		Cost	Task
Logan Simpson Design, Inc.	$	-	(Public Involvement -MBE/WBE)
ATL, Inc.	$	-	(Geotechnical - MBE/WBE)
AZTEC Engineering, Inc.	$	-	(Survey - MBE/WBE)
Premier Engineering Corp.	$	-	(Structures - MBE/WBE)
Aqua Engineering	$	-	(Landscape Irrigation)
TBE, Inc.	$	12,260.00	(Utility Locating)
Subtotal:	$	12,260.00	

Subtotal Labor:	$	830.09
Subtotal Expenses:	$	100.00
Subtotal Subconsultants:	$	12,260.00
Total Consultant Cost:	$	13,190.09
Net Fee (Subtotal Labor x 12%):	$	99.61
TOTAL PROPOSED FEE:	$	13,289.70

FLOOD CONTROL DISTRICT of Maricopa County
Bethany Home Outfall Channel
Task Listing - Optional Items

Section	Task	Project Principal $ 62.31	Project Manager $ 40.91	Discipline Manager $ 44.52	Sr. Project Engineer $ 37.92	Project Engineer $ 32.49	Landscape Architect $ 37.26	Engineer/ Designer $ 22.71	Landscape Designer $ 21.00	CADD/ Technician $ 18.89	Clerical $ 15.91	Total
FINAL DESIGN												
14.1.3.2	Potholing 23 locations		2			8						10
	Manhours	0	2	0	0	8	0	0	0	0	0	10

TBE GROUP, INC.

ENGINEERS
PLANNERS
SURVEYORS and MAPPERS
SUBSURFACE UTILITY ENGINEERS

July 16, 2001

RECEIVED
JUL 17 2001
DMJM

Mr. Jeff Minch, P.E.
DMJM Arizona, Inc
2777 E. Camelback Rd., Suite 200
Phoenix, AZ 85016-4302

Re: Proposal for Surveying and Utility Locating Services
Bethany Home Outfall Channel, Phase II.

Dear Mr. Minch:

TBE Group, Inc, is pleased to submit this proposal to provide professional surveying and utility locating services (potholing) on the above referenced project. The following is our scope of work and estimated fee.

SCOPE OF WORK

TBE will provide air/vacuum excavation potholing on existing utilities to determine their depth, horizontal and vertical location, size and material composition at the locations depicted on the plan sheets provided. In addition, we will provide field survey to establish invert elevations on six manholes and two catch basins. The pothole unit rate is $460.00 and includes mobilization, traffic control for single lane closures, survey, and utility location reports for excavation up to six (6) feet deep. For excavation in excess of six (6) feet and less than fourteen (14) feet in depth there is a surcharge of $30.00/foot. For excavation in excess of fourteen (14) feet and less than twenty (20) feet in depth there is a surcharge of $40.00/foot. Reimbursable costs include permit fees, special barricading for night work or multiple lane closures in signalized intersections and use of off-duty police officers.

ESTIMATED FEE

1.	Potholes –23 @ $460.00 each	$10,580.00
2.	Field Survey-2 person crew 3 hours @ $110.00/hr	$330.00
3.	Traffic Control/Off-duty police officer	$450.00
4.	Permit Fees	$100.00
5.	Extra depth surcharges	$800.00
	Total	**$12,260.00**

COMPENSATION

TBE proposes compensation for the work defined above be on a Lump Sum basis for the total amount of, $12,260.00.

2236 W. Shangri-La Road Phoenix, Arizona 85029 602•749•8550 Fax 602•749•8551

SCHEDULE

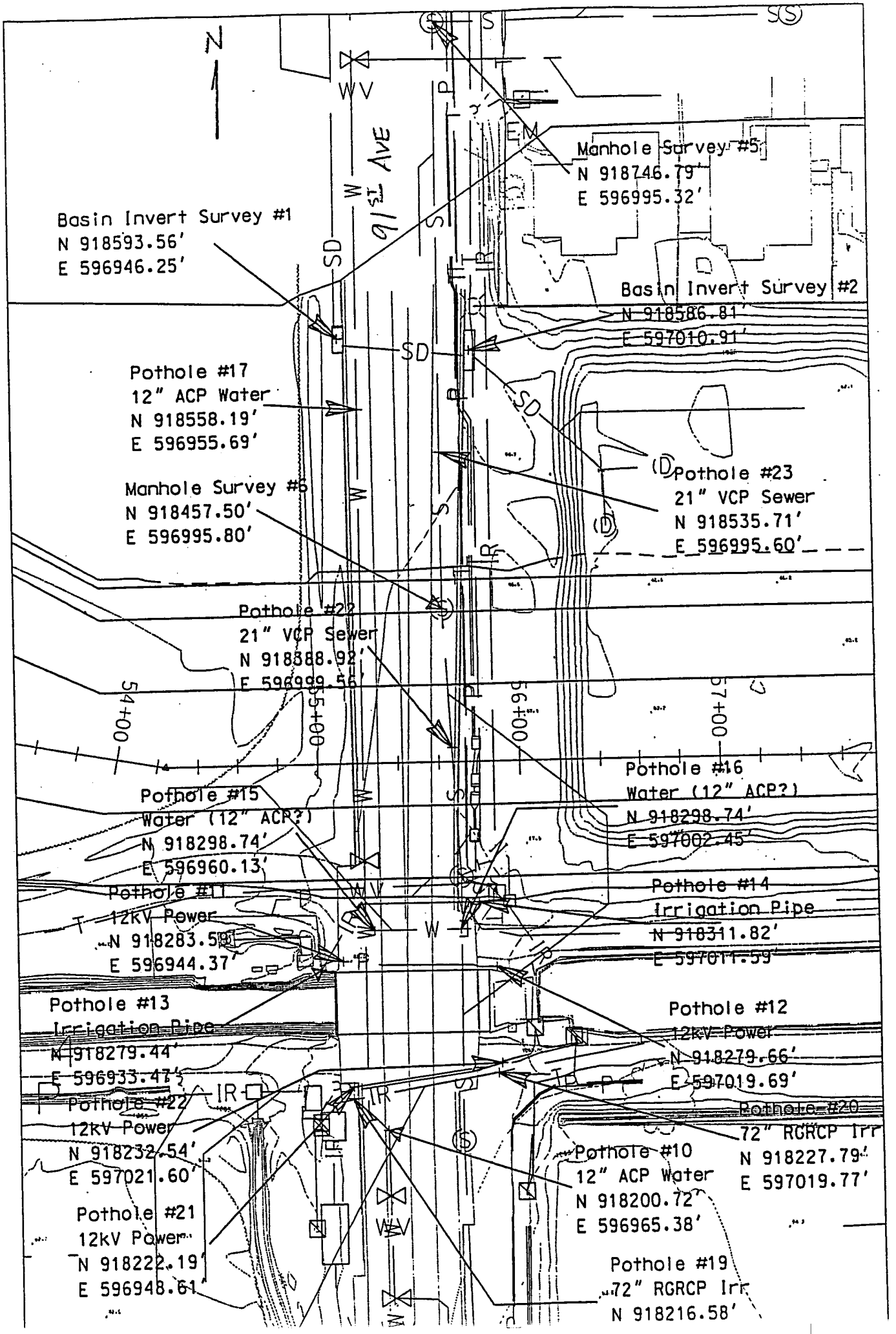
From date of notice to proceed, please allow 10 working days to complete the field work and provide final deliverables.

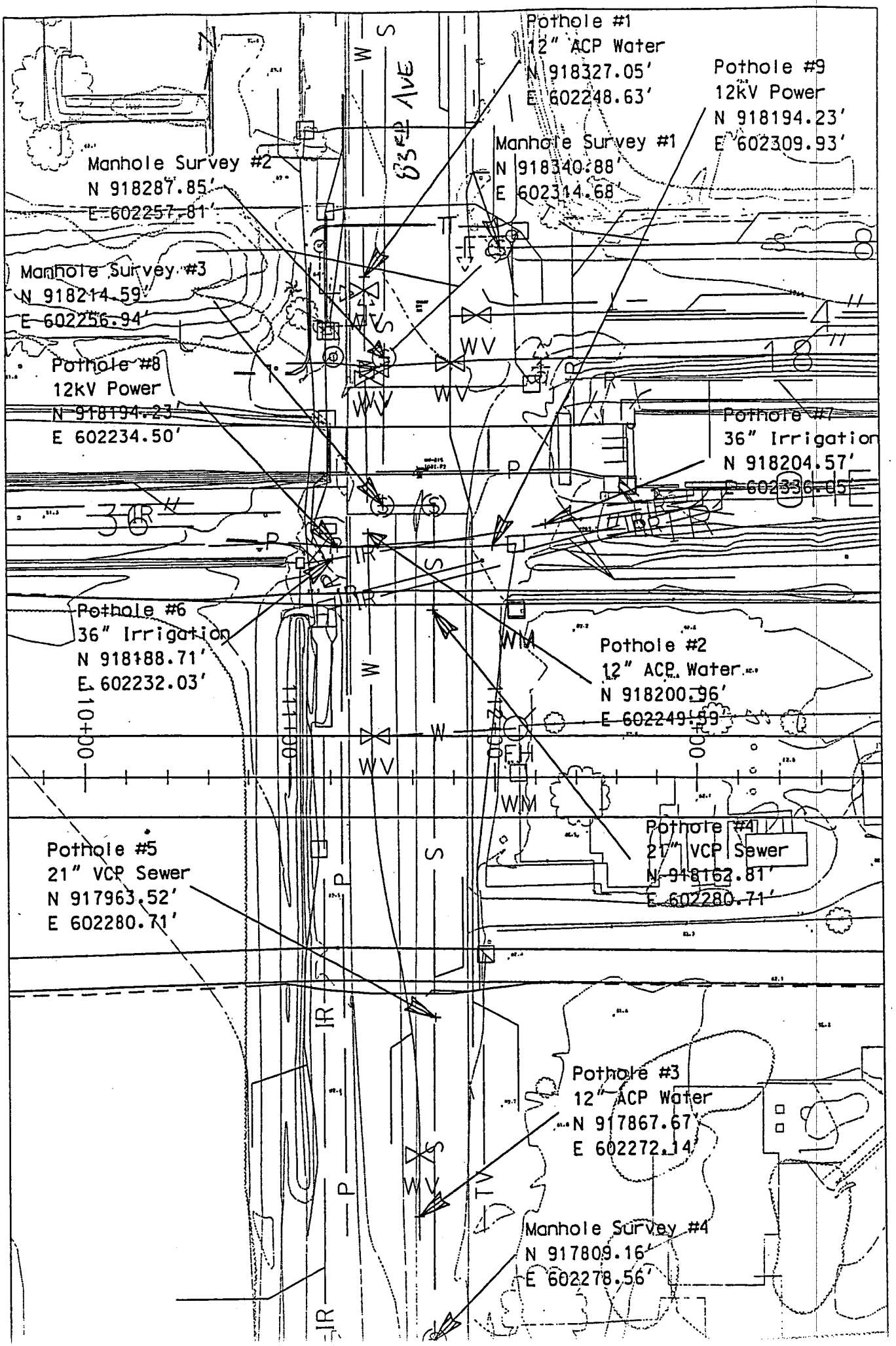
TBE Group, Inc. appreciates this opportunity to be of service. Should you have any questions or require additional information, please call.

Sincerely,

David S. Huscher

David S. Huscher, RLS
Director SUE/Survey Services


N
91ST AVE
Manhole Survey #5
N 918746.79'
E 596995.32'
Basin Invert Survey #1
N 918593.56'
E 596946.25'
Basin Invert Survey #2
N 918586.81'
E 597010.91'
Pothole #17
12" ACP Water
N 918558.19'
E 596955.69'
Pothole #23
21" VCP Sewer
N 918535.71'
E 596995.60'
Manhole Survey #6
N 918457.50'
E 596995.80'
Pothole #22
21" VCP Sewer
N 918388.92'
E 596999.56'
54+00
55+00
56+00
57+00
Pothole #16
Water (12" ACP?)
N 918298.74'
E 597002.45'
Pothole #15
Water (12" ACP?)
N 918298.74'
E 596960.13'
Pothole #11
12kV Power
N 918283.59'
E 596944.37'
Pothole #14
Irrigation Pipe
N 918311.82'
E 597011.59'
Pothole #13
Irrigation Pipe
N 918279.44'
E 596933.47'
Pothole #12
12kV Power
N 918279.66'
E 597019.69'
Pothole #22
12kV Power
N 918232.54'
E 597021.60'
Pothole #20
72" RGRCP Irr
N 918227.79'
E 597019.77'
Pothole #10
12" ACP Water
N 918200.72'
E 596965.38'
Pothole #21
12kV Power
N 918222.19'
E 596948.61'
Pothole #19
72" RGRCP Irr
N 918216.58'


Pothole #1
12" ACP Water
N 918327.05'
E 602248.63'
Pothole #9
12kV Power
N 918194.23'
E 602309.93'
Manhole Survey #1
N 918340.88'
E 602314.68'
Manhole Survey #2
N 918287.85'
E 602257.81'
Manhole Survey #3
N 918214.59'
E 602256.94'
Pothole #8
12kV Power
N 918194.23'
E 602234.50'
Pothole #7
36" Irrigation
N 918204.57'
E 602336.05'
Pothole #6
36" Irrigation
N 918188.71'
E 602232.03'
Pothole #2
12" ACP Water
N 918200.96'
E 602249.59'
Pothole #4
21" VCP Sewer
N 918162.81'
E 602280.71'
Pothole #5
21" VCP Sewer
N 917963.52'
E 602280.71'
Pothole #3
12" ACP Water
N 917867.67'
E 602272.14'
Manhole Survey #4
N 917809.16'
E 602278.56'
63RD AVE
10+00
11+00
12+00

INVERT MEASUREMENTS:
91 ST AVE & GRAND CANAL

PT. #	DESC.	MEAS. INV.	FLOW
1793	WV	-3.55	
	MH	-12.40	N & S
1815	WV	-4.25	
1630	MH		
1833	MH	-11.75	N & S
1853	MH	-11.45	E
1861	MH	-11.30	N & S
1862	MH		
1870	WV	-4.40	
1851	WV	-4.10	
1828	WV		
1817	WV	-4.60	
1816	WV	-3.50	

D. HAUGHT P.C. 10-6-99 BK. 1 Pg. 72

J. HARMON π

@ STA -6+30, 35' RT

#2 SEE SHEET
#2 SEE SHEET
SEWER (C.O.G.)
SEWER (C.O.G.)
SRP ELECTRIC (CANNOT OPEN)

(CANNOT OPEN)

91 ST AVENUE @ GRAND CANAL

B/S	26	5.66	C/P	
T	27	5.35	C/P	
F/S	1000 ~~50~~	5.43	W/P	N. GRAND CANAL W. 91 ST
F/S	1001	5.34	W/P	S. GRAND CANAL E 91 ST
B/S	27	5.395		
T	1001	5.305		

SOUTH OF GRAND CANAL
R.O.W. ON 91 ST AVE
PTS 1002 → 1400

B/S 27	6.01	
T 1000	5.52	

D. HAUGHT, P.C. 10-5-99 Bk. 1 Pg. 69

83 RD AVENUE, GRAND CANAL, & BETHANY HOME RD

PT. #	DESC.	DIR.	INV. (MEAS.)	Elev.
2821	SSMH	N&S	-13.10	
2823	WV		-3.50	
2822	SSMH	N&S	-12.52	
2824	WV		-3.70	
2835	WV		-2.45	
2834	WV		-1.60	
2833	WV		-3.70	
2831	WV		-3.75	
2830	WV		-2.70	
2318	WV		-3.10	
2319	WV	CANNOT GET		
2847	WV		-2.60	
2848	SSMH	N&S	-11.75	
2837	WV		-3.25	
2836	SSMH	E&SW	-8.85	

(JOB) DATA FILE. A14ATOPZ points (2000 → 2877)

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: #1861

MANHOLE DESCRIPTION – TYPE: City of Glendale Sanitary Sewer

SIZE: 2.75

CONDITION: GOOD, IN USE

NORTHING _____

EASTING _____

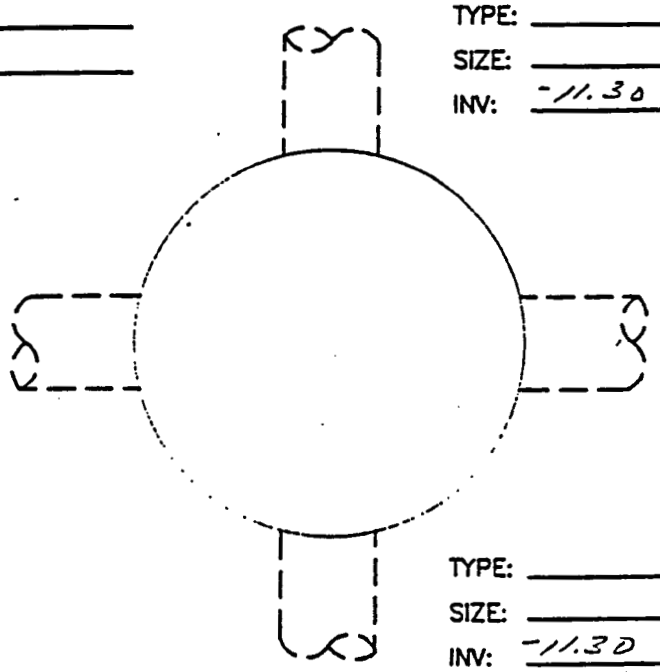
RIM ELEVATION _____

HORIZONTAL DATUM _____

VERTICAL DATUM M.C.H.D. 1070.05

LAT. N: _____

LONG. W: _____



TYPE: _____
SIZE: _____
INV: -11.30

TYPE: _____
SIZE: _____
INV: _____

TYPE: _____
SIZE: _____
INV: _____

TYPE: _____
SIZE: _____
INV: -11.30

LOCATION: On 91ST avenue on east North bound lane, North of Bonny Dr.

DESCRIBED BY: Dwayne Lee Navarro DATE RECOVERED: 10-5-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.284.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: PT.# 1853

MANHOLE DESCRIPTION – TYPE: City of Glendale Sanitary Sewer

SIZE: 2.75'

CONDITION: GOOD, IN USE

NORTHING _____

EASTING _____

RIM ELEVATION _____

HORIZONTAL DATUM _____

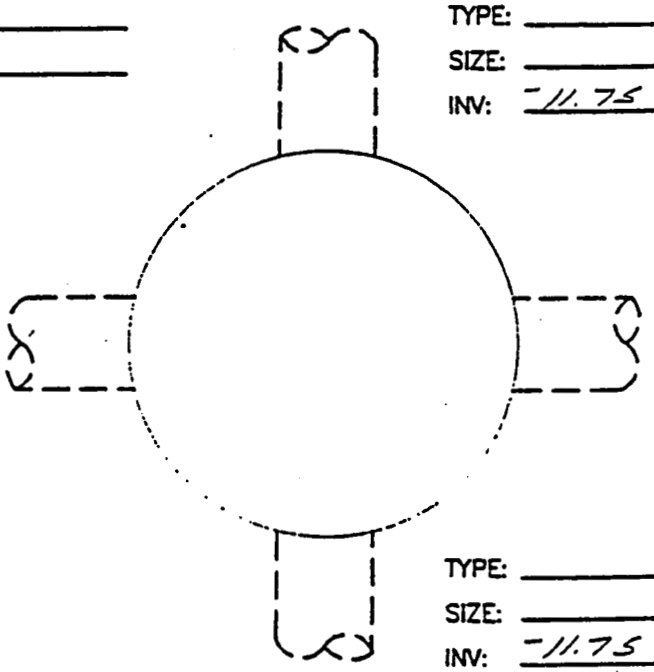
VERTICAL DATUM M.C.H.D. 1070.05

LAT. N: _____

LONG. W: _____

TYPE: _____
SIZE: _____
INV: -11.75

TYPE: _____
SIZE: _____
INV: _____



TYPE: PVC
SIZE: 8"
INV: -11.45

TYPE: _____
SIZE: _____
INV: -11.75

LOCATION: @ 91ST & ROVEY DR. East North bound Lane of 91ST AVE.

DESCRIBED BY: Dwayne Lee Haught DATE RECOVERED: 10-6-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.254.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: Pt II

MANHOLE DESCRIPTION – TYPE: City of Glendale Sanitary Sewer

SIZE: 2.75'

CONDITION: GOOD, IN USE

NORTHING

EASTING

RIM ELEVATION

HORIZONTAL DATUM

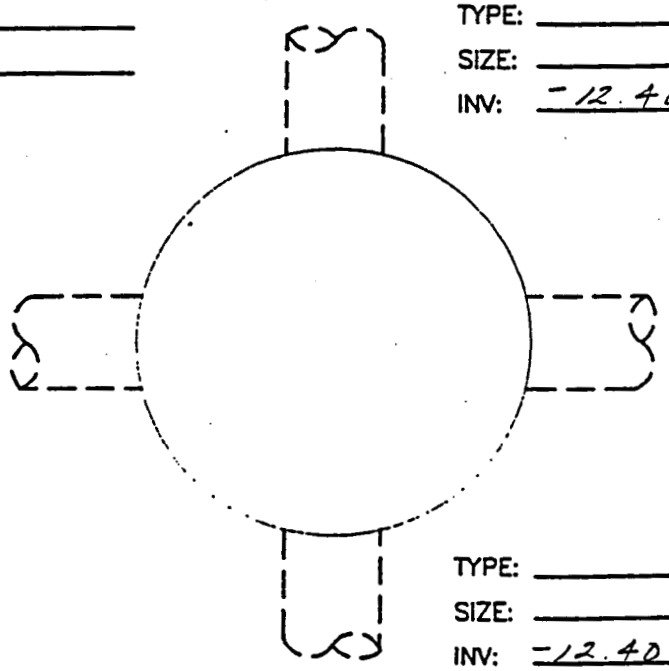
VERTICAL DATUM M.C.H.D. 1070.04

LAT. N:

LONG. W:

TYPE:
SIZE:
INV: -12.40

TYPE:
SIZE:
INV:



TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV: -12.40

LOCATION: From 91ST Avenue & Grand Canal go south 630± and 35' East

DESCRIBED BY: Dwayne Lee Naylor DATE RECOVERED: 10-6-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

SEWER CATALOGING

VERIFY DESC TYPE & SIZE FROM CITY PLANS

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: 3

MANHOLE DESCRIPTION – TYPE: City of Glendale Sanitary Sewer

SIZE: 2.75

CONDITION: Good, in use

NORTHING

EASTING

RIM ELEVATION 1066.91

HORIZONTAL DATUM

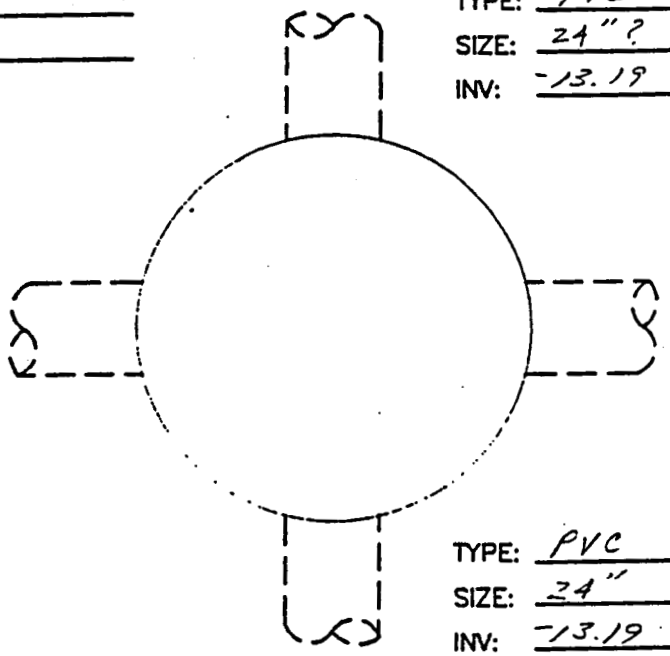
VERTICAL DATUM MCHD 1070.0452

LAT. N:

LONG. W:

TYPE: PVC
SIZE: 24"?
INV: -13.19

TYPE:
SIZE:
INV:



TYPE:
SIZE:
INV:

TYPE: PVC
SIZE: 24"
INV: -13.19

LOCATION: North of the Grand Canal 194.5' and 9.4' West of East back of curb on 91st Avenue

DESCRIBED BY: Dwayne Lee Hayworth DATE RECOVERED: 8-26-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

SEWER CATALOGING

VERIFY DESC. TYPE & SIZE PER CITY PLANS

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: 2

MANHOLE DESCRIPTION – TYPE: City of Glendale Sanitary Sewer

SIZE: 3.75'

CONDITION: Good, no mas

NORTHING

EASTING

RIM ELEVATION 1068.00

HORIZONTAL DATUM

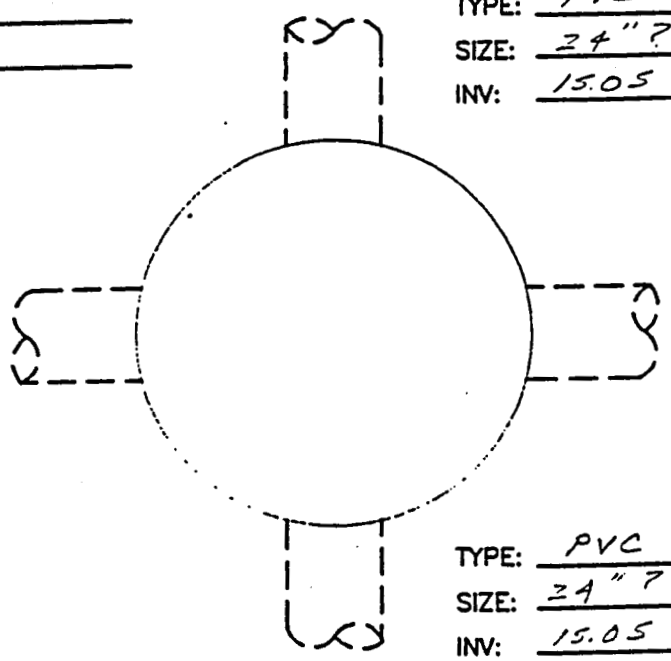
VERTICAL DATUM M.C.H.D 1070.0452

LAT. N:

LONG. W:

TYPE: PVC
SIZE: 24" ?
INV: 15.05

TYPE:
SIZE:
INV:



TYPE:
SIZE:
INV:

TYPE: PVC
SIZE: 24" ?
INV: 15.05

LOCATION: North of the Grand Canal 61.5' and 1.75' East of East Back of Curb on 91st Avenue

DESCRIBED BY: Dwayne Lee Hayport

DATE RECOVERED: 8-26-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.254.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

VERIFY DESC, TYPE, & SIZE PER CITY PLANS

MANHOLE NUMBER: 1

MANHOLE DESCRIPTION – TYPE: City of Glendale SANITARY SEWER

SIZE: 2.75

CONDITION: GOOD, IN USE

NORTHING

EASTING

RIM ELEVATION 1068.04

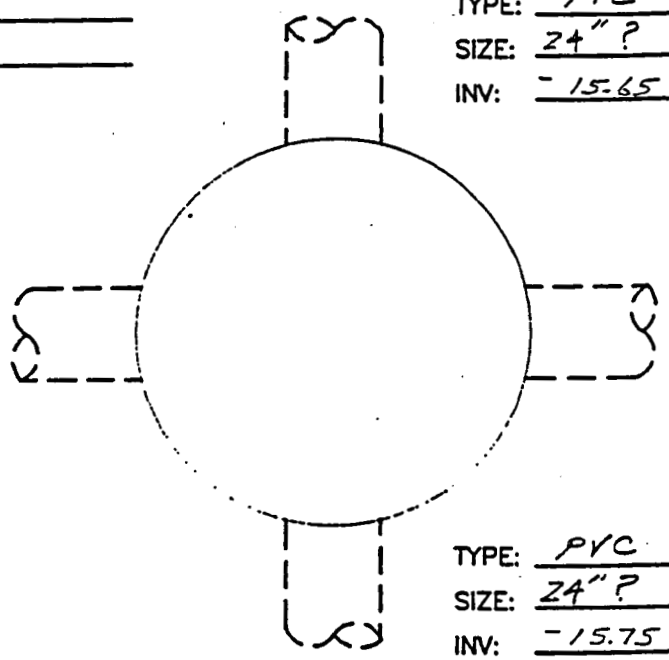
HORIZONTAL DATUM

VERTICAL DATUM M.C.H.R. 1070.0452

LAT. N:

LONG. W:

TYPE: PVC
SIZE: 24"?
INV: -15.65



TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV:

TYPE: PVC
SIZE: 24"?
INV: -15.75

LOCATION: South of the Grand Canal 67.5', and 1.75' East of East back of curb on 91ST Avenue.

