

DS #: 4545

APN: _____

PROJECT: DURANGO DRIVE - WESTCLIFF TO VEGAS

SUBMITTAL: 1ST

SCANNED BY/DATE: _____

CHECKED BY/DATE: _____



DRAINAGE STUDY INFORMATION FORM

412.416

Name of Development: Durango Dr. from Westcliff Dr. To Vegas Dr. Date: May 2003

Location of Development: a) Descriptive (Cross Streets): North/South: Durango Dr East/West: Westcliff/Vegas Dr.

b) Sect. 28, 29 Twn. 20S Rng. 60E

Name of Owner: City of Las Vegas Assessors Parcel No: 138-28-301-001

Telephone: 229-6541 Facsimile No: _____

Address: 731 South Fourth Street

Las Vegas Nevada 89101

Contact Person - Name Rick Read, P.E. Telephone No: (702) 804-2000

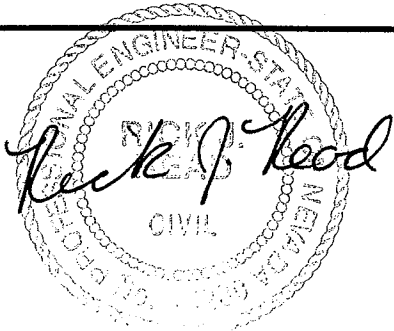
Firm: G. C. Wallace, Inc.

Address: 1555 South Rainbow Boulevard; Las Vegas, NV 89146

Type of Land Development / Land Disturbance Process:

☐	Rezoning	☐	Subdivision Map	☐	Clearing and Grading Only
☐	Parcel Map	☐	Planned Unit Development	☒	Other (Please specify below)
☐	Large Parcel Map	☐	Building Permit	☐	Street Improvements

- Total Owned Land Area: At Site: 12 acres Being Developed / Disturbed: 12 acres
- Is a portion or all of the subject property located in a designated FEMA Flood Hazard Area? Yes* ☒ No ☐
- Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? ☒ Yes ☐ No
- Proposed type of development: (Residential, Commercial, etc.)? Street Improvements
- Approximate upstream land area which drains to the subject site? 30 ± acres
- Has the site drainage been evaluated in the past? ☒ YES ☐ NO If yes, please identify documentation:
Technical Drainage Study for the Villas at Angel Park PBS & J 7/96
Pre-Design Report Vegas Dr. Street Imp. Kennedy/Jenks Consultants 1/96
- If known, please briefly identify the proposed discharge point(s) of runoff from the site:
Storm drain in Vegas Drive and in Westcliff Drive
- Briefly describe your proposed schedule for the subject project: ASAP



Engineer's Seal
5/7/03
Exp 12/31/03

Submit this form as part of the required drainage study to the local entity which has jurisdiction over the subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

*Review and concurrence of the Clark County Regional Flood Control District is required.

Local Entity File No. _____

Revision	Date

REFERENCE:

STANDARD FORM 1

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

Project Name: Durango Dr. From Westcliff Dr. to Vegas Dr.		Map ID:	
Firm Name: G. C. Wallace, Inc.		Engineer: Rick J. Read, P.E.	
Address: 1555 South Rainbow Boulevard			
City: Las Vegas	State: Nevada	Zip: 89146	
Phone Number: 804-2225		Fax Number: 804-2299	
Property Owner: City of Las Vegas			
Address: 731 South Fourth Street			
City: Las Vegas	State: Nevada	Zip: 89101	
Reviewed By:		Date Received:	Date Accepted for Review:

The following checklist is intended as a guide for the engineer preparing a Technical Drainage Study to submit to the local entity and Clark County Regional Flood Control District (if necessary). The listed items are the minimum information required prior to the entity performing a review. The engineer will remain responsible to ensure the Technical Drainage Study is prepared within the guidelines as set forth in the Clark County Regional Flood Control District (CCRFCD) Hydrologic Criteria and Drainage Design Manual (MANUAL).

This document is intended as an aid in preparing Technical Drainage Studies. Each study submitted is reviewed for compliance with local and regional criteria. This form is not intended to be all inclusive and does not limit the extent of the information, calculations or exhibits which may be necessary to properly evaluate the intended land use.

If items are not applicable for the subject site, provide N/A.

I. GENERAL REQUIREMENT:

Yes	No	
☒	☐	Design Manual Standard Form 1 with the engineer's seal and signature.
☒	☐	Design Manual Standard Form 4 .
☒	☐	2 copies of the 24" x 36" Drainage Plan.
☒	☐	A notarized letter from the adjacent property owner(s) allowing off-site grading or discharge.
Reference:		STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

II. MAPS AND EXHIBITS

Yes	No	
☒	☐	A copy of a current Flood Insurance Rate Map (FIRM) with the site delineated.
☒	☐	A copy of the current CCRFCD Master Plan Update Figure, (F-x), for Flood Control Facilities and Environmental areas with the site delineated.
☒	☐	On-site drainage basin maps for existing and proposed conditions showing the existing topography, basin boundaries, concentration points, and on-site and off-site flows in cfs.
☒	☐	Vicinity Map with local and major cross streets identified and a north arrow.
☒	☐	Off-site drainage basin maps for existing, interim and future conditions showing the existing topography, basin boundaries, concentration points, and flows in cfs.

III. DRAINAGE PLAN

Yes	No	
☒	☐	Sheet size: 24" x 36" sealed by a registered engineer in the State of Nevada.
☒	☐	Minimum scale: 1" = 60'.
☒	☐	Project name.
☒	☐	Vicinity Map with local and major cross streets.
☒	☐	Revision box.
☒	☐	North arrow and bar scale.
☒	☐	Engineer's/consultant's address and phone number.
☒	☐	Elevation datum and benchmark.
☒	☐	Legend for symbols and abbreviations.
☒	☐	Cut/fill scarps, where applicable.
☒	☐	Street names, grades, widths.
☒	☐	Proposed future and existing spot grades for top of curbs and street crowns at lot lines, grade breaks, and along curb returns on both sides of the street.

REFERENCE:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
☒	☐	Existing contours encompassing the site and 100 feet beyond with spot elevations for important locations, where appropriate.
☐	☐	Minimum finish floor elevations with top-of-curb elevations at upstream end of lot.
☒	☐	Proposed typical street sections.
☐	☐	Streets with off-set crowns.
☒	☐	Proposed contours or spot elevations in sufficient detail to exhibit intended drainage patterns and slopes.
☒	☐	Property lines.
☒	☐	Right-of-way lines and widths, existing and proposed.
☒	☐	Existing improvements and their elevations.
☒	☐	Delineation of proposed on-site drainage basins indicating area and 10-year and 100-year storm peak flows at basin concentration points.
☐	☐	Concentration points and drainage flow direction with Q_{100} and V_{100} and D_{100} in streets.
☒	☐	Cumulative flows, velocity, and direction of flow at upstream and downstream ends of site for the 10-year and 100-year flows.
☒	☐	Location and cross-section of street capacity calculations.
☐	☐	Cross-sectional detail for channels, including cutoff wall locations.
☒	☐	Existing and proposed drainage facilities, appurtenances, and connections (i.e., sidewalk, ditches, swales, storm drain systems, unimproved and improved channels, and culverts, etc.) stating size, material, shape, and slope with plan and profile and HGL calculations.
☒	☐	Existing and proposed drainage easements and widths shown with sufficient detail. A cross sectional detail must be provided that shows appropriate lining and reinforcement.
☐	☐	Location and detail of existing, proposed, and future block wall openings. Minimum size is 16"x48". Wrought iron gate is required for flows > 10 cfs.
☐	☐	Location and detail of flood walls illustrating depth of flow, proposed grouting height, etc.

REFERENCE:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes

No

- | | | |
|-----|-------|--|
| ✓ | _____ | Perimeter retaining wall locations. All existing and proposed walls (retaining screen and flood) must be shown with adjacent ground elevations. Flood Walls with 8-inch concrete masonry unit. |
| N/A | _____ | Building and/or lot numbers. |
| ✓ | _____ | Alignment of all existing, proposed, or future Regional Facilities adjacent to the site. |
| N/A | _____ | Limits of existing floodplain based on current FIRM or best available information; limits of proposed floodplains based on best available information. |
| N/A | _____ | For areas in Zone A, AE, AH, and AO, base flood elevations (BFEs) must be shown for each lot; BFEs may be listed on each lot, or in a table. Finish floor elevations must be a minimum of 18 inches above BFE. |
| W/A | _____ | Appropriately elevated "humps" 6 inches above the 100-year water surface elevation at site accesses where the intent is to protect the site from the Q ₁₀₀ flows. |
| ✓ | _____ | Street slopes for perimeter and interior streets. The minimum slope is 0.4 percent. |

IV. HYDROLOGIC ANALYSIS

Yes

No

- | | | |
|---|-------|--|
| ✓ | _____ | Appropriate soil information and Soils Map for existing and future conditions with subbasins and property delineated. |
| ✓ | _____ | Input and output information for existing conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models. |
| ✓ | _____ | Input and output information for future conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models. |
| ✓ | _____ | Use of correct precipitation values in and around the McCarran Airport Rainfall Area. |
| ✓ | _____ | A discussion in the text of the hydrologic analysis justifying subbasin boundaries and cutoffs, supporting assumptions, and calculations. |
| ✓ | _____ | A summary table of storm water flows showing basin area, Q ₁₀ and Q ₁₀₀ for both individual basins and combined basin flows, where acceptable. |
| ✓ | _____ | Copies of supporting technical information referenced from a previously approved study and a statement accepting these results. |
| ✓ | _____ | On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners in accordance with current Nevada Drainage Law. |

REFERENCE:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

V. HYDRAULIC ANALYSIS

Yes	No	
	✓	Flow split calculations and supporting documentation or reference for the method of flow split calculations used.
✓		Normal depth street flow calculations and cross section diagrams for all interior and perimeter streets. Provide "d x v" products for the Q_{100} and Q_{10} flows representing the worst case for interior and all perimeter streets. $Q_{100} d \times v \leq 8$. $Q_{10} d \times v \leq 6$ and 12 foot dry lane for rights-of-way ≥ 80 feet. Calculations must be labeled by street name as indicated on the Grading Plan.
✓		A summary table of interior and exterior street capacity calculations showing the street name, Q_{100} flow, slope, depth of flow, velocity and depth times velocity product and streets needing to meet 12 foot dry lane criteria.
	✓	Appropriate hydraulic calculations for block wall openings assuming a 50 percent vertical clogging factor. (Assume the lower half of the opening is plugged.)
n/a		Appropriate hydraulic calculations at drainage easement entrance and discharge locations to set finish floor elevations. Hydraulic calculations must include submerged weir, superelevation and tee intersection losses, where appropriate.
n/a		Provide necessary freeboard requirements to set the finished floor elevations of all proposed buildings, 2 x depth of flow or depth of flow plus 18 inches of freeboard, whichever is less. The minimum requirement is 6 inches above adjacent upstream top of curb. Buildings adjacent to drainage easements must always be provided with 18 inches of freeboard above the Q_{100} weir height or flow depth, which ever is greater.
	✓	A complete water surface profile analysis (HEC-2, HEC-RAS, etc.) for channel flows and FEMA Zone A flood zones. • Field survey data. • Input and output information. • Plotted cross-sections based on survey with proper encroachments. • A map showing the location of the cross-sections. • Analysis of both sub- and super-critical flow segments. • A summary table and a discussion of the results in the text of the report.
✓		Provide a 50 percent clogging factor in the capacity calculation for drop inlets.
	✓	Hydraulic calculations for culverts and storm drains. D-Load calculations must be provided for storm drain pipes in public rights-of-way, including headwater pool inundation.
✓		The mitigation of nuisance water, both during construction and in the fully developed condition, must be addressed.

REFERENCE:

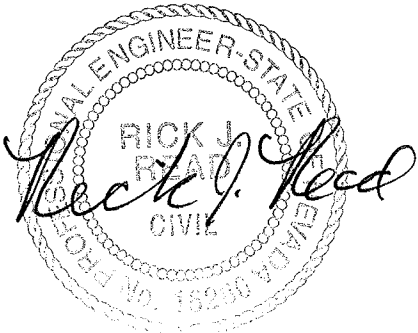
STANDARD FORM 2

**DRAINAGE STUDY
FOR
DURANGO DRIVE
FROM WESTCLIFF DRIVE TO VEGAS DRIVE**

30% PRELIMINARY DESIGN SUBMITTAL

412.416

May 2003



*5/7/03
Exp. 12/31/03*

Prepared for:

**City Of Las Vegas
731 South Fourth Street
Las Vegas, Nevada 89101
Phone: (702) 229-6541
Fax: (702) 382-8551**

Prepared by:

**G. C. Wallace, Inc.
1555 South Rainbow Boulevard
Las Vegas, Nevada 89146
Phone: (702) 804-2000
Fax: (702) 804-2299**

TABLE OF CONTENTS

<u>No.</u>	<u>Description</u>	<u>Page</u>
I.	INTRODUCTION	1
II.	LOCATION AND DESCRIPTION.....	2
III.	PREVIOUS STUDIES.....	2
IV.	FEMA FLOODPLAIN STATUS	3
V.	CCRFCD MPU.....	3
VI.	DESIGN PROCEDURES & CRITERIA	8
VII.	HYDROLOGIC MODELS.....	11
VIII.	RECOMMENDED DRAINAGE FACILITIES.....	17
IX.	STREET HYDRAULICS.....	20
X.	CONCLUSIONS AND RECOMMENDATIONS	23
XI.	REFERENCES	24
	APPENDIX LAYOUT	25



LIST OF TABLES

<u>No.</u>	<u>Description</u>	<u>Page</u>
TABLE 1	PREVIOUS STUDIES & REFERENCE DRAWINGS	2
TABLE 2	LAND USE SUMMARY & COMPOSITE CURVE NUMBER	9
TABLE 3	MANNINGS "N" DESIGN VALUES	10
TABLE 4	SUMMARY OF EXISTING CONDITION HEC-1 ANALYSIS	13
TABLE 5	SUMMARY OF INTERIM CONDITION HEC-1 ANALYSIS	13
TABLE 6	SUMMARY OF ULTIMATE CONDITION HEC-1	15
TABLE 7	SUMMARY OF PROPOSED DRAINAGE FACILITIES	20
TABLE 8	SUMMARY OF STREET FLOW HYDRAULICS DURING A 100-YEAR STORM EVENT	20
TABLE 9	SUMMARY OF STREET FLOW HYDRAULICS DURING A 10-YEAR STORM EVENT	22

LIST OF FIGURES

<u>No.</u>	<u>Description</u>	<u>Page</u>
FIGURE 1	VICINITY MAP	4
FIGURE 2	LOCATION MAP	5
FIGURE 3	FEMA FLOODPLAIN.	6
FIGURE 4	CCRFCD FLOOD CONTROL FACILITIES	7
FIGURE 5	EXISTING CONDITION DRAINAGE MAP	12
FIGURE 6	INTERIM / ULTIMATE CONDITION DRAINAGE MAP	14
FIGURE 6A	INTERIM / ULTIMATE OVERALL DRAINAGE PATTERNS	16
FIGURE 7	PROPOSED STORM DRAIN FACILITIES	21

I. INTRODUCTION

The City of Las Vegas (CLV) has contracted with G. C. Wallace, Inc. to provide engineering and design services with general regard to grading, drainage, right-of-way, lighting, utilities, traffic design and construction phasing for improvements to Durango Drive from Westcliff Drive to Vegas Drive. The proposed project encompasses full improvements within the 100-foot right-of-way of Durango Drive within the project limits. The project also includes the construction of the Durango Drive Bridge over Summerlin Parkway. An access ramp to Summerlin Parkway for the eastbound traffic and an exit ramp to Durango Drive for west bound traffic are also a part of this project.

This report addresses the 30-percent design level for the necessary drainage improvements resulting from the development of the project segment of Durango Drive. The intention of this report is to provide detailed hydrologic and hydraulic analyses in support of the drainage recommendations for the ultimate conditions of the project. The following tasks were performed in the preparation of this report:

- ♦ Identified and reviewed previous drainage studies for the project.
- ♦ Identified record drawings for area projects and utilities, and extracted information pertinent to the recommended drainage facilities.
- ♦ Determined the FEMA floodplain designation within the project limits.
- ♦ Identified existing and proposed CCRFCD drainage facilities adjacent to the project site.
- ♦ Estimated runoff generated from off-site and on-site subbasins for 100-year and 10-year return period storm for the existing, interim and ultimate conditions.
- ♦ Determined design flows for recommended drainage facilities derived from various hydrologic models.
- ♦ Performed site field investigation.
- ♦ Recommended ultimate condition drainage facilities.
- ♦ Performed normal flow depth calculations for the recommended storm drain facilities.
- ♦ Identified project constraints and anticipated resolutions.
- ♦ Prepared preliminary storm drain improvement plans incorporating recommended ultimate drainage facility recommendations.