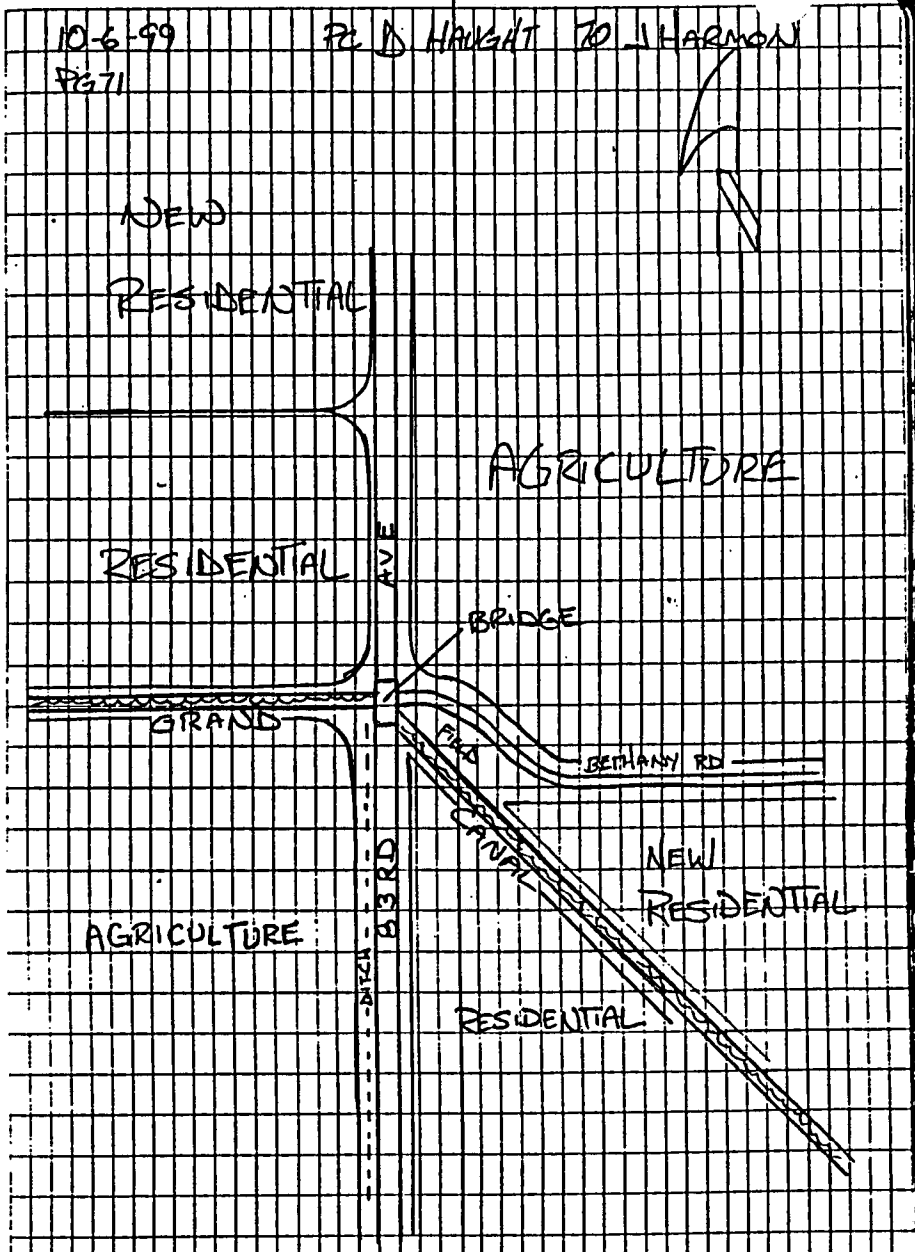
DESCRIBED BY: Dwayne Lee Hazzard

DATE RECOVERED: 8-26-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.254.7505

10-6-99 PC D HAUGHT TO J HARMON

PG71



* ROW TOPO WAS DONE 1100' N, S, & E ALONG 83RD AVE & BETHANY RD

SEWER CATALOGING

VERIFY DESC., TYPE, & SIZE PER CITY PLANS

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: 4 (PT # 2827)

MANHOLE DESCRIPTION – TYPE: Sanitary Sewer

SIZE: 2.40

CONDITION: Good, in use

NORTHING 918086.69

EASTING 602185.50

RIM ELEVATION 1083.90 12.39

HORIZONTAL DATUM

VERTICAL DATUM BM 93 (4.0E, 10.0N) 1088.7506

LAT. N:

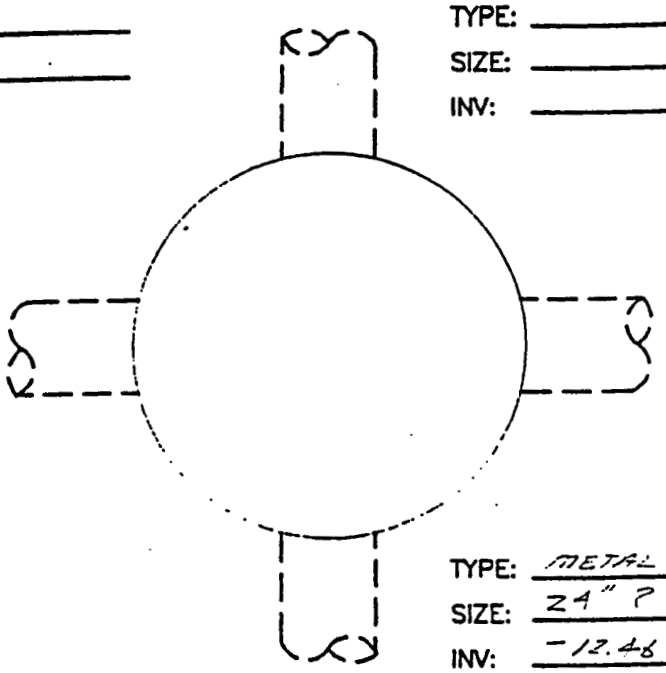
LONG. W:

TYPE:
SIZE:
INV:

TYPE: METAL
SIZE: 24" ?
INV: -12.39

INV = 1071.51

TYPE:
SIZE:
INV:



TYPE: METAL
SIZE: 24" ?
INV: -12.46

LOCATION: 8' East of the Northwest corner of Section 14 and 18' South of the Northwest corner of Section 14 @ the intersection of Rothrock Wash Rd and Road name

DESCRIBED BY: Dwayne Ted Nagent DATE RECOVERED: 8-26-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.254.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

VERIFY DESC., TYPE, & SIZE PER CITY PLANS

MANHOLE NUMBER: 5 (2526)

MANHOLE DESCRIPTION – TYPE:

SIZE: 2.4 Sanitary Sewer

CONDITION:

NORTHING 918866.64

EASTING 602160.73

RIM ELEVATION 1083.57

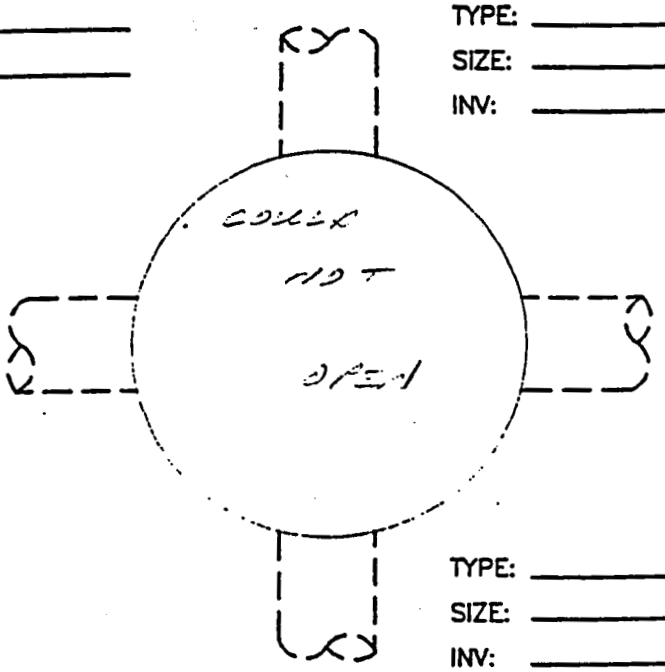
HORIZONTAL DATUM

VERTICAL DATUM BM 93 (4.0 E, 10.0 N) 1088.7506

LAT. N:

LONG. W:

TYPE:
SIZE:
INV:



TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV:

LOCATION: 17 West of the Northwest corner of Section 14 and 16' South of the Northwest corner Section 14 @ the intersection of Bethany Home Rd and 83rd Avenue

DESCRIBED BY: [signature] DATE RECOVERED: 8-26-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

SEWER CATALOGING

VERIFY DESC, TYPE, SIZE PER CITY PLANS

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: 6 (2828)

MANHOLE DESCRIPTION – TYPE: Sanitary Sewer

SIZE: 2.40

CONDITION: Good in use

NORTHING 918139.84

EASTING 602161.77

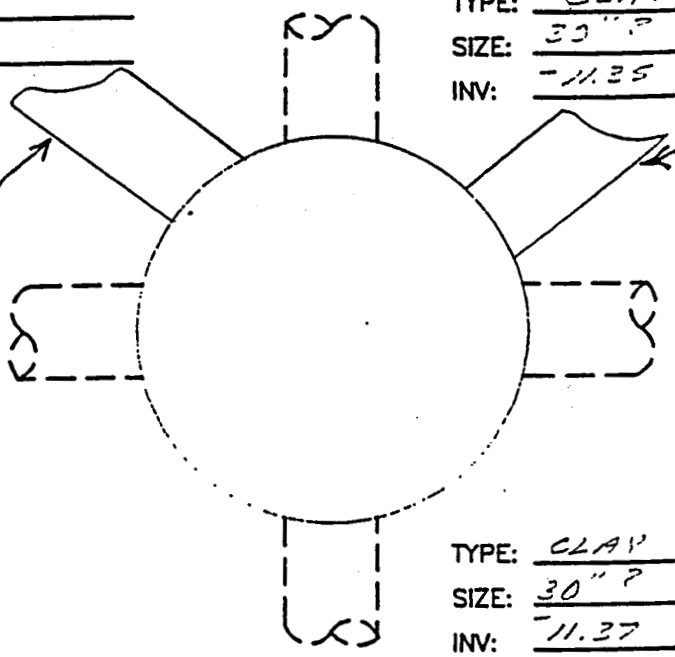
RIM ELEVATION 1083.58

HORIZONTAL DATUM

VERTICAL DATUM EM 93 (4.0E, 10.0N) 1088.7506

LAT. N:

LONG. W:



TYPE: CLAY
SIZE: 33"?
INV: -11.35

TYPE: PVC
SIZE: 8"?
INV: -8.85
1074.73

TYPE: PVC
SIZE: 8"?
INV: -10.30
1073.28

TYPE: CLAY
SIZE: 18"?
INV: -10.63
1072.95

TYPE: CLAY
SIZE: 30"?
INV: -11.37
1072.21

LOCATION: 16' West of the Northwest corner of Section 14 and 57' North of the Northwest corner of Section 14 @ the intersection of Bethany Home Road and 83rd Avenue.

DESCRIBED BY: Dwayne Lee Hartsell DATE RECOVERED: 8-20-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: #2821

MANHOLE DESCRIPTION – TYPE: City of Glendale SANITARY SEWER

SIZE: 2.75

CONDITION: IN USE

NORTHING

EASTING

RIM ELEVATION

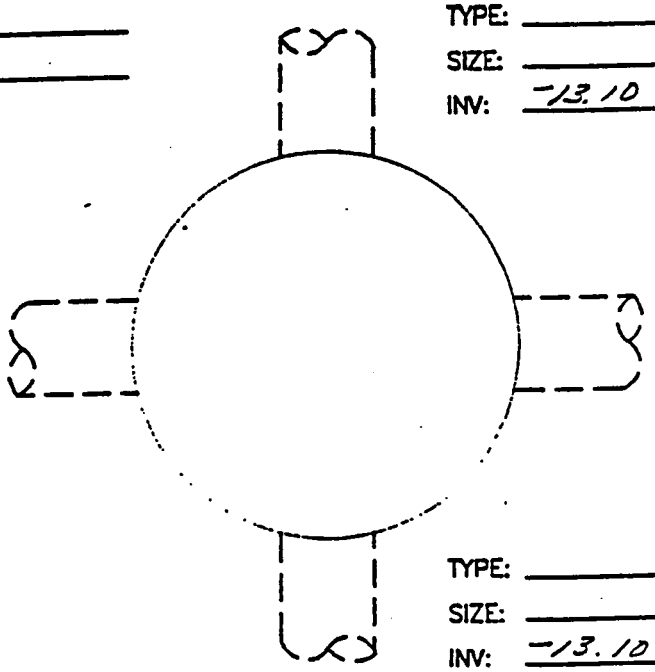
HORIZONTAL DATUM

B.M. #93 (4.0E, 10.0N)

VERTICAL DATUM 1088.75

LAT. N:

LONG. W:



TYPE:
SIZE:
INV: -13.10

TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV: -13.10

LOCATION: On 83rd avenue ±870 south of Bethany Home Rd and ±8' East of ℄ (West North Bound Lane of 83rd)

DESCRIBED BY: Dwayne Lee Kautzel DATE RECOVERED: 10-5-99

Collins Piña Consulting Engineers, Inc.

40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.284.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: #2822

MANHOLE DESCRIPTION – TYPE: City of Glendale SANITARY SEWER

SIZE: 2.75

CONDITION: GOOD, IN USE

NORTHING

EASTING

RIM ELEVATION

HORIZONTAL DATUM

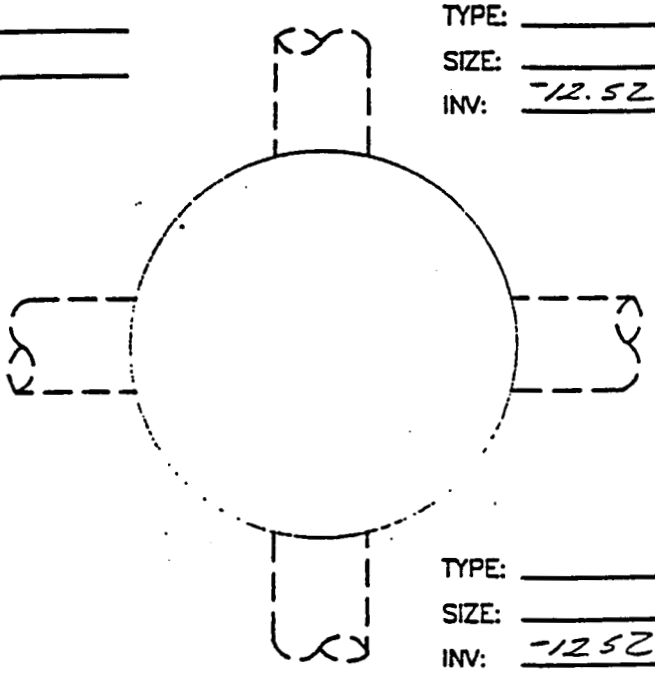
VERTICAL DATUM B.M. #93 (4.0E, 10.0N) 1088.75

LAT. N:

LONG. W:

TYPE:
SIZE:
INV: -12.52

TYPE:
SIZE:
INV:



TYPE:
SIZE:
INV:

TYPE:
SIZE:
INV: -12.52

LOCATION: On 83rd Avenue ±425' south of Bethany Home Rd. 8' East of ℄ (West North Bound Travel Lane)

DESCRIBED BY: Dwayne Lee Hargrove DATE RECOVERED: 10-5-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

28367

MANHOLE NUMBER: #2838

MANHOLE DESCRIPTION – TYPE: City of Glendale Sanitary Sewer

SIZE: 2.75

CONDITION: Good, IN USE

NORTHING _____ HORIZONTAL DATUM _____

EASTING _____

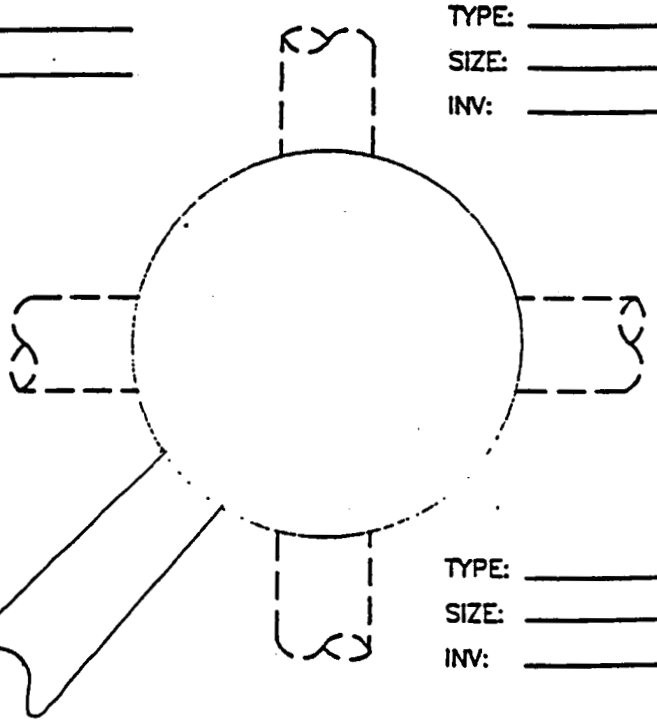
RIM ELEVATION _____ VERTICAL DATUM _____

LAT. N: _____

LONG. W: _____

TYPE: _____
SIZE: _____
INV: _____

TYPE: _____
SIZE: _____
INV: _____



TYPE: _____
SIZE: _____
INV: -8.85

TYPE: _____
SIZE: _____
INV: -8.85

TYPE: _____
SIZE: _____
INV: _____

LOCATION: @ North East Corner of 83RD Avenue and Bethany Home Road, in curb return area

DESCRIBED BY: Dwayne Lee Nauman DATE RECOVERED: 10-5-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

SEWER CATALOGING

SEWER MANHOLE DATA SHEET

MANHOLE NUMBER: #2848

MANHOLE DESCRIPTION – TYPE: SANITARY SEWER

SIZE: 2.75

CONDITION: GOOD, IN USE

NORTHING _____

EASTING _____

RIM ELEVATION _____

HORIZONTAL DATUM _____

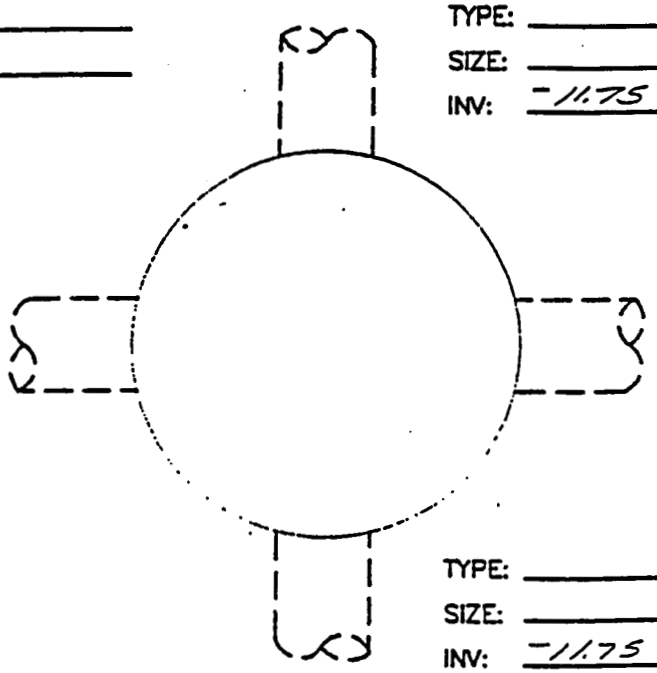
BM 93 (4.0E, 10.0N)

VERTICAL DATUM 1088.75

LAT. N: _____

LONG. W: _____

TYPE: _____
SIZE: _____
INV: -11.75



TYPE: _____
SIZE: _____
INV: _____

TYPE: _____
SIZE: _____
INV: _____

TYPE: _____
SIZE: _____
INV: -11.75

LOCATION: On 83rd avenue, ±525' North of Bethany Home Rd and ± 8' West of ℄ (in East bound South Bound Lane)

DESCRIBED BY: Dwayne Lee Naught DATE RECOVERED: 10-5-99

Collins Piña Consulting Engineers, Inc.
40 E. VIRGINIA AVENUE SUITE 200 PHOENIX AZ 85004 - 602.264.7505