II. LOCATION AND DESCRIPTION

The Durango Drive improvements project is located inside the corporate limits of the City of Las Vegas, Clark County, Nevada. More specifically, the project is bounded by Westcliff Drive to the south and Vegas Drive on the north. Figures 1 and 2 depict the vicinity and location of the project.

The project limits will incorporate improvements to approximately 1 mile of Durango Drive. The project improvements will also include construction of a bridge over Summerlin Parkway and an access and exit ramp to Summerlin Parkway from Durango Drive.

Currently, one northbound and one southbound travel lane comprise the developed condition of Durango Drive. Durango Drive is barricaded on the south and north at Summerlin Parkway. The site is bordered on the west by the Angel Park Detention Basin, on the east by residential and commercial developments, on the north by Vegas Drive, and on the south by Durango Drive full street improvements. The portion of Durango Drive south of Summerlin Parkway drains to a sump condition at the Westcliff Drive intersection. Durango Drive north of Summerlin Parkway drains to a sump condition at Washington Drive and as a continuous grade to Vegas Drive.

III. PREVIOUS STUDIES

Several previous studies and record drawings were utilized in the preliminary planning of the recommended drainage facilities. Relevant reference material taken from the previous studies have been included in Appendix C. Table 1 provides a summary of the previous studies and record drawings utilized in the preparation of this report.

TABLE 1 Previous Studies & Reference Drawings	
Type	Description
Drainage Study #1	<i>Summerlin Parkway Drainage Improvements Rampart Boulevard to Buffalo Channel</i> , dated June 1997, prepared by The City of Las Vegas Flood Control Section.
Drainage Study #2	<i>Technical Drainage Study For the Villas At Angel Park</i> , dated July 1996 by PBS&J
Drainage Study #3	<i>Technical Hydrology Study For Durango Trails City of Las Vegas, Nevada</i> , dated December 1994, prepared by VTN, Nevada.
Drainage Study #4	<i>Hydrology Study For Westcliff & Durango City of Las Vegas, Nevada</i> , dated August 1994, prepared by L. R. Nelson Consulting Engineers, Inc.
Drainage Study #5	<i>Pre-Design Report Vegas Drive Street Improvements</i> , dated December 1996, prepared by Kennedy/Jenks Consultants

TABLE 1 Previous Studies & Reference Drawings	
Type	Description
Drainage Study #6	1997 City of Las Vegas, City-Wide Hydrology Study, by PBS&J, Inc.

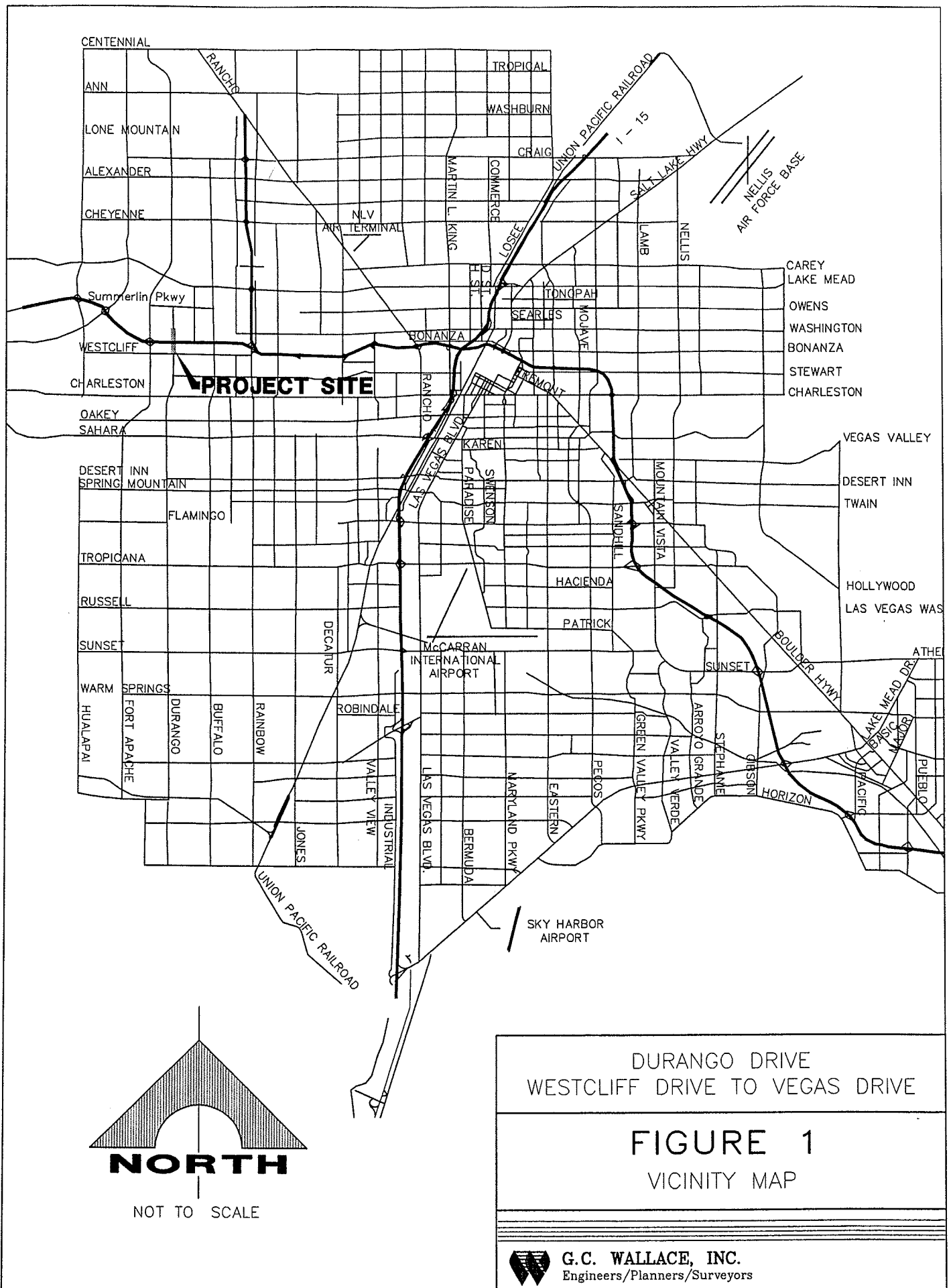
The drainage studies listed in Table 1 are designated as Reference 1 through Reference 6 in Appendix C. Additionally, the studies will be referred to as (1) *Summerlin Pkwy Study* (2) *The Villas Study*, (3) *The Durango Trails Study*, (4) *The Westcliff Study*, (5) *the Vegas Drive Study*, and (6) *City of Las Vegas City-Wide Hydrology Study* in the following text.

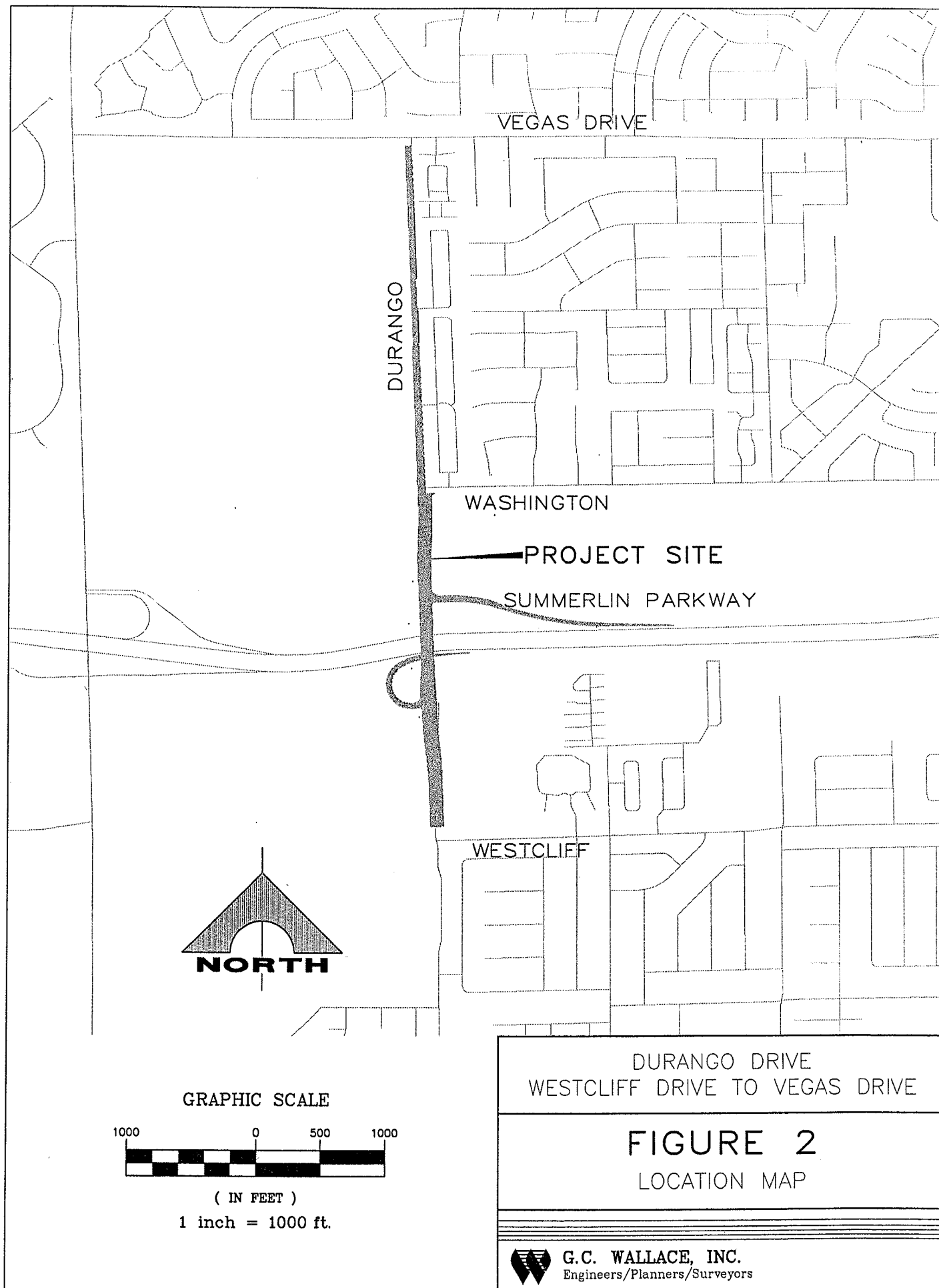
IV. FEMA FLOOD PLAIN STATUS

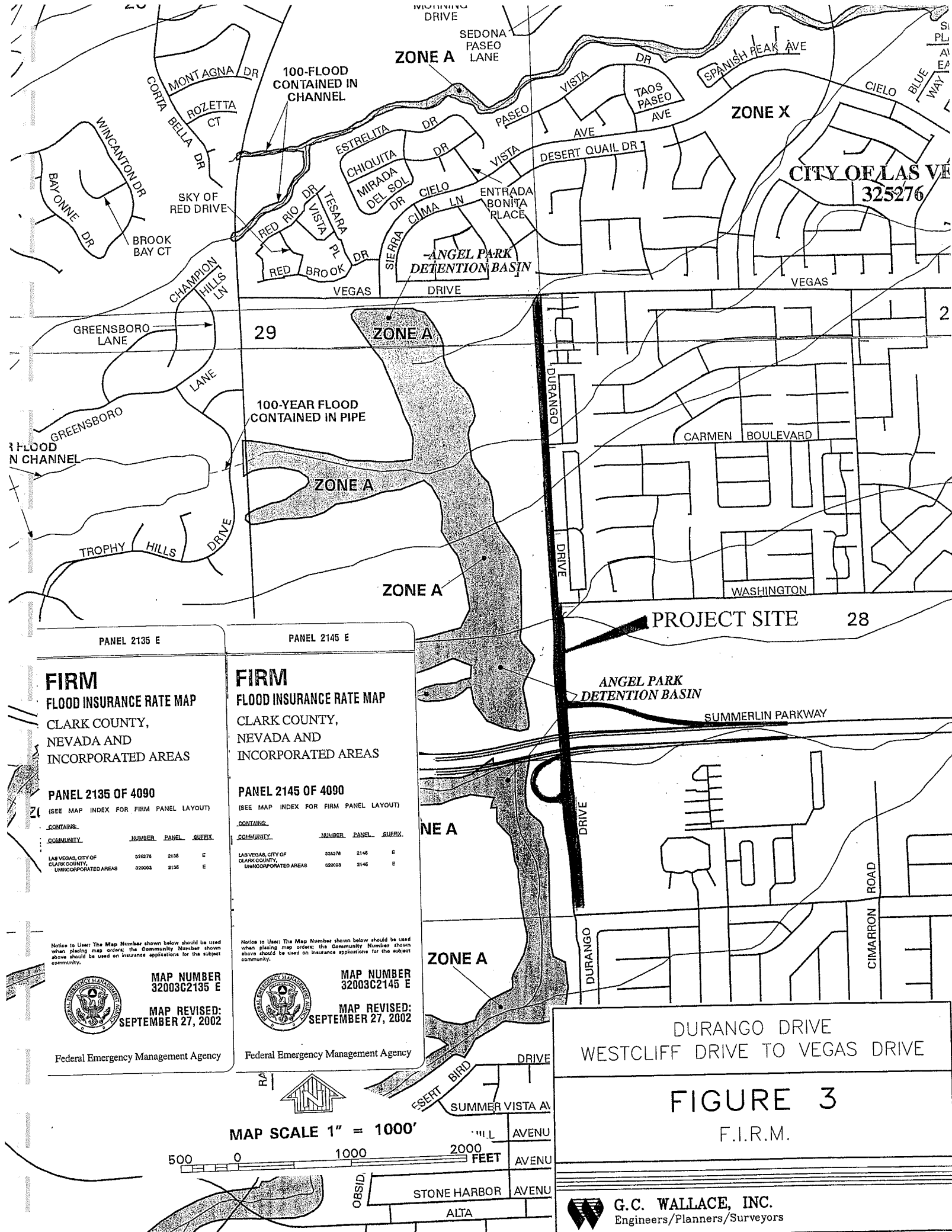
The limits of the project are located on Flood Insurance Rate Map (FIRM) Panels 32003C2135 E and 32003C2145 E for Clark County, Nevada, and incorporated areas, dated September 27, 2002. As is shown on Figure 3, the site is not located in a FEMA-designated Special Flood Hazard Area (SFHA).

V. CCRFCD FLOOD CONTROL MASTER PLAN UPDATE

Figure 4 is reproduced from Figure F-12 as taken from the *Clark County Regional Flood Control District 2002 Master Plan Update* (Reference 7, hereinafter referred to as the MPU). This figure depicts the location of the subject project in relation to existing and proposed flood control facilities. As shown on the figure, there are several existing CCRFCD regional facilities adjacent to the site. Facility APNO 0000 is described as the existing 1400 ac-foot Angel Park Detention Basin. Facility APNO 0001, 0002, and 0003 are described as two 33-inch RCP and one 42-inch RCP Emergency Outlets. Facility APNO 0004 is an equalization storm drain under Summerlin Parkway for the Angel Park Detention Basin and is described as an existing 14-foot wide by 12-foot high RCBC. Facility LCCH 0582 is described as an existing 24-inch RCP storm drain. Facility APOF 0124 is described as an existing 54-inch RCP storm drain and Facility APOF 0015 is described as an existing 60-inch RCP storm drain. Upon receipt of a conditional letter of approval from CLV this study will be submitted to CCRFCD for concurrence.







FIRM
FLOOD INSURANCE RATE MAP
 CLARK COUNTY,
 NEVADA AND
 INCORPORATED AREAS

PANEL 2135 OF 4090
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS	COMMUNITY	NUMBER	PANEL	SUFFIX
	LAS VEGAS, CITY OF	320276	2135	E
	CLARK COUNTY, UNINCORPORATED AREAS	320003	2135	E

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

MAP NUMBER
 32003C2135 E

MAP REVISED:
 SEPTEMBER 27, 2002



Federal Emergency Management Agency

FIRM
FLOOD INSURANCE RATE MAP
 CLARK COUNTY,
 NEVADA AND
 INCORPORATED AREAS

PANEL 2145 OF 4090
 (SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS	COMMUNITY	NUMBER	PANEL	SUFFIX
	LAS VEGAS, CITY OF	320276	2145	E
	CLARK COUNTY, UNINCORPORATED AREAS	320003	2145	E

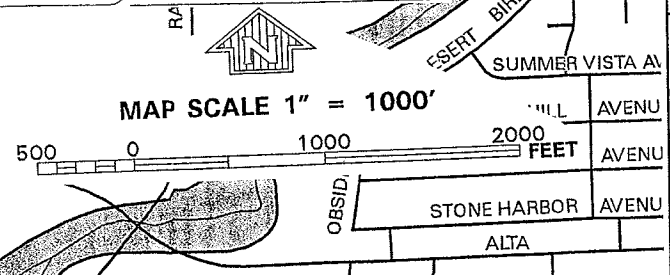
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
 32003C2145 E

MAP REVISED:
 SEPTEMBER 27, 2002



Federal Emergency Management Agency



DURANGO DRIVE
 WESTCLIFF DRIVE TO VEGAS DRIVE

FIGURE 3
 F.I.R.M.