RIGHT-OF-WAY AND EASEMENTS

```
Cogo Generated Coordinates
##############################
#   BHOC Properties          #
#   DEVELOPED: 05-08-01 GJJ  #
    Revised by DBL 7-29-01   #
##############################
*       QC by JRM
###  DELETE GEOMETRY CREATED
DEL COOR  (500-1199)  # delete all coordinates
        35 point(s) deleted
DEL COOR  (1210-8150)
        78 point(s) deleted
DEL F     [600-700]
    Figure 600 deleted
    Figure 700 deleted
        2 alignment(s) deleted
DEL F     [1000-8299]  # delete all figures
    Figure 1000 deleted
    Figure 1100 deleted
    Figure 2000 deleted
    Figure 3000 deleted
    Figure 4000 deleted
    Figure 4100 deleted
    Figure 5000 deleted
    Figure 6000 deleted
    Figure 7000 deleted
    Figure 8000 deleted
    Figure 8100 deleted
    Figure 8110 deleted
        12 alignment(s) deleted
DEL COOR (8400-8499)
        6 point(s) deleted
DEL F     [8400]
    Figure 8400 deleted
        1 alignment(s) deleted
*
*       SECTION CONTROL COORDINATES
*       RESULTS OF SURVEY BY COLLINS PINA 5/3/00
*
S       500  918084.33  591686.37  # NW COR SEC 16, BETHANY HOME AND 99TH AVE.
       500     918084.3300     591686.3700          0.0000 grd-pts
        501  918250.31  596975.69  # NW COR SEC 15, BETHANY HOME AND 91ST AVE.
       501     918250.3100     596975.6900          0.0000 grd-pts
        502  918231.17  602274.29  # NW COR SEC 14, BETHANY HOME AND 83RD AVE.
       502     918231.1700     602274.2900          0.0000 grd-pts
* S       500  918084.327 591686.367 # NW COR SEC 16, BETHANY HOME AND 99TH
AVE.
*         501  918250.308 596975.648 # SE COR SEC  9, BETHANY HOME AND 91ST
AVE.
*         502  918231.171 602274.249 # NE COR SEC 15, BETHANY HOME AND 83RD
AVE.
#   SRP MEASURED R/W (North)
L DI 500 600 N00-00-00E 71.00
       600     918155.3300     591686.3700          0.0000 grd-pts
        600 601 N87-12-36E 26.59
       601     918156.6243     591712.9285          0.0000 grd-pts
        601 602 N86-46-57E 2619.38
       602     918303.6408     594328.1795          0.0000 grd-pts
        602 603 N89-38-06E 2535.97
       603     918319.7960     596864.0980          0.0000 grd-pts
        603 604 N89-42-47E 111.61
       604     918320.3549     596975.7066          0.0000 grd-pts
        604 605 S00-04-04W 13.34
       605     918307.0149     596975.6908          0.0000 grd-pts
        605 606 s89-48-03E 2644.46
       606     918297.8225     599620.1349          0.0000 grd-pts
        606 607 n00-11-27e 6.20
       607     918304.0225     599620.1555          0.0000 grd-pts
F     600 (600-607)
        600     ( 600 601 602 603 604 605 606 607  )
F D     [600] *NORTH R/W GRAND CANAL
  Figure ID    Figure Description
-----------------------------------------------------------------------
```

```
         600   NORTH R/W GRAND CANAL
#   SRP MEASURED R/W (South)
L DI 500 700 S00-00-00W 38.05
       700      918046.2800      591686.3700          0.0000 grd-pts
        700 701 N86-37-04E 1324.34
       701      918124.4116      593008.4032          0.0000 grd-pts
        701 702 N86-34-08E 1249.58
       702      918199.1970      594255.7433          0.0000 grd-pts
        702 703 S80-37-36E 74.23
       703      918187.1074      594328.9822          0.0000 grd-pts
        703 704 N89-27-02E 2646.76
       704      918212.4884      596975.6205          0.0000 grd-pts
        704 705 N00-11-40W 3.83
       705      918216.3184      596975.6075          0.0000 grd-pts
        705 706 S89-47-32E 2629.35
       706      918206.7833      599604.9402          0.0000 grd-pts
        706 707 S00-12-28E 4.63
       707      918202.1533      599604.9570          0.0000 grd-pts
        707 708 S89-50-14E 2669.18
       708      918194.5702      602274.1263          0.0000 grd-pts
        708 709 S00-21-29W 7.29
       709      918187.2803      602274.0807          0.0000 grd-pts
        709 710 S89-18-25E 489.92
       710      918181.3543      602763.9649          0.0000 grd-pts
        710 711 S47-15-01E 270.31
       711      917997.8687      602962.4605          0.0000 grd-pts
        711 712 S42-11-13E 1038.55
       712      917228.3471      603659.9006          0.0000 grd-pts
S F     700 (700-712)
         700     ( 700 701 702 703 704 705 706 707 708 709 710 711 712  )
F D     [700] *SOUTH R/W GRAND CANAL
  Figure ID    Figure Description
-----------------------------------------------------------------------
         700   SOUTH R/W GRAND CANAL
##############################################################################
#############
  Parcel # 102-01-001
# Item # A002.001
L DI    500 1000 n87-44-07e  2639.58    # PT 500 IS S 1/4 COR SEC 9
      1000      918188.6371      594323.8883          0.0000 grd-pts
        1000 1001 n00-00-00e  115.00
      1001      918303.6371      594323.8883          0.0000 grd-pts
        1001 1002 s86-43-10w 1317.53
      1002      918228.2412      593008.5173          0.0000 grd-pts
        1002 1003 n00-00-00e  230.62
      1003      918458.8612      593008.5173          0.0000 grd-pts
        1003 1004 n86-43-10e 1317.53
      1004      918534.2571      594323.8883          0.0000 grd-pts
        1004 1005 S00-00-00e  230.62
      1005      918303.6371      594323.8883          0.0000 grd-pts
L DI 602 1500 S86-46-57W 1317.53 # Locate common point along proposed R/W
from measured
      1500      918229.6925      593012.7263          0.0000 grd-pts
                                   # bearing for transformation calculation.
C T (1001 1002) (602 1500)
Rotation angle is 359^56'13.0000"
Scale factor  is   1.00000000
Northing translation is       0.0037
Easting translation is       4.2912
T CO (1000-1005)
      1000      918188.6409      594328.0529          0.0000 grd-pts
      1001      918303.6408      594328.1795          0.0000 grd-pts
      1002      918229.6925      593012.7263          0.0000 grd-pts
      1003      918460.3124      593012.9801          0.0000 grd-pts
      1004      918534.2607      594328.4333          0.0000 grd-pts
      1005      918303.6408      594328.1795          0.0000 grd-pts
S F     1000 (1001 1002 1003 1004 1001)
        1000     ( 1001 1002 1003 1004 1001  )
  ##############################################################################
#########
# Parcel # 102-01-002E
# Item # A002.002
L DI    501 2001 n00-00-00e   70.20   # PT 501 IS SE 1/4 COR SEC 9
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      2001     918320.5100     596975.6900          0.0000 grd-pts
        2001 2002 s89-32-58w 2649.95
      2002     918299.6719     594325.8219          0.0000 grd-pts
        2002 2003 n00-00-00e  230.00
      2003     918529.6719     594325.8219          0.0000 grd-pts
        2003 2004 n89-32-58e 2645.80
      2004     918550.4774     596971.5401          0.0000 grd-pts
    2004 2005 s00-00-00e  230.00
      2005     918320.4774     596971.5401          0.0000 grd-pts
C T (2001 2002) (604 602)
Rotation angle is 359^54'40.1543"
Scale factor  is   0.99910561
Northing translation is      -0.1551
Easting translation is       0.0166
T CO (2000-2005)
      2001     918320.3549     596975.7066          0.0000 grd-pts
      2002     918303.6408     594328.1795          0.0000 grd-pts
      2003     918533.4348     594328.5358          0.0000 grd-pts
      2004     918550.1228     596971.9167          0.0000 grd-pts
      2005     918320.3287     596971.5604          0.0000 grd-pts
S F     2000 (2001 2002 2003 2004 2001)
        2000    ( 2001 2002 2003 2004 2001  )
##############################################################################
#########
# Parcel # 102-04-003F
# Item # A002.003
L DI    501 3001 n00-09-00e   56.70   # PT 501 IS SW 1/4 COR SEC 10
      3001     918307.0098     596975.8384          0.0000 grd-pts
        3001 3002 n00-09-00e  300.00
      3002     918607.0088     596976.6238          0.0000 grd-pts
        3002 3003 s89-54-43e   62.00
      3003     918606.9135     597038.6238          0.0000 grd-pts
        3003 3004 s89-54-43e  228.00
      3004     918606.5631     597266.6235          0.0000 grd-pts
        3004 3005 s00-09-00w  300.00
      3005     918306.5641     597265.8381          0.0000 grd-pts
        3005 3006 n89-54-43w  221.27
      3006     918306.9042     597044.5684          0.0000 grd-pts
L DI 605 3500 S89-48-03E 68.73 # Locate common point along proposed R/W from
measured
      3500     918306.7760     597044.4204          0.0000 grd-pts
                               # bearing for transformation calculation.
C T (3001 3006) (605 3500)
Rotation angle is 359^53'20.0000"
Scale factor  is   1.00000000
Northing translation is       0.0051
Easting translation is      -0.1476
T CO (3001-3006)
      3001     918307.0149     596975.6908          0.0000 grd-pts
      3002     918607.0118     596977.0580          0.0000 grd-pts
      3003     918606.7963     597039.0576          0.0000 grd-pts
      3004     918606.0037     597267.0562          0.0000 grd-pts
      3005     918306.0069     597265.6891          0.0000 grd-pts
      3006     918306.7760     597044.4204          0.0000 grd-pts
S F     3000 (3003 3004 3005 3006 3003)
        3000    ( 3003 3004 3005 3006 3003  )
##############################################################################
#########
# Parcel # 102-04-003H
# Item # A002.004
S 4000 100000.000 100000.000 # RANDOM POINT
      4000     100000.0000     100000.0000          0.0000 grd-pts
L DI 4000 4001 s89-50-14e  63.49
      4001      99999.8196     100063.4897          0.0000 grd-pts
        4001 4002 n00-04-16w  293.60
      4002     100293.4194     100063.1254          0.0000 grd-pts
        4002 4003 n89-48-03w 2368.40
      4003     100301.6522      97694.7397          0.0000 grd-pts
        4003 4004 s00-02-48e  300.00
      4004     100001.6523      97694.9840          0.0000 grd-pts
        4004 4005 s89-48-03e 2354.43
      4005      99993.4681     100049.3998          0.0000 grd-pts
        4005 4006 n00-11-27e    6.40
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      4006      99999.8680     100049.4211          0.0000 grd-pts
        4006 4007 S89-50-14E 14.07
      4007      99999.8281     100063.4910          0.0000 grd-pts
  DI 606 4500 N89-48-03W 2354.43 # Locate common point along proposed R/W
 rom measured
      4500     918306.0068     597265.7191          0.0000 grd-pts
                                                                  # bearing
for transformation calculation.
C T (4005 4004) (606 4500)
Rotation angle is   0^00'00.0000"
Scale factor  is   1.00000000
Northing translation is  818304.3544
Easting translation is  499570.7351
T CO (4001-4007)
      4001     918304.1741     599634.2248          0.0000 grd-pts
      4002     918597.7738     599633.8604          0.0000 grd-pts
      4003     918606.0067     597265.4747          0.0000 grd-pts
      4004     918306.0068     597265.7191          0.0000 grd-pts
      4005     918297.8225     599620.1349          0.0000 grd-pts
      4006     918304.2225     599620.1562          0.0000 grd-pts
      4007     918304.1825     599634.2261          0.0000 grd-pts
S F 4000 (4001 4002 4003 4004 4005 4006 4007)
        4000    ( 4001 4002 4003 4004 4005 4006 4007  )
##############################################################################
#########
# Parcel # 102-11-010B
# Item # A002.005
L DI 502 5001 s89-47-22w 3275.13   # PT 502 IS NE 1/4 COR SEC 15
      5001     918219.1343     598999.1821          0.0000 grd-pts
        5001 5002 s00-12-38e   34.03
      5002     918185.1045     598999.3072          0.0000 grd-pts
        5002 5003 s34-19-15e  585.60
      5003     917701.4614     599329.4839          0.0000 grd-pts
        5003 5004 n89-44-43e  810.01
      5004     917705.0625     600139.4859          0.0000 grd-pts
        5004 5005 n51-50-07e  406.89
      5005     917956.4897     600459.3981          0.0000 grd-pts
        5005 5006 n89-44-43e 1760.01
      5006     917964.3143     602219.3907          0.0000 grd-pts
        5006 5007 n00-01-15w  230.00
      5007     918194.3142     602219.3071          0.0000 grd-pts
        5007 5008 s89-44-43w 2304.29
      5008     918184.0700     599915.0398          0.0000 grd-pts
        5008 5009 s00-00-37e  296.57
      5009     917887.5000     599915.0930          0.0000 grd-pts
        5009 5010 s89-47-22w  290.00
      5010     917886.4343     599625.0950          0.0000 grd-pts
        5010 5011 n00-00-37w  296.35
      5011     918182.7843     599625.0418          0.0000 grd-pts
        5011 5012 s89-44-43w   19.86
      5012     918182.6960     599605.1820          0.0000 grd-pts
        5012 5013 n01-00-32w    4.63
      5013     918187.3253     599605.1005          0.0000 grd-pts
        5013 5014 s89-47-25w  605.80
      5014     918185.1078     598999.3046          0.0000 grd-pts
L DI 706 5500 N89-47-32W 605.80 # Locate common point along proposed R/W from
measured
      5500     918208.9802     598999.1442          0.0000 grd-pts
                                                                  # bearing
for transformation calculation.
C T (5013 5014) (706 5500)
Rotation angle is 359^34'57.0000"
Scale factor  is   1.00000000
Northing translation is      19.4580
Easting translation is      -0.1603
T CO (5001-5014)
      5001     918243.0066     598999.2697          0.0000 grd-pts
      5002     918208.9768     598999.1468          0.0000 grd-pts
      5003     917722.9406     599325.7906          0.0000 grd-pts
      5004     917720.6394     600135.7974          0.0000 grd-pts
      5005     917969.7289     600457.5331          0.0000 grd-pts
      5006     917964.7287     602217.5360          0.0000 grd-pts
      5007     918194.7232     602219.1283          0.0000 grd-pts
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      5008     918201.2697     599914.8476          0.0000 grd-pts
      5009     917904.7072     599912.7398          0.0000 grd-pts
      5010     917905.7546     599622.7417          0.0000 grd-pts
      5011     918202.0971     599624.8480          0.0000 grd-pts
      5012     918202.1535     599604.9880          0.0000 grd-pts
      5013     918206.7833     599604.9402          0.0000 grd-pts
      5014     918208.9802     598999.1442          0.0000 grd-pts
S F     5000 (5002 5003 5004 5005 5006 5007 5008 5009 5010 5011 5012 5013
5014)
        5000    ( 5002 5003 5004 5005 5006 5007 5008 5009 5010 5011 5012
                5013 5014
                )
# Parcel # 102-10-005T
# Item # A002.007
##########################################################################
#########
L DI    502 7001 n89-08-30e   33.00   # PT 5000 IS NW 1/4 COR SEC 14
      7001     918231.6643     602307.2863          0.0000 grd-pts
        7001 7002 s00-00-00e   44.35
      7002     918187.3143     602307.2863          0.0000 grd-pts
        7002 7003 s00-00-00e   18.00
      7003     918169.3143     602307.2863          0.0000 grd-pts
        7003 7004 s89-42-00e  250.43
      7004     918168.0031     602557.7129          0.0000 grd-pts
        7004 7005 s00-00-00e  137.64
      7005     918030.3631     602557.7129          0.0000 grd-pts
        7005 7006 n89-04-37e  369.44
      7006     918036.3147     602927.1049          0.0000 grd-pts
        7006 7007 n47-39-48w  220.73
      7007     918184.9732     602763.9413          0.0000 grd-pts
        7007 7008 n89-42-00w  457.00
      7008     918187.3660     602306.9475          0.0000 grd-pts
L DI 709 7500 S89-18-25E 33.00 # Locate common point along proposed R/W from
measured
      7500     918186.8812     602307.0783          0.0000 grd-pts
                                                                  # bearing
 or transformation calculation.
C T (7002 7007) (7500 710)
Rotation angle is 359^36'02.4739"
Scale factor  is   1.00056726
Northing translation is      -0.4332
Easting translation is      -0.2080
T CO (7001-7008)
      7001     918231.2552     602307.3876          0.0000 grd-pts
      7002     918186.8812     602307.0783          0.0000 grd-pts
      7003     918168.8714     602306.9528          0.0000 grd-pts
      7004     918165.8131     602557.5062          0.0000 grd-pts
      7005     918028.0984     602556.5464          0.0000 grd-pts
      7006     918031.4773     602926.1805          0.0000 grd-pts
      7007     918181.3543     602763.9649          0.0000 grd-pts
      7008     918186.9352     602306.7397          0.0000 grd-pts
S F     7000 (7002 7003 7004 7005 7006 7007 7008)
        7000    ( 7002 7003 7004 7005 7006 7007 7008  )
# Parcel # 102-10-005Q
# Item # A002.008
##########################################################################
#########
L DI 502 8001 n89-08-30e   33.00   # PT 502 IS NW 1/4 COR SEC 14
      8001     918231.6643     602307.2863          0.0000 grd-pts
        8001 8002 s00-00-00e  126.37
      8002     918105.2943     602307.2863          0.0000 grd-pts
        8002 8003 n87-42-00e  199.00
      8003     918113.2806     602506.1260          0.0000 grd-pts
        8003 8004 n00-00-00e   54.79
      8004     918168.0706     602506.1260          0.0000 grd-pts
        8004 8005 s89-42-00e   51.59
      8005     918167.8004     602557.7153          0.0000 grd-pts
        8005 8006 s00-00-00e  154.93
      8006     918012.8704     602557.7153          0.0000 grd-pts
        8006 8007 s87-42-00w  251.00
      8007     918002.7974     602306.9175          0.0000 grd-pts
        8007 8008 n00-00-00e  102.50
      8008     918105.2974     602306.9175          0.0000 grd-pts
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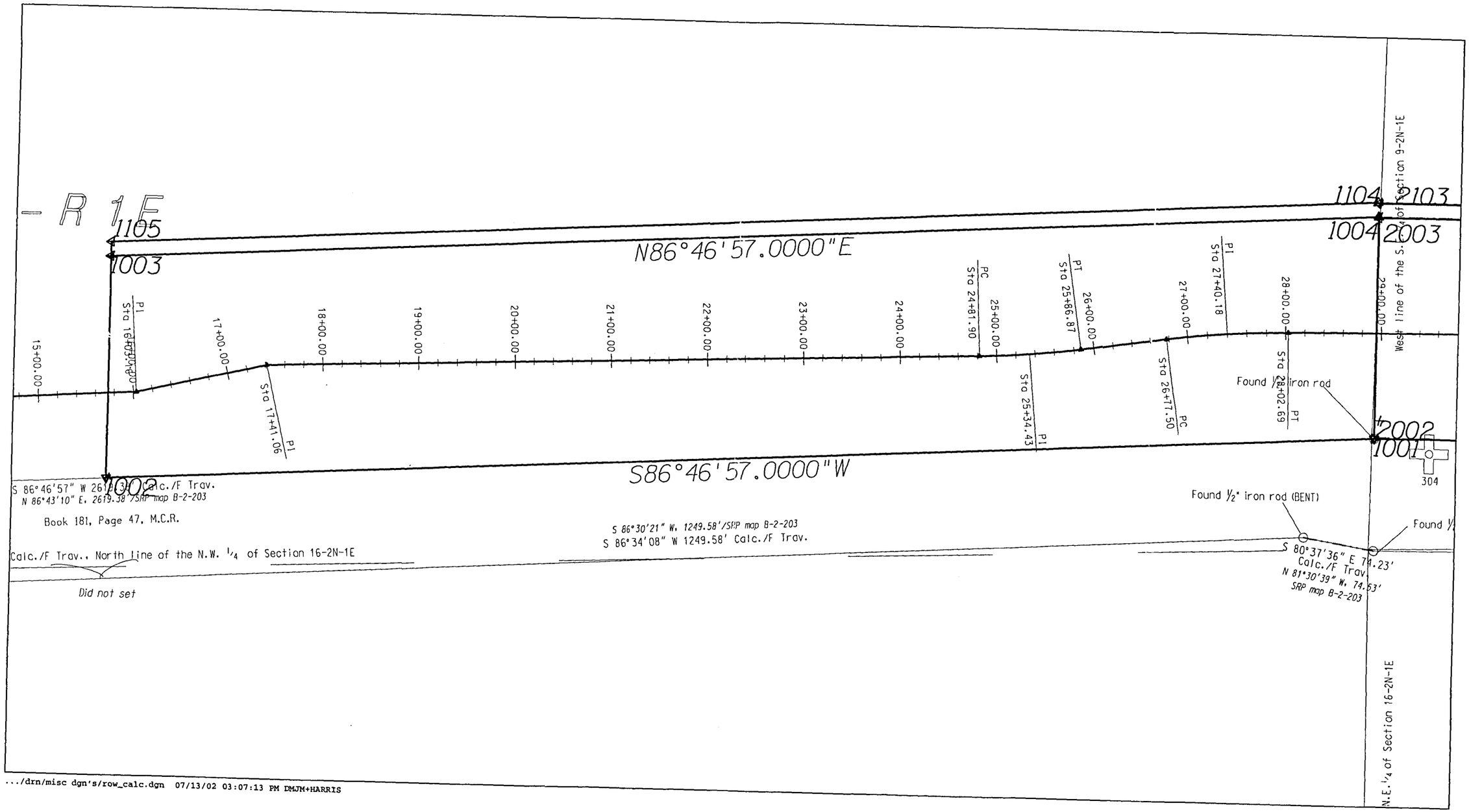
L DI 7004 8150 N89-18-25W 51.59 # Locate common point along proposed R/W from
measured
      8150     918166.4372     602505.9199          0.0000 grd-pts
                                                                  # bearing
 or transformation calculation.
C T (8005 8004) (7004 8150)
Rotation angle is 359^36'25.0000"
Scale factor  is   1.00000000
Northing translation is      -1.9873
Easting translation is      -0.2091
T CO (8001-8008)
      8001     918231.3935     602307.5212          0.0000 grd-pts
      8002     918105.0265     602306.6543          0.0000 grd-pts
      8003     918111.6485     602505.5441          0.0000 grd-pts
      8004     918166.4372     602505.9199          0.0000 grd-pts
      8005     918165.8131     602557.5062          0.0000 grd-pts
      8006     918010.8868     602556.4433          0.0000 grd-pts
      8007     918002.5344     602305.5823          0.0000 grd-pts
      8008     918105.0320     602306.2855          0.0000 grd-pts
S F     8000 (8002 8003 8004 8005 8006 8007 8008)
        8000    ( 8002 8003 8004 8005 8006 8007 8008  )
##############################################################################
#########
# Parcel # 102-10-005R
# Item # A002.006
L DI    502 6001 n89-08-30e   33.00   # PT 502 IS NW 1/4 COR SEC 14
      6001     918231.6643     602307.2863          0.0000 grd-pts
        6001 6002 s00-00-00e   62.56
      6002     918169.1043     602307.2863          0.0000 grd-pts
        6002 6003 s89-42-00e   17.00
      6003     918169.0153     602324.2861          0.0000 grd-pts
        6003 6004 s89-42-00e  181.84
      6004     918168.0632     602506.1236          0.0000 grd-pts
        6004 6005 s00-00-00e   54.79
      6005     918113.2732     602506.1236          0.0000 grd-pts
        6005 6006 s87-42-00w  182.00
      6006     918105.9692     602324.2702          0.0000 grd-pts
L DI 8150 6500 N89-18-25W 181.84
      6500     918168.6367     602324.0932          0.0000 grd-pts
C T (6003 6004) (6500 8150)
Rotation angle is 359^36'25.0000"
Scale factor  is   1.00000000
Northing translation is      -0.3787
Easting translation is      -0.1928
T CO (6001-6006)
      6001     918231.4008     602307.5237          0.0000 grd-pts
      6002     918168.8423     602307.0945          0.0000 grd-pts
      6003     918168.6367     602324.0932          0.0000 grd-pts
      6004     918166.4372     602505.9199          0.0000 grd-pts
      6005     918111.6485     602505.5441          0.0000 grd-pts
      6006     918105.5922     602323.6449          0.0000 grd-pts
S F     6000 (6003 6004 6005 6006 6003)
        6000    ( 6003 6004 6005 6006 6003  )
##############################################################################
#########
# NEW R/W  BETWEEN 83RD AVE. AND GRAND CANAL
PA L 101 124 -33.0 8102 8103
      8102     918230.9422     602307.2892       1083.7600 grd-pts
      8103     915589.4544     602289.0560       1080.7400 grd-pts
PO DI I 8100 8102 8103 5006 (A 5005 5006)
      8100     917964.4789     602305.4499          0.0000 grd-pts
PO DI I 8101 711 712 8100 (A 709 710)
      8101     917956.0730     603000.3411          0.0000 grd-pts
S F 8100 (8100 8101)
        8100    ( 8100 8101  )
# NEW EASEMENT
PA L 8100 8101 30.0 8110 8111
      8110     917934.4811     602305.0870          0.0000 grd-pts
      8111     917926.0752     602999.9782          0.0000 grd-pts
PO DI I 8113 711 712 8111 (A 8110 8111)
      8113     917925.7383     603027.8344          0.0000 grd-pts
PO DI I 8112 124 101 8111 (A 8111 8110) 33
      8112     917934.4792     602305.2428          0.0000 grd-pts
```

```
S F 8110 (8112 8113)
        8110    ( 8112 8113  )
F D [8110] *30' Easement
  Figure ID    Figure Description
 ---------------------------------------------------------------------
        8110   30' Easement
##########################################################################
###########
# 15' Easement North of channel
PA L 1003 1004 -15 1103 1104
      1103     918475.2887     593012.1382          0.0000 grd-pts
      1104     918549.2370     594327.5914          0.0000 grd-pts
     2003 2004 -15 2103 2104
      2103     918548.4345     594328.4411          0.0000 grd-pts
      2104     918565.1225     596971.8220          0.0000 grd-pts
     121 102 33 1121 1102
      1121     920845.6539     596941.3454          0.0000 grd-pts
      1102     918250.2929     596942.6900          0.0000 grd-pts
DI I 1105 1104 (A1104 1103) 1002 (A1002 1003)
      1105     918475.3370     593012.9967          0.0000 grd-pts
     2105 2103 (A2103 2104) 1121 (A1121 1102)
      2105     918564.9375     596942.5270          0.0000 grd-pts
     2106 1121 (A1121 1102) 2003 (A2003 2004)
      2106     918549.9373     596942.5348          0.0000 grd-pts
S F 1100 (1003 1105 1104 2103 2105 2106)
        1100    ( 1003 1105 1104 2103 2105 2106  )
F D [1100] *15' Easement
  Figure ID    Figure Description
---------------------------------------------------------------------
        1100   15' Easement
##########################################################################
###########
# move R/w to the west at 91st Det. Basin
PA L 4001 4002 -11 4101 4102
      4101     918304.1604     599623.2248          0.0000 grd-pts
      4102     918597.7602     599622.8604          0.0000 grd-pts
     4005 4006 -11 4105 4106
      4105     918297.8591     599609.1349          0.0000 grd-pts
      4106     918304.2591     599609.1562          0.0000 grd-pts

S F 4100 (4102 4101 4106 4105)
        4100    ( 4102 4101 4106 4105  )
F D [4100] *ADJUSTED R/W
  Figure ID    Figure Description
---------------------------------------------------------------------
        4100   ADJUSTED R/W
##########################################################################
###########
# New Right-of-way line
PA L 124 101 33 8402 8403
      8402     915589.4544     602289.0560       1080.7400 grd-pts
      8403     918230.9422     602307.2892       1083.7600 grd-pts
     101 100 441.2 8404 8405
      8404     917789.9839     602277.7922       1083.7600 grd-pts
      8405     917831.4139     607496.8422          0.0000 grd-pts
DI I 8400 8402 (A8402 8403) 8404 (A8404 8405)
      8400     917790.1939     602304.2469       1082.2500 grd-pts
L DEF 8402 8400 8401 88-04-30 826.77
      8401     917812.2620     603130.7223       1082.2500 grd-pts
S F 8400 (8400 8401)
        8400    ( 8400 8401  )
F D [8400] *New R/W 83rd to GC
  Figure ID    Figure Description
---------------------------------------------------------------------
        8400   New R/W 83rd to GC
##########################################################################
##########
CE A 10000
        Horizontal alignment 10000 activated
        Beginning station is 10+00.18
S A O   [600]
                  Baseline      Centerline  Baseline              Centerline
Type               Station        Station    Offset Elevation     Skew Angle
```

```
-----------------------------------------------------------------------------
                                 0+00.00 No baseline point found
                                 0+26.59 No baseline point found
  PI   602        28+92.96        26+45.97  109.2314    0.0000  87^46'16.1797"
  PI   603        54+32.91        51+81.94  105.8062    0.0000  89^44'14.1926"
  PI   604        55+44.52        52+93.55  105.4464    0.0000  89^48'55.1926"
  PI   605        55+44.48        53+06.89  118.7864    0.0000-179^49'47.8074"
  PI   606        79+57.11        79+51.35 -467.7847    0.0000-150^00'31.0827"
 POE   607        79+51.74        79+57.55 -470.8831    0.0000 119^58'58.9173"
       [700]
                 Baseline      Centerline  Baseline              Centerline
Type              Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
                                 0+00.00 No baseline point found
  PI   701        15+57.29        13+24.34  192.8447    0.0000  90^04'20.8602"
  PI   702        28+18.73        25+73.92  212.4099    0.0000  87^33'27.1797"
  PI   703        28+91.75        26+48.15  225.7614    0.0000 100^21'43.1797"
  PI   704        55+44.24        52+94.91  213.3126    0.0000  89^33'10.1926"
  PI   705        55+44.23        52+98.74  209.4827    0.0000   0^05'31.8074"
  PI   706        84+53.44        79+28.09 -388.3583    0.0000 -90^27'28.1824"
  PI   707        84+53.51        79+32.72 -383.7289    0.0000   0^52'24.1824"
  PI   708       112+03.31       106+01.90 -117.1009    0.0000 -90^06'44.9395"
  PI   709       112+03.30       106+09.19 -109.8109    0.0000   0^04'58.0605"
  PI   710       116+93.21       110+99.11 -106.2385    0.0000 -89^34'55.9395"
  PI   711       118+92.58       113+69.42   76.2914    0.0000 132^28'28.0605"
                               124+07.97 No baseline point found
       [1000]
                 Baseline      Centerline  Baseline              Centerline
Type              Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  1001        28+92.96         0+00.00  109.2314    0.0000 -92^13'43.8203"
  PI  1002        15+67.95        13+17.53   88.0156    0.0000 -89^45'46.1398"
  PI  1003        15+82.10        15+48.15 -142.1698    0.0000-176^28'56.1398"
  PI  1004        28+97.19        28+65.68 -121.3497    0.0000 -92^13'43.8203"
 POE  1001        28+92.96        30+96.30  109.2314    0.0000-178^56'53.8203"
       [2000]
                 Baseline      Centerline  Baseline              Centerline
Type              Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  2001        55+44.52         0+00.00  105.4464    0.0000 -90^15'33.9617"
  PI  2002        28+92.96        26+47.58  109.2314    0.0000 -89^22'22.9746"
  PI  2003        28+97.28        28+77.37 -120.5222    0.0000-178^55'20.9746"
  PI  2004        55+41.14        55+20.81 -124.3278    0.0000 -90^15'33.9617"
 POE  2001        55+44.52        57+50.61  105.4464    0.0000 179^09'26.2946"
       [3000]
                 Baseline      Centerline  Baseline              Centerline
Type              Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  3003        56+08.38         0+00.00 -180.8814    0.0000 -89^41'54.8074"
  PI  3004        58+36.38         2+28.00 -179.6819    0.0000 -89^41'54.8074"
  PI  3005        58+34.48         5+28.00  120.3121    0.0000-179^38'11.8074"
  PI  3006        56+13.21         7+49.27  119.1480    0.0000 -89^41'54.8074"
 POE  3003        56+08.38        10+49.34 -180.8814    0.0000 179^04'41.6519"
       [4000]
                 Baseline      Centerline  Baseline              Centerline
Type              Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  4001        79+58.60         0+00.00 -483.1683    0.0000 119^43'15.9173"
  PI  4002        77+03.63         2+93.60 -628.7288    0.0000 119^43'15.9173"
  PI  4003        58+34.80        26+62.00 -179.6876    0.0000  90^18'05.1926"
  PI  4004        58+34.51        29+62.00  120.3123    0.0000-179^56'39.8074"
  PI  4005        79+57.11        53+16.43 -467.7847    0.0000-150^00'31.0827"
  PI  4006        79+51.57        53+22.83 -470.9831    0.0000 119^58'58.9173"
 POE  4007        79+58.60        53+36.90 -483.1736    0.0000-150^02'42.0827"
       [5000]
                 Baseline      Centerline  Baseline              Centerline
Type              Station         Station    Offset Elevation    Skew Angle
-----------------------------------------------------------------------------
 POB  5002        77+25.68         0+00.00  115.2728    0.0000  85^53'19.9173"
  PI  5003        82+39.88         5+85.60  145.4187    0.0000 118^57'08.6354"
  PI  5004        89+34.35        13+95.61  142.8333    0.0000 114^49'55.9486"
  PI  5005        93+48.81        18+02.50  102.1662    0.0000  69^42'36.0220"
  PI  5006       111+47.83        35+62.51  113.0098    0.0000  89^53'15.0605"
```

```
  PI  5007       111+48.31        37+92.51 -116.9897    0.0000-179^52'42.9395"
  PI  5008        89+16.40        60+96.80 -386.1468    0.0000 112^11'41.1221"
  PI  5009        87+65.57        63+93.37  -89.8649    0.0000   0^16'50.7883"
  PI  5010        84+74.73        66+83.37  -87.5567    0.0000  89^32'28.8176"
  PI  5011        84+73.40        69+79.72 -383.9037    0.0000 179^44'29.8176"
  PI  5012        84+53.54        69+99.58 -383.7294    0.0000  89^29'49.8176"
  PI  5013        84+53.44        70+04.21 -388.3583    0.0000 178^44'34.8176"
 POE  5014        77+25.67        76+10.01  115.2733    0.0000-150^00'00.0827"
        [8000]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-------------------------------------------------------------------------------
 POB  8002       112+36.27         0+00.00  -27.7145    0.0000 -92^10'55.9395"
  PI  8003       114+35.12         1+99.00  -35.2920    0.0000 -92^10'55.9395"
  PI  8004       114+35.24         2+53.79  -90.0818    0.0000-179^52'55.9395"
  PI  8005       114+86.83         3+05.38  -89.7057    0.0000 -89^34'55.9395"
  PI  8006       114+86.51         4+60.31   65.2240    0.0000-179^52'55.9395"
  PI  8007       112+35.69         7+11.31   74.7815    0.0000 -92^10'55.9395"
 POE  8008       112+35.90         8+13.81  -27.7183    0.0000-179^52'55.9395"
        [7000]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-------------------------------------------------------------------------------
 POB  7002       112+36.30         0+00.00 -109.5703    0.0000   0^07'26.5865"
  PI  7003       112+36.26         0+18.01  -91.5602    0.0000   0^07'26.5865"
  PI  7004       114+86.83         2+68.58  -89.7057    0.0000 -89^34'33.4135"
  PI  7005       114+86.53         4+06.30   48.0121    0.0000-179^52'33.4135"
  PI  7006       118+56.14         7+75.95   42.8574    0.0000  89^12'03.5865"
  PI  7007       116+93.21         9+96.81 -106.2385    0.0000 132^27'38.5865"
 POE  7008       112+35.96        14+54.06 -109.6227    0.0000  90^25'26.5865"
        [6000]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-------------------------------------------------------------------------------
 POB  6003       112+53.40         0+00.00  -91.4078    0.0000 -89^34'55.9395"
  PI  6004       114+35.24         1+81.84  -90.0818    0.0000 -89^34'55.9395"
  PI  6005       114+35.12         2+36.63  -35.2920    0.0000   0^07'04.0605"
  PI  6006       112+53.26         4+18.63  -28.3619    0.0000  87^49'04.0605"
 POE  6003       112+53.40         4+81.68  -91.4078    0.0000-179^52'04.0102"
        [8100]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-------------------------------------------------------------------------------
 POB  8100       112+35.74         0+00.00  112.8372    0.0000  90^25'04.0605"
 POE  8101       119+30.66         6+94.94  117.9046    0.0000  90^25'04.0605"
        [8110]
                  Baseline      Centerline  Baseline              Centerline
Type               Station         Station    Offset Elevation    Skew Angle
-------------------------------------------------------------------------------
 POB  8112       112+35.68         0+00.00  142.8375    0.0000  90^25'04.0605"
 POE  8113       119+58.30         7+22.64  148.1069    0.0000  90^25'04.0605"
#END
```



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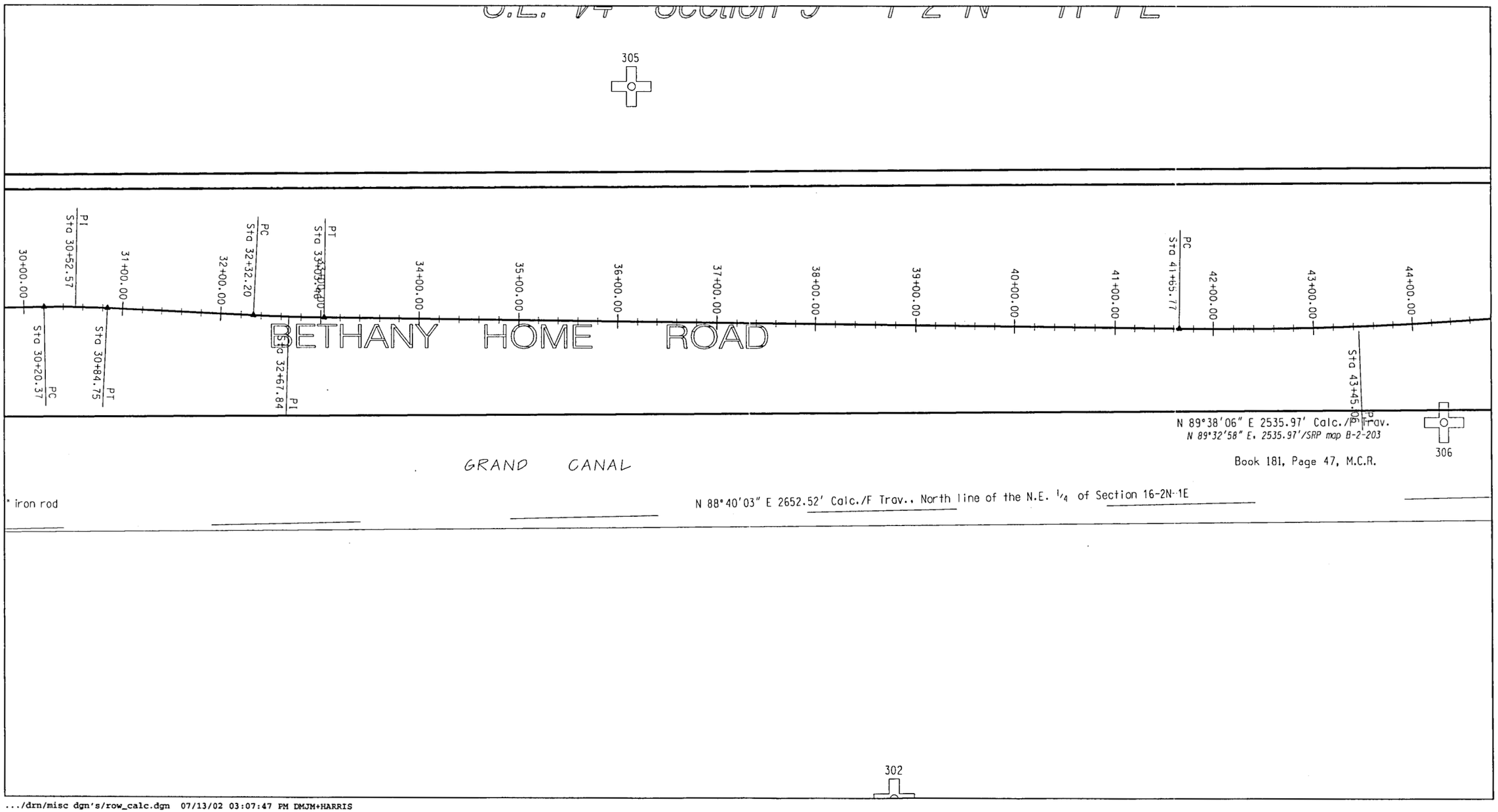

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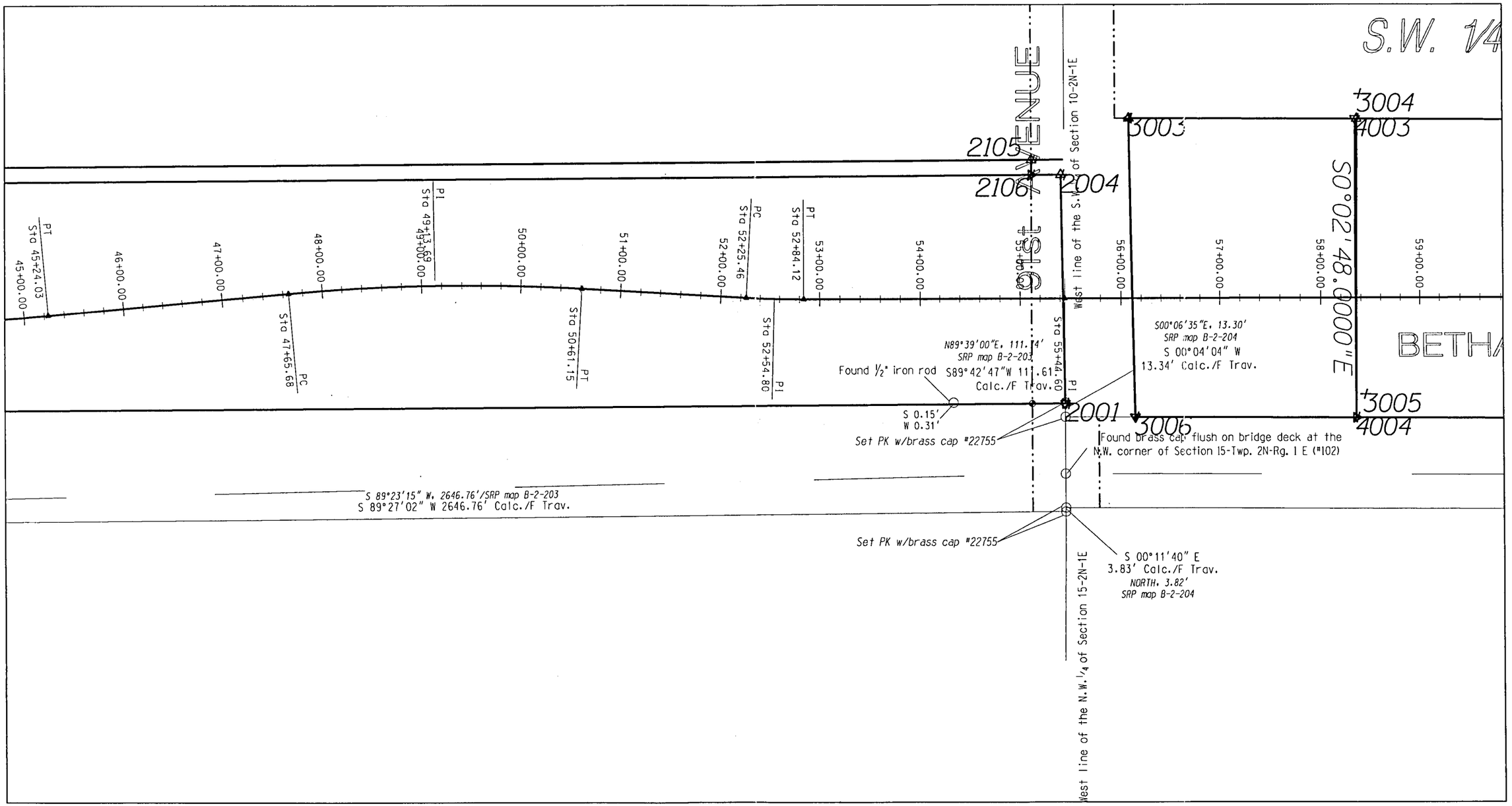

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Section 10 - T 2 N - R 1 E

N89°48'03.0000"W

60+00.00
PC Sta 60+21.36
PI Sta 61+00.00
62+00.00
PT Sta 61+86.66
63+00.00
64+00.00
65+00.00
PC Sta 65+19.93
66+00.00
PI Sta 66+00.18
PT Sta 66+80.95
67+00.00
68+00.00
69+00.00
312
70+00.00
71+00.00
72+00.00
73+00.00
74+00.00

ANY HOME ROAD

GRAND CANAL

Book 181, Page 5, M.C.R.

S 89°47'35" E 5298.64' Calc./F Trav., North line of Section 15-2N-1E

N 89°47'22" E, 5298.56'/SRP map B-2-204

S 89°48'03" E 2644.46' Calc./F Trav.

N 89°46'54" E, 2644.55'/SRP map B-2-204

S 89°47'25" W, 2629.35'/SRP map B-2-204

S 89°47'32" E 2629.35' Calc./F Trav.

S89°48'03.0000"E

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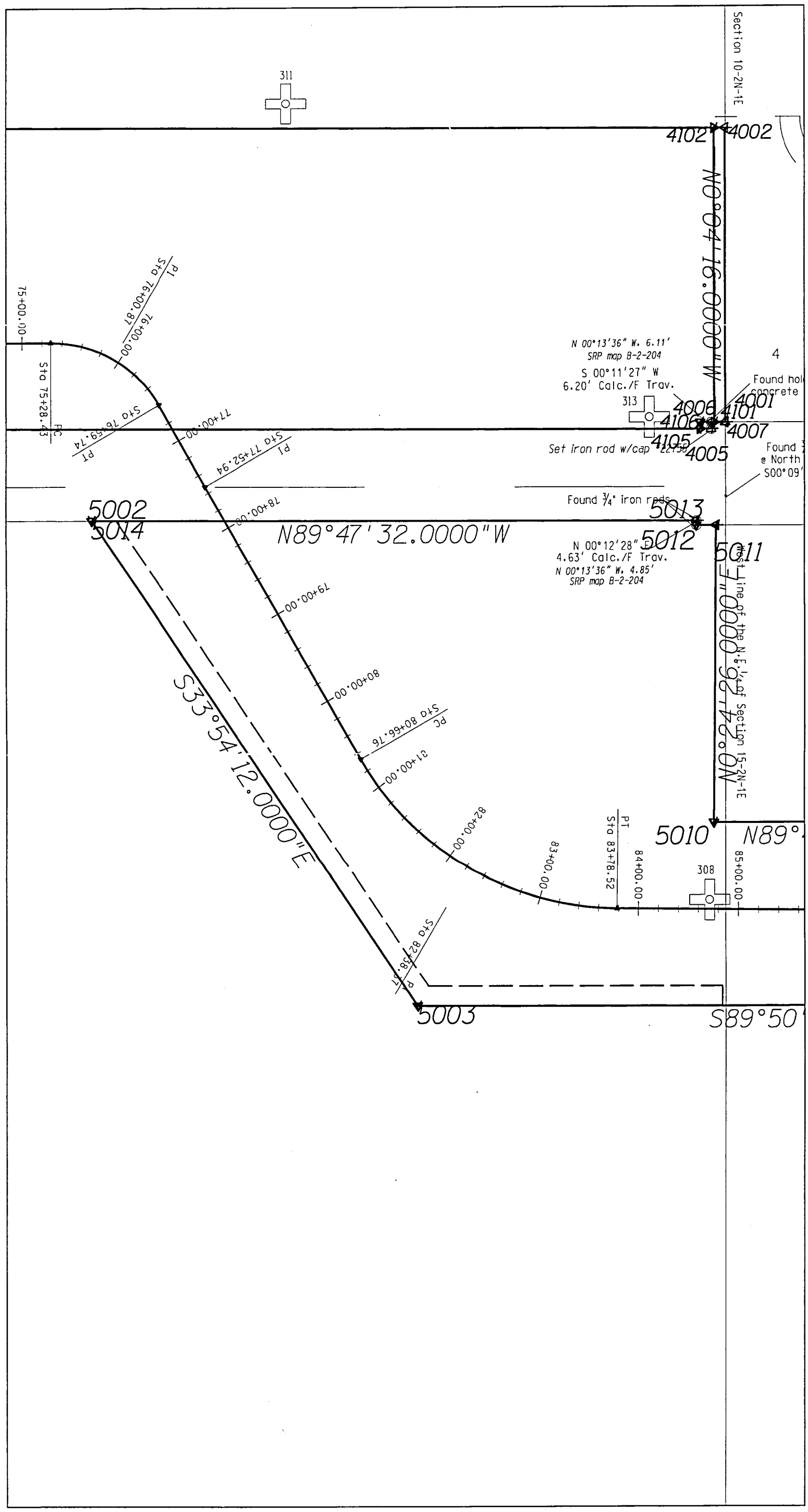

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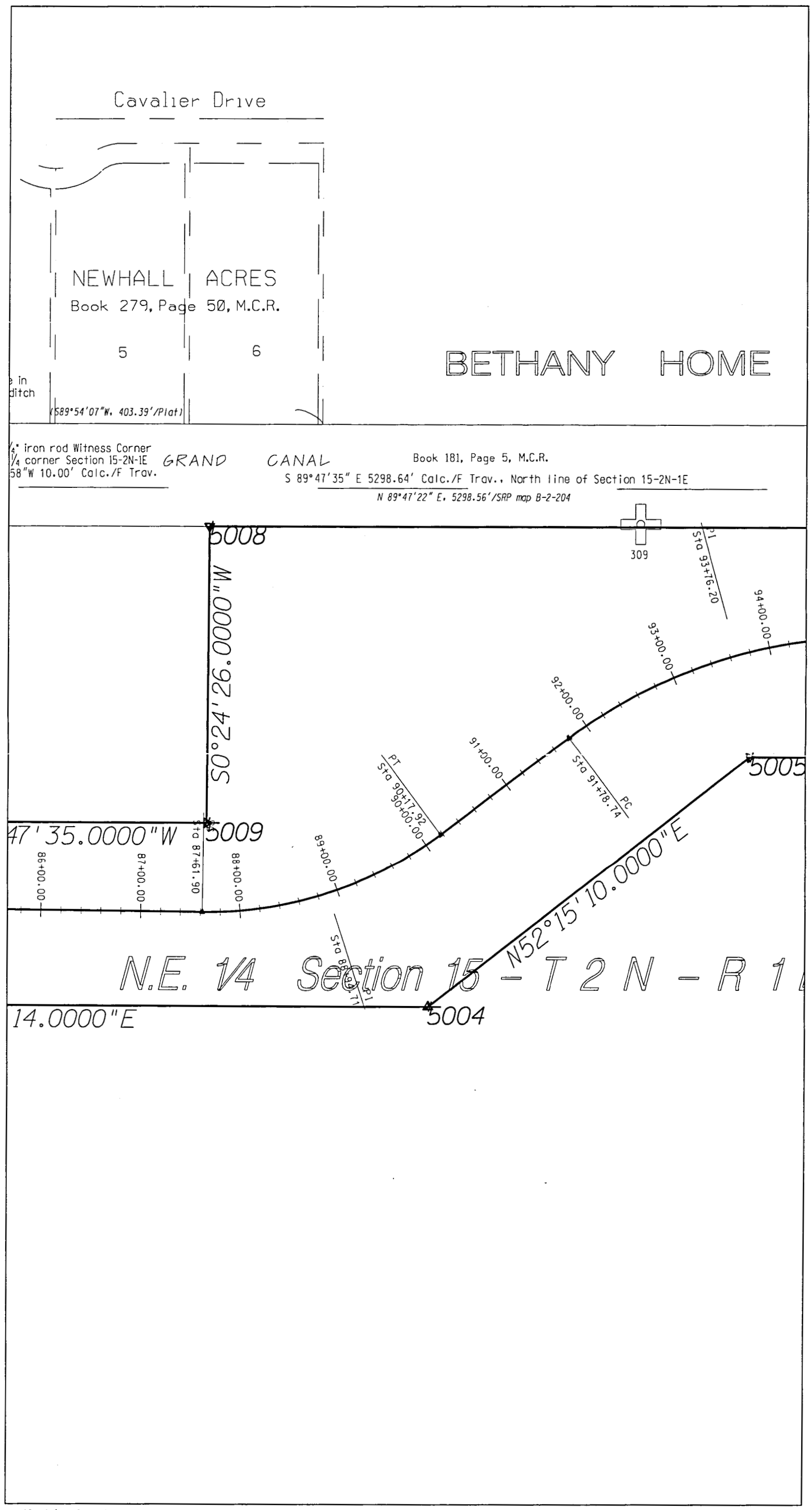
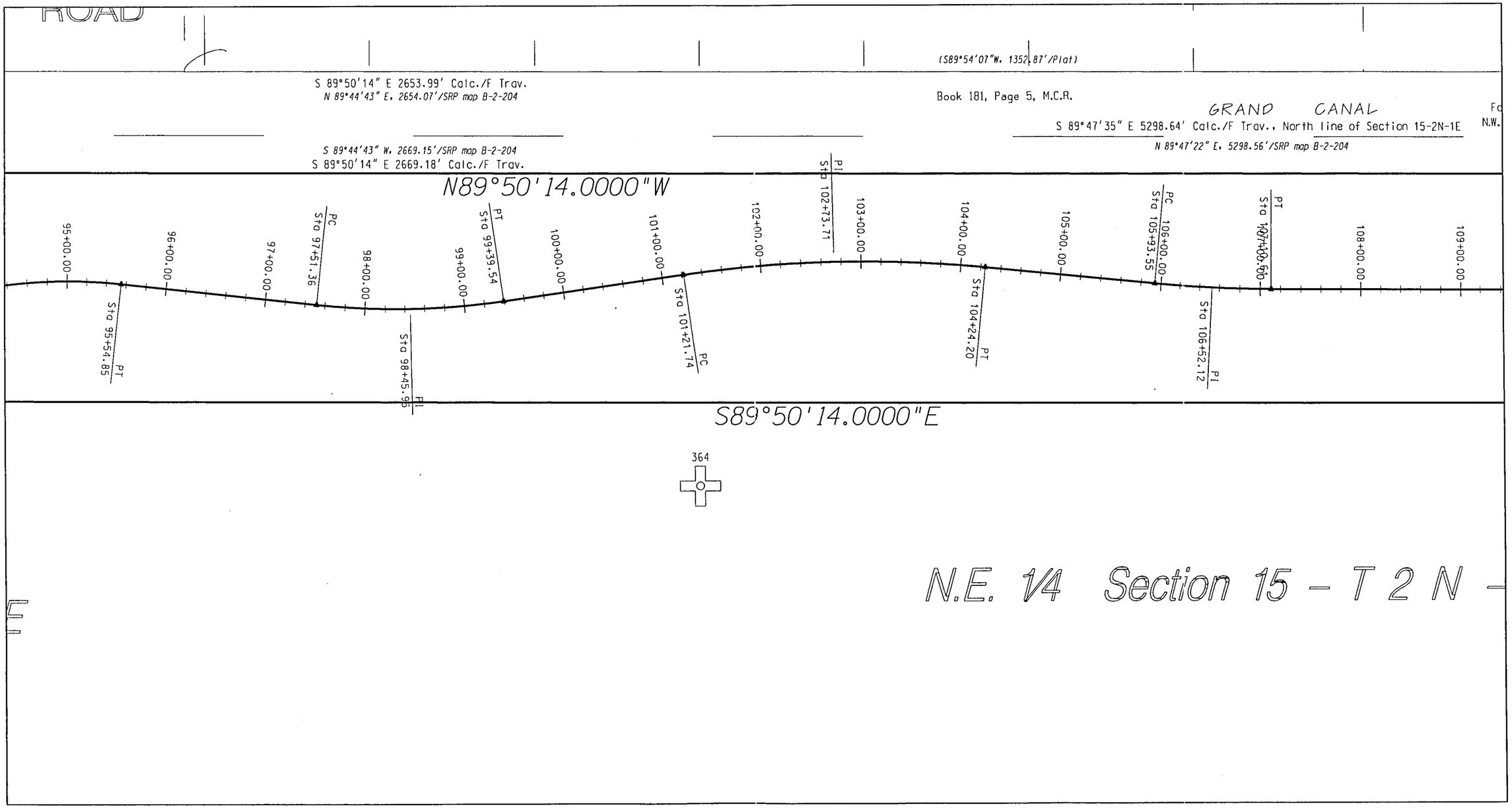

Cavalier Drive
NEWHALL ACRES
Book 279, Page 50, M.C.R.
5
6
BETHANY HOME
(S89°54'07"W, 403.39'/Plat)
GRAND CANAL
Book 181, Page 5, M.C.R.
S 89°47'35" E 5298.64' Calc./F Trav., North line of Section 15-2N-1E
N 89°47'22" E, 5298.56'/SRP map B-2-204
5008
309
Sta 93+76.20
94+00.00
93+00.00
92+00.00
91+00.00
PT
Sta 90+17.92
90+00.00
Sta 91+78.74
PC
5005
S0°24'26.0000"W
47'35.0000"W
5009
Sta 87+61.90
86+00.00
87+00.00
88+00.00
89+00.00
N52°15'10.0000"E
N.E. 1/4 Section 15 - T 2 N - R 1
14.0000"E
5004



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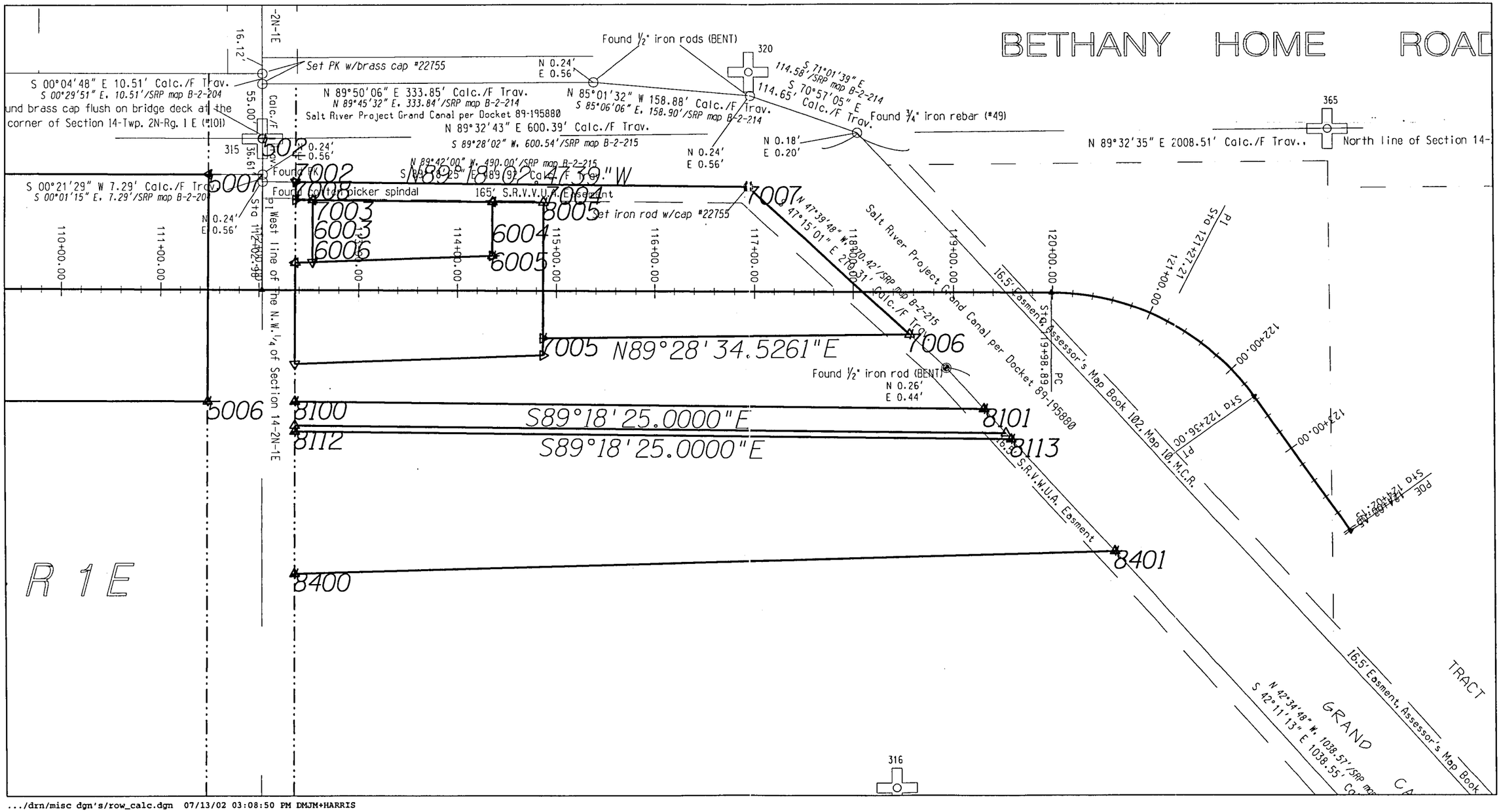

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STRUCTURAL CALCULATIONS

(UNDER SEPARATE COVER -VOLUME 2, 3 & 4)

QUANTITY AND COST CALCULATIONS

BHOC PHASE II

DMJM Project No. 6888.0010

By: DBL

Trapezoidal Channel Lining Excavation: (Scour Protection)

Section Depth (Ct) in ft.: 0.50										
Station From	**Station To**	**Length L (ft)**	**Avg. Bottom Width B (ft)**	**Side Slope**	**Avg. Lined Depth d (ft)**	**Area A_2 (sf)**	**Area A_3 (sf)**	**Total Area (sf)**	**Volume (cy)**	**Drawing #**
15+16	16+03	87	58	2	11	29.0	27.6	56.6	183	
16+03	17+41	138	71.5	4.2	11	35.8	50.5	86.2	441	C-2.01
54+51	56+33	182.35	65.0	3.7	10.0	32.5	41.3	73.8	499	C-2.05
111+35	112+81	146.07	40.0	3.6	16.5	20.0	64.6	84.6	458	C-2.11
								Subtotal =	**1,581**	

Area Weighted Calc for conc Chan. Lining:		
Area	Cost	AxC
2823	$ 25.00	70575
1340	$ 25.00	33500
649	$ 25.00	16225
725	$ 72.00	52200
678	$ 72.00	48816
1110	$ 72.00	79920
981	$ 72.00	70632
Σ Area = 371868		
Σ A x C = 8306		
Avg. $/SY = 45		

EARTH WORK

Breakdown on a per sheet basis.

Net Cut = Cut -(Fill x 1.08_{SHRINK})

Station	Cut cy	Fill cy	Net cy	Σ cy	Sht cy	Sheet	Lndsc. Berms	Chan. Lining	Tot. Qty.
16+03	1377	2	1375	1375	1375				
17+41	5896	52	5840	7215	7215				
17+00	149	0	149	7364	7364				
18+00	5427	1	5426	12790	12790				
19+00	5490	0	5490	18280	18280				
20+00	5384	0	5384	23664	23664				
21+00	5124	3	5121	28785	28785				
22+00	4967	5	4962	33747	33747				
23+00	5180	6	5174	38921	38921	C-2.01		624	39545
24+00	5664	4	5660	44581	5660				
25+00	5848	1	5847	50428	11507				
26+00	5258	1	5257	55685	16764				
27+00	4766	1	4765	60450	21529				
28+00	4846	1	4845	65295	26374				
29+00	4842	15	4826	70121	31200				
30+00	4815	18	4796	74917	35996				
31+00	5113	4	5109	80026	41105				
32+00	4990	1	4989	85015	46094				
33+00	4577	2	4575	89590	50669	C-2.02			50669
34+00	4731	1	4730	94320	4730				
35+00	4810	2	4808	99128	9538				
36+00	4652	4	4648	103776	14186				
37+00	4646	5	4641	108417	18827				
38+00	4662	3	4659	113076	23486				
39+00	4626	2	4624	117700	28110				
40+00	4694	1	4693	122393	32803				
41+00	4809	0	4809	127202	37612				
42+00	4775	2	4773	131975	42385				
43+00	4931	4	4927	136902	47312	C-2.03			47312
44+00	5019	9	5010	141912	5010				
45+00	4952	7	4945	146857	9955				
46+00	5151	3	5148	152005	15103				
47+00	5253	6	5247	157252	20350				
48+00	5206	9	5197	162449	25547				
49+00	5156	10	5146	167595	30693				
50+00	5293	4	5289	172884	35982				
51+00	5525	0	5525	178409	41507				
52+00	5580	0	5580	183989	47087				
53+00	5615	0	5615	189604	52702	C-2.04			52702
53+73	4025	0	4025	193629	4025				
54+50	3740	0	3740	197369	7765				
56+00	7057	0	7057	204426	14822				
56+33	1249	149	1089	205515	15911				
57+00	1481	714	710	206225	16621				
57+30	638	308	306	206531	16927				
58+00	1536	774	701	207232	17628				
59+00	2098	1577	395	207627	18023				
60+00	2132	1491	522	208149	18545				
61+00	2223	1558	541	208690	19086				
62+00	2079	1733	208	208898	19294				
63+00	2005	1595	283	209181	19577	C-2.05	4406	499	15670

EARTH WORK
Breakdown on a per sheet basis.

Net Cut = Cut -(Fill x 1.08_{SHRINK})

Station	Cut cy	Fill cy	Net cy	Σ cy	Sht cy	Sheet	Lndsc. Berms	Chan. Lining	Tot. Qty.
64+00	1939	2090	-319	208862	-319				
65+00	1925	1704	85	208947	-235				
66+00	1849	904	873	209820	638				
67+00	1754	979	697	210517	1335				
68+00	1753	960	717	211234	2052				
69+00	1751	909	770	212004	2822				
70+00	1675	855	752	212756	3574				
71+00	1646	845	734	213490	4308				
72+00	1646	893	682	214172	4990		Berms		
73+00	1613	951	586	214758	5576	**C-2.06**	2057		**3519**
74+00	1560	1012	468	215226	468				
75+00	2105	830	1209	216435	1677				
76+00	2790	469	2284	218719	3961				
76+60	859	97	755	219474	4716				
78+17	0	0	0	219474	4716				
78+28	242	1	241	219715	4957				
78+76	1908	8	1900	221615	6857				
79+00	874	9	865	222480	7722				
80+00	3610	35	3573	226053	11295				
81+00	3500	22	3477	229530	14772				
82+00	3669	66	3598	233128	18370				
83+00	3938	106	3824	236952	22194	**C-2.08**	5062		**17132**
84+00	3736	125	3601	240553	3601				
85+00	3581	64	3512	244065	7113				
86+00	3739	0	3739	247804	10852				
87+00	3756	1	3755	251559	14607				
88+00	3734	15	3718	255277	18325				
89+00	3773	18	3754	259031	22079				
90+00	4071	14	4056	263087	26135				
91+00	4224	49	4172	267259	30307				
92+00	4106	76	4024	271283	34331		Berms		
93+00	4152	109	4035	275318	38366	**C-2.09**	4183		**34183**
94+00	4388	90	4291	279609	4291				
95+00	4839	27	4810	284419	9101				
96+00	5227	17	5209	289628	14310				
97+00	5326	18	5307	294935	19617				
98+00	5382	28	5352	300287	24969				
99+00	5464	25	5437	305724	30406				
100+00	5672	16	5655	311379	36061				
101+00	5945	30	5913	317292	41974				
102+00	6078	32	6044	323336	48018				
103+00	6421	10	6411	329747	54429	**C-2.10**			**54429**

EARTH WORK
Breakdown on a per sheet basis.

Net Cut = Cut -(Fill x 1.08_{SHRINK})

Station	Cut cy	Fill cy	Net cy	Σ cy	Sht cy	Sheet	Lndsc. Berms	Chan. Lining	Tot. Qty.
104+00	6810	2	6808	336555	6808				
105+00	6635	5	6630	343185	13438				
106+00	6425	15	6409	349594	19847				
107+00	6940	16	6923	356517	26770				
108+00	7403	5	7398	363915	34168				
109+00	7199	1	7198	371113	41366				
110+00	6906	0	6906	378019	48272				
110+75	5323	1	5322	383341	53594				
111+35	4256	1	4255	387596	57849				
112+66	8758	0	8758	396354	66607				
112+81	979	0	979	397333	67586				
113+00	1367	1	1366	398699	68952	**C-2.11**		458	**69410**
113+43	3322	4	3318	402017	3318				
114+00	4562	5	4557	406574	7875				
115+00	7605	4	7601	414175	15476				
116+00	7293	65	7223	421398	22699				
116+14	1007	19	987	422385	23686				
117+00	6012	69	5938	428323	29624				
117+15	1021	5	1016	429339	30640				
117+55	1357	8	1349	430688	31989				
120+00	68	3	65	430753	32054				
120+29	246	17	228	430981	32282	**C-2.12**			**32282**
Detention Basin Quantities									
10+25	0	0	0	0	0				
11+00	0	320	-346	-320	-320				
12+00	0	888	-960	-1208	-1208				
13+00	15	787	-835	-1980	-1980				
14+00	33	670	-691	-2617	-2617				
15+00	48	628	-631	-3197	-3197				
16+00	107	529	-465	-3619	-3619				
17+00	176	521	-387	-3964	-3964				
18+00	254	513	-301	-4223	-4223				
19+00	258	469	-249	-4434	-4434				
20+00	448	312	112	-4298	-4298				
21+00	644	155	477	-3809	-3809				
22+00	913	126	777	-3022	-3022				
23+00	1871	143	1717	-1294	-1294				
24+00	2674	279	2373	1101	1101				
25+00	2613	565	2003	3149	3149				
26+00	4550	390	4129	7309	7309				
27+00	4244	15	4228	7378	11538				
27+31	276	1	275	7653	11813	**C-2.07**			**11813**
check	476900	34726		438634	424,507		15708	1,581	**428666**

June 27, 19102 * * * EARTHWORK * * * Page 1 of 3
01:25 PM Report Template: BASIC_END_AREA_80

BASELINE STATION NUMBER	CUT FACT	CUT AREA (sq ft)	CUT VOLUME (cu yd)	CUT ADJUSTED (cu yd)	FILL FACT	FILL AREA (sq ft)	FILL VOLUME (cu yd)	FILL ADJUSTED (cu yd)	MASS ORD. (cu yd)
15+16	1.00	18.67	0	0	1.00	44.71	0	0	0
Cumulative Zero Mass:			0	0			0	0	
16+03	1.00	834.40	1377	1377	1.00	6.82	83	83	1294
17+41	1.00	1473.62	5896	5896	1.00	1.30	21	21	7169
18+00	1.00	1477.47	3219	3219	1.00	0.06	1	1	10386
19+00	1.00	1486.97	5490	5490	1.00	0.00	0	0	15876
20+00	1.00	1420.20	5384	5384	1.00	0.11	0	0	21259
21+00	1.00	1346.74	5124	5124	1.00	1.32	3	3	26381
22+00	1.00	1335.58	4967	4967	1.00	1.39	5	5	31343
23+00	1.00	1461.55	5180	5180	1.00	1.82	6	6	36517
24+00	1.00	1597.26	5664	5664	1.00	0.40	4	4	42177
25+00	1.00	1560.70	5848	5848	1.00	0.04	1	1	48025
26+00	1.00	1278.34	5257	5257	1.00	0.35	1	1	53281
27+00	1.00	1295.24	4766	4766	1.00	0.04	1	1	58046
28+00	1.00	1321.84	4846	4846	1.00	0.35	1	1	62892
29+00	1.00	1292.56	4841	4841	1.00	7.98	15	15	67718
30+00	1.00	1307.35	4815	4815	1.00	1.87	18	18	72515
31+00	1.00	1453.49	5113	5113	1.00	0.05	4	4	77624
32+00	1.00	1241.32	4990	4990	1.00	0.62	1	1	82613
33+00	1.00	1254.11	4621	4621	1.00	0.33	2	2	87232
34+00	1.00	1333.78	4792	4792	1.00	0.34	1	1	92023
35+00	1.00	1273.61	4829	4829	1.00	0.49	2	2	96850
36+00	1.00	1238.48	4652	4652	1.00	1.85	4	4	101498
37+00	1.00	1270.15	4646	4646	1.00	1.07	5	5	106138
38+00	1.00	1247.35	4662	4662	1.00	0.54	3	3	110797
39+00	1.00	1250.78	4626	4626	1.00	0.39	2	2	115422
40+00	1.00	1283.98	4694	4694	1.00	0.06	1	1	120115
41+00	1.00	1312.93	4809	4809	1.00	0.01	0	0	124924
42+00	1.00	1265.79	4775	4775	1.00	1.05	2	2	129697
43+00	1.00	1401.73	4940	4940	1.00	1.08	4	4	134633
44+00	1.00	1304.65	5012	5012	1.00	3.47	8	8	139637
45+00	1.00	1361.20	4937	4937	1.00	0.30	7	7	144566
46+00	1.00	1420.56	5151	5151	1.00	1.48	3	3	149715
48+00	1.00	1395.42	10430	10430	1.00	3.12	17	17	160127
49+00	1.00	1388.71	5156	5156	1.00	2.01	10	10	165273
50+00	1.00	1467.39	5289	5289	1.00	0.00	4	4	170559
51+00	1.00	1509.67	5513	5513	1.00	0.00	0	0	176072
52+00	1.00	1499.71	5573	5573	1.00	0.00	0	0	181645
53+00	1.00	1532.42	5615	5615	1.00	0.00	0	0	187260
54+00	1.00	1378.96	5391	5391	1.00	0.00	0	0	192651
55+00	1.00	1313.49	4986	4986	1.00	0.00	0	0	197637
56+00	1.00	1434.75	5089	5089	1.00	0.00	0	0	202727
56+33	1.00	622.74	1271	1271	1.00	258.08	159	159	203838
Page Total:			202966	202966			240	240	