G.C. WALLACE, INC.
 Engineers/Planners/Surveyors

VI. DESIGN PROCEDURES AND CRITERIA

The procedures and criteria used in the design and planning of recommended drainage facilities are based on standards published in the CCRFCD *Hydrologic and Drainage Design Manual* (Reference 8, hereinafter referred to as the Manual). Specific design criteria are described in further detail as follows.

Hydrologic Model Description

The existing and interim / ultimate condition off-site watershed hydrology was modeled using the SCS Unit Hydrograph method within the U.S. Army Corps of Engineers (USACOE) *HEC-1 Flood Hydrograph Package* (Reference 9).

Precipitation

The project limits along Durango Drive lie within the McCarran Rainfall Area. The 100-year and 10-year point precipitation values range are 2.77 and 1.58 inches, respectively.

The point precipitation depths were not adjusted to estimate the average rainfall depth over an entire drainage area by the application of the Depth Area Reduction Factor (DARF) since the area tributary to the site are small.

Since the drainage area for the project is less than 8 square miles, an SDN 3 design storm was selected for use in the HEC-1 computer model.

Curve Number & Runoff Coefficient

The soils information utilized for the offsite hydrologic models was obtained from the *SCS Soil Survey of the Las Vegas Valley* as provided by the United States Department of Agriculture (USDA, Reference 10). The Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) methodology for computing runoff divides soils into four hydrologic soil groups A, B, C, and D. The soil survey was used to determine the hydrologic soil group of each soil type for use in determination of composite curve numbers. The hydrologic soil groups are defined as follows:

- ♦ HSG A: High infiltration rate, low runoff potential
- ♦ HSG B: Moderate infiltration rate, moderately low runoff potential
- ♦ HSG C: Slow infiltration rate, moderately high runoff potential

- ♦ HSG D: Very slow infiltration rate, high runoff potential

Table 2 summarizes land use designations and associated curve numbers used in the existing and ultimate conditions hydrology.

TABLE 2 Land Use Summary & Composite Curve Number	
Land Use Designation	HSG and Curve Number
	D
Impervious (Streets)	98
Open Space (lawns, parks, golf courses, cemeteries, etc.) good condition	80
Newly graded areas (pervious areas only, no vegetation)	94

Drainage Areas and Flow Patterns

The existing condition subbasins, flow patterns and slopes were determined utilizing existing topography and contours obtained by G. C. Wallace, Inc. for the area. Ultimate condition offsite hydrology was based on subbasin assumptions for the park area on the west and from referenced drainage studies. Ultimate condition onsite subbasins were determined utilizing design roadway profiles from AutoCad files and typical sections for the Durango Drive improvements project.

Lag Time

The lag time is described as the time between the center of mass of rainfall excess and the time to peak discharge from a basin. Lag time (t_L) can be related to time of concentration (t_c) by the following relationship: $t_L = 0.6(t_c)$. The time of concentration is defined as the time required for runoff to flow from the hydrologically most distant point of the subbasin to the outlet of the subbasin or concentration point. The procedure for calculating t_c is outlined in Section 602 of the Manual. Lag time calculations for the subject property subbasins, as incorporated on Standard Form 4, are included in Appendix A.

Manning's "n" Values

The following table summarizes Manning's "n" values used for each material and facility type recommended for the Durango Drive improvements. Values used are consistent with recommended values contained in Table 702 of the Manual. Additionally, recommended maximum permissible velocities associated with each material type are also listed. Maximum permissible velocities are consistent with Table 703 in the Manual.

TABLE 3 Mannings "n" Design Values		
Facility Type	Mannings "n" Value	Maximum Permissible Velocity (fps)
RCP Storm Drain	0.013	35

Storm Drain

Storm drain facilities were conceptually sized to convey the entire 10-year storm flow with consideration to street flow capacity and maintaining a 10-year 12-foot wide dry lane. Nuisance drop inlets are provided at 800-foot intervals per Regional Transportation requirements. For this submittal the proposed storm drain was sized using normal depth calculations since only a conceptual design is provided at this submittal level. Storm drain normal flow depth calculations using the Flowmaster program are included in Appendix B. As the project design develops, the hydraulic grade line of the storm drain pipe will be designed to be a minimum of 1-foot below finished grade in accordance with Section 804 of the Manual.

Drop Inlets

Ultimate condition drop inlet facilities located along Durango Drive have been designed in accordance with Section 805 of the Manual. Drop inlets located in sump conditions and on a continuous grade have been designed to capture the anticipated 10-year storm event runoff or enough to maintain 12-foot dry lane. Drop inlet calculations are included in Appendix B.

Street Flow Hydraulics

The Durango Drive typical roadway section consists of a 100-foot right-of-way width. The ultimate condition back-of-curb to back-of-curb width will be 90 feet.

The street will have "L"-type curbing and a 5-foot sidewalk on each side. A typical section will have a 14-foot median. The Durango overpass roadway section consists of a 93-foot wide street section with "L"-type curbing, a 4-foot median island, and a 10-foot wide shared path.

The street flow hydraulics have been designed in accordance with Section 304.4 of the Manual. Section 304.4 requires the depth (D) and velocity (V) times depth ($V \cdot D$) for the 100-year storm event to be less than or equal to 8. Additionally, depth of flow in the gutter flowline for the 100-year storm event will be less than or equal to 2 feet and less than 1 foot at through traffic streets as required by the Manual. Section 304.4 requires the depth (D) and velocity (V) times depth ($V \cdot D$) for the 10-year storm event to be less than or equal to 6. Additionally, Section 304.4 requires a 12-foot wide dry lane be maintained in either direction for the 10-year storm event. Street flow hydraulics are discussed in further detail later on in this report.

VII. HYDROLOGIC MODELS

Three separate hydrologic models were developed for use in determination of the existing, interim and ultimate overall drainage design of Durango Drive. The three separate models were developed in order to address the existing, interim, and ultimate conditions that occur or are anticipated to occur in the future. Peak flow rates were utilized in the design of the recommended drainage facilities and were based on the "worst case" peak flow rate determined from the interim and ultimate hydrologic models. The following paragraphs discuss each model in more detail as well as present a summary of peak flow rates determined.

The first model addresses the existing condition flows to Durango Drive. This model analyzes offsite subbasins draining to Durango Drive from the west and existing conditions for Durango Drive. Land uses and drainage patterns determined for this model are based on aerial topography and development information was obtained from aerial photos and site field investigation current to the date of submittal of this report. This model was developed to determine the existing offsite and onsite drainage patterns. Figure 5 shows the subbasins and drainage patterns used in the hydrologic analysis for the existing condition. A copy of the HEC-1 model is included in Appendix A. Table 4 summarizes the 100-year and 10-year peak flow rates determined by the HEC-1 model.

TABLE 4 Summary of Existing Condition HEC-1 Analysis		
Subbasin or Concentration Point	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
EX1	78	39
EX2	8	5
PT1	86	44
EX3	38	20
EX4	9	5
EX5	23	12

The second model addresses the interim condition flows to Durango Drive. This model analyzes existing offsite subbasins draining to Durango Drive from the west, the existing condition within Summerlin Parkway, along with full street improvements for Durango Drive, the Durango Drive Overpass, and the proposed on ramp and off ramp for Summerlin Parkway. Land uses and drainage patterns determined for this model are based on aerial topography and development information was obtained from aerial photos, previous drainage studies, site field investigation, and the proposed finished grading with this project. This model was developed to determine the existing offsite and developed onsite drainage patterns. Figure 6 shows the subbasins and drainage patterns used in the hydrologic analysis for the interim condition. Additionally, Figure 6A shows the overall drainage patterns in the area. A copy of the HEC-1 model is included in Appendix A. Table 5 summarizes the 100-year and 10-year peak flow rates determined by the HEC-1 model.

TABLE 5 Summary of Interim Condition HEC-1 Analysis		
Subbasin or Concentration Point	Q ₁₀₀ (cfs)	Q ₁₀ (cfs)
ULT1	15	8
INT2	77	38
PT1	91	46
ULT3	10	6
INT4	21	10
PT2	31	16
ULT5	12	6
ULT6	10	6
ULT7	12	6
PT3	22	11
ULT8	21	11

The third model addresses the ultimate condition flows to Durango Drive. This model analyzes ultimate offsite subbasins draining to Durango Drive from the west along with full street improvements for Durango Drive, the Durango Drive Overpass, and the on ramp and off ramp for Summerlin Parkway. For this model the offsite drainage patterns were assumed to be the same as for the interim condition. The open area north of Summerlin Parkway between the proposed street improvements and the Angel Park Detention Basin dike has been designated as a park area and is currently under preliminary design at Stantec Engineering. Subbasins INT2 and INT4 from the interim condition model are designated as Subbasins ULT2 and ULT4 in the HEC-1 model for ultimate conditions. The only changes in the hydrologic parameters to these subbasins are a lower curve number. A CN value of 87 (assuming that approximately 50 percent of the area between the street improvements and the Angel Park Detention Basin will be a park with grass) was used for these subbasins. Land uses and drainage patterns determined for this model are based on aerial topography and the proposed finished grading for Durango Drive. Figure 6 and 6A show the subbasins and drainage patterns used in the hydrologic analysis for the ultimate condition. A copy of the HEC-1 model is included in Appendix A. Table 6 summarizes the 100-year and 10-year peak flow rates determined by the HEC-1 model.

TABLE 6		
Summary of Ultimate Condition HEC-1 Analysis		
Subbasin or Concentration Point	Q₁₀₀ (cfs)	Q₁₀ (cfs)
ULT1	15	8
ULT2	55	21
PT1	69	29
ULT3	10	6
ULT4	15	6
PT2	26	12
ULT5	12	6
ULT6	10	6
ULT7	12	6
PT3	22	11
ULT8	21	11

As discussed previously, the various interim and ultimate condition hydrologic models were developed to determine "worst case" peak flows for use in the drainage facility designs. According to the HEC-1 results, the interim conditions model

established the "worst case" peak flows. Therefore, the calculated flows from this model will be used for sizing the storm drain facilities. Recommended drainage facilities are discussed in more detail in the following section of this report.

VIII. RECOMMENDED DRAINAGE FACILITIES

The recommended drainage improvements along Durango Drive and within the project limits were generally designed to be consistent with existing drainage patterns in the area and also consistent with previous drainage studies for the surrounding area and those established in the Las Vegas City-Wide Study. More specifically, drainage north of Washington and west of Durango (future park) will be directed to the north along Durango Drive and will discharge to the existing storm drain in Vegas Drive in accordance with the City Wide Study and the Vegas Drive Study. Drainage on the north side of Summerlin Parkway south of Washington and west of Durango (future Park) will drain under Durango Drive through the proposed bicycle path tunnel and into the park area on the east. Drainage on the south side of Summerlin Parkway will drain to an existing 24-inch RCP that was designed as a part of the Westcliff and Durango Dur West Partners Improvement Plans.

The storm runoff in Summerlin Parkway that drains to the west bound off ramp will be conveyed east through a 30-inch RCP culvert that perpetuates existing drainage patterns. Additionally, the runoff generated in the open area within the on-ramp for Summerlin Parkway east bound traffic will drain as surface flow into an existing swale within the Parkway. Runoff in Summerlin Parkway west of the eastbound on ramp will be conveyed east through a proposed 18-inch RCP culvert that perpetuates existing drainage patterns.

Three types of drop inlets have been recommended for the project. Four (4)-foot Type "A" drop inlets are proposed for Durango Drive to intercept nuisance flows only. Two Type "B" drop inlets are proposed in Durango Drive on the south side of the overpass that are designed to intercept storm flows upstream of the on-ramp. Type CM drop inlets are proposed at the Durango Drive/Washington Drive intersection and in Durango Drive south of Summerlin Parkway to intercept the 10-year storm runoff. NDOT Type 2A drop inlets are proposed at the west side of the bicycle path and at the upstream end of the on-ramp and off-ramp to Summerlin Parkway to intercept the 10-year storm runoff. Drop inlet calculations are included in Appendix B.

There are a number of existing drainage facilities in the area that will be utilized to convey the on-site and off-site runoff from the developed conditions for this area. The first area under discussion is the area north of Washington. There is an existing 39-foot Neenah drop inlet on the west side of Durango Drive and south of Vegas Drive. The inlet was designed as a part of the Vegas Drive improvements to intercept the 100-year storm flows from Durango Drive and from the open area between Durango and the Angel Park Detention Basin. Additionally, there is an existing berm on the west side of the proposed improvements that direct offsite flows to this inlet. The berm will protect Durango Drive from off-site flows from the west from draining into the street improvements upstream of the existing 39-foot drop inlet in the interim condition. Two 5.5-foot Type CM drop inlets are proposed at the Durango/Washington intersection to intercept the 10-year storm flows generated within the street improvements and convey them via an 18-inch RCP to the existing 39-foot drop inlet. Pertinent excerpts from the Vegas Drive Study are enclosed in Appendix C.

Under interim conditions there will be 84 cfs of runoff in the west side of Durango Drive at the existing 39-foot drop inlet, which exceeds the 100-year storm capacity of the drop inlet. Under Ultimate Conditions after the park has been constructed the storm runoff in the west half of the Durango Drive improvements is reduced to 63 cfs (ULT2 plus $\frac{1}{2}$ of ULT1). At that time the total 100-year storm runoff will be intercepted into the existing 39-foot Neenah drop inlet (Capacity equals 69 cfs, see Vegas Drive Study calculations in Appendix C).

Storm drain facilities are proposed in Durango Drive that will tie into the side of the existing inlet and continue south in Durango Drive to the sump area at the Durango/Washington intersection. Nuisance inlets are proposed along the west side of the street improvements at 800-foot spacing to accommodate offsite flows from the future park on the west. The east side of Durango is currently developed in this area and the driveways for the Villas At Angel Park and for the Durango Trails developments have been humped to prevent runoff in Durango Drive from entering these sites. Pertinent excerpts from the technical drainage studies for these developments are included in Appendix C. No drop inlets are proposed along the east side of Durango Drive for this area since the developments on the east will not

drain into the existing street improvements and there is no nuisance flow from the east.

An NDOT Type 2A drop inlet and a 30-inch RCP storm drain are proposed on the west side of Durango Drive at the upstream end of the proposed bicycle path tunnel that is designed to intercept the 10-year storm flows from Subbasin INT4/ULT4. G. C. Wallace, Inc. and Stantec Engineering (designing the park on the east side of the overpass) have agreed that the park will be designed to accept these flows.

There is an existing 24-inch RCP in the Durango Drive improvements at the Westcliff/ Durango intersection. The existing Durango Drive improvements on the west side of the Westcliff/ Durango intersection has been designed as a sump. There are three 4-foot Type "A" drop inlets on the west side of Durango across from the intersection that are designed to intercept runoff that drains to this sump area. An 18-inch RCP storm drain and two 5.5-foot Type CM drop inlets are proposed to intercept 6 cfs (10-year storm runoff) into the existing 24-inch RCP in Westcliff Drive.

There are four NDOT Type 2A drop inlets in Summerlin Parkway located at the upstream end of Subbasins ULT5 and ULT8 (See Figure 6 and 6A) that intercept surface runoff in Summerlin Parkway into the Angel Park Detention Basin. Therefore, no runoff west of these subbasins will drain to the proposed 18-inch and 30-inch storm drain proposed at the downstream end of the on ramp and off ramp. Pertinent excerpts from the Summerlin Parkway Study are enclosed in Appendix C.

Table 7 on the following page provides an inventory of recommended drainage facilities. Figure 7 depicts the location of each drainage facility.