June 27, 19102 * * * EARTHWORK * * * Page 2 of 3
01:25 PM Report Template: BASIC_END_AREA_80

BASELINE TATION UMBER	STATION CUT FACT	CUT AREA (sq ft)	CUT VOLUME (cu yd)	CUT ADJUSTED (cu yd)	FILL FACT	FILL AREA (sq ft)	FILL VOLUME (cu yd)	FILL ADJUSTED (cu yd)	MASS ORD. (cu yd)
57+00	1.00	576.65	1480	1480	1.00	337.27	735	735	204583
58+00	1.00	620.07	2216	2216	1.00	379.75	1328	1328	205472
59+00	1.00	520.62	2112	2112	1.00	469.27	1572	1572	206012
60+00	1.00	631.05	2133	2133	1.00	333.30	1486	1486	206658
61+00	1.00	569.62	2223	2223	1.00	507.99	1558	1558	207324
62+00	1.00	553.04	2079	2079	1.00	426.51	1731	1731	207672
63+00	1.00	529.60	2005	2005	1.00	433.44	1592	1592	208085
64+00	1.00	517.45	1939	1939	1.00	697.62	2095	2095	207929
65+00	1.00	522.10	1925	1925	1.00	224.38	1707	1707	208147
66+00	1.00	476.08	1848	1848	1.00	263.93	904	904	209091
67+00	1.00	471.29	1754	1754	1.00	264.70	979	979	209867
68+00	1.00	478.05	1758	1758	1.00	253.82	960	960	210664
69+00	1.00	469.77	1755	1755	1.00	236.79	909	909	211511
70+00	1.00	434.53	1675	1675	1.00	224.74	855	855	212331
71+00	1.00	454.17	1646	1646	1.00	231.42	845	845	213132
72+00	1.00	433.61	1644	1644	1.00	251.72	895	895	213881
73+00	1.00	436.17	1611	1611	1.00	262.98	953	953	214539
74+00	1.00	406.30	1560	1560	1.00	283.34	1012	1012	215087
75+00	1.00	730.34	2105	2105	1.00	165.03	830	830	216362
76+00	1.00	776.51	2790	2790	1.00	87.97	469	469	218684
76+60	1.00	968.78	1931	1931	1.00	111.09	220	220	220395
76+75	1.00	0.00	274	274	1.00	0.00	31	31	220637
76+78	1.00	0.00	0	0	1.00	0.00	0	0	220637
78+17	1.00	0.00	0	0	1.00	0.00	0	0	220637
78+28	1.00	1135.41	242	242	1.00	1.27	0	0	220878
78+76	1.00	994.98	1909	1909	1.00	11.91	12	12	222776
79+00	1.00	1004.33	874	874	1.00	0.45	5	5	223644
80+00	1.00	945.17	3610	3610	1.00	0.76	2	2	227252
81+00	1.00	945.02	3500	3500	1.00	11.36	22	22	230730
82+00	1.00	1041.76	3679	3679	1.00	23.56	65	65	234345
83+00	1.00	1090.21	3948	3948	1.00	32.49	104	104	238189
84+00	1.00	927.12	3736	3736	1.00	33.98	123	123	241802
85+00	1.00	1006.85	3581	3581	1.00	0.00	63	63	245320
86+00	1.00	1012.69	3740	3740	1.00	0.00	0	0	249060
87+00	1.00	1015.65	3756	3756	1.00	0.44	1	1	252816
88+00	1.00	1000.81	3734	3734	1.00	7.82	15	15	256534
89+00	1.00	1036.66	3773	3773	1.00	2.17	19	19	260289
90+00	1.00	1161.84	4071	4071	1.00	5.30	14	14	264347
91+00	1.00	1119.33	4224	4224	1.00	21.27	49	49	268522
92+00	1.00	1097.79	4106	4106	1.00	19.58	76	76	272552
93+00	1.00	1144.23	4152	4152	1.00	39.25	109	109	276595
94+00	1.00	1225.02	4387	4387	1.00	9.33	90	90	280892
95+00	1.00	1387.79	4839	4839	1.00	5.37	27	27	285704
96+00	1.00	1434.84	5227	5227	1.00	3.61	17	17	290914
97+00	1.00	1441.18	5326	5326	1.00	6.29	18	18	296222
Page Total:			112825	112825			24638	24638	

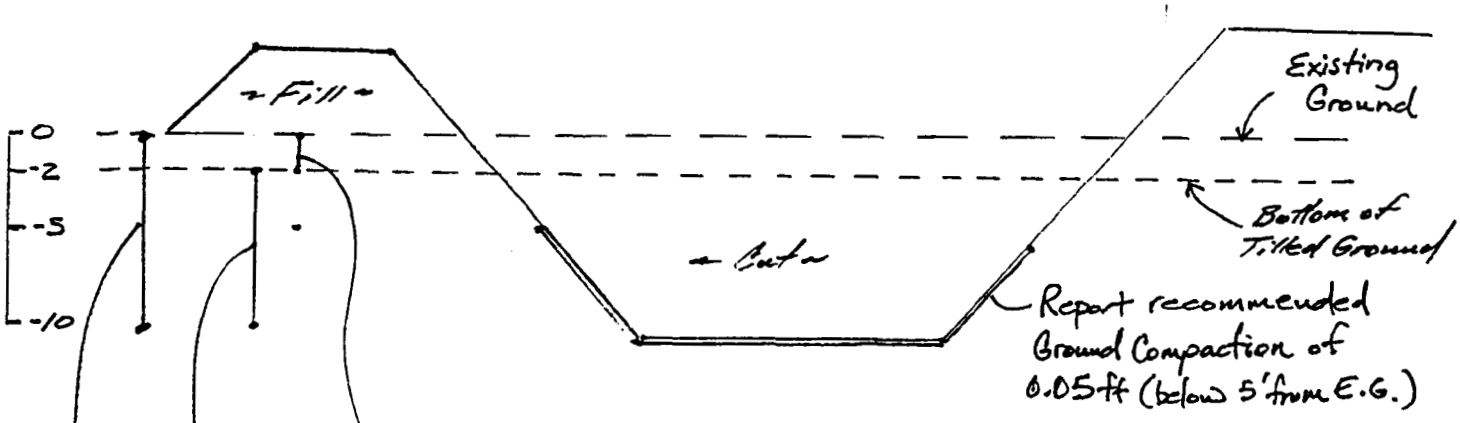
June 27, 19102 * * * EARTHWORK * * * Page 3 of 3
01:25 PM Report Template: BASIC_END_AREA_80

BASELINE STATION NUMBER	STATION CUT FACT	CUT AREA (sq ft)	CUT VOLUME (cu yd)	CUT ADJUSTED (cu yd)	FILL FACT	FILL AREA (sq ft)	FILL VOLUME (cu yd)	FILL ADJUSTED (cu yd)	MASS ORD. (cu yd)
98+00	1.00	1465.44	5383	5383	1.00	8.80	28	28	301576
99+00	1.00	1485.34	5464	5464	1.00	4.56	25	25	307016
100+00	1.00	1577.79	5672	5672	1.00	4.19	16	16	312672
101+00	1.00	1632.62	5945	5945	1.00	12.27	30	30	318587
102+00	1.00	1649.68	6078	6078	1.00	4.98	32	32	324633
103+00	1.00	1817.73	6421	6421	1.00	0.23	10	10	331045
104+00	1.00	1859.84	6810	6810	1.00	0.92	2	2	337853
105+00	1.00	1722.82	6635	6635	1.00	1.71	5	5	344483
106+00	1.00	1746.60	6425	6425	1.00	6.26	15	15	350893
107+00	1.00	2001.10	6940	6940	1.00	2.24	16	16	357817
108+00	1.00	1996.65	7403	7403	1.00	0.26	5	5	365216
109+00	1.00	1890.67	7199	7199	1.00	0.26	1	1	372414
110+00	1.00	1838.51	6906	6906	1.00	0.01	0	0	379319
111+00	1.00	1870.68	6869	6869	1.00	22.49	42	42	386146
112+00	1.00	2000.42	7169	7169	1.00	1.64	45	45	393270
112+66	1.00	1831.50	4683	4683	1.00	25.35	33	33	397921
113+00	1.00	1973.17	2396	2396	1.00	16.07	26	26	400290
114+00	1.00	2119.41	7579	7579	1.00	0.95	32	32	407838
115+00	1.00	1987.07	7605	7605	1.00	0.32	2	2	415440
116+00	1.00	1950.68	7292	7292	1.00	35.02	65	65	422667
116+14	1.00	1932.56	1007	1007	1.00	37.28	19	19	423655
117+00	1.00	1923.94	6142	6142	1.00	5.51	68	68	429728
117+15	1.00	1954.95	1077	1077	1.00	5.71	3	3	430803
117+55	1.00	0.00	1448	1448	1.00	0.00	4	4	432247
120+28	1.00	0.00	0	0	1.00	0.00	0	0	432247
Page Total:			141874	141874			542	542	

June 27, 19102 * * * EARTHWORK * * * Page 3 of 3
01:25 PM Report Template: BASIC_END_AREA_80

Grand Total:			457666	457666			25419	25419	

DMJM HARRIS	PROJECT: BHOC, Phase II	JOB NO. 6888.0060	SHEET of
		DESIGNED BY KHD	DATE 3/07/02
SUBJECT: Earthwork - Shink/Ground Compaction		CHECKED BY	DATE



This volume will shrink ~ 20% (~~0.6~~ 0.4 feet) if excavated and recompacted to 95%

This volume will likely shrink ~ 5% (varies) if excavated and recompacted to 95%

Overall shrink is likely 8% (varies depending on depth) if excavated & recompacted to 95%

Where compacted to 90% shrink still on the order of 7 to 8%

Additional Recommendations

Ground Compaction 0 to -2' (0.5 feet - Farmland
(0.25 feet - Other Areas)

Ground Compaction -2' to -5' (0.2 feet)

Overall (Below -2') (0.15 feet ±)

	CuYd	Gal/Cy	Total						
Channel Excavation	428666								
Channel Lining Ex	1,581								
	430247	55	23,663,585						
Channel Fill	34726								
Landscape berms	15708								
	50434.32	39	1,966,938						
Net Excavation	379812.7								
		Total	25,630,523	gal	days	hours	sec/hr	cfs	gpm
			3,426,541	cu ft	215	8	3600	0.55	248.15
			78.66	ac-ft					

BHOC PHASE II
DMJM Project No. 6888.0010

By: DBL

Definitions:

s=span
h=height
H=average height of fill
t=top slab thickness
T=bottom slab thickness
w=wall thickness
W=bottom slab width
c=height of box plus thickness of top and bottom slabs
Vex=volume of structural excavation of RCBC
Vbf=volume of backfill of RCBC
Abf=area of backfill of RCBC
L=length

Formulas:

W=(#of barrels)*(s)+[(#of barrels+1)*(w/12)]+(8/12)
c=(h)+[2(t)+2]/12(for boxes of 2 barrels or more),otherwise c=(h)+[(2*t)/12
Vex=[H(L)*(W+3)]/27
Abf=2{[(.5)*(1.5)*(c^2)]+[c-(T/12)]4/12}
Vbf=[Abf*(L+2h)]/27
T=t+2 (for boxes of 2 barrels or more, otherwise, T=t)

Notes:

1. Qty's per ADOT Highways Division Structures Section Standard Drawings

Assumptions
Concrete $/cy = $200
Steel $/lb = $0.35
STR. Bkfl. $/cy = $15
STR. Exc. $/cy = $8

QUANTITY CALCULATIONS

Structural Excavation & Backfill of RCBC

RCBC ID (TYPE)	Number of Barrels	s (ft)	h (ft)	L (ft)	w (in)	H (ft)	t (in)	Conc/ft B-02.70	Steel/ft B-02.70	T (in)	c (ft)	W (ft)	Abf (ft)	Concrete (cy)	Steel (lb)	Vbf (cy)	Vex (cy)	Cost $/L.F.
I	6	10.00	5.00	140.3	11.00	11.00	10.50	5.984	868.70	12.50	6.92	67.08	96.51	840	121879	538	4,006	$1,790
III	3	10.00	8.00	237	11.00	16.00	15.00	4.474	531.10	17.00	10.67	34.33	208.89	1061	125871	1958	5,244	$1,390

CONSTRUCTION ESTIMATE - STRUCTURES

ITEM NUMBER	DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST
87th Ave RCBC (this work is included in the per foot price of the RCBC)					
	Steel Reinforcement (Headwall)	Lb.	$0.50	6,035	$3,018
	Portland Cement Concrete (Headwall), Class A	CY	$225.00	34	$7,650
	Retaining Walls	Sq.Ft.	$25.00	2,702	$67,550
	Channel Lining	Sq.Yd.	$35.00	492	$17,220
	Access Barriers	L.Sum	$6,800.00	1	$6,800
	Architectural Treatment	SF	$15.00	3,476	$52,140
	Pedestrian Rail	L.Ft.	$40.00	420	$16,800
				Subtotal	$171,178
83rd Ave RCBC (this work is included in the per foot price of the RCBC)					
	Steel Reinforcement (Headwall)	Lb.	$0.50	4,260	$2,130
	Portland Cement Concrete (Headwall), Class A	CY	$225.00	24	$5,400
	Retaining Walls	Sq.Ft.	$25.00	3,751	$93,775
	Access Barriers	L.Sum	$2,200.00	1	$2,200
	Architectural Treatment	SF	$15.00	2,694	$40,410
	Pedestrian Rail	L.Ft.	$40.00	309	$12,360
				Subtotal	$156,275
				SUBTOTAL:	$327,453

	Total $/LF
87th Ave. RCBC	$3,010
83rd Ave. RCBC	$2,049

Item No.	Item Description	Unit	Quantity	Unit Price	Amount
336-2	Pavement Replacement 91st and 83rd Ave.	1806	SY	17.00	30,702.00
340-1	Concrete Sidewalk	1069	SF	2.00	2,138.00
340-2	Concrete Curb & Gutter (MAG Detail 220, Type A)	230	LF	9.00	2,070.00
345-1	Adjust Manhole Frame and Cover	4	EA	500.00	2,000.00
345-2	Adjust Valve Box and Cover (Type A)	4	EA	300.00	1,200.00
350-2	Pavement Removal	3767	SY	2.00	7,534.00
350-3	Curb & Gutter Removal	603	LF	1.50	904.50
	Total Roadway Items				46,548.50

83rd Ave

Pavement
Sta. 6+49.54 to 7+57.32 cstr centerline
(monument line sta 6+50.00 to 7+57.32)

	width	length	area	
west	24.00	107.32	2575.68	sf
east	32.10	84.73	2719.83	sf
	33.50	22.50	753.75	sf
total			6049.26	sf

Sta. 9+35.32 to 9+80.13 cstr centerline
(monument line sta. 9+35.32 to 9+79.00)

width	length	area	
58.00	43.68	2533.44	sf

Total Pavement 83rd Ave 8582.70 sf
953.63 sy

Curb and Gutter

se	22.5	lf
sw	22.5	lf
ne	2.5	lf
nw	2.5	lf
total	50	lf

Sidewalk

width	length	area	
6.65	20	133	sf
		2	sides
	total	266	sf

curb removal
sta 8+89 to 9+79 west side
90 lf

Pavement removal

	width	length	area	
west	33	90	2970	sf
	31.1	239	7432.9	sf
east	24	329	7896	sf
total			18298.9	sf
			2033.211	sy

91st Ave

Pavement
Sta. 10+45.93 to 10+93.23 cstr centerline)
(monument line sta. 10+47.00 to 10+93.23)

	width	length	area	
south	52.00	46.23	2403.96	sf

Sta. 12+57.73 to 13+25.74 cstr centerline
(monument line sta. 12+57.73 to 13+50.00)

	width	length	area	
west	24.50	92.27	2260.62	sf
east	33.50	37.00	1239.50	sf
	32.25	30.27	976.21	sf
	31.40	25.00	785.00	sf
total pavement			7665.28	sf
			851.70	sy

curb and gutter

sw	2.50
se	2.50
ne	67.27
middle w	67.27
nw	39.5
total	179.04

Sidewalk

	width	length		
nw	6.65	37.00	246.05	sf
ne	6.65	37	246.05	sf
	5.825	5	29.13	sf
	5	56.27	281.35	sf
total			802.58	sf

Curb Removal

sta.'s	beg	end	length	
west	1081	1325	244	lf
east	1056	1325	269	lf
total			513	lf

Pavement Removal

east	width	length	area	
	26	9	234	sf
	27.5	294	8085	sf
west	26	34	884	sf
	23.75	269	6388.75	sf
total			15591.75	sf
			1732.417	sy

Bethany Home/Grand Canal Flood Control Project
Bethany Home Outfall Channel, Phase II

CONSTRUCTION ESTIMATE - STRUCTURES					
ITEM NUMBER	DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST
502-1	42" Diameter Drilled Shaft Foundation (Bridge)	L.Ft.	$125.00	1,953	$244,125
502-2	42" Diameter Drilled Shaft Foundation (Bridge)(Contingenc	L.Ft.	$50.00	1,953	$97,650
502-3	30" Diameter Drilled Shaft Foundation (Bridge)	L.Ft.	$90.00	220	$19,800
502-4	30" Diameter Drilled Shaft Foundation (Bridge)(Contingenc	L.Ft.	$30.00	220	$6,600
505-1	***91St Avenue Bridge***				
	Structural Excavation	CY	$10.00	351	$3,510
	Structural Backfill	CY	$20.00	349	$6,980
	Reinforcing Steel (Bridge)	Lb.	$0.50	289,890	$144,945
	Portland Cement Concrete (Bridge), Class A	CY	$225.00	151	$33,975
	Portland Cement Concrete (Bridge), Class AA	CY	$275.00	1,294	$355,850
	Architectural Treatment	SF	$15.00	1,000	$15,000
	Bridge Railing	L.Ft.	$50.00	270	$13,500
	Safety Railing	L.Ft.	$40.00	71	$2,840
	Subtotal				$576,600
505-2	***83rd Avenue Bridge***				
	Structural Excavation	CY	$10.00	351	$3,510
	Structural Backfill	CY	$20.00	338	$6,760
	Reinforcing Steel (Bridge)	Lb.	$0.50	336,210	$168,105
	Portland Cement Concrete (Bridge), Class A	CY	$225.00	139	$31,275
	Portland Cement Concrete (Bridge), Class AA	CY	$275.00	1,514	$416,350
	Architectural Treatment	SF	$15.00	1,100	$16,500
	Bridge Railing	L.Ft.	$50.00	309	$15,450
	Safety Railing	L.Ft.	$40.00	73	$2,920
	Subtotal				$660,870
505-3	***87th Ave RCBC (this work is included in the per foot price of the RCBC)***				
	Steel Reinforcement (Headwall)	Lb.	$0.50	5,010	$2,505
	Portland Cement Concrete (Headwall), Class A	CY	$225.00	35	$7,875
	Retaining Walls	Sq.Ft.	$25.00	2,646	$66,150
	Channel Lining	Sq.Yd.	$35.00	83	$2,905
	Access Barriers	L.Sum	$6,800.00	1	$6,800
	Architectural Treatment	SF	$15.00	3,578	$53,670
	Safety Railing	L.Ft.	$40.00	420	$16,800
	Subtotal				$156,705
505-4	***83rd Ave RCBC (this work is included in the per foot price of the RCBC)***				
	Steel Reinforcement (Headwall)	Lb.	$0.50	6,224	$3,112
	Portland Cement Concrete (Headwall), Class A	CY	$225.00	24	$5,400
	Retaining Walls	Sq.Ft.	$25.00	3,786	$94,650
	Access Barriers	L.Sum	$2,200.00	1	$2,200
	Architectural Treatment	SF	$15.00	4,437	$66,555
	Safety Railing	L.Ft.	$40.00	210	$8,400
	Subtotal				$180,317

Bethany Home/Grand Canal Flood Control Project
Bethany Home Outfall Channel, Phase II

505-7	***83rd Avenue Pedestrian Bridge***				
	Structural Excavation	CY	$10.00	80	$800
	Structural Backfill	CY	$20.00	70	$1,400
	Reinforcing Steel (Bridge)	Lb.	$0.50	7,025	$3,513
	Portland Cement Concrete (Bridge), Class A	CY	$225.00	18	$4,050
	Portland Cement Concrete (Bridge), Class AA	CY	$225.00	32	$7,200
	Prefabricated Steel Truss Bridge	L.Sum	$60,000.00	1	$60,000
	Concrete Lining	SQ.YD.	$20.00	20	$400
	Subtotal				$75,163
505-8	***87th Ave Pedestrian Bridge***				
	Structural Excavation	CY	$10.00	80	$800
	Structural Backfill	CY	$20.00	70	$1,400
	Reinforcing Steel (Bridge)	Lb.	$0.50	7,025	$3,513
	Portland Cement Concrete (Bridge), Class A	CY	$225.00	18	$4,050
	Portland Cement Concrete (Bridge), Class AA	CY	$225.00	32	$7,200
	Prefabricated Steel Truss Bridge	L.Sum	$55,000.00	1	$55,000
	Concrete Lining	SQ.YD.	$20.00	20	$400
	Subtotal				$70,163
505-9	***Concrete Painting***				
	91st Ave Bridge	Sq.Ft.	$0.75	17,600	$13,200
	83rd Ave bridge	Sq.Ft.	$0.75	20,200	$15,150
	87th Ave RCBC	Sq.Ft.	$0.75	3,830	$2,873
	83rd Ave RCBC	Sq.Ft.	$0.75	2,571	$1,928
	87th Ave Pedestrian Bridge	Sq.Ft.	$0.75	270	$203
	83rd Ave Pedestrian Bridge	Sq.Ft.	$0.75	260	$195
	Subtotal			44,731	$33,548
			SUBTOTAL:		$2,121,540
			CONTINGENCY:	0%	$0
			TOTAL COST:		$2,121,540

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Structural Quantities (f'c = 4000 psi) - CLASS AA

For BHOC, all 4000 psi shall include:

- Columns
- Abutment caps
- Pier caps
- Wingwalls
- Superstructure deck
- Concrete parapets
- Sidewalks

It does NOT include approach slabs nor retaining walls which shall be quantitied as class A concrete.

Superstructure Deck

$Length := 3 \cdot 44ft - 2 \cdot 2.25ft$ $\quad Length = 127.5\,ft$ Length of deck based on CL abut to CL abut with the abutment caps at the end taken out.

$Deckarea := 195.18ft^2$ 1'-10" deck cross-sectional area

$lighting := 4 \cdot (3ft) \cdot (1ft) \cdot \left[2ft + \frac{1}{2}(1ft + 1ft)\right]$ Lighting support blisters (4 total)

$Superdeck := Length \cdot Deckarea + lighting$ $\quad Superdeck = 923\,CY$

Columns

$ncolumns := 6$ Number of columns

$npier := 2$ Number of piers

$Colvol := npier\left[ncolumns \cdot \frac{\pi \cdot (2 \cdot ft)^2}{4}\right] \cdot \left(\left(\frac{1067.43ft + 1067.19ft}{2} - 2.83 \cdot ft - 1052.75ft\right)\right)$ Average PGL used, 2'-10" pier cap thickness, top of shaft elevation = bottom of column elevation

$Colvol = 16.4\,CY$

Checked by: _____
Date: _____

Sidewalk

$nsdwlk := 2$ Number of swlks

$sdwlkarea := 4.33ft^2$ Cross-sectional area of swlk

$sdwlklength := 164.5ft$

$vol32 := nsdwlk \cdot sdwlkarea \cdot sdwlklength$ $vol32 = 52.8\,CY$

Pedestrian Parapet/Dado

$nped := 1$

$pedarea := 2.7ft \cdot 0.896ft$

$pedlength := (132.0 \cdot ft + 14 \cdot ft - 2.25 \cdot ft + 0.916 \cdot ft - 10 \cdot ft) \cdot 2$

$dado := 4 \cdot 0.7 \cdot CY$

$volped := nped \cdot pedarea \cdot pedlength + dado$ $volped = 26.9\,CY$

Pier Cap

$pierdeckvol := 2 \cdot 5ft \cdot \left(106.46ft^2\right)$ Volume of deck below superstructure at piers (2 total)

$piervol := pierdeckvol$ $piervol = 39.4\,CY$

"Super Cap" on top of Abutment Cap

$$Supercap := 2 \cdot \left[\left[\frac{2.79ft + \frac{(1.99ft + 1.99ft)}{2}}{2}\right] \cdot (106.54ft) \cdot 4.5ft - 1ft \cdot (1ft + 0.5in) \cdot 106.54ft\right]$$

Notch in abutment cap where approach slab meets is taken out.

$Supercap = 76.7\,CY$

Abutment Cap on top of drilled shafts

$Abutcap := 2 \cdot (106.46ft) \cdot 4ft \cdot 4.5ft$ $Abutcap = 141.9\,CY$

Checked by: _____
Date: _____

Wingwalls (Retaining walls are 3000 psi only!)

$wingabutonewestvol := 0CY$

$wingabutoneeastvol := 0CY$

$wingabuttwowestlength := 14ft - (2ft + 3in)$

$wingabuttwoeastlength := 14ft - (2ft + 3in)$

$wingabuttwowestvol := wingabuttwowestlength \cdot 18.57 \cdot ft^2$

$wingabuttwowestvol = 8.1\,CY$

$wingabuttwoeastvol := wingabuttwowestlength \cdot 18.57 \cdot ft^2$

$wingabuttwoeastvol = 8.1\,CY$

$wingvol := wingabutonewestvol + wingabutoneeastvol + wingabuttwowestvol + wingabuttwoeastvol$

$wingvol = 16.2\,CY$

Class AA TOTAL

$classAA := Superdeck + Colvol + vol32 + volped + piervol + Supercap + Abutcap + wingvol$

$\boxed{classAA = 1293.3\,CY}$

Structural Quantities (f'c = 3000 psi) - CLASS A

Approach Slab

$apprslab := [\,106.46 \cdot ft \cdot 15 \cdot ft + (106.46 \cdot ft - 2 \cdot 1.17 \cdot ft) \cdot 15 \cdot ft\,] \cdot 1 \cdot ft$ $\boxed{apprslab = 117\,CY}$

Checked by: _____
Date: _____

Retaining walls

Length of radial retaining walls at abutment two were measured in Microstation on outside face (conservative).

$wingabutonewestlength := 0 \cdot ft$

$wingabutoneeastlength := 0 ft$

$wingabut2westretwall := 32.5 \cdot ft + 1 \cdot 3 \cdot ft$

$wingabut2eastretwall := 32.5 ft + 1 \cdot 3 \cdot ft$

$wingabutonewestarea := 0 \cdot sqft$ cross-sectional area of retaining wall

$wingabutoneeastarea := wingabutonewestarea$

$wingabuttwowestarea := 10.75 \cdot in \cdot 7.17 \cdot ft + (4 \cdot ft + 6 \cdot in) \cdot 1 \cdot ft + (1 \cdot ft + 3 \cdot in) \cdot (1 \cdot ft + 6 \cdot in)$ s-sectional area of retaining wall only

$wingabuttwoeastarea := wingabuttwowestarea$

$wingabutonewestvol := wingabutonewestarea \cdot wingabutonewestlength$ $wingabutonewestvol = 0\ CY$

$wingabutoneeastvol := wingabutoneeastarea \cdot wingabutoneeastlength$ $wingabutoneeastvol = 0\ CY$

$wingabuttwowestvol := wingabut2westretwall \cdot wingabuttwowestarea$

$wingabuttwowestvol = 16.8\ CY$

$wingabuttwoeastvol := wingabut2eastretwall \cdot wingabuttwoeastarea$

$wingabuttwoeastvol = 16.8\ CY$

$retwallabut1 := wingabutonewestvol + wingabutoneeastvol$ $retwallabut1 = 0\ CY$

$retwallabut2 := wingabuttwowestvol + wingabuttwoeastvol$ $retwallabut2 = 33.7\ CY$

$retwallvol := retwallabut1 + retwallabut2$

$retwallvol = 33.7\ CY$

Checked by: _____
Date: _____

Drilled Shafts

Abutment Drilled Shafts - 42" ϕ

$Abut1shaft := 6\cdot(1061.10ft - 1021.1ft)$ $\qquad Abut1shaft = 240\,lf$

$Abut2shaft := 6\cdot(1060.37ft - 1020.37ft)$ $\qquad Abut2shaft = 240\,lf$

Pier Drilled Shafts - 42" ϕ

$Pier1shaft := 6\cdot(1053ft - 1025ft)$ $\qquad Pier1shaft = 168\,ft$

$Pier2shaft := 6\cdot(1052.50ft - 1025ft)$ $\qquad Pier2shaft = 165\,ft$

$Total42abut := Abut1shaft + Abut2shaft$ $\qquad Total42abut = 480\,ft$

$Total42pier := Pier1shaft + Pier2shaft$ $\qquad Total42pier = 333\,ft$

Reinforcing Steel - by location

Superstructure steel at 225 lb/CY. Column steel at 175 lb/CY. Abutment & wingwalls @ 125 lb/CY.
Approach slabs -- assume 125 lb/CY. Pedestrian barrier -- 200 lb/CY, 32" barrier - 175 lb/CY

$Supersteel := \left(225\frac{lb}{CY}\right)\cdot(Superdeck + piervol + Supercap)$ $\qquad Supersteel = 233798\,lb$

$sidewalk := \left(175\frac{lb}{CY}\right)\cdot(vol32)$ $\qquad sidewalk = 9233\,lb$

$pedsteel := \left(200\frac{lb}{CY}\right)\cdot(volped)$ $\qquad pedsteel = 5386\,lb$

$Superstructuretotal := Supersteel + sidewalk + pedsteel$ $\qquad \boxed{Superstructuretotal = 248418\,lb}$ to report on drawir

$Colsteel := \left(175\frac{lb}{CY}\right)\cdot(Colvol)$ $\qquad Colsteel = 2866\,lb$

$Abut1wingsteel := \left(125\frac{lb}{CY}\right)\cdot\left(\frac{Abutcap}{2} + wingvol + retwallabut1\right)$ $\qquad Abut1wingsteel = 10892\,lb$

$Abut2wingsteel := \left(125\frac{lb}{CY}\right)\cdot\left(\frac{Abutcap}{2} + retwallabut2\right)$ $\qquad Abut2wingsteel = 13078\,lb$

$Approachsteel := \left(125\frac{lb}{CY}\right)\cdot(apprslab)$ $\qquad Approachsteel = 14624\,lb$

$TotalREINFORCING := Supersteel + Colsteel + Abut1wingsteel + Abut2wingsteel + Approachsteel + sidewalk + pedsteel$

$\boxed{TotalREINFORCING = 289878\,lb}$

Checked by: _____
Date: _____

Railing

$Railing := 1 \cdot pedlength$ $\quad Railing = 269.3\,ft$

Excavation - Abutment 1

Excavation to include abutment cap, and wingwalls)

Abutments

$abut1excv := (106.45 \cdot ft) \cdot (2.5ft) \cdot (7.5ft)$

From berm to bottom of abutment, approximately 2' -- 7' wide per standard ADOT (4'-6" plus 1'-6" plus 1'-6")

$abut1excv = 73.9\,CY$

Wingwalls

$wing1excv := 2 \cdot (1066.88ft - 1060.84ft) \cdot [14ft + 1.5 \cdot ft - (2ft + 3in)] \cdot 7ft$

1.5' + 1.5' + 1' wide

$wing1excv = 41.5\,CY$

Retaining walls

$ret1excv := (6ft + 1ft) \cdot (4.5 \cdot ft + 1.5ft + 1.5ft) \cdot (0ft)$

Total length included - assume full height of wall for excavation

$ret1excv = 0\,CY$

$Total1EXCV := abut1excv + wing1excv + ret1excv$

$\boxed{Total1EXCV = 115.4\,CY}$

Excavation - Abutment 2

Excavation to include abutment cap, and retaining walls.

Abutments

$abut2excv := (106.46ft) \cdot (2.5ft) \cdot (7.5ft)$

From berm to bottom of abutment, approximately 2' -- 7' wide per standard ADOT (4.5' plus 1'-6" plus 1'-6")

$abut2excv = 73.9\,CY$

Checked by: _____
Date: _____

Wingwalls

$wing2excv := 2 \cdot (1066.89ft - 1060.85ft) \cdot [19ft - (2ft + 3in)] \cdot 0ft$ 1.5' + 1.5' + 1' wide

$wing2excv = 0\,CY$

Retaining walls

$ret2excv := (7.17ft + 1ft) \cdot (4.5 \cdot ft + 1.5ft + 1.5ft) \cdot (32.5 \cdot ft + 32.5 \cdot ft + 2 \cdot 3 \cdot ft)$ Total length included - assume full height of wall for excavation

$ret2excv = 161.1\,CY$

$Total2EXCV := abut2excv + wing2excv + ret2excv$

$\boxed{Total2EXCV = 235.1\,CY}$

Backfill - Abutment 1

Abutments

$abut1back := (106.46 \cdot ft - 2 \cdot 1.0 \cdot ft) \cdot (3ft) \cdot (6.5ft)$

$abut1back = 75.4\,CY$

Wingwalls

$wing1back := 2 \cdot (1066.88ft - 1060.84ft) \cdot [14ft - (2ft + 3in)] \cdot 3ft$

$wing1back = 15.8\,CY$

Approach Slab

$approachslab := apprslab \cdot 0.5$ $approachslab = 58.5\,CY$

Retaining walls

$ret1back := (6ft + 1ft) \cdot (1.5ft) \cdot (0ft)$ Total length included - assume full height of wall for excavation

$ret1back = 0\,CY$

$Total1back := abut1back + wing1back + approachslab + ret1back$

$\boxed{Total1back = 149.7\,CY}$

Backfill - Abutment 2

Abutments

$abut2back := (106.46ft - 2 \cdot 1.0ft) \cdot (3ft) \cdot (6.5ft)$ Wingwalls subtracted out from tally; 2 * 1.5 ft = 3ft

$abut2back = 75.4\,CY$

Checked by: _____
Date: _____

Wingwalls

$wing2back := 2 \cdot (1067.17ft - 1060.00ft) \cdot [19ft - (2ft + 3in)] \cdot 0ft$

$wing2back = 0\,CY$

Approach Slab

$approachslab := apprslab \cdot 0.5$ $\qquad$ $approachslab = 58.5\,CY$

Retaining walls

$ret2back := (2 \cdot 32.5 \cdot ft + 2 \cdot 3 \cdot ft) \cdot (3.0ft) \cdot (7.17ft + 1.0 \cdot ft)$

$ret2back = 64.5\,CY$

$Total2back := abut2back + wing2back + approachslab + ret2back$

$\boxed{Total2back = 198.4\,CY}$

Checked by: _____
Date: _____

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Structural Quantities (f'c = 4000 psi) - CLASS AA

For BHOC, all 4000 psi shall include:

- Columns
- Abutment caps
- Pier caps
- Wingwalls
- Superstructure deck
- Concrete parapets
- Sidewalks

It does NOT include approach slabs nor retaining walls which shall be quantitied as class A concrete.

Superstructure Deck

$Length := 3 \cdot 48.5ft - 2 \cdot 2.25ft$ $\quad Length = 141\ ft$ Length of deck based on CL abut to CL abut with the abutment caps at the end taken out.

$Deckarea := 212.92ft^2$ 2'-0" deck cross-sectional area

$lighting := 4 \cdot (3ft) \cdot (1ft) \cdot \left[2ft + \frac{1}{2}(1ft + 1ft)\right]$ Lighting support blisters (4 total)

$Superdeck := Length \cdot Deckarea + lighting$ $\quad Superdeck = 1113.2\,CY$

Columns

$ncolumns := 6$ Number of columns

$npier := 2$ Number of piers

$$Colvol := npier\left[ncolumns \cdot \frac{\pi \cdot (2 \cdot ft)^2}{4}\right] \cdot \left(\left(\frac{1084.17ft + 1084.18ft}{2} - 3 \cdot ft - 1064.5ft\right)\right)$$

$Colvol = 23.3\,CY$

Average PGL used, 3' pier cap thickness, top of shaft elevation = bottom of column elevation

Checked by: _____
Date: _____

Sidewalk

$nsdwlk := 2$ Number of swlks

$sdwlkarea := 4.33ft^2$ Cross-sectional area of swlk

$sdwlklength := 178.00ft$

$vol32 := nsdwlk \cdot sdwlkarea \cdot sdwlklength$ $vol32 = 57.1\,CY$

Pedestrian Parapet/Dado

$nped := 1$

$pedarea := 2.7ft \cdot 0.896ft$

$pedlength := (145.5 \cdot ft + 20 \cdot ft - 5 \cdot ft - 5 \cdot ft - 2.25 \cdot ft + 0.916 \cdot ft) \cdot 2$

$dado := 4 \cdot 0.7 \cdot CY$

$volped := nped \cdot pedarea \cdot pedlength + dado$ $volped = 30.4\,CY$

Pier Cap

$pierdeckvol := 2 \cdot 5ft \cdot \left(106.46ft^2\right)$ Volume of deck below superstructure at piers (2 total)

$piervol := pierdeckvol$ $piervol = 39.4\,CY$

"Super Cap" on top of Abutment Cap

$$Supercap := 2 \cdot \left[\left[\frac{2.96ft + \frac{(2.16ft + 2.16ft)}{2}}{2}\right] \cdot (106.54ft) \cdot 4.5ft - 1ft \cdot (1ft + 0.5in) \cdot 106.54ft\right]$$

Notch in abutment cap where approach slab meets is taken out.

$Supercap = 82.7\,CY$

Abutment Cap on top of drilled shafts

$Abutcap := 2 \cdot (106.46 \cdot ft) \cdot 4ft \cdot 4.5ft$ $Abutcap = 141.9\,CY$

Checked by: _____
Date: _____

Wingwalls (Retaining walls are 3000 psi only!)

$wingabutonewestvol := 0CY$

$wingabutoneeastvol := 0CY$

$wingabuttwowestlength := 20ft - (2ft + 3in)$

$wingabuttwoeastlength := 20ft - (2ft + 3in)$

$wingabuttwowestvol := wingabuttwowestlength \cdot 18.57ft^2 + 0.25 \cdot CY$

$wingabuttwowestvol = 12.5\,CY$

$wingabuttwoeastvol := wingabuttwowestlength \cdot 18.57 \cdot ft^2 + 0.25 \cdot CY$

$wingabuttwoeastvol = 12.5\,CY$

$wingvol := wingabutonewestvol + wingabutoneeastvol + wingabuttwowestvol + wingabuttwoeastvol$

$wingvol = 24.9\,CY$

Class AA TOTAL

$classAA := Superdeck + Colvol + vol32 + volped + piervol + Supercap + Abutcap + wingvol$

$\boxed{classAA = 1513\,CY}$

Structural Quantities (f'c = 3000 psi) - CLASS A

Approach Slab

$apprslab := [106.46 \cdot ft \cdot 15 \cdot ft + (106.46 \cdot ft - 2 \cdot 1.17 \cdot ft) \cdot 15 \cdot ft - 4 \cdot 10 \cdot ft \cdot (7.23 \cdot ft + 1.5 \cdot ft) - 2 \cdot 10 \cdot ft \cdot 1 \cdot ft] \cdot 1.0 \cdot ft$

$\boxed{apprslab = 103.3\,CY}$

Checked by: _____
Date: _____

Retaining walls

Length of radial retaining walls at abutment one were measured in Microstation on outside face (conservative). The cross-sectional areas of the retaining walls--including footings--will be calculated using ADOT's detail.

$wingabutonewestlength := 32.5ft + 2.75 \cdot ft + 1 \cdot ft$

$wingabutoneeastlength := 32.5 \cdot ft + 2.75 \cdot ft + 1 \cdot ft$

$wingabut2westretwall := 0 \cdot ft$

$wingabut2eastretwall := 0ft$

$wingabutonewestarea := 10.75in \cdot 7.26ft + (4ft + 6in) \cdot 1ft + (1ft + 3in) \cdot (1ft + 6in)$ cross-sectional area of retaining wall

$wingabutoneeastarea := wingabutonewestarea$

$wingabuttwowestarea := 0 \cdot sqft$ cross-sectional area of retaining wall only

$wingabuttwoeastarea := wingabuttwowestarea$

$wingabutonewestvol := wingabutonewestarea \cdot wingabutonewestlength$ $wingabutonewestvol = 17.3\ CY$

$wingabutoneeastvol := wingabutoneeastarea \cdot wingabutoneeastlength$ $wingabutoneeastvol = 17.3\ CY$

$wingabuttwowestvol := wingabut2westretwall \cdot wingabuttwowestarea$

$wingabuttwowestvol = 0\ CY$

$wingabuttwoeastvol := wingabut2eastretwall \cdot wingabuttwoeastarea$

$wingabuttwoeastvol = 0\ CY$

$retwallabut1 := wingabutonewestvol + wingabutoneeastvol$ $retwallabut1 = 34.6\ CY$

$retwallabut2 := wingabuttwowestvol + wingabuttwoeastvol$ $retwallabut2 = 0\ CY$

$retwallvol := retwallabut1 + retwallabut2$

$retwallvol = 34.6\ CY$

Checked by: _____
Date: _____

Drilled Shafts

Abutment Drilled Shafts - 42" ϕ

$Abut1shaft := 6\cdot(1077.26ft - 1027.26ft)$ $\quad Abut1shaft = 300\,lf$

$Abut2shaft := 6\cdot(1077.30ft - 1027.3\cdot ft)$ $\quad Abut2shaft = 300\,lf$

Pier Drilled Shafts - 42" ϕ

$Pier1shaft := 6\cdot(1064.5ft - 1019.5ft)$ $\quad Pier1shaft = 270\,ft$

$Pier2shaft := 6\cdot(1064.5ft - 1019.5ft)$ $\quad Pier2shaft = 270\,ft$

$Total42abut := Abut1shaft + Abut2shaft$ $\quad Total42abut = 600\,ft$

$Total42pier := Pier1shaft + Pier2shaft$ $\quad Total42pier = 540\,ft$

Reinforcing Steel - by location

Superstructure steel at 225 lb/CY. Column steel at 175 lb/CY. Abutment & wingwalls @ 125 lb/CY. Approach slabs -- assume 125 lb/CY. Pedestrian barrier -- 200 lb/CY, 32" barrier - 175 lb/CY

$Supersteel := \left(225\frac{lb}{CY}\right)\cdot(Superdeck + piervol + Supercap)$ $\quad Supersteel = 277959\,lb$

$sidewalk := \left(175\frac{lb}{CY}\right)\cdot(vol32)$ $\quad sidewalk = 9991.1\,lb$

$pedsteel := \left(200\frac{lb}{CY}\right)\cdot(volped)$ $\quad pedsteel = 6085\,lb$

$Superstructuretotal := Supersteel + sidewalk + pedsteel$ $\quad Superstructuretotal = 294035\,lb$ to report on drawir

$Colsteel := \left(175\frac{lb}{CY}\right)\cdot(Colvol)$ $\quad Colsteel = 4074\,lb$

$Abut1wingsteel := \left(125\frac{lb}{CY}\right)\cdot\left(\frac{Abutcap}{2} + wingvol + retwallabut1\right)$ $\quad Abut1wingsteel = 16309\,lb$

$Abut2wingsteel := \left(125\frac{lb}{CY}\right)\cdot\left(\frac{Abutcap}{2} + retwallabut2\right)$ $\quad Abut2wingsteel = 8872\,lb$

$Approachsteel := \left(125\frac{lb}{CY}\right)\cdot(apprslab)$ $\quad Approachsteel = 12914\,lb$

$TotalREINFORCING := Supersteel + Colsteel + Abut1wingsteel + Abut2wingsteel + Approachsteel + sidewalk + pedsteel$

$\boxed{TotalREINFORCING = 336204\,lb}$

Checked by: _____
Date: _____

Railing

$Railing := 1 \cdot pedlength$ $\qquad$ $Railing = 308.3\,ft$

Excavation - Abutment 1

Excavation to include abutment cap, wingwalls, and retaining walls.

Abutments

$abut1excv := (106.45 \cdot ft) \cdot (2.5ft) \cdot (7.5ft)$

From berm to bottom of abutment, approximately 2' -- 7' wide per standard ADOT (4' -6"plus 1'-6" plus 1'-6")

$abut1excv = 73.9\,CY$

Wingwalls

$wing1excv := 0CY$

Only retaining walls at abutment 1

Retaining walls

$ret1excv := (6.23ft + 1ft) \cdot (4.5 \cdot ft + 1.5ft + 1.5ft) \cdot (32.5 \cdot ft + 2.75 \cdot ft + 1.0 \cdot ft) \cdot (2)$ Total length included - assume full height of wall for excavation

$ret1excv = 145.6\,CY$

$Total1EXCV := abut1excv + wing1excv + ret1excv$

$\boxed{Total1EXCV = 219.5\,CY}$

Excavation - Abutment 2

Excavation to include abutment cap, wingwalls, and retaining walls.

Abutments

$abut2excv := (106.45ft) \cdot (2.5ft) \cdot (7.5 \cdot ft)$

From berm to bottom of abutment, approximately 2' -- 7' wide per standard ADOT (4'-6" plus 1'-6" plus 1'-6")

$abut2excv = 73.9\,CY$

Checked by: _____
Date: _____

Wingwalls

$wing2excv := 2 \cdot (1083.25ft - 1077.05ft) \cdot [20ft - (2ft + 3in)] \cdot 7ft$ 1.5' + 1.5' + 4' wide

$wing2excv = 57.1\,CY$

Retaining walls

$ret2excv := 0(4ft + 1ft) \cdot (3.5 \cdot ft + 1.5ft + 1.5ft) \cdot (6.25ft + 5.75 \cdot ft)$ Total length included - assume full height of wall for excavation

$ret2excv = 0\,CY$

$Total2EXCV := abut2excv + wing2excv + ret2excv$

$\boxed{Total2EXCV = 131\,CY}$

Backfill - Abutment 1

Abutments

$abut1back := (106.46ft - 2 \cdot 1 \cdot ft) \cdot (3ft) \cdot (6.5ft)$

$abut1back = 75.4\,CY$

Wingwalls

$wing1back := 0CY$ Only retaining walls at abutment 1

Approach Slab

$approachslab := apprslab \cdot 0.5$ $approachslab = 51.7\,CY$

Retaining walls

$ret1back := (6.23ft + 1ft) \cdot (3ft) \cdot (32.5 \cdot ft + 2.75 \cdot ft + 1 \cdot ft) \cdot 2$ Total length included - assume full height of wall for excavation

$ret1back = 58.2\,CY$

$Total1back := abut1back + wing1back + approachslab + ret1back$

$\boxed{Total1back = 185.3\,CY}$

Backfill - Abutment 2

Abutments

$abut2back := (106.46ft - 2 \cdot 1 \cdot ft) \cdot (3ft) \cdot (6.5ft)$

$abut2back = 75.4\,CY$

Checked by: _____
Date: _____

Wingwalls

$wing2back := 2 \cdot (1083.25ft - 1077.05ft) \cdot [20ft - (2ft + 3in)] \cdot 3.0ft$

$wing2back = 24.5\,CY$

Approach Slab

$approachslab := apprslab \cdot 0.5$ $\qquad$ $approachslab = 51.7\,CY$

Retaining walls

$ret2back := 0(6ft + 1ft) \cdot (3ft) \cdot (6.25 \cdot ft + 5.75ft)$

$ret2back = 0\,CY$

$Total2back := abut2back + wing2back + approachslab + ret2back$

$\boxed{Total2back = 151.6\,CY}$

Checked by: _____
Date: _____

General Unit Definitions

$kips := 1000lbf$ $pcf := \frac{lbf}{ft^3}$ $CY := 27ft^3$ $lf := ft$

$kcf := 1000pcf$ $ksi := 1000psi$ $sqft := ft^2$ $sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Inlet Retaining Walls

Concrete quantities are per ADOT Std B-18.30

$seinletwall := 30ft \cdot 1.048\frac{CY}{ft} + 32ft \cdot 0.645\frac{CY}{ft} + (30ft + 10in) \cdot 0.421\frac{CY}{ft}$

$swinletwall := 30ft \cdot 1.048\frac{CY}{ft} + 25ft \cdot 0.645\frac{CY}{ft} + (12ft + 8in) \cdot 0.421\frac{CY}{ft}$

$inletwall := seinletwall + swinletwall$

$\boxed{inletwall = 118CY}$

Inlet Class A (f'c=3000 psi) Headwall

$inletheight := 1070.54ft - (10.5in) - 1058.17ft - 5ft$

$inletheight = 6.5ft$

$inletheadwall := inletheight \cdot 12in \cdot 66.5ft$ Length as measured in Microstation

$\boxed{inletheadwall = 16CY}$

See spreadsheet for reinforcing

Inlet Channel Liner

Note -- channel slopes at this location, so slope is adjusted by 1.030 (approx. 4:1 slope) -- with a flat spot at beginning of culvert

$$inletliner := 64.58ft \cdot (11ft + 2.5in) \cdot 1.030$$

$$\boxed{inletliner = 82.8\,sqyd}$$

Inlet Safety Railing

Length is measured in Microstation

$$\boxed{inletrail := 228.5ft}$$

Outlet Retaining Walls

Concrete quantities are per ADOT Std B-18.30

$$nwoutletwall := 21ft \cdot 1.048\frac{CY}{ft} + 20ft \cdot 0.645\frac{CY}{ft} + (15ft + 11.5in) \cdot 0.372\frac{CY}{ft}$$

$$neoutletwall := 20ft \cdot 1.048\frac{CY}{ft} + 20ft \cdot 0.645\frac{CY}{ft} + (15ft + 6.5in) \cdot 0.372\frac{CY}{ft}$$

$$outletwall := nwoutletwall + neoutletwall$$

$$\boxed{outletwall = 80.5\,CY}$$

Outlet Class A (f'c=3000 psi) Headwall

$outletheight := 1070.43ft - (10.5in) - 1058.05ft - 5ft$

$outletheight = 6.5ft$

$outletheadwall := outletheight \cdot 12in \cdot 76.7ft$ Length as measured in Microstation

$\boxed{outletheadwall = 18.5CY}$

See spreadsheet for reinforcing

Outlet Pedestrian Rail

Length is measured in Microstation

$\boxed{outletrail := 191.4ft}$

Excavation

Assume existing ground elevation is 1070 ft for inlet and outlet (a little low for inlet, but higher for outlet -- averages out)

SE Wall

$sewallexcv := 30ft \cdot (1070ft - 1056.54ft + 1.25ft) \cdot (9ft + 3ft) + 32ft \cdot (1070ft - 1061.54ft + 1.16ft) \cdot (6.25ft + 3ft) + 30.83ft \cdot (1070ft - 1064.54ft + 1ft) \cdot (4.5ft + 3ft) + 92.83ft \cdot 1.25ft \cdot 1.5ft$

$sewallexcv = 363.4CY$

SW Wall

$swwallexcv := 30ft \cdot (1070ft - 1056.54ft + 1.25ft) \cdot (9ft + 3ft) + 25ft \cdot (1070ft - 1061.54ft + 1.16ft) \cdot (6.25ft + 3ft) + 12.66ft \cdot (1070ft - 1064.54ft + 1ft) \cdot (4.5ft + 3ft) + 67.66ft \cdot 1.25ft \cdot 1.5ft$

$swwallexcv = 305.9CY$

NW Wall

$nwwallexcv := 21ft \cdot (1070ft - 1056.43ft + 1.25ft) \cdot (9ft + 3ft) + 20ft \cdot (1070ft - 1061.43ft + 1.16ft) \cdot (6.25ft + 3ft) + 15.96ft \cdot (1070ft - 1065.43ft + 1ft) \cdot (4ft + 3ft) + 56.96ft \cdot 1.25ft \cdot 1.5ft$

$nwwallexcv = 232CY$

NE Wall

$newallexcv := 20ft \cdot (1070ft - 1056.43ft + 1.25ft) \cdot (9ft + 3ft) + 20ft \cdot (1070ft - 1061.43ft + 1.16ft) \cdot (6.25ft + 3ft) + 15.54ft \cdot (1070ft - 1065.43ft + 1ft) \cdot (4ft + 3ft) + 55.54ft \cdot 1.25ft \cdot 1.5ft$

$newallexcv = 224.7CY$

Backfill

Backfill includes headwalls

SE Wall

$sewallback := 30ft \cdot (1070ft - 1056.54ft + 1.25ft) \cdot (3ft) + 32ft \cdot (1070ft - 1061.54ft + 1.16ft) \cdot (3ft) + 30.83ft \cdot (1070ft - 1064.54ft + 1ft) \cdot (3ft)$

$sewallback = 105.4CY$

SW Wall

$swwallback := 30ft \cdot (1070ft - 1056.54ft + 1.25ft) \cdot (3ft) + 25ft \cdot (1070ft - 1061.54ft + 1.16ft) \cdot (3ft) + 12.66ft \cdot (1070ft - 1064.54ft + 1ft) \cdot (3ft)$

$swwallback = 84.8CY$

NW Wall

$nwwallback := 21ft \cdot (1070ft - 1056.43ft + 1.25ft) \cdot (3ft) + 20ft \cdot (1070ft - 1061.43ft + 1.16ft) \cdot (3ft) + 15.96ft \cdot (1070ft - 1065.43ft + 1ft) \cdot (3ft)$

$nwwallback = 66.1CY$

NE Wall

$newallback := 20ft \cdot (1070ft - 1056.43ft + 1.25ft) \cdot (3ft) + 20ft \cdot (1070ft - 1061.43ft + 1.16ft) \cdot (3ft) + 15.54ft \cdot (1070ft - 1065.43ft + 1ft) \cdot (3ft)$

$newallback = 64.2CY$

Inlet Headwall

$inletback := (6.5ft - 0.5ft) \cdot 66.5ft \cdot 3ft$ $inletback = 44.3CY$

Outlet Headwall

$outletback := (6.5ft - 0.5ft) \cdot 76.7ft \cdot 3ft$ $outletback = 51.1CY$

Totals (reinforcing -- see spreadsheet)

conctotal := outletwall + outletheadwall + inletwall + inletheadwall

conctotal = 232.9CY

pedrail := inletrail + outletrail

pedrail = 419.9ft

extotal := sewallexcv + swwallexcv + nwwallexcv + newallexcv

extotal = 1126CY

backtotal := sewallback + swwallback + nwwallback + newallback + inletback + outletback

backtotal = 415.9CY

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Inlet Retaining Walls Painting

$inletwall1 := 1.02 \cdot \left[16in \cdot (92.83ft + 9.5in) + 697sqft + 92ft^2\right]$ SE Wall measured in Microstation, 2% added as well as as top of and backside (6") -- includes culvert area

$inletwall2 := 1.02 \cdot \left[16in \cdot (67.66ft + 9.5in) + 509sqft\right]$ SW Wall measured in Microstation, 2% added as well and backside (6")

$inlettotal := inletwall1 + inletwall2$ $\quad \boxed{inlettotal = 1544.4ft^2}$

Inlet Class A (f'c=3000 psi) Headwall Painting

$inletheadwall := 66.5ft \cdot (6.5ft + 12.75in + 6in)$ Length as measured in Microstation

$\boxed{inletheadwall = 536.2sqft}$

Outlet Retaining Walls Painting

$$outletwall1 := 1.02 \cdot \left[16in \cdot (56.96ft + 9.5in) + 430sqft + \frac{92ft^2}{\cos\left(30 \cdot \frac{3.14}{180}\right)}\right]$$

$$outletwall2 := 1.02 \cdot \left[16in \cdot (55.54ft + 9.5in) + 420sqft\right]$$

NW Wall measured in Microstation, 2% added as well as as top of and backside (6") -- includes skewed culvert area (wall 1)

NE Wall measured in Microstation, 2% added as well as as top of and backside (6") (wall 2)

$outlettotal := outletwall1 + outletwall2$ $\quad \boxed{outlettotal = 1130.5ft^2}$

Outlet Class A (f'c=3000 psi) Headwall Painting

$outletheadwall := 76.7ft \cdot (6.5ft + 12.75in + 6in)$ Length as measured in Microstation

$\boxed{outletheadwall = 618.4ft^2}$

$painttotal := inlettotal + outlettotal + inletheadwall + outletheadwall$ $\quad \boxed{painttotal = 3829.4sqft}$

Aesthetic Treatments

Inlet Headwall

$aesthinlethead := 66.5ft \cdot (6.5ft)$

$aesthinlethead = 432.3sqft$

Inlet Retaining Wall

$aesthinletwall := 697ft^2 + 509ft^2$

$aesthinletwall = 1206sqft$

Outtlet Headwall

$aesthoutlethead := 76.7ft \cdot 7ft$

$aesthoutlethead = 536.9sqft$

Outlet Retaining Wall

$aesthoutletwall := 430ft^2 + 420ft^2$

$aesthoutletwall = 850sqft$

$aesthtotal := aesthinlethead + aesthinletwall + aesthoutlethead + aesthoutletwall$

$aesthtotal = 3025.2sqft$

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Inlet Retaining Walls

Concrete quantities are per ADOT Std B-18.30

$$southinletwall := 10ft \cdot 1.988\frac{CY}{ft} + 10ft \cdot 1.285\frac{CY}{ft} + (13ft + 4.5in) \cdot \left(0.790\frac{CY}{ft}\right)$$

$$northinletwall := 10ft \cdot 1.988\frac{CY}{ft} + 10ft \cdot 1.285\frac{CY}{ft} + (17ft + 2.75in) \cdot \left(0.790\frac{CY}{ft}\right)$$

$inletwall := southinletwall + northinletwall$

$\boxed{inletwall = 89.6CY}$

Inlet Class A (f'c=3000 psi) Headwall

$inletheight := 1085.66ft - (1ft + 0.5in) - 1066.73ft - 8ft$

$inletheight = 9.9ft$

$inletheadwall := inletheight \cdot 12in \cdot 33.7ft$ Length as measured in Microstation

$\boxed{inletheadwall = 12.3CY}$

See spreadsheet calculations for reinforcing.