TABLE 7 Summary of Proposed Drainage Facilities		
Facility Description*	Design Flows 10-year (cfs)	Location
18" RCP Storm Drain	5.5	East side of Durango Drive (North of Washington)
Type "A" Drop Inlets	Nuisance	East side of Durango Drive (North of Washington)
5.5' Type CM D. I.	3	West side of Durango Drive (Sta. 73+92)
5.5' Type CM D. I.	2.5	East side of Durango Drive @ Washington (Sta. 73+92)
NDOT Type 2A	10	West of Durango Drive Sta. 65+50
30" RCP	10	Durango Drive Sta. 65+50
18" RCP	3 (1/2 ULT5)	Summerlin Parkway
NDOT Type 2A	3 (1/2 ULT5)	Summerlin Parkway
18" RCP	2	Durango Drive Sta. 57+30
(2) Type "B" D. I.	1	Durango Drive Sta. 57+30
5.5' Type CM D. I.	3	West Side of Durango Drive Sta. 52+75
5.5' Type CM D. I.	3	East Side of Durango Drive Sta. 52+75
18" RCP Storm Drain	6	Durango Drive (South of on ramp to Summerlin Parkway)
Modified NDOT Type 2A	11	Summerlin Parkway
30" RCP	11	Summerlin Parkway

*See Figure 7 for location.

IX. STREET HYDRAULICS

The resulting street flow data is based on the flows established from the interim conditions HEC-1 model. Table 8 summarizes the street flow hydraulic computations for a 100-year storm event.

TABLE 8 Summary of Street Flow Hydraulics During a 100-Year Storm Event (Major Storm)						
X-Section*	Slope (%)	R.O.W. Width (feet)	100-Year Storm Event			
			Q (cfs)	Depth (feet)	Velocity (fps)	V*D
A (West)	1.50	100	84	0.86	5.6	4.8
A (East)	1.50	100	7.5	0.44	3.2	1.4
B	0.40	100	8	0.44	1.7	0.7
C (West)	0.40	100	17	0.66	2.2	1.5
D	3.40	100	2	0.23	2.9	0.7

*See Figure 6 and Figure 7.

Table 9 summarizes the street flow hydraulic computations for the 10-year storm event.

TABLE 9 Summary of Street Flow Hydraulics During a 10-Year Storm Event (Minor Storm)						
X-Section*	Slope (%)	R.O.W. Width (feet)	10-Year Storm Event			
			Q (cfs)	Depth (feet)	Velocity (fps)	V*D
A (West)	1.50	100	42	0.71	4.7	3.3
B	0.40	100	5	0.39	1.5	0.6
C (West)	0.40	100	9	0.56	1.9	1.1
E	0.5	100	6	0.39	1.7	0.7

*See Figure 6 and Figure 7.

Based on the calculated street flow characteristics, the Design Manual criteria for depth (D) and velocity times depth (VXD) during the 10-year and 100-year storm events for major streets will be met. Additionally, a 12-foot dry lane will be maintained in a 10-year event. Please note that the 10-year flow at cross-section A is located at the existing 39-foot drop inlet in Durango. This flow is intercepted by the existing drop inlet and a 10-year dry lane is maintained downstream of the inlet.

X. CONCLUSIONS AND RECOMMENDATIONS

1. The recommended drainage facilities are shown on the attached preliminary construction drawings plan and profile sheets.
2. The methods used to calculate storm runoff and various hydraulic characteristics for this project are in compliance with the Manual.
3. All storm drain facilities are designed to convey a 10-year design storm or nuisance flows.
4. All Type CM, Type B, and NDOT Type 2A drop inlets are proposed to intercept 10-year storm flows.
5. The proposed 4-foot type "A" drop inlets are intended for nuisance flows only.
6. Runoff from the site will not have a negative effect on downstream properties or drainage facilities.
7. The project is not located in a FEMA-designated Special Flood Hazard Area (SFHA)

XI. REFERENCES

1. The City of Las Vegas Flood Control Section, *Summerlin Parkway Drainage Improvements Rampart Boulevard to Buffalo Channel*, June 1997.
2. PBS&J, *Technical Drainage Study for the Villas At Angel Park*, July 1996.
3. VTN, Inc., *Technical Hydrology Study for Durango Trails City of Las Vegas, Nevada*, December 1994.
4. L. R. Nelson Consulting Engineers, Inc., *Hydrology Study for Westcliff & Durango City of Las Vegas, Nevada*, August 1994.
5. Kennedy/Jenks Consultants, *Pre-Design Report Vegas Drive Street Improvements*, December 1996.
6. 1997 *City of Las Vegas City-Wide Hydrology Study*, PBS&J, Inc.
7. PBS&J, Inc., G. C. Wallace, Inc., and Louis Berger and Associates, *Clark County Regional Flood Control District, the 2002 Master Plan Update of the Las Vegas Valley*. October 2002.
8. CCRFCD, *Hydrologic Criteria and Drainage Design Manual*, 1990.
9. U.S. Army Corps of Engineers, *HEC-1 Flood Hydrograph Package*, revised June 1998, Version 4.1.
10. U.S.D.A. Soil Conservation Service, *Soil Survey of Las Vegas Valley Area, Nevada, Part of Clark County*, July 1985.

APPENDIX A

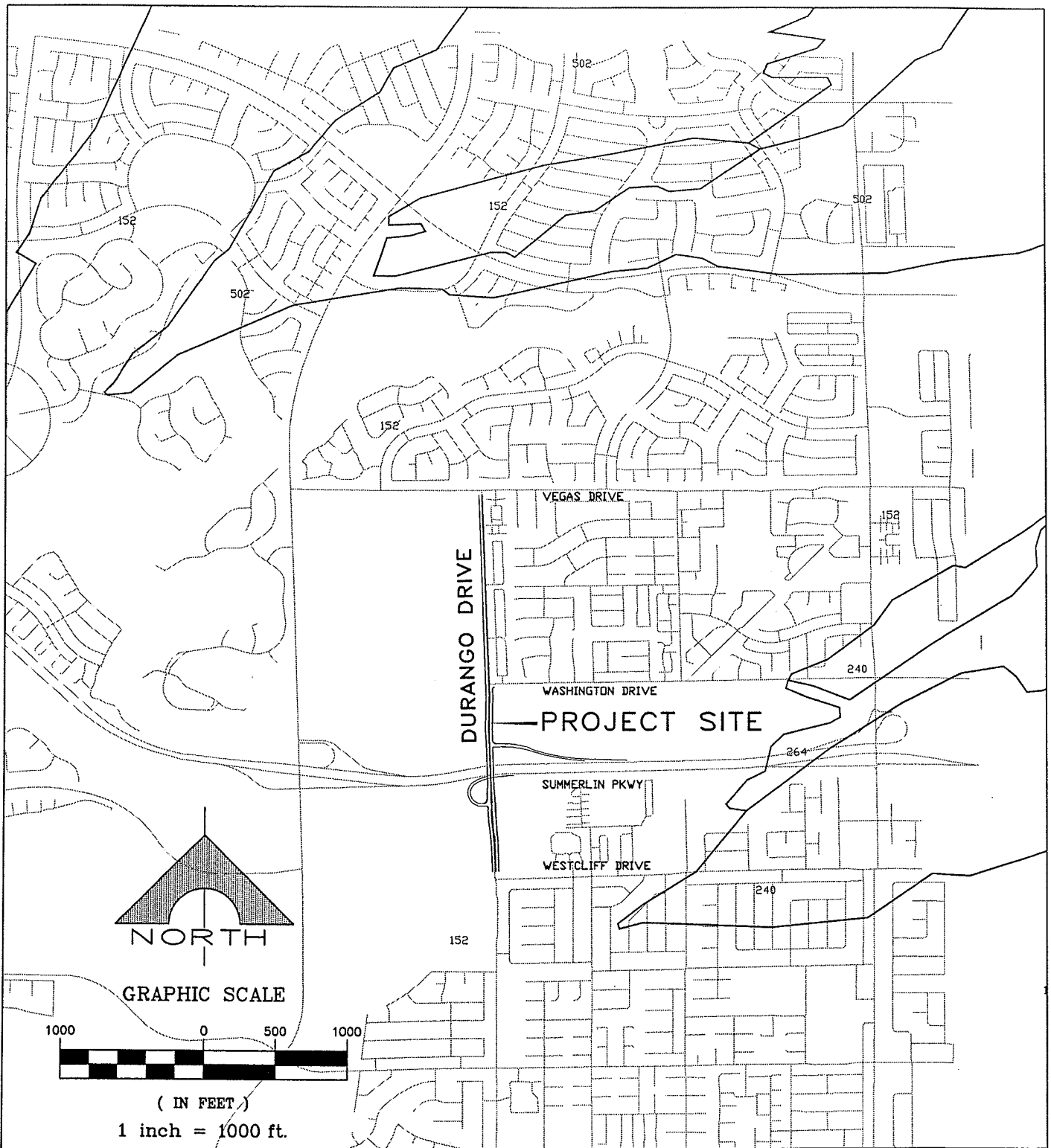
Rainfall and Soils Data

Standard Form 4

Existing Condition HEC-1

Interim Condition HEC-1

Ultimate Condition HEC-1



LEGEND

~ SOILS BOUNDARY

152 SOILS NUMBER

DURANGO DRIVE
WESTCLIFF DRIVE TO VEGAS DRIVE

SOILS MAP
EXHIBIT



G.C. WALLACE, INC.
Engineers/Planners/Surveyors

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DEPTH-DURATION-FREQUENCY VALUES FOR McCARRAN AIRPORT RAINFALL AREA (IN INCHES)

TIME	RECURRENCE INTERVAL					
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5 min.	0.15	0.27	0.35	0.46	0.54	0.63
10 min.	0.25	0.44	0.57	0.74	0.89	1.02
15 min.	0.33	0.57	0.74	0.97	1.15	1.32
30 min.	0.44	0.78	1.01	1.31	1.55	1.79
1 hour	0.52	0.89	1.15	1.50	1.78	2.06
2 hour	0.59	1.01	1.30	1.70	2.01	2.30
3 hour	0.64	1.08	1.39	1.82	2.15	2.48
6 hour	0.72	1.22	<u>1.58</u>	2.05	2.41	<u>2.77</u>
24 hour (TR-55)	1.20	1.60	1.80	2.40	2.70	2.96

- NOTE: 1. Refer to Figure 513 for a description and drawing of the area included in the McCarran Airport Rainfall Area.
2. The 24 hour values presented above are for use with TR-55 only.
3. Table 501 adjustments not required.

Revision	Date

WRC
ENGINEERING

REFERENCE:

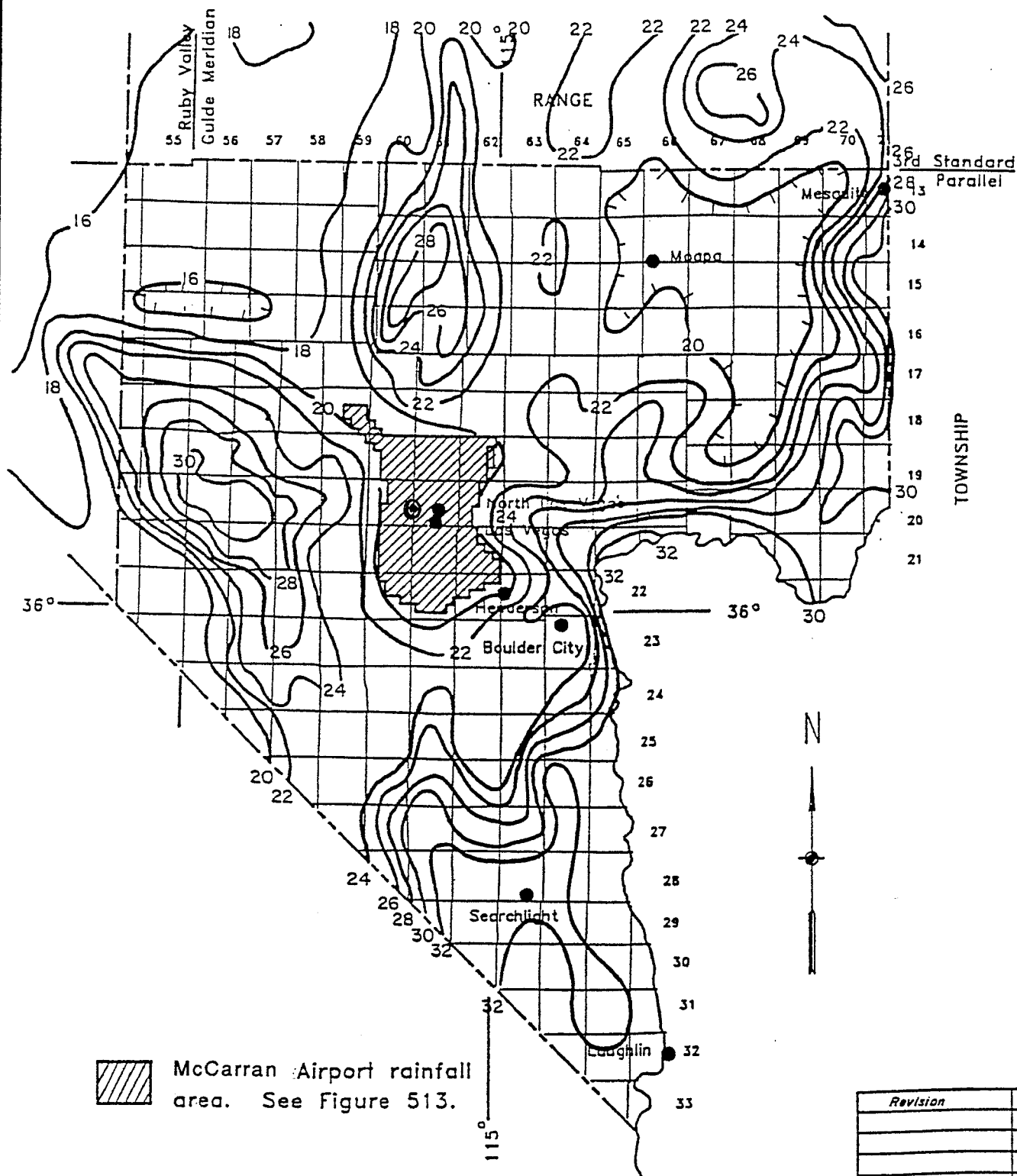
USACE, Los Angeles District, 1988

TABLE 505

RAINFALL DEPTH-DURATION-FREQUENCY

100-YEAR, 6-HOUR

(DEPTHS IN TENTHS OF INCHES)



HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

RUNOFF CURVE NUMBERS (URBAN AREAS¹)

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area ²	A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³ :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%).....		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved: curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved: open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴ ...		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					

See Table 602A

Developing urban areas

Newly graded areas (pervious areas only, no vegetation) ⁵	77	86	91	94
--	----	----	----	----

- 1 Average runoff condition, and $I_p = 0.2S$.
- 2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system. Impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 603.
- 3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
- 4 Composite CN's for natural desert landscaping should be computed using Figure 603 based on the impervious area percentage (CN #98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
- 5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 603 based on the degree of development impervious area percentage) and the CN's for the newly graded pervious areas.

Revision	Date

WRC
ENGINEERING

REFERENCE:
SCS TR-55, USDA, June 1986.

TABLE 602
1 of 4

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TIME OF CONCENTRATION

G.C.Wallace Inc.										BY: KL									
File: durango-exis.xls										Durango Road - Westcliff Drive to Vegas Drive									
Project No.: 412-416										Existing/Interim Conditions									
SUBBASIN DATA										TRAVEL TIME (Tt)									
Subbasin Name (1)	DEV/JEX. (D or E)	Soil Type	CN	K	Area (a.c.) (3)	Area miz (4)	INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)			Tc CHECK			Tc	Tlag	REMARKS	
							Initial Length (ft) (4)	Slope % (5)	Ti min (6)	Travel Length (ft) (7)	Slope % (8)	V1 Velocity fps (9a)	V2 Velocity fps (9b)	Tt min (10)	Total Length ft (11)	Tc= (L/180+10) min (12)	Tc Calc. (13)	Tag= 0.6Tc/60 hours	Rainfall Inches 100-year
EX1	D	D	94	0.8508	29.23	0.04567	258	7.80	3.6	1414	1.00	2.02	3.06	9.1	1672	19.3	12.7	0.127	2.77/1.58
EX2	D	D	98	0.9036	2.84	0.00444	50	2.00	2.0	2283	1.50	2.47	3.75	11.3	2333	23.0	13.3	0.133	2.77/1.58
EX3	D	D	95	0.8640	11.99	0.01873	242	8.30	3.3	471	0.85	1.86	2.82	4.2	713	14.0	7.5	0.075	2.77/1.58
EX4	D	D	95	0.8640	2.58	0.00403	48	2.00	2.3	405	2.20	3.00	4.54	2.3	453	12.5	4.6	0.050	2.77/1.58
EX5	D	D	95	0.8640	9.33	0.01458	276	3.60	4.6	1263	0.24	0.99	1.50	16.9	1539	18.6	21.5	0.186	2.77/1.58
INT2	D	D	94	0.8508	28.73	0.04489	258	7.80	3.6	1414	1.00	2.02	3.06	9.1	1672	19.3	12.7	0.127	2.77/1.58
INT4	D	D	94	0.8508	6.77	0.01058	242	8.30	3.4	471	0.85	1.86	2.82	4.2	713	14.0	7.7	0.077	2.77/1.58
Tc = Ti + Tt										Existing V1 = 14.8*(S/100)^1/2									
Ti = 1.8 (1.1 - K) L^1/2/S^1/3										Developed V1 = 20.2*(S/100)^1/2									
K = 0.0132 (CN) - 0.39										Developed V2 = 30.6*(S/100)^1/2									
REFERENCE:										STANDARD FORM 4									

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TIME OF CONCENTRATION

G.C.Wallace Inc.
 File: durango-ULT.xls
 Project No.: 412-416

Durango Road - Westcliff Drive to Vegas Drive
 Ultimate Conditions

BY: RJR

Subbasin Name (1)	DEV/EX. (D or E)	Soil Type	CN	K	Area (a.c.) (3)	Area mi ²	INITIAL / OVERLAND TIME (11)			TRAVEL TIME (11)				Tc CHECK URBANIZED BASINS			Tc	Tag	REMARKS
							Initial Length (ft) (4)	Slope % (5)	Ti min (6)	Travel Length (ft) (7)	Slope % (8)	V1 Velocity fps (9a)	V2 Velocity fps (9b)	Tt min (10)	Total Length ft (11)	Tc= (L/180+10) min (12)			
ULT1	D	D	98	0.9036	5.03	0.00786	36	2.00	1.7	2360	1.42	2.41	3.64	12.0	2396	23.3	13.7	0.137	2.77/1.58
ULT2	D	D	87	0.7584	28.73	0.04489	255	8.24	4.9	2360	1.18	2.19	3.32	13.1	2615	24.5	18.0	0.180	2.77/1.58
ULT3	D	D	98	0.9036	3.05	0.00477	36	2.00	1.7	1241	2.63	3.28	4.96	5.0	1277	17.1	6.7	0.067	2.77/1.58
ULT4	D	D	87	0.7584	6.77	0.01058	228	8.30	4.6	1241	2.63	3.28	4.96	5.0	1469	18.2	9.6	0.096	2.77/1.58
ULT5	D	D	96	0.8772	3.56	0.00556	36	2.00	1.9	1100	3.03	3.52	5.33	4.2	1136	16.3	6.2	0.062	2.77/1.58
ULT6	D	D	98	0.9036	3.13	0.00489	36	2.00	1.7	1420	1.59	2.55	3.86	7.2	1456	18.1	8.9	0.089	2.77/1.58
ULT7	D	D	94	0.8508	4.51	0.00705	325	4.00	5.1	1020	1.00	2.02	3.06	7.0	1345	17.5	12.1	0.121	2.77/1.58
ULT8	D	D	96	0.8772	7.67	0.01198	30	2.00	1.7	2480	1.59	2.55	3.86	11.8	2510	23.9	13.6	0.136	2.77/1.58

Tc = Ti + Tt
 Ti = 1.8 (1.1 - K) L^{1/2}/S^{1/3}
 K = 0.0132 (CN) - 0.39

For the travel time (Tt) calculations,
 V1 applies to the first 500 feet of travel distance;
 V2 applies to the remaining travel distance.

Existing V1 = 14.8*(S/100)^{1/2}
 Existing V2 = 29.4*(S/100)^{1/2}

Developed V1 = 20.2*(S/100)^{1/2}
 Developed V2 = 30.6*(S/100)^{1/2}

REFERENCE:

STANDARD FORM 4


```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 19MAR03 TIME 15:33:17
*
*****

```

```

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

```

```

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

```

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

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

1 HEC-1 INPUT PAGE 1

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

```

*DIAGRAM
1 ID *****
2 ID * ..... *
3 ID * : DURANGO DRIVE : *
4 ID * : WESTCLIFF DRIVE TO VEGAS DRIVE : *
5 ID * : EXISTING CONDITIONS : *
6 ID * : : *
7 ID * : ..... : *
8 ID * : RETURN PERIOD _ _ _ 100-YEAR/10-YEAR : *
9 ID * : DISTRIBUTION _ _ _ 6-HOUR SDN3 : *
10 ID * : : *
11 ID * : FILENAME _ _ _ _ 416-EX.H1 : *
12 ID * : DATE MODELED _ _ _ 03/19/03 : *
13 ID * : MODELED BY _ _ _ _ KL : *
14 ID * : : *
15 ID * : ..... : *
16 ID *****
17 ID
18 IT 5 0 0 300
19 IO 5
20 IN 5 0 0
21 JR PREC 1 .57
*

22 KK EX1
23 KM EXISTING SUBBASIN 1
24 KM AREA 29.23 AC
25 KM CURVE NO 94
26 KM LAG .127 HR
27 BA .04567
28 PB 2.77
29 PC .000 .020 .057 .070 .087 .108 .124 .130 .130 .130
30 PC .130 .130 .130 .133 .140 .142 .148 .158 .172 .181
31 PC .190 .197 .199 .200 .201 .204 .214 .229 .241 .249
32 PC .251 .256 .270 .278 .281 .283 .295 .322 .352 .409
33 PC .499 .590 .710 .744 .781 .812 .819 .835 .851 .856
34 PC .860 .868 .876 .888 .910 .926 .937 .950 .970 .976
35 PC .982 .985 .987 .989 .990 .993 .993 .994 .995 .998
36 PC .998 .999 1.00
37 LS 0 94
38 UD .127

```

```

*
39      KK      EX2
40      KM      EXISTING DURANGO DRIVE FROM WASHINGTON TO VEGAS
41      KM      AREA      2.84  AC
42      KM      CURVE NO    98
43      KM      LAG      .133  HR
44      BA      .00444
45      PB      2.77
46      LS      0        98
47      UD      .133
*

```

1

HEC-1 INPUT

PAGE 2

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

```

48      KK      PT1
49      KM      COMBINE EX1 & EX2 AT WASHINGTON AND VEGAS
50      HC      2
*

```

```

51      KK      EX3
52      KM      EXISTING SUBBASIN 3
53      KM      AREA      11.99 AC
54      KM      CURVE NO    95
55      KM      LAG      .075  HR
56      BA      .01873
57      PB      2.77
58      LS      0        95
59      UD      .075
*

```

```

60      KK      EX4
61      KM      EXISTING SUBBASIN 4 - SUMMERLIN PARKWAY
62      KM      AREA      2.58  AC
63      KM      CURVE NO    95
64      KM      LAG      .050  HR
65      BA      .00403
66      PB      2.77
67      LS      0        95
68      UD      .050
*

```

```

69      KK      EX4
70      KM      EXISTING SUBBASIN 4
71      KM      AREA      9.33  AC
72      KM      CURVE NO    95
73      KM      LAG      .186  HR
74      BA      .01458
75      PB      2.77
76      LS      0        95
77      UD      .186
*
78      ZZ

```

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

```

INPUT
LINE  (V) ROUTING      (--->) DIVERSION OR PUMP FLOW

NO.   (.) CONNECTOR    (<---) RETURN OF DIVERTED OR PUMPED FLOW

22      EX1
.
.
39      .      EX2
.
.
48      PT1.....
.
.
51      .      EX3
.
.
60      .      .      EX4
.
.
69      .      .      .      EX4

```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 19MAR03 TIME 15:33:17
*
*****
```

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

```
*****
* .....
* : DURANGO DRIVE :
* : WESTCLIFF DRIVE TO VEGAS DRIVE :
* : EXISTING CONDITIONS :
* : :
* : .....
* : RETURN PERIOD _ _ _ 100-YEAR/10-YEAR :
* : DISTRIBUTION _ _ _ 6-HOUR SDN3 :
* : :
* : FILENAME _ _ _ _ 416-EX.H1 :
* : DATE MODELED _ _ _ 03/19/03 :
* : MODELED BY _ _ _ _ KL :
* : :
* : .....
*****
```

```
19 IO OUTPUT CONTROL VARIABLES
      IPRNT      5 PRINT CONTROL
      IPLOT      0 PLOT CONTROL
      QSCAL      0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
      NMIN      5 MINUTES IN COMPUTATION INTERVAL
      IDATE      1 0 STARTING DATE
      ITIME      0000 STARTING TIME
      NQ        300 NUMBER OF HYDROGRAPH ORDINATES
      NDDATE      2 0 ENDING DATE
      NDTIME      0055 ENDING TIME
      ICENT      19 CENTURY MARK
```

```
COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 24.92 HOURS
```

ENGLISH UNITS

```
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT
```

```
JP MULTI-PLAN OPTION
      NPLAN      1 NUMBER OF PLANS
```

```
JR MULTI-RATIO OPTION
      RATIOS OF PRECIPITATION
      1.00 .57
```

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION	
				RATIO 1	RATIO 2
				1.00	.57
HYDROGRAPH AT					
+	EX1	.05	1 FLOW	78.	39.
			TIME	3.58	3.58

HYDROGRAPH AT						
+	EX2	.00	1	FLOW	8.	5.
				TIME	3.58	3.58

2 COMBINED AT						
+	PT1	.05	1	FLOW	86.	44.
				TIME	3.58	3.58

HYDROGRAPH AT						
+	EX3	.02	1	FLOW	38.	20.
				TIME	3.50	3.50

HYDROGRAPH AT						
+	EX4	.00	1	FLOW	9.	5.
				TIME	3.50	3.50

HYDROGRAPH AT						
+	EX4	.01	1	FLOW	23.	12.
				TIME	3.58	3.58

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

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 28APR03 TIME 14:03:37
*
*****

```

```

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

```

```

X X XXXXXX XXXX X
X X X X X XX
X X X X X X
XXXXXXX XXXX X XXXXX X
X X X X X X
X X X X X X
X X XXXXXX XXXX XXX

```

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

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

1

HEC-1 INPUT

PAGE 1

```

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*DIAGRAM
1 ID *****
2 ID *
3 ID * DURANGO DRIVE
4 ID * WESTCLIFF DRIVE TO VEGAS DRIVE
5 ID * INTERIM CONDITION
6 ID *
7 ID *
8 ID *
9 ID * RETURN PERIOD 100-YEAR/10-YEAR
10 ID * DISTRIBUTION 6-HOUR SDN3
11 ID *
12 ID * FILENAME 416-ULT.H1
13 ID * DATE MODELED 04/25/03
14 ID * MODELED BY RJR
15 ID *
16 ID *****
17 ID
18 IT 5 0 0 300
19 IO 5
20 IN 5 0 0
21 JR PREC 1 .57
*
22 KK ULT1
23 BA .00786
24 PB 2.77
25 PC .000 .020 .057 .070 .087 .108 .124 .130 .130 .130
26 PC .130 .130 .130 .133 .140 .142 .148 .158 .172 .181
27 PC .190 .197 .199 .200 .201 .204 .214 .229 .241 .249
28 PC .251 .256 .270 .278 .281 .283 .295 .322 .352 .409
29 PC .499 .590 .710 .744 .781 .812 .819 .835 .851 .856
30 PC .860 .868 .876 .888 .910 .926 .937 .950 .970 .976
31 PC .982 .985 .987 .989 .990 .993 .993 .994 .995 .998
32 PC .998 .999 1.00
33 LS 0 98
34 UD 0.137
*
35 KK INT2
36 BA .04489
37 LS 0 94
38 UD 0.127
*
39 KK PT1
40 KM COMBINE SUBBASINS ULT1 AND ULT2
41 HC 2
*

```

1

HEC-1 INPUT

PAGE 2

```

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
42 KK ULT3
43 BA .00477
44 LS 0 98
45 UD .067
*
46 KK INT4
47 BA .01058
48 LS 0 94
49 UD .077
*
50 KK PT2
51 KM COMBINE SUBBASINS ULT3 AND ULT4
52 HC 2
*
53 KK ULT5

```

54	BA	.00556	
55	LS	0	96
56	UD	.062	
	*		
57	KK	ULT6	
58	BA	.00489	
59	LS	0	98
60	UD	.089	
	*		
61	KK	ULT7	
62	BA	.00705	
63	LS	0	94
64	UD	.121	
	*		
65	KK	PT3	
66	KM	COMBINE SUBBASINS ULT6 AND ULT7	
67	HC	2	
	*		
68	KK	ULT8	
69	BA	.01198	
70	LS	0	96
71	UD	.136	
	*		
72	ZZ		

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE	(V) ROUTING	(--->) DIVERSION OR PUMP FLOW
NO.	(.) CONNECTOR	(<---) RETURN OF DIVERTED OR PUMPED FLOW
22	ULT1	
	.	
35	.	INT2
	.	
39	PT1.....	
	.	
42	.	ULT3
	.	
46	.	INT4
	.	
50	.	PT2.....
	.	
53	.	ULT5
	.	
57	.	ULT6
	.	
61	.	ULT7
	.	
65	.	PT3.....
	.	
68	.	ULT8

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```

*****
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* JUN 1998 *
* VERSION 4.1 *
* RUN DATE 28APR03 TIME 14:03:37 *
*****

```

```

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

```

```

*****
* : DURANGO DRIVE : *
* : WESTCLIFF DRIVE TO VEGAS DRIVE : *
* : INTERIM CONDITION : *
* : : *
* : : *
* : RETURN PERIOD -- 100-YEAR/10-YEAR : *
* : DISTRIBUTION -- 6-HOUR SDN3 : *
* : : *
* : FILENAME -- 416-ULT.H1 : *
* : DATE MODELED -- 04/25/03 : *
* : MODELED BY -- RJR : *
* : : *
*****

```

19 IO

OUTPUT CONTROL VARIABLES

IPRNT	5	PRINT CONTROL
IPLST	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT

HYDROGRAPH TIME DATA

NMIN	5	MINUTES IN COMPUTATION INTERVAL
IDATE	1	STARTING DATE
ITIME	0000	STARTING TIME
NQ	300	NUMBER OF HYDROGRAPH ORDINATES

NDDATE 2 0 ENDING DATE
 NDTIME 0055 ENDING TIME
 ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
 TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES
 LENGTH, ELEVATION FEET
 FLOW CUBIC FEET PER SECOND
 STORAGE VOLUME ACRE-Feet
 SURFACE AREA ACRES
 TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
 NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
 RATIOS OF PRECIPITATION
 1.00 .57

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
 TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION	
				RATIO 1	RATIO 2
				1.00	.57
HYDROGRAPH AT					
+	ULT1	.01	1 FLOW	15.	8.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	INT2	.04	1 FLOW	77.	38.
			TIME	3.58	3.58
2 COMBINED AT					
+	PT1	.05	1 FLOW	91.	46.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	ULT3	.00	1 FLOW	10.	6.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	INT4	.01	1 FLOW	21.	10.
			TIME	3.50	3.50
2 COMBINED AT					
+	PT2	.02	1 FLOW	31.	16.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT5	.01	1 FLOW	12.	6.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT6	.00	1 FLOW	10.	6.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT7	.01	1 FLOW	12.	6.
			TIME	3.58	3.58
2 COMBINED AT					
+	PT3	.01	1 FLOW	22.	11.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT8	.01	1 FLOW	21.	11.
			TIME	3.58	3.58

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

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 28APR03 TIME 13:01:02
*
*****

```

```

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

```

```

X X XXXXXXX XXXXX X
X X X X X XX
X X X X X
XXXXXXXX XXXX X XXXXX X
X X X X X
X X X X X
X X XXXXXXX XXXXX XXX

```

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

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

1

HEC-1 INPUT

PAGE 1

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

```

*DIAGRAM
1 ID *****
2 ID *
3 ID * DURANGO DRIVE
4 ID * WESTCLIFF DRIVE TO VEGAS DRIVE
5 ID * ULTIMATE CONDITION
6 ID *
7 ID *
8 ID * RETURN PERIOD 100-YEAR/10-YEAR
9 ID * DISTRIBUTION 6-HOUR SDN3
10 ID *
11 ID * FILENAME 416-ULT.H1
12 ID * DATE MODELED 04/25/03
13 ID * MODELED BY RJR
14 ID *
15 ID *
16 ID *****
17 ID
18 IT 5 0 0 300
19 IO 5
20 IN 5 0 0
21 JR PREC 1 .57
*
22 KK ULT1
23 BA .00786
24 PB 2.77
25 PC .000 .020 .057 .070 .087 .108 .124 .130 .130 .130
26 PC .130 .130 .130 .133 .140 .142 .148 .158 .172 .181
27 PC .190 .197 .199 .200 .201 .204 .214 .229 .241 .249
28 PC .251 .256 .270 .278 .281 .283 .295 .322 .352 .409
29 PC .499 .590 .710 .744 .781 .812 .819 .835 .851 .856
30 PC .860 .868 .876 .888 .910 .926 .937 .950 .970 .976
31 PC .982 .985 .987 .989 .990 .993 .993 .994 .995 .998
32 PC .998 .999 1.00
33 LS 0 98
34 UD 0.137
*
35 KK ULT2
36 BA .04489
37 LS 0 87
38 UD .180
*
39 KK PT1
40 KM COMBINE SUBBASINS ULT1 AND ULT2
41 HC 2
*

```

1

HEC-1 INPUT

PAGE 2

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

```

42 KK ULT3
43 BA .00477
44 LS 0 98
45 UD .067
*
46 KK ULT4
47 BA .01058
48 LS 0 87
49 UD .096
*
50 KK PT2
51 KM COMBINE SUBBASINS ULT3 AND ULT4
52 HC 2
*
53 KK ULT5

```


54	BA	.00556	
55	LS	0	96
56	UD	.062	
	*		
57	KK	ULT6	
58	BA	.00489	
59	LS	0	98
60	UD	.089	
	*		
61	KK	ULT7	
62	BA	.00705	
63	LS	0	94
64	UD	.121	
	*		
65	KK	PT3	
66	KM	COMBINE SUBBASINS ULT6 AND ULT7	
67	HC	2	
	*		
68	KK	ULT8	
69	BA	.01198	
70	LS	0	96
71	UD	.136	
	*		
72	ZZ		

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE	(V) ROUTING	(-->) DIVERSION OR PUMP FLOW
NO.	(.) CONNECTOR	(<-->) RETURN OF DIVERTED OR PUMPED FLOW
22	ULT1	
	.	
35	ULT2	
	.	
39	PT1.....	
	.	
42	ULT3	
	.	
46	.	ULT4
	.	
50	PT2.....	
	.	
53	.	ULT5
	.	
57	.	ULT6
	.	
61	.	ULT7
	.	
65	.	PT3.....
	.	
68	.	ULT8
	.	