Inlet Pedestrian Rail

Length is measured in Microstation

$\boxed{inletrail := \cancel{104.3ft}}$ 0.0

Outlet Retaining Walls

Concrete quantities are per ADOT Std B-18.30

$nwoutletwall := 30ft \cdot 1.988 \frac{CY}{ft} + 30ft \cdot 1.163 \frac{CY}{ft} + (27ft + 0.25in) \cdot 0.725 \frac{CY}{ft}$

$swoutletwall := 30ft \cdot 1.988 \frac{CY}{ft} + 30ft \cdot 1.163 \frac{CY}{ft} + \left(27ft + 10in + \frac{5}{16}in\right) \cdot 0.725 \frac{CY}{ft}$

$outletwall := nwoutletwall + swoutletwall$

$\boxed{outletwall = 228.8CY}$

Outlet Class A (f'c=3000 psi) Headwall

$outletheight := 1084.80ft - (1ft + 0.5in) - 1066.35ft - 8ft$

$outletheight = 9.4ft$

$outletheadwall := outletheight \cdot 12in \cdot 33.7ft$ Length as measured in Microstation

$\boxed{outletheadwall = 11.7CY}$

See spreadsheet for reinforcing

Outlet Pedestrian Rail

Length is measured in Microstation

$\boxed{outletrail := 209.2ft}$

Excavation

Assume existing ground elevation is 1085.1 ft for inlet and 1084.3 outlet

N Wall

$Nwallexcv := 10ft \cdot (1085.1ft - 1064.66ft + 1.83ft) \cdot (12.5ft + 3ft) + 10ft \cdot (1085.1ft - 1069.66ft + 1.42ft) \cdot (10ft + 3ft) + 17.23ft \cdot (1085.1ft - 1074.66ft + 1ft) \cdot (7.5ft + 3ft) + 37.23ft \cdot 1.25$

$Nwallexcv = 288.3CY$

S Wall

$Swallexcv := 10ft \cdot (1085.1ft - 1064.66ft + 1.83ft) \cdot (12.5ft + 3ft) + 10ft \cdot (1085.1ft - 1069.66ft + 1.42ft) \cdot (10ft + 3ft) + 13.38ft \cdot (1085.1ft - 1074.66ft + 1ft) \cdot (7.5ft + 3ft) + 33.38ft \cdot 1.25$

$Swallexcv = 270.9CY$

NW Wall

$nwwallexcv := 30ft \cdot (1084.3ft - 1063.8ft + 1.83ft) \cdot (12.5ft + 3ft) + 30ft \cdot (1084.3ft - 1069.8ft + 1.33ft) \cdot (9.5ft + 3ft) + 27.02ft \cdot (1084.3ft - 1074.8ft + 1ft) \cdot (6.83ft + 3ft) + 87.02ft \cdot 1.25ft$

$nwwallexcv = 713.8CY$

SW Wall

$SWwallexcv := 30ft \cdot (1084.3ft - 1063.8ft + 1.83ft) \cdot (12.5ft + 3ft) + 30ft \cdot (1084.3ft - 1069.8ft + 1.33ft) \cdot (9.5ft + 3ft) + 27.86ft \cdot (1084.3ft - 1074.8ft + 1ft) \cdot (6.83ft + 3ft) + 87.86ft \cdot 1.25f$

$SWwallexcv = 717CY$

Backfill

Backfill includes headwalls

N Wall

$Nwallback := 10ft \cdot (1085.1ft - 1064.66ft + 1.83ft) \cdot (3ft) + 10ft \cdot (1085.1ft - 1069.66ft + 1.42ft) \cdot (3ft) + 17.23ft \cdot (1085.1ft - 1074.66ft + 1ft) \cdot (3ft)$

$Nwallback = 65.4CY$

S Wall

$Swallback := 10ft \cdot (1085.1ft - 1064.66ft + 1.83ft) \cdot (3ft) + 10ft \cdot (1085.1ft - 1069.66ft + 1.42ft) \cdot (3ft) + 13.38ft \cdot (1085.1ft - 1074.66ft + 1ft) \cdot (3ft)$

$Swallback = 60.5CY$

NW Wall

$nwwallback := 30ft \cdot (1084.3ft - 1063.8ft + 1.83ft) \cdot (3ft) + 30ft \cdot (1084.3ft - 1069.8ft + 1.33ft) \cdot (3ft) + 27.02ft \cdot (1084.3ft - 1074.8ft + 1ft) \cdot (3ft)$

$nwwallback = 158.7CY$

SW Wall

$SWwallback := 30ft \cdot (1084.3ft - 1063.8ft + 1.83ft) \cdot (3ft) + 30ft \cdot (1084.3ft - 1069.8ft + 1.33ft) \cdot (3ft) + 27.86ft \cdot (1084.3ft - 1074.8ft + 1ft) \cdot (3ft)$

$SWwallback = 159.7CY$

Inlet Headwall

$inletback := (9.9ft - 0.5ft) \cdot 33.7ft \cdot 3ft$ $inletback = 35.2CY$

Outlet Headwall

$outletback := (9.4ft - 0.5ft) \cdot 33.7ft \cdot 3ft$ $outletback = 33.3CY$

Totals (reinforcing -- see spreadsheet)

conctotal := outletwall + outletheadwall + inletwall + inletheadwall

$\boxed{conctotal = 342.6CY}$

pedrail := inletrail + outletrail

$\boxed{pedrail = \cancel{313.5ft}}$ 210 C

extotal := Nwallexcv + Swallexcv + nwwallexcv + SWwallexcv $\boxed{extotal = 1989.9CY}$

backtotal := Nwallback + Swallback + nwwallback + SWwallback + inletback + outletback $\boxed{backtotal = 512.8CY}$

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Inlet Retaining Walls Painting

$inletwall1 := 0sqft$

$inletwall2 := 0sqft$

No paint or aesthetics for inlet retaining walls since they are temporary

$inlettotal := inletwall1 + inletwall2$

$\boxed{inlettotal = 0ft^2}$

Inlet Class A (f'c=3000 psi) Headwall Painting

$inletheadwall := 0sqft$

$\boxed{inletheadwall = 0sqft}$

Outlet Retaining Walls Painting

$outletwall1 := 1.02 \cdot [16in \cdot (87.02ft + 9.5in) + 920sqft + 66sqft]$ IW Wall measured in Microstation, 2% added as well as as top of and backside (6") -- includes culvert area

$outletwall2 := 1.02 \cdot [16in \cdot (87.86ft + 9.5in) + 929sqft]$ SW Wall measured in Microstation, 2% added as well as as top of and backside (6")

$outlettotal := outletwall1 + outletwall2$

$\boxed{outlettotal = 2193.3ft^2}$

Outlet Class A (f'c=3000 psi) Headwall Painting

$outletheadwall := 33.7ft \cdot (9.4ft + 12.75in + 6in) \cdot 1.02$ Length as measured in Microstation, 2% added

$\boxed{outletheadwall = 376.8ft^2}$

$painttotal := inlettotal + outlettotal + inletheadwall + outletheadwall$

$\boxed{painttotal = 2570.1sqft}$

Aesthetic Treatments

Inlet Headwall

$aesthinlethead := 0sqft$

$aesthinlethead = 0sqft$

Inlet Retaining Wall

$aesthinletwall := 0sqft$

$aesthinletwall = 0sqft$

Outlet Headwall

$aesthoutlethead := 33.7ft \cdot 9.4ft$

$aesthoutlethead = 316.8sqft$

Outlet Retaining Wall

$aesthoutletwall := 920ft^2 + 929ft^2$

$aesthoutletwall = 1849sqft$

$aesthtotal := aesthinlethead + aesthinletwall + aesthoutlethead + aesthoutletwall$

$aesthtotal = 2165.8sqft$

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Structural Quantities (f'c = 4000 psi) - CLASS AA

Includes:
- Abutment caps
- Backwalls
- Wingwalls
- Retaining Walls
- Approach slabs

Abutment 1

$abut1maincap := (1073.02ft - 1070.02ft)\cdot[12ft + 10in + 2\cdot(1ft + 11in)]\cdot(1ft + 9in + 11in + 14in)$

$abut1maincap = 7.1\,CY$

$abut1stem := [12ft + 10in + 2\cdot(1ft + 11in)]\cdot(14\cdot in\cdot 1.57\cdot ft) + 10\cdot ft\cdot 1.5\cdot ft\cdot 1\cdot ft + 2\cdot(10\cdot in)\cdot(1.57\cdot ft)\cdot(1\cdot ft + 9\cdot in + 11\cdot in)$

$abut1stem = 1.9\,CY$

$abut1wing := 2\cdot(68.13sqft)\cdot(14in)$

$abut1wing = 5.9\,CY$

$abut1retwall := (4.41\cdot sqft)\cdot(7\cdot ft)\cdot 2$

$abut1retwall = 2.3\,CY$

$fillets := 0.17\cdot CY$

$abut1TOTAL := abut1maincap + abut1stem + abut1wing + abut1retwall + fillets$ $\quad \boxed{abut1TOTAL = 17.4\,CY}$

Abutment 2

$abut2maincap := (1073.33ft - 1070.33ft)\cdot[12ft + 10in + 2\cdot(1ft + 11in)]\cdot(1ft + 9in + 11in + 14in)$

$abut2maincap = 7.1\,CY$

$abut2stem := [12ft + 10in + 2\cdot(1ft + 11in)]\cdot(14in\cdot 1.59\cdot ft) + 10\cdot ft\cdot 1.5\cdot ft\cdot 1\cdot ft + 2\cdot(10\cdot in)\cdot(1.59\cdot ft)\cdot(1\cdot ft + 9\cdot in + 11\cdot in)$

$abut2stem = 2\,CY$

$abut2wing := 2\cdot(68.31\cdot sqft)\cdot(14in)$

$abut2wing = 5.9\,CY$

Checked by: _____
Date: _____

$abut2retwall := (4.50 \cdot sqft) \cdot (7 \cdot ft) \cdot 2$

$abut2retwall = 2.3\,CY$

$fillets = 0.17\,CY$

$abut2TOTAL := abut2maincap + abut2stem + abut2wing + abut2retwall + fillets$ $\boxed{abut2TOTAL = 17.5\,CY}$

Approach Slabs (2)

$apprslab := 2 \cdot 10ft \cdot 16 \cdot ft \cdot 1 \cdot ft$

$\boxed{apprslab = 11.9\,CY}$

Drilled Shafts

Abutment Drilled Shafts - ~~24" ϕ~~ 30"

$Abut1shaft := 2 \cdot (1070.27ft - 1045.27ft)$ $Abut1shaft = 50\,lf$

$Abut2shaft := 2 \cdot (1070.58ft - 1045.58ft)$ $Abut2shaft = 50\,lf$

Shotcrete

$Abut1shot := 10sqyd$ $Abut1shot = 10\,sqyd$

$Abut2shot := 10sqyd$ $Abut2shot = 10\,sqyd$

Reinforcing Steel - by location - calculated utilzing spreadsheet

$reinfabut1 := 2414 \cdot lb$

$reinfabut2 := 2415 \cdot lb$

$reinfapprslab := 2192 \cdot lb$

$reinftotal := reinfabut1 + reinfabut2 + reinfapprslab$ $reinftotal = 7021\,lb$

Checked by: _____
Date: _____

Concrete Painting

Wingwall and Retaining Walls

$Paint := 4 \cdot 18 \cdot ft \cdot (1.22 \cdot ft + 0.5 \cdot ft + 1.167 \cdot ft) + 4 \cdot 7 \cdot ft \cdot (0.75 \cdot ft + 0.5 \cdot ft + 0.8333 \cdot ft)$

$Paint = 266.2\,ft^2$

Excavation - Abutment 1

Excavation to include abutment cap, wingwalls, and retaining walls

Abutments

$abut1excv := [\,16ft + 8in + 2 \cdot (1ft + 6in)\,] \cdot (3ft) \cdot [\,1 \cdot (3.83 \cdot ft) + 2 \cdot (1ft + 6in)\,]$

$abut1excv = 14.9\,CY$

Wingwalls

$wing1excv := 2 \cdot [\,14in + 2 \cdot (1ft + 6in)\,] \cdot 2.58ft \cdot (18 \cdot ft - 1.5 \cdot ft)$

$wing1excv = 13.1\,CY$

$retwallexcv := 2 \cdot (7 \cdot ft + 1.5 \cdot ft) \cdot (2 \cdot ft) \cdot [\,3 \cdot ft + 2(1.5 \cdot ft)\,]$

$retwallexcv = 7.6\,CY$

$Total1EXCV := abut1excv + wing1excv + retwallexcv$

$\boxed{Total1EXCV = 35.6\,CY}$

Excavation - Abutment 2

Excavation to include abutment cap, wingwalls, and retaining walls.

Abutments

$abut2excv := [\,16ft + 8in + 2 \cdot (1ft + 6in)\,] \cdot (3ft) \cdot [\,1 \cdot (3.83 \cdot ft) + 2 \cdot (1ft + 6in)\,]$

$abut2excv = 14.9\,CY$

Wingwalls

$wing2excv := 2 \cdot [\,14in + 2 \cdot (1ft + 6in)\,] \cdot 2.57 \cdot ft \cdot (18.0ft - 1.5 \cdot ft)$

$wing2excv = 13.1\,CY$

$Total2EXCV := abut2excv + wing2excv + retwallexcv$

$\boxed{Total2EXCV = 35.6\,CY}$

Checked by: _____
Date: _____

Backfill - Abutment 1

Abutments

$abut1back := (16ft + 8in)\cdot(3ft)\cdot(4.57ft)$

$abut1back = 8.5\,CY$

Approach Slab

$AppSlab1 := 1\cdot ft\cdot(16\cdot ft - 3\cdot ft)\cdot 10\cdot ft$

$AppSlab1 = 4.8\,CY$

Wingwalls

$wing1back := 2\cdot(3.79ft)\cdot(18\cdot ft)\cdot 3\cdot ft$

$wing1back = 15.2\,CY$

$retwallback := 2\cdot 3\cdot ft\cdot 2\cdot ft\cdot 7\cdot ft$

$retwallback = 3.1\,CY$

$Total1back := abut1back + wing1back + AppSlab1 + retwallback$

$\boxed{Total1back = 31.5\,CY}$

Backfill - Abutment 2

Abutments

$abut2back := (16ft + 8in)\cdot(3ft)\cdot(4.59ft)$

$abut2back = 8.5\,CY$

Approach Slab

$AppSlab2 := 1\cdot ft\cdot(16\cdot ft - 3\cdot ft)\cdot 10\cdot ft$

$AppSlab2 = 4.8\,CY$

Wingwalls

$wing2back := 2\cdot(3.80ft)\cdot(18\cdot ft)\cdot 3\cdot ft$

$wing2back = 15.2\,CY$

$Total2back := abut2back + wing2back + AppSlab2 + retwallback$

$\boxed{Total2back = 31.6\,CY}$

Checked by: _____
Date: _____

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad sqyd := 9ft^2$

$wconc := 150pcf$ weight of concrete

Structural Quantities (f'c = 4000 psi) - CLASS AA

Includes:
- Abutment caps
- Backwalls
- Wingwalls
- Retaining Walls
- Approach slabs

Abutment 1

$abut1maincap := (1088.24ft - 1085.24ft)\cdot[12ft + 10in + 2\cdot(1ft + 11in)]\cdot(1ft + 9in + 11in + 14in)$

$abut1maincap = 7.1\,CY$

$abut1stem := [12ft + 10in + 2\cdot(1ft + 11in)]\cdot(14\cdot in\cdot 1.62\cdot ft) + 10\cdot ft\cdot 1.5\cdot ft\cdot 1\cdot ft + 2\cdot(10\cdot in)\cdot(1.62\cdot ft)\cdot(1\cdot ft + 9\cdot in + 11\cdot in)$

$abut1stem = 2\,CY$

$abut1wing := 2\cdot(68.58sqft)\cdot(14in)$

$abut1wing = 5.9\,CY$

$abut1retwall := (4.36\cdot sqft)\cdot(7\cdot ft)\cdot 2$

$abut1retwall = 2.3\,CY$

$fillets := 0.17\cdot CY$

$abut1TOTAL := abut1maincap + abut1stem + abut1wing + abut1retwall + fillets$ $\quad \boxed{abut1TOTAL = 17.4\,CY}$

Abutment 2

$abut2maincap := (1087.46ft - 1084.46ft)\cdot[12ft + 10in + 2\cdot(1ft + 11in)]\cdot(1ft + 9in + 11in + 14in)$

$abut2maincap = 7.1\,CY$

$abut2stem := [12ft + 10in + 2\cdot(1ft + 11in)]\cdot(14in\cdot 1.54\cdot ft) + 10\cdot ft\cdot 1.5\cdot ft\cdot 1\cdot ft + 2\cdot(10\cdot in)\cdot(1.54\cdot ft)\cdot(1\cdot ft + 9\cdot in + 11\cdot in)$

$abut2stem = 1.9\,CY$

$abut2wing := 2\cdot(68.58\cdot sqft)\cdot(14in)$

$abut2wing = 5.9\,CY$

Checked by: _____
Date: _____

$abut2retwall := (4.29 \cdot sqft) \cdot (7 \cdot ft) \cdot 2$

$abut2retwall = 2.2\,CY$

$fillets = 0.17\,CY$

$abut2TOTAL := abut2maincap + abut2stem + abut2wing + abut2retwall + fillets$ $\boxed{abut2TOTAL = 17.3\,CY}$

Approach Slabs (2)

$apprslab := 2 \cdot 10ft \cdot 16 \cdot ft \cdot 1 \cdot ft$

$\boxed{apprslab = 11.9\,CY}$

Drilled Shafts

Abutment Drilled Shafts - ~~24" ϕ~~ 30"

$Abut1shaft := 2 \cdot (1085.49ft - 1055.49ft)$ $Abut1shaft = 60\,lf$

$Abut2shaft := 2 \cdot (1084.71ft - 1054.71ft)$ $Abut2shaft = 60\,lf$

Shotcrete

$Abut1shot := 10sqyd$ $Abut1shot = 10\,sqyd$

$Abut2shot := 10sqyd$ $Abut2shot = 10\,sqyd$

Reinforcing Steel - by location - calculated utilzing spreadsheet

$reinfabut1 := 2415 \cdot lb$

$reinfabut2 := 2413 \cdot lb$

$reinfapprslab := 2194 \cdot lb$

$reinftotal := reinfabut1 + reinfabut2 + reinfapprslab$ $reinftotal = 7022\,lb$

Checked by: _____
Date: _____

Concrete Painting

Wingwall and Retaining Walls

$Paint := 4 \cdot 18 \cdot ft \cdot (1.22 \cdot ft + 0.5 \cdot ft + 1.167 \cdot ft) + 4 \cdot 7 \cdot ft \cdot (0.46 \cdot ft + 0.5 \cdot ft + 0.8333 \cdot ft)$

$Paint = 258.1\, ft^2$

Excavation - Abutment 1

Excavation to include abutment cap, wingwalls, and retaining walls

Abutments

$abut1excv := [16ft + 8in + 2 \cdot (1ft + 6in)] \cdot (3ft) \cdot [1 \cdot (3.83 \cdot ft) + 2 \cdot (1ft + 6in)]$

$abut1excv = 14.9\, CY$

Wingwalls

$wing1excv := 2 \cdot [14in + 2 \cdot (1ft + 6in)] \cdot 2.64ft \cdot (18 \cdot ft - 1.5 \cdot ft)$

$wing1excv = 13.4\, CY$

$retwallexcv := 2 \cdot (7 \cdot ft + 1.5 \cdot ft) \cdot (2 \cdot ft) \cdot [3 \cdot ft + 2(1.5 \cdot ft)]$

$retwallexcv = 7.6\, CY$

$Total1EXCV := abut1excv + wing1excv + retwallexcv$

$\boxed{Total1EXCV = 35.9\, CY}$

Excavation - Abutment 2

Excavation to include abutment cap, wingwalls, and retaining walls.

Abutments

$abut2excv := [16ft + 8in + 2 \cdot (1ft + 6in)] \cdot (3ft) \cdot [1 \cdot (3.83 \cdot ft) + 2 \cdot (1ft + 6in)]$

$abut2excv = 14.9\, CY$

Wingwalls

$wing2excv := 2 \cdot [14in + 2 \cdot (1ft + 6in)] \cdot 2.64 \cdot ft \cdot (18.0ft - 1.5 \cdot ft)$

$wing2excv = 13.4\, CY$

$Total2EXCV := abut2excv + wing2excv + retwallexcv$

$\boxed{Total2EXCV = 35.9\, CY}$

Checked by: _____
Date: _____

Backfill - Abutment 1

Abutments

$abut1back := (16ft + 8in)\cdot(3ft)\cdot(4.62ft)$

$abut1back = 8.6\,CY$

Approach Slab

$AppSlab1 := 1\cdot ft\cdot(16\cdot ft - 3\cdot ft)\cdot 10\cdot ft$

$AppSlab1 = 4.8\,CY$

Wingwalls

$wing1back := 2\cdot(3.81ft)\cdot(18\cdot ft)\cdot 3\cdot ft$

$wing1back = 15.2\,CY$

$retwallback := 2\cdot 3\cdot ft\cdot 2\cdot ft\cdot 7\cdot ft$

$retwallback = 3.1\,CY$

$Total1back := abut1back + wing1back + AppSlab1 + retwallback$

$\boxed{Total1back = 31.7\,CY}$

Backfill - Abutment 2

Abutments

$abut2back := (16ft + 8in)\cdot(3ft)\cdot(4.54ft)$

$abut2back = 8.4\,CY$

Approach Slab

$AppSlab2 := 1\cdot ft\cdot(16\cdot ft - 3\cdot ft)\cdot 10\cdot ft$

$AppSlab2 = 4.8\,CY$

Wingwalls

$wing2back := 2\cdot(3.77ft)\cdot(18\cdot ft)\cdot 3\cdot ft$

$wing2back = 15.1\,CY$

$Total2back := abut2back + wing2back + AppSlab2 + retwallback$

$\boxed{Total2back = 31.4\,CY}$

Checked by: _____
Date: _____

PROJECT: BETHANY HOME OUTFALL CHANNEL

BY: GLADWIN 07-08-02

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

DMJM+HARRIS NO. 6888

SUBJECT: COST ESTIMATE WORKSHEET (100% DESIGN) - LANDSCAPE ARCHITECTURE

ITEM NO.	DESCRIPTION NEW CONSTRUCTION	QTY	UNIT	UNIT COST	TOTAL
1	MISC. EARTH GRADING & BERMS	9,400	SF	$3.00	$28,200.00
2	FINE GRADING	2,416,118	SF	$0.05	$120,805.90
3	TREES (15 GAL.)	989	EA	$75.00	$74,175.00
4	TREES (24" BOX)	649	EA	$225.00	$146,025.00
5	SHRUBS (5 GAL)	3,545	EA	$17.00	$60,265.00
6	GROUNDCOVER (1 GAL)	2,695	EA	$7.00	$18,865.00
7	BOULDERS	291	EA	$125.00	$36,375.00
8	CONCRETE HEADER (6"x12")	19,319	LF	$11.00	$212,509.00
9	TURF SEEDING (INCL. SOIL PREP)	1,824,840	SF	$0.15	$273,726.00
10	DECOMPOSED GRANITE (PLANTING AREAS)	591,278	SF	$0.30	$177,383.40
11	TRAIL MILE MARKERS	8	EA	$500.00	$4,000.00
12	CONCRETE PAVING (Does not include the secondary path conc.through the nodes)	505	SF	$2.50	$1,262.50
13	COLORED CONCRETE PAVING	3,303	SF	$7.00	$23,121.00
14	INTERLOCKING CONCRETE PAVERS	1,566	SF	$7.00	$10,962.00
15	STAMPED, COLORED CONCRETE BANDS (Includes all secondary paths to primary path intersections)	5,830	SF	$7.00	$40,810.00
16	TUBULAR STEEL SAFETY RAILING	400	LF	$50.00	$20,000.00
17	PUMP STATION ENCLOSURE (incl. CMU walls, T.S. gate, chain link cover at pump station)	584	SF	$20.00	$11,680.00
18	CMU RETAINING WALL (Neighborhood Nodes only)	924	SF	$50.00	$46,200.00
19	VEHICLE ACCESS RAMP (Neighborhood Nodes only)	2	EA	$6,000.00	$12,000.00
20	REMOVEABLE BOLLARDS (All nodes)	12	EA	$400.00	$4,800.00
21	PARK BENCH	13	EA	$1,350.00	$17,550.00
22	CONCRETE SEAT PODS	6	EA	$600.00	$3,600.00
23	BICYCLE LOOPS	20	EA	$125.00	$2,500.00
24	DRINKING FOUNTAIN	7	EA	$3,875.00	$27,125.00
25	TRASH RECEPTACLES	8	EA	$440.00	$3,520.00
26	PICNIC TABLE	2	EA	$1,150.00	$2,300.00
27	BARBECUE GRILL	2	EA	$260.00	$520.00
28	SHADE RAMADA	2	EA	$15,000.00	$30,000.00
	TOTAL LANDSCAPE & HARDSCAPE - ALL NODES AND LINEAR PARK				**$1,410,279.80**

PROJECT: BETHANY HOME OUTFALL CHANNEL

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

SUBJECT: BID ITEMS (100% DESIGN) - LANDSCAPE ARCHITECTURE

BY: GLADWIN 07-08-02
DMJM+HARRIS NO. 6888

ITEM NO.	DESCRIPTION NEW CONSTRUCTION	QTY	UNIT	UNIT COST	TOTAL
	MISC. EARTH GRADING & BERMS (No Pay Item)	9,400	SF	$3.00	$28,200.00
	FINE GRADING (No Pay Item)	2,416,118	SF	$0.05	$120,805.90
430-1	TREES (24" BOX)	649	EA	$225.00	$146,025.00
430-2	TREES (15 GALLON)	989	EA	$75.00	$74,175.00
430-3	SHRUBS (5 GALLON)	3,545	EA	$17.00	$60,265.00
430-4	GROUNDCOVER (1 GALLON)	2,695	EA	$7.00	$18,865.00
430-5	BOULDERS	291	EA	$125.00	$36,375.00
430-6	TURF (HYDROSEED)	1,824,840	SF	$0.15	$273,726.00
430-7	DECOMPOSED GRANITE	591,278	SF	$0.30	$177,383.40
430-8	CONCRETE HEADER	19,319	LF	$11.00	$212,509.00
430-11	STABILIZED DECOMPOSED GRANITE (EQUESTRIAN TRAIL)	0	SF	$0.00	$0.00
	SUBTOTAL				**$1,148,329.30**
430-9	HARDSCAPE ELEMENTS				
A	TRAIL MILE MARKERS	8	EA	$500.00	$4,000.00
B	CONCRETE PAVING (Does not include the secondary path conc. through the nodes)	505	SF	$2.50	$1,262.50
C	COLORED CONCRETE PAVING	3,303	SF	$7.00	$23,121.00
D	INTERLOCKING CONCRETE PAVERS	1,566	SF	$7.00	$10,962.00
E	VEHICLE ACCESS RAMP (Neighborhood nodes Only)	2	EA	$6,000.00	$12,000.00
F	STAMPED COLORED CONCRETE BANDS (Includes all secondary paths to primary path intersections)	5,830	SF	$7.00	$40,810.00
G	CMU RETAINING WALL (Neighborhood nodes only)	924	SF	$50.00	$46,200.00
H	TUBULAR STEEL SAFETY RAILING (All nodes)	400	LF	$50.00	$20,000.00
I	PUMP STATION ENCLOSURE (CMU walls, T.S. Gate, C.L. Fence Cover)	584	SF	$20.00	$11,680.00
	SUBTOTAL				**$170,035.50**
430-10	SITE AMENITIES				
A	PARK BENCH	13	EA	$1,350.00	$17,550.00
B	CONCRETE SEAT PODS	6	EA	$600.00	$3,600.00
C	PICNIC TABLE	2	EA	$1,150.00	$2,300.00
D	BARBECUE GRILL	2	EA	$260.00	$520.00
E	BICYCLE LOOPS	20	EA	$125.00	$2,500.00
F	DRINKING FOUNTAIN	7	EA	$3,875.00	$27,125.00
G	PARK SIGN - N.I.C.	0	EA	$0.00	$0.00
H	WARNING SIGN - N.I.C.	0	EA	$0.00	$0.00
I	REMOVEABLE BOLLARDS (All nodes)	12	EA	$400.00	$4,800.00
J	TRASH RECEPTACLES	8	EA	$440.00	$3,520.00
K	SHADE RAMADA	2	EA	$15,000.00	$30,000.00
	SUBTOTAL				**$91,915.00**
	TOTAL LANDSCAPE, HARDSCAPE & SITE AMENITIES				**$1,410,279.80**

BHOC
FINAL QUANTITY SUMMARY SHEET

UTILITY QUANTITY SUMMARY SHEET

ITEM NO.	ITEM DESCRIPTION	UNIT	SHEET NUMBERS												TOTAL QUANTITY
			U-1.01	U-1.02	U-1.03	U-1.04	U-1.05	U-1.06	U-1.07	U-1.08	U-2.01	U-2.02	U-2.03	U-2.04	
350-3	REMOVE EXISTING WATER PIPE	LF	280			615									895
350-4	REMOVE EXISTING SEWER PIPE	LF	245			395									640
602-1	JACK AND BORE 36-INCH PIPE	LF					78								78
610-1	DUCTILE IRON PIPE (12"), CLASS 150	LF			357			351							708
610-2	STEEL CASING PIPE (18")	LF	220			144									364
610-3	COMBINATION AIR/VAC VALVE	EA			2			2							4
610-4	12" GATE VALVE	EA			2			1							3
615-1	LINED DUCTILE IRON PIPE (8"), CLASS 150	LF					336								336
615-2	LINED DUCTILE IRON PIPE (12"), CLASS 150	LF					168								168
615-3	LINED DUCTILE IRON PIPE (20"), CLASS 150	LF		311			262								573
625-2	SANITARY SEWER MANHOLE, 5' DIAMETER, MAG DTL 420	EA		3			2								5
625-3	SANITARY SEWER MANHOLE, 6' DIAMETER, MAG DTL 420	EA					2								2

BHOC
FINAL SUMMARY COST ESTIMATE

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	EXTENDED AMOUNT
350-3	REMOVE EXISTING WATER PIPE	LF	895	$2	$1,790
350-4	REMOVE EXISTING SEWER PIPE	LF	640	$5	$4,475
602-1	JACK AND BORE 36-INCH PIPE	LF	78	$350	$27,300
610-1	DUCTILE IRON PIPE (12"), CLASS 150	LF	708	$70	$49,560
610-2	STEEL CASING PIPE (18")	LF	364	$60	$21,840
610-3	COMBINATION AIR/VAC VALVE	EA	4	$5,000	$20,000
610-4	12" GATE VALVE	EA	3	$1,700	$5,100
615-1	LINED DUCTILE IRON PIPE (8"), CLASS 150	LF	336	$73	$24,528
615-2	LINED DUCTILE IRON PIPE (12"), CLASS 150	LF	168	$120	$20,160
615-3	LINED DUCTILE IRON PIPE (20"), CLASS 150	LF	573	$150	$85,950
625-2	SANITARY SEWER MANHOLE, 5' DIAMETER, MAG DTL 420	EA	5	$7,500	$37,500
625-3	SANITARY SEWER MANHOLE, 6' DIAMETER, MAG DTL 420	EA	2	$20,000	$40,000
TOTAL					**$338,203**

Bethany Home Outfall Channel

City of Glendale

Opinion of Probable Cost
for the Final Bid Submittal

September 9, 2002

Element	Units	Number	Unit Cost	Total Cost
Irrigation System				
Pump Station, Wet Well, Intake Pipe	L.S.	1	$125,000.00	$125,000.00
Flow Meter/Master Valve Assembly	L.S.	1	$6,500.00	$6,500.00
Isolation Gate Valve (12")	Ea.	1	$2,200.00	$2,200.00
Isolation Gate Valve (8")	Ea.	8	$1,800.00	$14,400.00
Isolation Gate Valve (6")	Ea.	13	$1,200.00	$15,600.00
Isolation Gate Valve (4")	Ea.	14	$1,000.00	$14,000.00
Isolation Gate Valve (3")	Ea.	2	$400.00	$800.00
Quick Coupling Valves	Ea.	102	$125.00	$12,750.00
IRRINET Controller Assembly (48 station)	Ea.	1	$24,000.00	$24,000.00
IRRINET Controller Assembly (32 station)	Ea.	2	$20,000.00	$40,000.00
SCORPIO Controller Assembly (16 station)	Ea.	6	$5,000.00	$30,000.00
SCORPIO Controller Assembly (24 station)	Ea.	1	$7,000.00	$7,000.00
SCORPIO Controller Assembly (32 station)	Ea.	6	$9,000.00	$54,000.00
12" Class 200 PVC Pipe (mainline w/fittings)	L.F.	600	$20.00	$12,000.00
8" Class 200 PVC Pipe (mainline w/fittings)	L.F.	4,800	$14.00	$67,200.00
6" Class 200 PVC Pipe (mainline w/fittings)	L.F.	7,500	$9.00	$67,500.00
4" Class 200 PVC Pipe (mainline w/fittings)	L.F.	6,000	$6.00	$36,000.00
3" Class 200 PVC Pipe (mainline w/fittings)	L.F.	5,000	$5.00	$25,000.00
2" Class 200 PVC Pipe (mainline w/fittings)	L.F.	2,000	$3.00	$6,000.00
2" Remote Control Valve Assembly (inc. low voltage wire)	Ea.	247	$375.00	$92,625.00
1.5" Remote Control Valve Assembly (inc. low voltage wire)	Ea.	29	$325.00	$9,425.00
1" Remote Control Valve Assembly (inc. low voltage wire)	Ea.	5	$225.00	$1,125.00
1" Drip Remote Control Valve Assembly (inc. low voltage wire)	Ea.	81	$300.00	$24,300.00
Pop-up Rotary Sprinklers w/ lateral (Hunter I-40)	Ea.	792	$165.00	$130,680.00
Pop-up Rotary Sprinklers w/ lateral (Hunter I-20/I-25)	Ea.	841	$90.00	$75,690.00
Drip Emitter Assemblies at #5 Shrubs w/ lateral	Ea.	3,545	$8.00	$28,360.00
Drip Emitter Assemblies at #1 Shrubs w/ lateral	Ea.	2,695	$4.00	$10,780.00
Drip Emitter Assemblies at Trees in Turf w/ lateral	Ea.	610	$18.00	$10,980.00
Drip Emitter Assemblies at Trees w/ lateral	Ea.	910	$18.00	$16,380.00
Drip Flush Cap Assemblies	Ea.	205	$15.00	$3,075.00
24" C900 PVC Pipe (sleeving)	L.F.	50	$35.00	$1,750.00
20" C900 PVC Pipe (sleeving)	L.F.	350	$28.00	$9,800.00
14" C900 PVC Pipe (sleeving)	L.F.	220	$25.00	$5,500.00
12" Class 200 PVC Pipe (sleeving)	L.F.	300	$18.00	$5,400.00
8" Class 200 PVC Pipe (sleeving)	L.F.	500	$12.00	$6,000.00
6" Class 200 PVC Pipe (sleeving)	L.F.	200	$9.00	$1,800.00
4" Class 200 PVC Pipe (sleeving)	L.F.	2,000	$6.00	$12,000.00
Subtotal				**$1,005,620.00**
Contingency (10%)				$100,562.00
Total Irrigation				**$1,106,182.00**

Aqua Engineering, Inc.