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```

*****
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*   JUN 1998                      *
*   VERSION 4.1                    *
* RUN DATE 28APR03 TIME 13:01:02 *
*****
  
```

```

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

```

*****
* : DURANGO DRIVE                *
* : WESTCLIFF DRIVE TO VEGAS DRIVE *
* : ULTIMATE CONDITION            *
* :                               *
* : RETURN PERIOD 100-YEAR/10-YEAR *
* : DISTRIBUTION 6-HOUR SDN3      *
* :                               *
* : FILENAME 416-ULT.H1           *
* : DATE MODELED 04/25/03         *
* : MODELED BY RJR                *
* :                               *
*****
  
```

19 IO

OUTPUT CONTROL VARIABLES

IPRNT	5	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT

HYDROGRAPH TIME DATA

NMIN	5	MINUTES IN COMPUTATION INTERVAL
IDATE	1	STARTING DATE
ITIME	0000	STARTING TIME
NQ	300	NUMBER OF HYDROGRAPH ORDINATES

NDDATE 2 0 ENDING DATE
 NDTIME 0055 ENDING TIME
 ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
 TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS
 DRAINAGE AREA SQUARE MILES
 PRECIPITATION DEPTH INCHES
 LENGTH, ELEVATION FEET
 FLOW CUBIC FEET PER SECOND
 STORAGE VOLUME ACRE-FEET
 SURFACE AREA ACRES
 TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
 NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
 RATIOS OF PRECIPITATION
 1.00 .57

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
 TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION	
				RATIO 1	RATIO 2
				1.00	.57
HYDROGRAPH AT					
+	ULT1	.01	1 FLOW	15.	8.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	ULT2	.04	1 FLOW	55.	21.
			TIME	3.58	3.58
2 COMBINED AT					
+	PT1	.05	1 FLOW	69.	29.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	ULT3	.00	1 FLOW	10.	6.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT4	.01	1 FLOW	15.	6.
			TIME	3.50	3.50
2 COMBINED AT					
+	PT2	.02	1 FLOW	26.	12.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT5	.01	1 FLOW	12.	6.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT6	.00	1 FLOW	10.	6.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT7	.01	1 FLOW	12.	6.
			TIME	3.58	3.58
2 COMBINED AT					
+	PT3	.01	1 FLOW	22.	11.
			TIME	3.50	3.50
HYDROGRAPH AT					
+	ULT8	.01	1 FLOW	21.	11.
			TIME	3.58	3.58

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

APPENDIX B

Hydraulics

Street Flow Calculations

Drop Inlet Calculations

Normal Depth Calculations For Storm Drain

SECT A WEST (100-YEAR)

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTA-WEST(100
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.015000 ft/ft
Discharge	84.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.86 ft
Elevation Range	0.00 to 1.39
Flow Area	14.9 ft ²
Wetted Perimeter	42.3446 ft
Top Width	41.5304 ft
Actual Depth	0.86 ft
Critical Elevation	1.01 ft
Critical Slope	0.004886 ft/ft
Velocity	5.66 ft/s
Velocity Head	0.50 ft
Specific Energy	1.36 ft
Froude Number	1.67
Flow Type	Supercritical

Calculation Messages:
Water elevation exceeds lowest end station by 0.26060854 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700

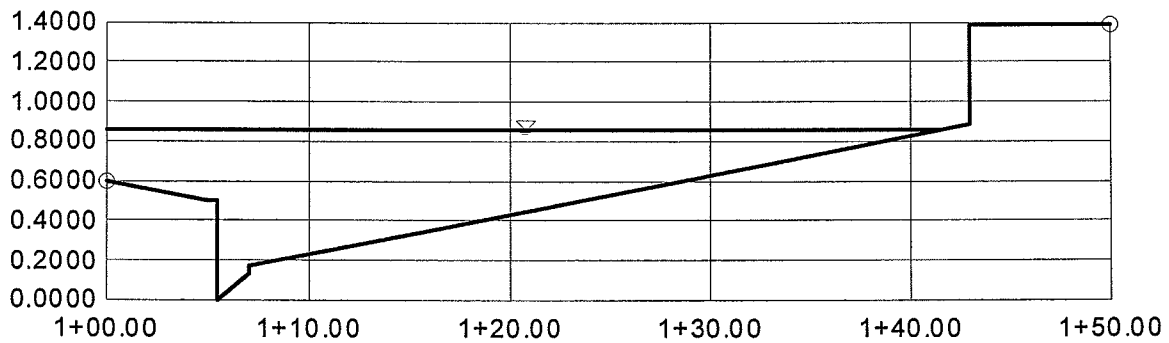
SECT A WEST (100-YEAR)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

Cross Section

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTA-WEST(100
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth
Section Data	
Mannings Coefficient	0.016
Slope	0.015000 ft/ft
Water Surface Elevation	0.86 ft
Elevation Range	0.00 to 1.39
Discharge	84.00 cfs



V:10.0
H:1
NTS

SECT A-EAST (100-YEAR)

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTA-EAST(100)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.015000 ft/ft
Discharge	7.50 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.44 ft
Elevation Range	0.00 to 1.39
Flow Area	2.3 ft ²
Wetted Perimeter	15.2536 ft
Top Width	14.7699 ft
Actual Depth	0.44 ft
Critical Elevation	0.49 ft
Critical Slope	0.006876 ft/ft
Velocity	3.24 ft/s
Velocity Head	0.16 ft
Specific Energy	0.60 ft
Froude Number	1.44
Flow Type	Supercritical

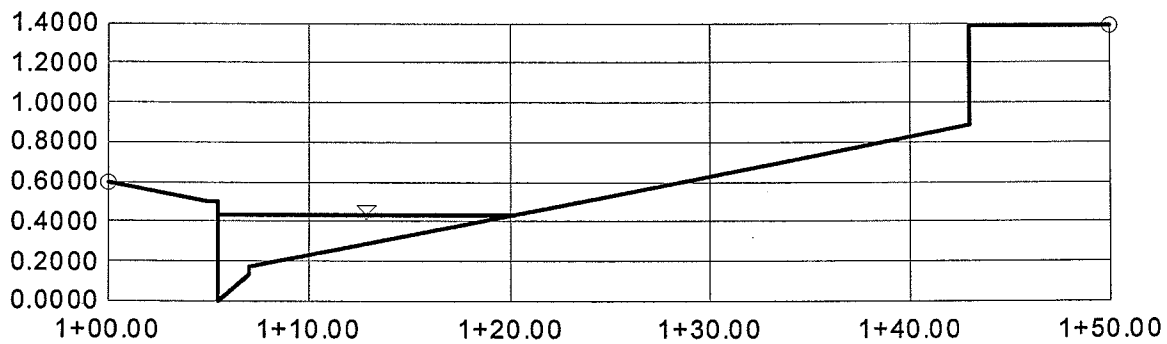
Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

SECT A-EAST (100-YEAR) **Cross Section for Irregular Channel**

Project Description	
Worksheet	SECTA-EAST(100)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.015000 ft/ft
Water Surface Elevation	0.44 ft
Elevation Range	0.00 to 1.39
Discharge	7.50 cfs



V:10.0
H:1
NTS

SECT B (100-YEAR) (3/4 OF SUBBASIN ULT3) **Worksheet for Irregular Channel**

Project Description	
Worksheet	SECTB(100)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.004000 ft/ft
Discharge	8.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.44 ft
Elevation Range	0.00 to 1.39
Flow Area	4.7 ft ²
Wetted Perimeter	30.9016 ft
Top Width	29.9264 ft
Actual Depth	0.44 ft
Critical Elevation	0.40 ft
Critical Slope	0.007479 ft/ft
Velocity	1.68 ft/s
Velocity Head	0.04 ft
Specific Energy	0.48 ft
Froude Number	0.75
Flow Type	Subcritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	2+00.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700

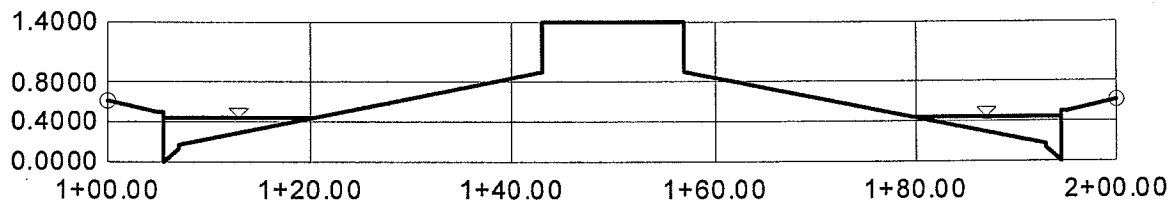
SECT B (100-YEAR) (3/4 OF SUBBASIN ULT3)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900
1+57.00	1.3900
1+57.00	0.8900
1+93.00	0.1700
1+93.00	0.1300
1+94.50	0.0000
1+94.50	0.5000
1+95.00	0.5000
2+00.00	0.6000

SECT B (100-YEAR)
Cross Section for Irregular Channel

Project Description	
Worksheet	SECTB(100)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.004000 ft/ft
Water Surface Elevation	0.44 ft
Elevation Range	0.00 to 1.39
Discharge	8.00 cfs



V:10.0
H:1
NTS

SECT C - WEST (100-YEAR) SUBBASIN ULT7 PLUS 1/2 ULT6 **Worksheet for Irregular Channel**

Project Description	
Worksheet	SECTC-WEST(100
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.004000 ft/ft
Discharge	17.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.66 ft
Elevation Range	0.00 to 1.39
Flow Area	7.6 ft ²
Wetted Perimeter	32.2138 ft
Top Width	31.6003 ft
Actual Depth	0.66 ft
Critical Elevation	0.62 ft
Critical Slope	0.006372 ft/ft
Velocity	2.24 ft/s
Velocity Head	0.08 ft
Specific Energy	0.74 ft
Froude Number	0.81
Flow Type	Subcritical

Calculation Messages:
Water elevation exceeds lowest end station by 0.62005228e-1 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700

SECT C - WEST (100-YEAR) SUBBASIN ULT7 PLUS 1/2 ULT6
Worksheet for Irregular Channel

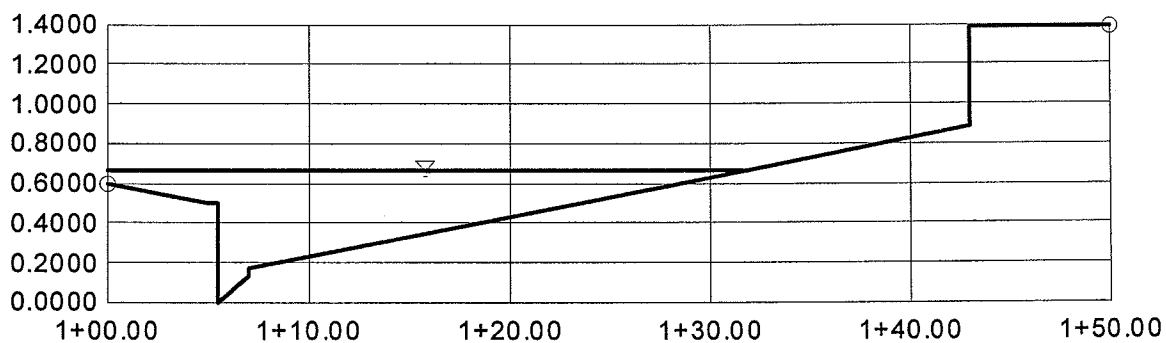
Natural Channel Points	
Station (ft)	Elevation (ft)
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

CROSS SECTION C WEST (100-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTC-WEST(100
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.004000 ft/ft
Water Surface Elevation	0.66 ft
Elevation Range	0.00 to 1.39
Discharge	17.00 cfs



V:10.0
H:1
NTS

SECT D **Worksheet for Irregular Channel**

100-year

Project Description	
Worksheet	SECTD
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.034000 ft/ft
Discharge	2.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.23 ft
Elevation Range	0.00 to 1.39
Flow Area	0.7 ft ²
Wetted Perimeter	9.6352 ft
Top Width	9.0811 ft
Actual Depth	0.23 ft
Critical Elevation	0.28 ft
Critical Slope	0.008931 ft/ft
Velocity	2.93 ft/s
Velocity Head	0.13 ft
Specific Energy	0.36 ft
Froude Number	1.89
Flow Type	Supercritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	2+00.00	0.016

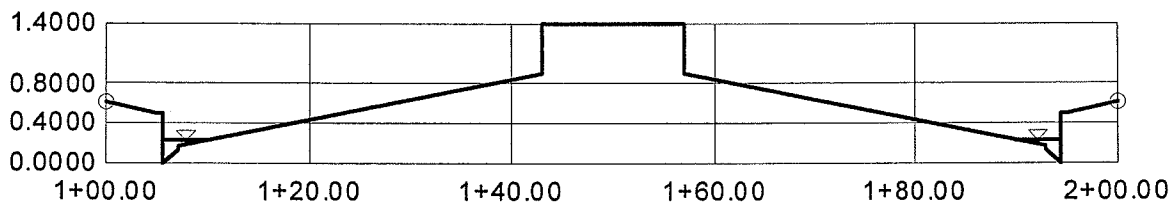
Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700

SECT D
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900
1+57.00	1.3900
1+57.00	0.8900
1+93.00	0.1700
1+93.00	0.1300
1+94.50	0.0000
1+94.50	0.5000
1+95.00	0.5000
2+00.00	0.6000

SECT D **Cross Section for Irregular Channel**

Project Description	
Worksheet	SECTD
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth
Section Data	
Mannings Coefficient	0.016
Slope	0.034000 ft/ft
Water Surface Elevation	0.23 ft
Elevation Range	0.00 to 1.39
Discharge	2.00 cfs



V:10.0
H:1
NTS

SECT A-WEST (10-YEAR)

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTA-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.015000 ft/ft
Discharge	42.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.71 ft
Elevation Range	0.00 to 1.39
Flow Area	9.0 ft ²
Wetted Perimeter	34.4495 ft
Top Width	33.7917 ft
Actual Depth	0.71 ft
Critical Elevation	0.81 ft
Critical Slope	0.005541 ft/ft
Velocity	4.66 ft/s
Velocity Head	0.34 ft
Specific Energy	1.04 ft
Froude Number	1.59
Flow Type	Supercritical

Calculation Messages:
Water elevation exceeds lowest end station by 0.10583432 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

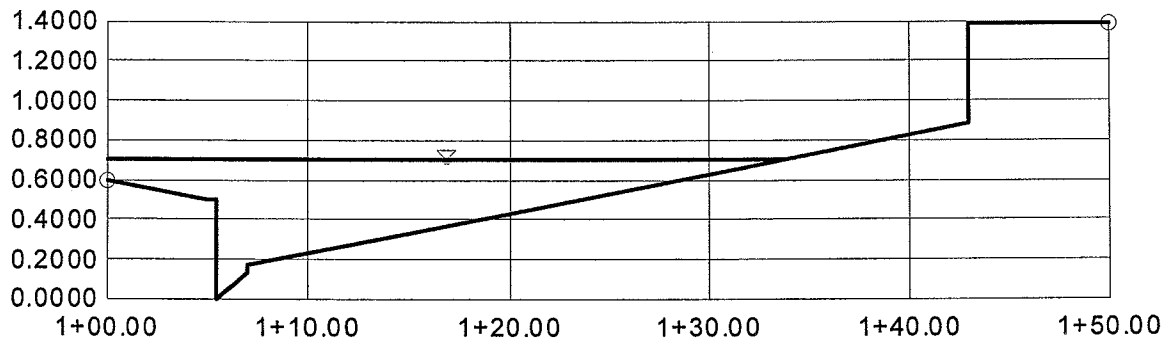
Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700