Lump Sum Breakdown by Bid Item

Element	Units	Number	Unit Cost	Total Cost
Pump Station, Wet Well, Intake Pipe	L.S.	1	$125,000.00	$125,000.00
Irrigation Control System	L.S.	1	$155,000.00	$155,000.00
Irrigation Distribution System	L.S.	1	$725,620.00	$725,620.00
Subtotal				**$1,005,620.00**
Contingency (10%)				$100,562.00
Total Irrigation				**$1,106,182.00**

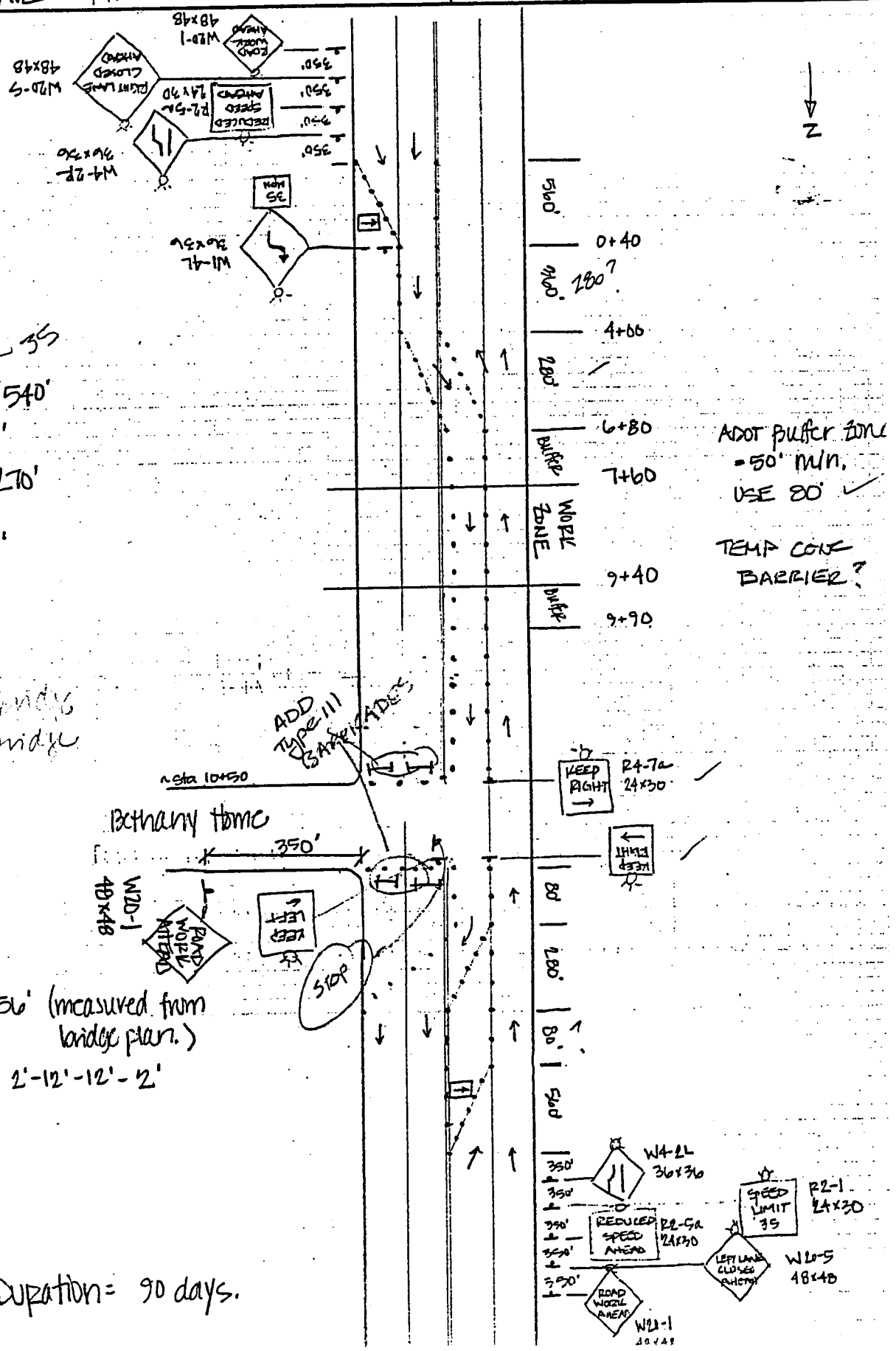
DMJM	PROJECT: BHOC 30%	JOB NO. 6888.0070	SHEET 1 of 9
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: Quantities		CHECKED BY CRAVE	DATE 08-10-01

summary, totals.

		83RD AVE		91ST AVE		
		PH1	PH2	PH1	PH2	TOTAL
7016030	Barricade (Typ. II, Vert. panel)	9180	9360	11,250	9180	38,970
7016032	Portable sign stand (Rigid)	1350 ~~1260~~	1260	990	900	4500 ~~4410~~
7016035	Warning Lights (Type A)	1350 ~~1260~~	1260	990	900	4500 ~~4410~~
7016037	Warning Lights (Type C)	9180	9360	11,250	9180	38,970
7016047	Temp sign (Typ. II)(≤10 SF)	1350 ~~810~~	1260 ~~810~~	990 ~~630~~	900 ~~540~~	4500 ~~2790~~
~~7016048~~	~~Temp sign (Typ II)(≥10 SF)~~	~~450~~	~~450~~	~~360~~	~~360~~	~~1620~~
7016061	Flashing Arrow panel	180	180	180	180	720
	Barricade (Typ. III)	360	–	–	–	360
	Temp. Cone. barrier (Install)	370'	370'	340'	350'	1430'
	Temp Cone. barrier (Use)	33,000	33,000	30,600	31,500	128,100
		$42,000		$42,000		

Total Cost $48,000 | $48,000

DMJM	PROJECT: BHOC 30%	JOB NO.	SHEET 2 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 83RD AVE - PHASE 1		CHECKED BY	DATE 08-10-01



USE S= 45 mph
W=12'

Merge Taper = W·S
= 45 × 12' = 540'
35
USE 560'

Shift Taper = $\frac{W \cdot S}{2}$ = 270'

USE 280'

ADOT buffer zone
= 50' min.
USE 80'

TEMP CONE BARRIER?

Exist Pavt width varies
52.2' south of bridge
to 58.0' north of bridge

Existing width= 56' (measured from bridge plan.)

Reduce to 28' @ 2'-12'-12'-2'

Construction Duration= 90 days.

DMJM	PROJECT: BITOC 302	JOB NO.	SHEET 3 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 83RD AVE - Phase 1 Quantities		CHECKED BY [illegible]	DATE 08-10-01

Vertical panel = 560' @ 40' * 1 = 14 each
560' @ 80' * 1 = 7
360' @ 40' * 2 = 18
(sta 6+80 - 10+50) 370' @ 80' * 2 = 10
@ Bethany Home 's = USE 8
Temp. Partition
80' @ 40' * 2 = 4
280' @ 40' * 2 = 14
280' @ 80' * 1 = 4
80' @ 80' * 2 = 2
560' @ 40' * 1 = 14
560' @ 80' * 1 = 7

Total = 102 each * 90 day = 9180 ea·d

Type 'C' Warning Lights = 102 each. * 90 d. = 9180 ea·d

Arrow Board = 2 each. * 90 d. = 180 ea·d

Temp sign (< 10 SF) =
R1-1 (30x30) @ 1 ea
R2-5a (24x30) @ 2 ea
R2-1 (24x30) @ 1 ea.
W4-2 (36x36) @ 2 ea.
R4-7a (24x30) @ 3 ea.
W1-4 (36x36) @ 1 ea.

Total = ~~9~~ 10 each * 90 d. = ~~810~~ 900 ea·d

~~Temp sign (> 10 SF)~~ =
W20-1 ~~(48x48)~~ 36x36 = 3 ea.
W20-9 ~~(48x48)~~ 36x36 = 2 ea.

30x30

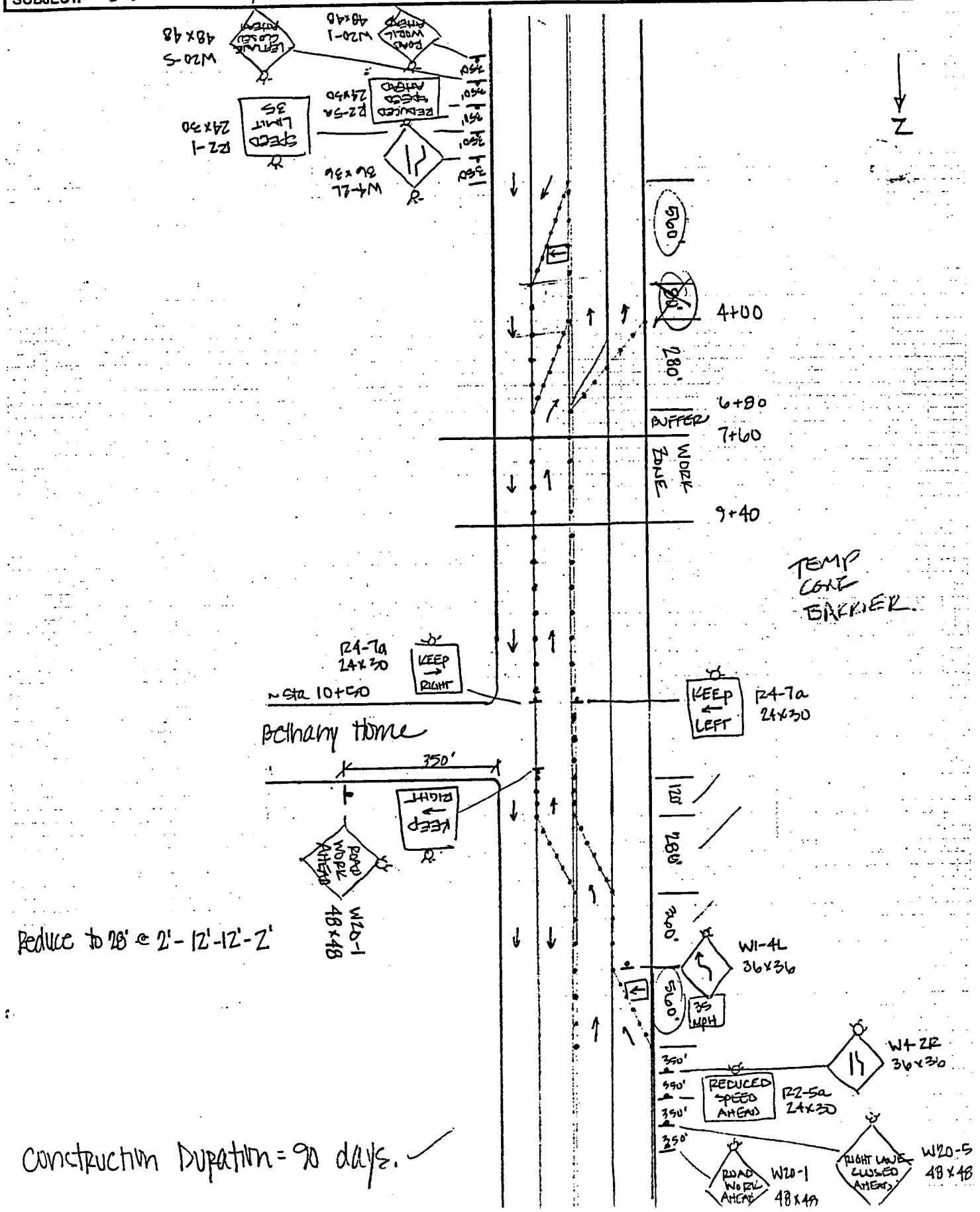
Total = 5 each. * 90 d = 450 ea·d

Type 'A' Warning Lights = ~~14~~ 15 each * 90 d. = ~~1260~~ 1350 ea·d

Rigid sign stand = ~~14~~ 15 each. * 90 d. = ~~1260~~ 1350 ea·d

Type III Barricade = 4 [illegible]

DMJM	PROJECT: BHOC 30%	JOB NO.	SHEET 4 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 83RD AVE - PHASE 2		CHECKED BY CTONE	DATE 08-10-01



Construction Duration = 90 days.

DMJM	PROJECT: BHOC 30%	JOB NO.	SHEET 5 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 83rd Ave - Phase 2 Quantities		CHECKED BY CROWE	DATE 08-10-01

Vertical panel = 560' @ 40' * 1 = 14 each
560' @ 80' * 1 = 7
80' @ 80' * 2 = 2
280' @ 80' * 1 = 4
280' @ 40' * 2 = 14
(Sta 6+80 - 10+50) 370' @ 80' * 2 = 10
@ Bethany Home 's = USE 2
120' @ 40' * 2 = 6
280' @ 40' * 2 = 14
360' @ 80' * 2 = 10
560' @ 40' * 1 = 14
560' @ 80' * 1 = 7

TEMP RAILINGS

Total = 104 each * 90 days = 9360 ea·d

Type 'C' Warning Lights = 104 each * 90d. = 9360 ea·d

Arrow Board = 2 each * 90d. = 180 ea·d

Temp sign (< 10 sf) = R2-5a (24x30) @ 2 ea.
R2-1 (24x30) @ 1 ea.
W4-2 (36x36) @ 2 ea.
R4-7a (24x30) @ 3 ea.
W1-4 (36x36) @ 1 ea

Total = 9 each * 90 d. = 810 ea·d

Temp sign (≥ 10 sf) = W20-1 (36x36) ~~(48x48)~~ @ 3 ea.
W20-5 (36x36) ~~(48x48)~~ @ 2 ea

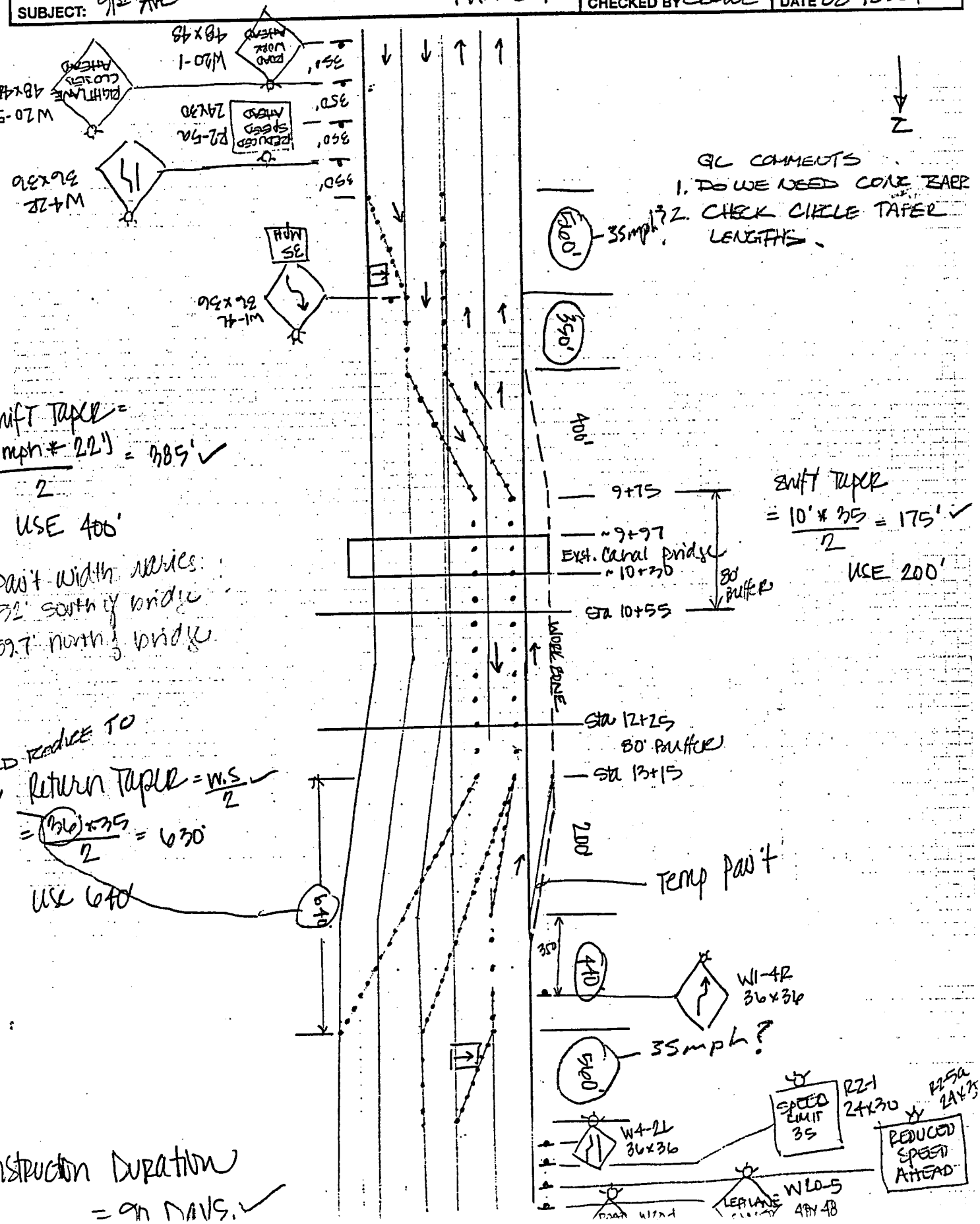
30x30

Total = 5 each * 90 d. = 450 ea·d

Type 'A' Warning Lights = 14 each * 90 d. = 1260 ea·d.

Rigid sign stand = 14 each * 90d. = 1260 ea·d

DMJM	PROJECT: BHOC 30%	JOB NO.	SHEET 6 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 9th AVE	PHASE 1	CHECKED BY CRBWE	DATE 08-10-01



Shift Taper = $\frac{(35\text{ mph} * 22')}{2} = 385'$ ✓

USE 400'

Exst pavt width varies:
52' southbound bridge
to 59.7' northbound bridge

Shift Taper = $\frac{10' * 35}{2} = 175'$ ✓

USE 200'

COULD REDUCE TO 24'

Return Taper = $\frac{W.S}{2}$ ✓

$= \frac{(36) * 35}{2} = 630'$

USE 640

Construction Duration = 90 DAYS. ✓

DMJM	PROJECT: BHOC 30%	JOB NO.	SHEET 7 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 91st AVE. Phase 1 Quantities		CHECKED BY CEOLE	DATE 08-10-01

Vertical panel = 560' @ 40' * 1 = 14 ea.
560' @ 80' * 1 = 7
350' @ 80' * 2 = 10
400' @ 40' * 2 = 20
(sta 9+75 - 13+15) 340' @ 80' * 2 = 10
640' @ 40' * 2 = 32
200' @ 40' * 1 = 5
440' @ 80' * 1 = 6
560' @ 40' * 1 = 14
560' @ 80' * 1 = 7

Temp barrier

Total = 125 each * 90 day = 11,250 ea·d

Type 'C' warning lights = 125 ea. * 90d = 11,250 ea·d
Arrow board = 2 ea. * 90d = 180 ea·d
Temp sign (< 10 sf) = R2-5a (24x30) @ 2 ea
R2-1 (24x30) @ 1 ea
W4-2 (36x36) @ 2 ea
W1-4 (36x36) @ 2 ea.

Total = 7 each * 90d = 630 ea·d

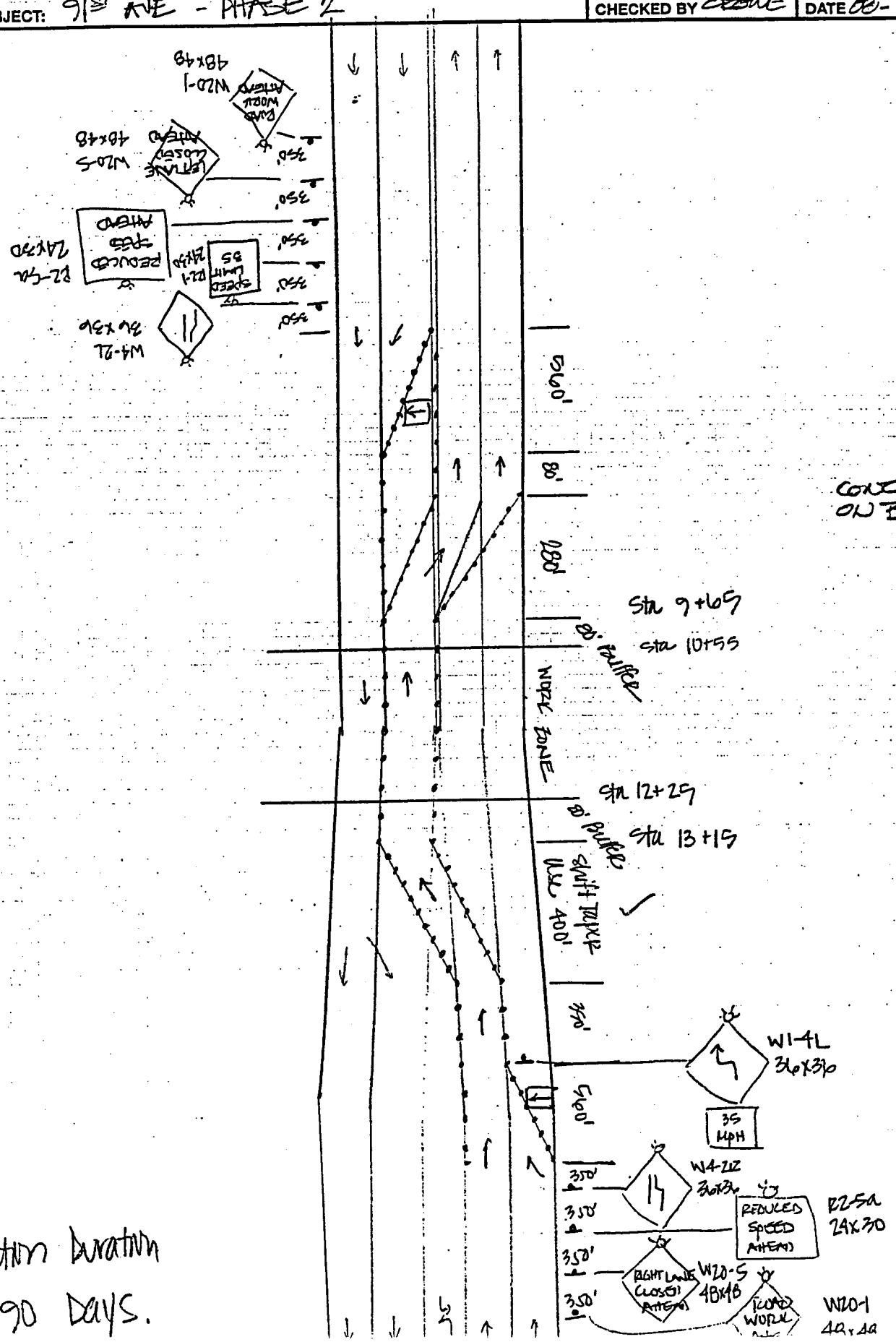
Temp sign (≥ 10 sf) = W20-1 ~~(48x48)~~ 36x36 = 2 ea.
City STREET REDUCE TO 30x30 W20-5 ~~(48x48)~~ 36x36 = 2 ea

Total = 4 ea. * 90d. = 360 ea·d

Type 'A' warning lights = 11 each * 90d. = 990 ea·d
Rigid sign stand = 11 each * 90d = 990 ea·d

Temp. pav't = (Sta 9+75 - Sta 13+15) * 10' + 400' (10'/2) + 200' (10'/2)
= 6400 sq. ft. = 711 sy.

DMJM	PROJECT: PHOC 30%	JOB NO.	SHEET 8 of
		DESIGNED BY JAB	DATE 08.08.01
SUBJECT: 91ST AVE - PHASE 2		CHECKED BY CROUE	DATE 08-10-01



Construction Duration = 90 Days.

DMJM	PROJECT: BHOC 30%	JOB NO.	SHEET 9 of
		DESIGNED BY JMB	DATE 08.08.01
SUBJECT: 91st Ave - Phase 2 Quantities		CHECKED BY CZONE	DATE 08-10-01

Vertical Panel = 560' @ 40' * 1 = 14 ea.
560' @ 80' * 1 = 7
80' @ 80' * 2 = 2
280' @ 80' * 1 = 4
280' @ 40' * 2 = 14
(Sta 9+65 - 13+15) 350' @ 80' * 2 = 10
400' @ 40' * 2 = 20
350' @ 80' * 2 = 10
560' @ 40' * 1 = 14
560' @ 80' * 1 = 7

Temp Barricade

Total = 102 each * 90 d. = 9180 ea·d

Type 'C' Warning Light = 102 each * 90 d. = 9180 ea·d

Arrow board = 2 each * 90 d. = 180 ea·d

Temp sign (<10 SF) = R2-5a (24x30) @ 2 ea
R2-1 (24x30) @ 1 ea
W4-2 (36x36) @ 2 ea
W1-4 (36x36) @ 1 ea

Total = 6 ea. * 90 d. = 540 ea·d

Temp sign (≥10 SF) = W20-1 ~~(48x48)~~ 30x36 @ 2 ea.
30x30 W20-5 ~~(48x48)~~ 30x36 @ 2 ea.

Total = 4 ea. * 90 d = 360 ea·d

Type 'A' Warning Light = 10 each * 90 d. = 900 ea·d

Rigid sign stand = 10 ea. * 90 d. = 900 ea·d

BHOC 100% Lighting Estimate

	E-1.02	E-1.03	E-1.04	E-1.05	E-1.06	E-1.07	E-1.08	E-1.09	E-1.10	E-1.11	E-1.12	E-2.02	E-3.01	E-3.02	Total	Unit	Unit Cost	Total
4" Square, Aluminum Pole - 24 Foot	3	7	7	8	11	10	15	7	7	11	7	2	0	0	95	Each	$ 500.00	$ 47,500.00
Pole Foundation	3	7	7	8	11	10	15	7	7	11	7	2	0	0	95	Each	$ 600.00	$ 57,000.00
100-Watt HPD Fixture - Area	3	7	7	8	11	10	15	7	7	11	7	2	0	0	95	Each	$ 300.00	$ 28,500.00
100-Watt HPS Fixture - Underpass	0	0	0	0	8	1	2	0	0	10	0	0	0	0	21	Each	$ 250.00	$ 5,250.00
ADOT No. 3-1/2 Pull Box	1	0	1	2	6	2	4	0	0	3	2	0	4	4	29	Each	$ 250.00	$ 7,250.00
ADOT No. 3-1/2 Pull Box										1	0	0	0	0	1	Each	$ 400.00	$ 400.00
1-1/2" Conduit (PVC)	570	1000	1070	1380	2050	1310	2220	1000	1050	1970	1170	0	1300	1300	17390	L. Ft.	$ 5.00	$ 86,950.00
3" Conduit (PVC)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	L. Ft.	$ 5.00	$ -
No. 10 Conductor	2100	10000	10140	11640	14240	10880	14700	8000	9160	14320	8520	0	0	0	113700	L. Ft.	$ 0.40	$ 45,480.00
No. 8 Bare Bond	570	1000	1070	1380	2050	1310	2220	1000	1050	1970	1170	0	0	0	14790	L. Ft.	$ 0.30	$ 4,437.00
480/277V, 3-Phase Service	0	0	0	0	1	0	0	0	0	0	0		0	0	1	Each	$20,000.00	$ 20,000.00
240/120, 1-Phase Lighting Service	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	Each	$ 5,000.00	$ 10,000.00
Total																		$312,767.00