SECT A-WEST (10-YEAR)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

SECT A-WEST (10-YEAR) **Cross Section for Irregular Channel**

Project Description	
Worksheet	SECTA-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth
Section Data	
Mannings Coefficient	0.016
Slope	0.015000 ft/ft
Water Surface Elevation	0.71 ft
Elevation Range	0.00 to 1.39
Discharge	42.00 cfs



V:10.0
H:1
NTS

SECT B (10 -YEAR) (5/6 OF SUBBASIN ULT3) Worksheet for Irregular Channel

Project Description	
Worksheet	SECTB(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.004000 ft/ft
Discharge	5.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Flow Area	3.3 ft ²
Wetted Perimeter	25.5668 ft
Top Width	24.6973 ft
Actual Depth	0.39 ft
Critical Elevation	0.35 ft
Critical Slope	0.007957 ft/ft
Velocity	1.51 ft/s
Velocity Head	0.04 ft
Specific Energy	0.42 ft
Froude Number	0.72
Flow Type	Subcritical

Calculation Messages:
Flow is divided.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	2+00.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700

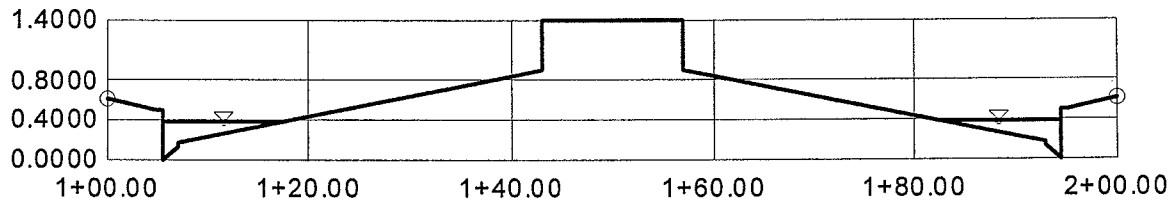
SECT B (100-YEAR) (5/6 OF SUBBASIN ULT3)
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900
1+57.00	1.3900
1+57.00	0.8900
1+93.00	0.1700
1+93.00	0.1300
1+94.50	0.0000
1+94.50	0.5000
1+95.00	0.5000
2+00.00	0.6000

SECT B (10-YEAR)
Cross Section for Irregular Channel

Project Description	
Worksheet	SECTB(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.004000 ft/ft
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Discharge	5.00 cfs



V:10.0
H:1
NTS

SECT C - WEST (10-YEAR) SUBBASIN ULT7 PLUS 1/2 ULT6

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTC-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.004000 ft/ft
Discharge	9.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.56 ft
Elevation Range	0.00 to 1.39
Flow Area	4.7 ft ²
Wetted Perimeter	25.1683 ft
Top Width	24.6181 ft
Actual Depth	0.56 ft
Critical Elevation	0.52 ft
Critical Slope	0.006805 ft/ft
Velocity	1.92 ft/s
Velocity Head	0.06 ft
Specific Energy	0.62 ft
Froude Number	0.77
Flow Type	Subcritical

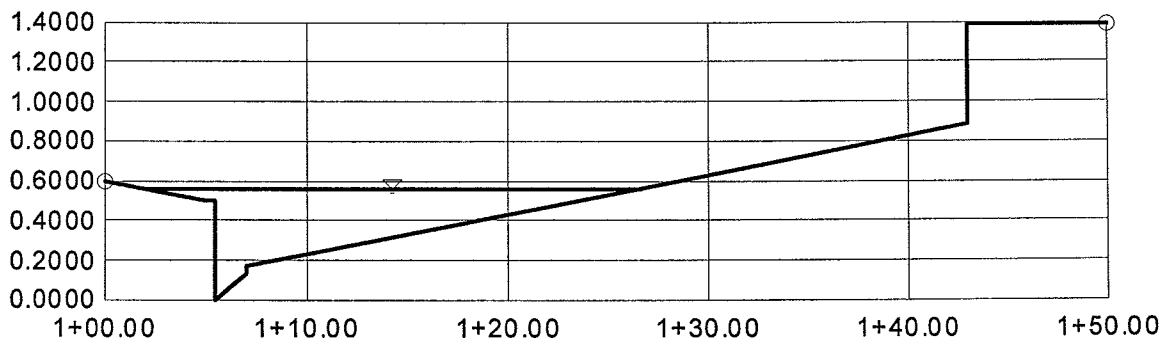
Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

CROSS SECTION C WEST (10-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTC-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth
Section Data	
Mannings Coefficient	0.016
Slope	0.004000 ft/ft
Water Surface Elevation	0.56 ft
Elevation Range	0.00 to 1.39
Discharge	9.00 cfs



V:10.0
H:1
NTS

SECT E - WEST (10-YEAR, 1/2 ULT7)

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTE-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.005000 ft/ft
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Flow Area	1.8 ft ²
Wetted Perimeter	13.1584 ft
Top Width	12.7162 ft
Actual Depth	0.39 ft
Critical Elevation	0.37 ft
Critical Slope	0.007768 ft/ft
Velocity	1.71 ft/s
Velocity Head	0.05 ft
Specific Energy	0.44 ft
Froude Number	0.81
Flow Type	Subcritical

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

Project Engineer: GCW USER
FlowMaster v6.1 [614n]

o:\412-416\drainage\calc\416-strts.fm2

G. C. Wallace Inc

05/02/03 08:10:25 AM © Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708 USA (203) 755-1666

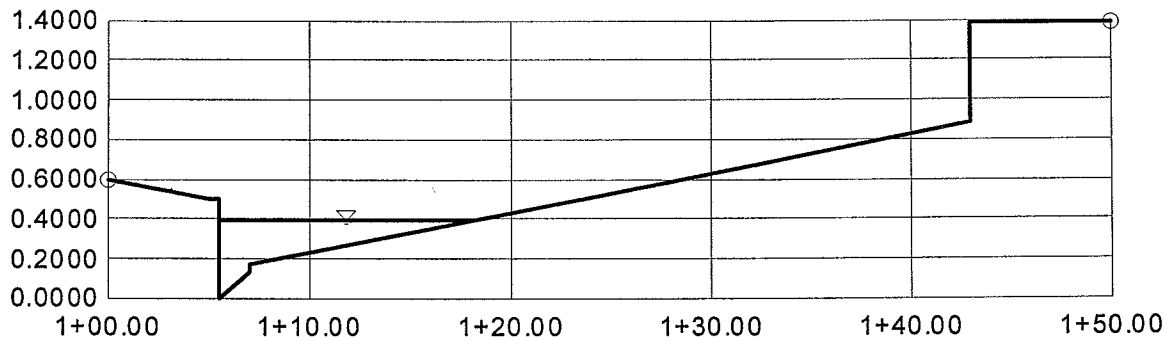
Page 1 of 1

CROSS SECTION E WEST (10-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTE-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.005000 ft/ft
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Discharge	3.00 cfs



V:10.0
H:1
NTS

SECT E - EAST (10-YEAR, 1/2 ULT6)

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTE-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.005000 ft/ft
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Flow Area	1.8 ft ²
Wetted Perimeter	13.1584 ft
Top Width	12.7162 ft
Actual Depth	0.39 ft
Critical Elevation	0.37 ft
Critical Slope	0.007768 ft/ft
Velocity	1.71 ft/s
Velocity Head	0.05 ft
Specific Energy	0.44 ft
Froude Number	0.81
Flow Type	Subcritical

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

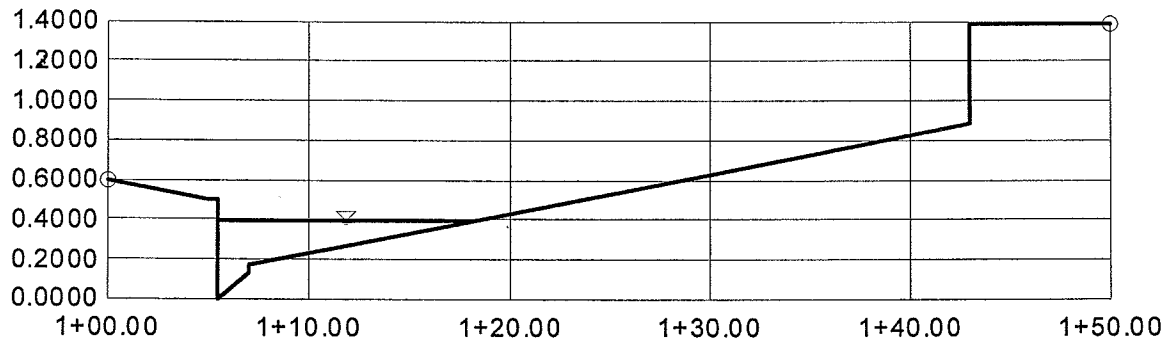
Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

CROSS SECTION E EAST (10-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTE-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.005000 ft/ft
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Discharge	3.00 cfs

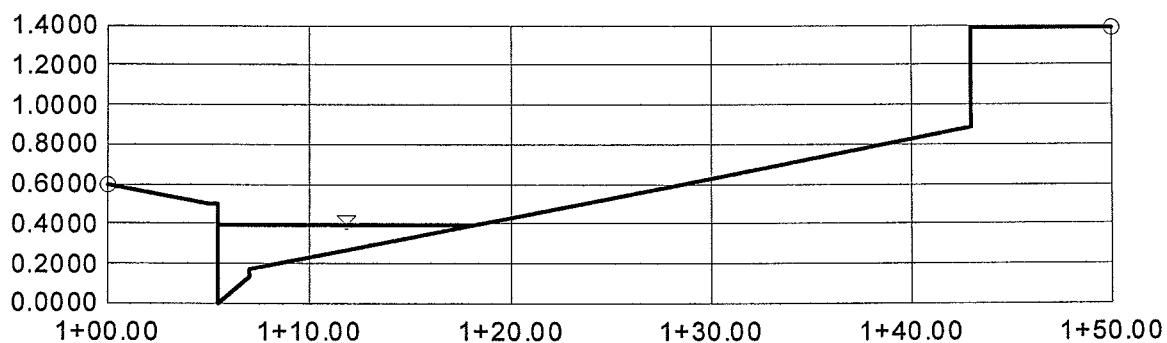


V:10.0
H:1
NTS

CROSS SECTION E EAST (10-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTE-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth
Section Data	
Mannings Coefficient	0.016
Slope	0.005000 ft/ft
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Discharge	3.00 cfs



V:10.0
H:1
NTS

Modified Type C Drop Inlet Sizing on a C. G.

EXISTING 40 FOOT NEENAH D. I. (10-YEAR)

Known:

Q_s =	Half Street flow (cfs)	42.0
S_o =	Longitudinal slope (ft/ft)	0.015
n =	Manning's roughness coef	0.016
V_s =	Flow velocity (fps)	4.7
D =	Flow depth (ft)	0.71
S_x =	Street transverse slope (ft/ft)	0.02
W =	Gutter Width (ft)	1.5
D_s =	Gutter Depression (in)	2.0
L_g =	Length of grate (ft)	39.0
L_c =	Length of curb opening (ft)	40.00
C_{fg} =	Clogging factor for grate (%)	50
C_{fc} =	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

R_f = Frontal flow factor = $1 - 0.09 \cdot (V_s - V_o)$ if $V_s > V_o$; else $R_f = 1$	1.00
V_o = Splash over velocity = $p + q \cdot L_g \cdot r \cdot L_g^2 + s \cdot L_g^3$ (fps)	113.93
E_o = Grate flow ratio = Q_w / Q_s	(0.00)
Q_w = Frontal flow = $Q_s - Q_x$	(0.04)
Q_x = Side flow = $0.56 / n \cdot (S_x^{1.67} \cdot T_x^{2.67} \cdot S_o^{0.5})$ (cfs)	42.0
T_x = Side flow spread $(D - D_{sfeet}) / S_x$ (ft)	27.17
R_s = Side flow factor = $1 / (1 + (0.15 \cdot V_s^{1.8}) / (S_x \cdot L_g^{2.3}))$	0.89
Q_{ig} = Flow intercepted = $[R_f \cdot E_o + R_s \cdot (1 - E_o)] \cdot Q_s$	37.2

* $p=1.76$; $q=3.12$; $r=0.45$; $s=0.03$ (based on Bar P 1-1/8 grate)

Curb Opening Capacity Calculations

S_e = Equivalent cross slope = $S_x + S_w \cdot E_o$ (ft/ft)	0.020
S_w = Gutter cross slope = D_{sfeet} / W	0.111
L_t = Total interception $L = 0.60 \cdot Q_s^{0.42} \cdot S_o^{0.30} \cdot (1/n \cdot S_e)^{0.6}$ (ft)	102.61
Q_{ic} = Flow intercepted = $(1 - (1 - L_c / L_t)^{1.8}) \cdot Q_s$ (cfs)	13.6

Total Inlet Calculations

Q_u = Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	42.0
Q_{bq} = Flow bypass = $Q_s - Q_u$ (cfs)	0.00
q = Interception per unit ratio = Q_u / L_g (cfs/ft)	1.05
E_q = Efficiency = $(Q_u / Q_s) \cdot 100$	100%

100-year

Modified Type C Drop Inlet Sizing on a C. G.		
DROP INLET EAST SIDE DURANGO @ STA 73+92		
Known:		
$Q_s =$	Half Street flow (cfs)	4.0
$S_o =$	Longitudinal slope (ft/ft)	0.004
$n =$	Manning's roughness coef	0.016
$V_s =$	Flow velocity (fps)	1.7
$D =$	Flow depth (ft)	0.44
$S_x =$	Street transverse slope (ft/ft)	0.02
$W =$	Gutter Width (ft)	1.5
$D_s =$	Gutter Depression (in)	2.0
$L_g =$	Length of grate (ft)	6.0
$L_c =$	Length of curb opening (ft)	5.50
$C_{fg} =$	Clogging factor for grate (%)	50
$C_{fc} =$	Clogging factor for curb opening (%)	50
Grate Capacity Calculations		
$R_f =$	Frontal flow factor = $1 - 0.09 \cdot (V_s - V_o)$ if $V_s > V_o$; else $R_f = 1$	1.00
$V_o =$	Splash over velocity = $p + q \cdot L_g - r \cdot L_g^2 + s \cdot L_g^3$ (fps)	7.88
$E_o =$	Grate flow ratio = Q_w / Q_s	0.13
$Q_w =$	Frontal flow = $Q_s - Q_x$	0.53
$Q_x =$	Side flow = $0.56 / n \cdot (S_x^{1.67} \cdot T_x^{2.67} \cdot S_o^{0.5})$ (cfs)	3.5
$T_x =$	Side flow spread $(D - D_{reet}) / S_x$ (ft)	13.67
$R_s =$	Side flow factor = $1 / (1 + (0.15 \cdot V_s^{1.8}) / (S_x \cdot L_g^{2.3}))$	0.39
$Q_{ig} =$	Flow intercepted = $[R_f \cdot E_o + R_s \cdot (1 - E_o)] \cdot Q_s$	1.9
* $p=1.76; q=3.12; r=0.45; s=0.03$ (based on Bar P 1-1/8 grate)		
Curb Opening Capacity Calculations		
$S_e =$	Equivalent cross slope = $S_x + S_w \cdot E_o$ (ft/ft)	0.035
$S_w =$	Gutter cross slope = D_{reet} / W	0.111
$L_t =$	Total interception $L = 0.60 \cdot Q_s^{0.42} \cdot S_o^{0.30} \cdot (1/n \cdot S_e)^{0.6}$ (ft)	18.38
$Q_{ic} =$	Flow intercepted = $(1 - (1 - L_c / L_t)^{1.8}) \cdot Q_s$ (cfs)	1.0
Total Inlet Calculations		
$Q_{ti} =$	Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	2.9
$Q_{tiq} =$	Flow bypass = $Q_s - Q_{ti}$ (cfs)	1.10
$q =$	Interception per unit ratio = Q_{ti} / L_g (cfs/ft)	0.48
$E_q =$	Efficiency = $(Q_{ti} / Q_s) \cdot 100$	73%

Modified Type C Drop Inlet Sizing on a C. G.

DROP INLET@ STA. 52+75-EAST AND WEST

Known:

$Q_s =$	Half Street flow (cfs)	3.0
$S_o =$	Longitudinal slope (ft/ft)	0.005
$n =$	Manning's roughness coef	0.016
$V_s =$	Flow velocity (fps)	1.7
$D =$	Flow depth (ft)	0.39
$S_x =$	Street tranverse slope (ft/ft)	0.02
$W =$	Gutter Width (ft)	1.5
$D_s =$	Gutter Depression (in)	2.0
$L_g =$	Length of grate (ft)	6.0
$L_c =$	Length of curb opening (ft)	5.50
$C_{fg} =$	Clogging factor for grate (%)	50
$C_{fc} =$	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

$R_f =$	Frontal flow factor = $1 - 0.09 \cdot (V_s - V_o)$ if $V_s > V_o$; else $R_f = 1$	1.00
$V_o =$	Splash over velocity = $p + q \cdot L_g - r \cdot L_g^2 + s \cdot L_g^3$ (fps)	7.88
$E_o =$	Grate flow ratio = Q_w / Q_s	0.25
$Q_w =$	Frontal flow = $Q_s \cdot Q_x$	0.74
$Q_x =$	Side flow = $0.56 / n \cdot (S_x^{1.67} \cdot T_x^{2.67} \cdot S_o^{0.5})$ (cfs)	2.3
$T_x =$	Side flow spread $(D - D_{sfeet}) / S_x$ (ft)	11.17
$R_s =$	Side flow factor = $1 / (1 + (0.15 \cdot V_s^{1.8}) / (S_x \cdot L_g^{2.3}))$	0.39
$Q_{ig} =$	Flow intercepted = $[R_f \cdot E_o + R_s \cdot (1 - E_o)] \cdot Q_s$	1.6

* $p=1.76$; $q=3.12$; $r=0.45$; $s=0.03$ (based on Bar P 1-1/8 grate)

Curb Opening Capacity Calculations

$S_e =$	Equivalent cross slope = $S_x + S_w \cdot E_o$ (ft/ft)	0.047
$S_w =$	Gutter cross slope = D_{sfeet} / W	0.111
$L_t =$	Total interception $L = 0.60 \cdot Q_s^{0.42} \cdot S_o^{0.30} \cdot (1 / n \cdot S_e)^{0.6}$ (ft)	14.47
$Q_{ic} =$	Flow Intercepted = $(1 - (1 - L_c / L_t)^{1.8}) \cdot Q_s$ (cfs)	0.9

Total Inlet Calculations

$Q_{ti} =$	Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	2.6
$Q_{tb} =$	Flow bypass = $Q_s - Q_{ti}$ (cfs)	0.43
$q =$	Interception per unit ratio = Q_{ti} / L_g (cfs/ft)	0.43
$E_q =$	Efficiency = $(Q_{ti} / Q_s) \cdot 100$	86%

Modified Type C Drop Inlet Sizing on a C. G.

Type "B" Drop Inlets @ Sta. 57+00

Known:

Q_s =	Half Street flow (cfs)	1.0
S_o =	Longitudinal slope (ft/ft)	0.034
n =	Manning's roughness coef	0.016
V_s =	Flow velocity (fps)	2.9
D =	Flow depth (ft)	0.23
S_x =	Street transverse slope (ft/ft)	0.02
W =	Gutter Width (ft)	1.5
D_s =	Gutter Depression (in)	2.0
L_g =	Length of grate (ft)	3.0
L_c =	Length of curb opening (ft)	2.50
C_{rg} =	Clogging factor for grate (%)	50
C_{rc} =	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

R_f = Frontal flow factor = $1 - 0.09 \cdot (V_s - V_o)$ if $V_s > V_o$; else $R_f = 1$	1.00
V_o = Splash over velocity = $p + q \cdot L_g \cdot r \cdot L_g^2 + s \cdot L_g^3$ (fps)	5.53
E_o = Grate flow ratio = Q_w / Q_s	0.80
Q_w = Frontal flow = $Q_s - Q_x$	0.80
Q_x = Side flow = $0.56 / n \cdot (S_x^{1.67} \cdot T_x^{2.67} \cdot S_o^{0.5})$ (cfs)	0.2
T_x = Side flow spread $(D - D_{sfeet}) / S_x$ (ft)	3.17
R_s = Side flow factor = $1 / (1 + (0.15 \cdot V_s^{1.8}) / (S_x \cdot L_g^{2.3}))$	0.05
Q_{ig} = Flow intercepted = $[R_f \cdot E_o + R_s \cdot (1 - E_o)] \cdot Q_s$	0.8

* $p=1.76$; $q=3.12$; $r=0.45$; $s=0.03$ (based on Bar P 1-1/8 grate)

Curb Opening Capacity Calculations

S_e = Equivalent cross slope = $S_x + S_w \cdot E_o$ (ft/ft)	0.108
S_w = Gutter cross slope = D_{sfeet} / W	0.111
L_t = Total interception $L = 0.60 \cdot Q_s^{0.42} \cdot S_o^{0.30} \cdot (1/n \cdot S_e)^{0.6}$ (ft)	9.86
Q_{ic} = Flow intercepted = $(1 - (1 - L_c/L_t)^{1.8}) \cdot Q_s$ (cfs)	0.2

Total Inlet Calculations

Q_{ti} = Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	1.0
Q_{tb} = Flow bypass = $Q_s - Q_{ti}$ (cfs)	0.00
q = Interception per unit ratio = Q_{ti} / L_g (cfs/ft)	0.33
E_q = Efficiency = $(Q_{ti} / Q_s) \cdot 100$	100%

Modified Type C Drop Inlet Sizing on a C. G.

DROP INLET EAST SIDE DURANGO @ STA 73+92

Known:

Q_s =	Half Street flow (cfs)	2.5
S_o =	Longitudinal slope (ft/ft)	0.004
n =	Manning's roughness coef	0.016
V_s =	Flow velocity (fps)	1.5
D =	Flow depth (ft)	0.39
S_x =	Street transverse slope (ft/ft)	0.02
W =	Gutter Width (ft)	1.5
D_s =	Gutter Depression (in)	2.0
L_g =	Length of grate (ft)	6.0
L_c =	Length of curb opening (ft)	5.50
C_{fg} =	Clogging factor for grate (%)	50
C_{fc} =	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

R_f = Frontal flow factor = $1 - 0.09 \cdot (V_s - V_o)$ if $V_s > V_o$; else $R_f = 1$	1.00
V_o = Splash over velocity = $p + q \cdot L_g \cdot r \cdot L_g^2 + s \cdot L_g^3$ (fps)	7.88
E_o = Grate flow ratio = Q_w / Q_s	0.19
Q_w = Frontal flow = $Q_s - Q_x$	0.48
Q_x = Side flow = $0.56 / n \cdot (S_x^{1.67} \cdot T_x^{2.67} \cdot S_o^{0.5})$ (cfs)	2.0
T_x = Side flow spread $(D - D_{sreet}) / S_x$ (ft)	11.17
R_s = Side flow factor = $1 / (1 + (0.15 \cdot V_s^{1.8}) / (S_x \cdot L_g^{2.3}))$	0.44
Q_{ig} = Flow intercepted = $[R_f \cdot E_o + R_s \cdot (1 - E_o)] \cdot Q_s$	1.4

* $p=1.76$; $q=3.12$; $r=0.45$; $s=0.03$ (based on Bar P 1-1/8 grate)

Curb Opening Capacity Calculations

S_e = Equivalent cross slope = $S_x + S_w \cdot E_o$ (ft/ft)	0.041
S_w = Gutter cross slope = D_{sreet} / W	0.111
L_t = Total interception $L = 0.60 \cdot Q_s^{0.42} \cdot S_o^{0.30} \cdot (1/n \cdot S_e)^{0.6}$ (ft)	13.62
Q_{ic} = Flow intercepted = $(1 - (1 - L_c / L_t)^{1.8}) \cdot Q_s$ (cfs)	0.8

Total Inlet Calculations

Q_u = Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	2.2
Q_{tq} = Flow bypass = $Q_s - Q_u$ (cfs)	0.29
q = Interception per unit ratio = Q_{ti} / L_g (cfs/ft)	0.37
E_q = Efficiency = $(Q_{ti} / Q_s) \cdot 100$	88%

Modified Type C Drop Inlet Sizing in a Sump

DROP INLET @ STA. 73+92 (10-YEAR)

Known:

D_p =	Ponding depth at inlet (ft)	0.3
W =	Gutter Width (ft)	1.50
L_g =	Length of grate (ft)	3.00
L_c =	Length of curb opening (ft)	2.50
H_c =	Curb opening height (ft)	0.547
C_{wc} =	Weir coefficient for curb opening	2.3
C_{wg} =	Weir coefficient for grate	3.0
C_o =	Orifice coefficient	0.67
R_o =	Grate opening factor	0.60
C_{fg} =	Clogging factor for grate (%)	50
C_{fc} =	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

P_g =	Active grate weir length (agwl) = $2*W+L_g$ (ft)	6.00
P_{agl} =	Adjusted agwl = $2*(1-C_{fg}/100)*W+L_g$ (ft)	4.50
A_g =	Grate area = $W*L_g$ (ft ²)	4.50
A_{aga} =	Adjusted open grate area = $A_g*R_o*(1-C_{fg}/100)$ (ft ²)	1.35
C =	check - If $D_p < 1.792*A_g/P_{agl}$; weir; else orifice	weir
Q_{ig} =	Flow intercepted by grate (cfs)	2.2
If "weir" controls $Q_{ig} = C_{wg}*P_{agl}*D_p^{1.5}$		
If "orifice" controls $Q_{ig} = C_o*A_{aga}*(64.4*D_p)^{0.5}$		

Curb Opening Capacity Calculations

P_c =	Active curb opening weir length (acowl) = $L_c+1.8$ (ft)	5.20
P_{acd} =	Adjusted acowl = $L_c+1.8*(1-C_{fc}/100)*W$ (ft)	3.85
A_c =	curb opening area (coa) = L_c*H_c (ft ²)	1.37
A_{aca} =	Adjusted coa = $A_c*(1-C_{fc}/100)$ (ft ²)	0.68
C =	check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} =	Flow int'd by curb opening (cfs)	1.5
If "weir" controls $Q_{ic} = C_{wc}*P_{acd}*D_p^{1.5}$		
If "orifice" controls $Q_{ic} = C_o*A_{aca}*(64.4*D_p-H_c/2)^{0.5}$		

Total Inlet Calculations

Q_{ti} =	Total flow intercepted = $Q_{ig}+Q_{ic}$ (cfs)	3.7
q =	Interception per unit length = Q_{ti}/L_g (cfs/ft)	1.2

Modified Type C Drop Inlet Sizing in a Sump

DROP INLET @ STA. 73+92 (100-YEAR)

Known:

D_p =	Ponding depth at inlet (ft)	0.3
W =	Gutter Width (ft)	1.50
L_g =	Length of grate (ft)	6.00
L_c =	Length of curb opening (ft)	5.50
H_c =	Curb opening height (ft)	0.547
C_{wc} =	Weir coefficient for curb opening	2.3
C_{wg} =	Weir coefficient for grate	3.0
C_o =	Orifice coefficient	0.67
R_o =	Grate opening factor	0.60
C_{fg} =	Clogging factor for grate (%)	50
C_{fc} =	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

P_g =	Active grate weir length (agwl) = $2*W+L_g$ (ft)	9.00
P_{agl} =	Adjusted agwl = $2*(1-C_{fg}/100)*W+L_g$ (ft)	7.50
A_g =	Grate area = $W*L_g$ (ft ²)	9.00
A_{aga} =	Adjusted open grate area = $A_g*R_o*(1-C_{fg}/100)$ (ft ²)	2.70
C =	check - If $D_p < 1.792*A_{ag}/P_{ag}$; weir; else orifice	weir
Q_{ig} =	Flow intercepted by grate (cfs)	3.7
If "weir" controls $Q_{ig} = C_{wg}*P_{agl}*D_p^{1.5}$		
If "orifice" controls $Q_{ig} = C_o*A_{aga}*(64.4*D_p)^{0.5}$		

Curb Opening Capacity Calculations

P_c =	Active curb opening weir length (acowl) = $L_c+1.8$ (ft)	8.20
P_{acl} =	Adjusted acowl = $L_c+1.8*(1-C_{fc}/100)*W$ (ft)	6.85
A_c =	curb opening area (coa) = L_c*H_c (ft ²)	3.01
A_{aca} =	Adjusted coa = $A_c*(1-C_{fc}/100)$ (ft ²)	1.50
C =	check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} =	Flow int'd by curb opening (cfs)	2.6
If "weir" controls $Q_{ic} = C_{wc}*P_{acl}*D_p^{1.5}$		
If "orifice" controls $Q_{ic} = C_o*A_{aca}*(64.4*D_p*H_c/2)^{0.5}$		

Total Inlet Calculations

Q_{ti} =	Total flow intercepted = $Q_{ig}+Q_{ic}$ (cfs)	6.3
q =	Interception per unit length = Q_{ti}/L_g (cfs/ft)	1.0

30" UNDER BICYCLE PATH TUNNEL
Worksheet for Circular Channel

Project Description	
Worksheet	30
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

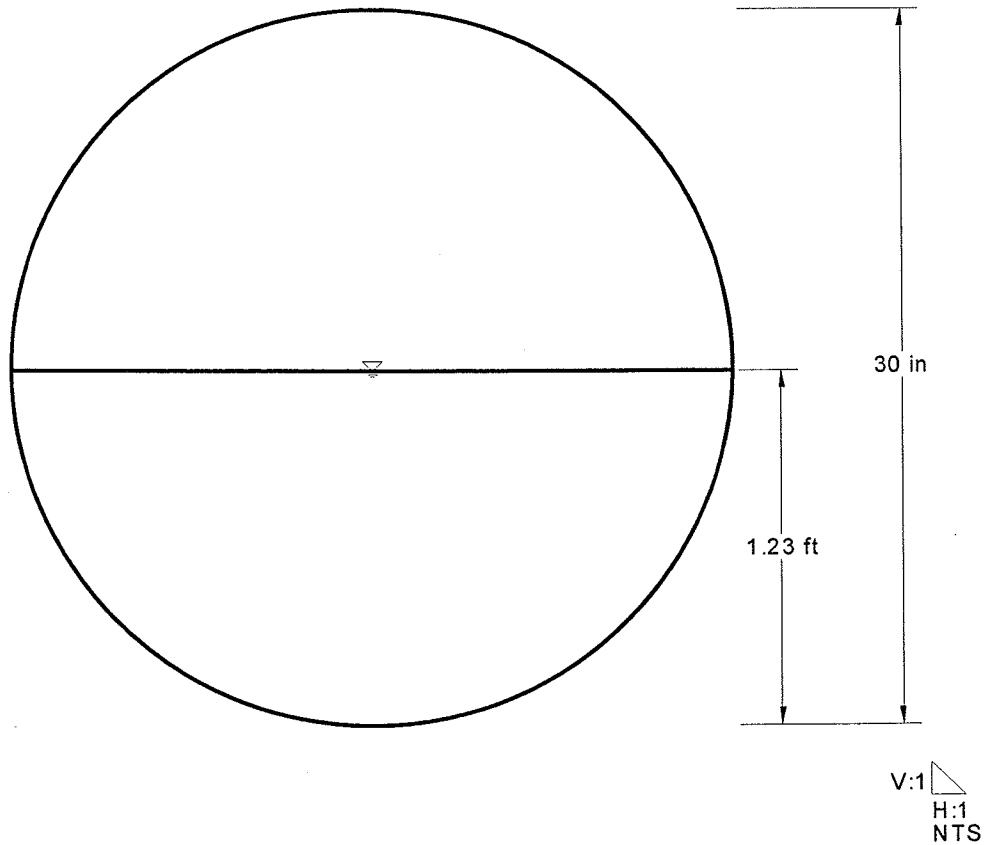
Input Data	
Mannings Coefficient	0.013
Slope	0.002500 ft/ft
Diameter	30 in
Discharge	10.00 cfs

Results	
Depth	1.23 ft
Flow Area	2.4 ft²
Wetted Perimeter	3.89 ft
Top Width	2.50 ft
Critical Depth	1.06 ft
Percent Full	49.3 %
Critical Slope	0.004284 ft/ft
Velocity	4.15 ft/s
Velocity Head	0.27 ft
Specific Energy	1.50 ft
Froude Number	0.75
Maximum Discharg	22.06 cfs
Discharge Full	20.51 cfs
Slope Full	0.000594 ft/ft
Flow Type	Subcritical

30" RCP (BICYCLE PATH TUNNEL)
Cross Section for Circular Channel

Project Description	
Worksheet	30
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.013
Slope	0.002500 ft/ft
Depth	1.23 ft
Diameter	30 in
Discharge	10.00 cfs



18" RCP IN SUMMERLIN PKWY (EAST BOUND ONRAMP)

Worksheet for Circular Channel

Project Description	
Worksheet	18
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

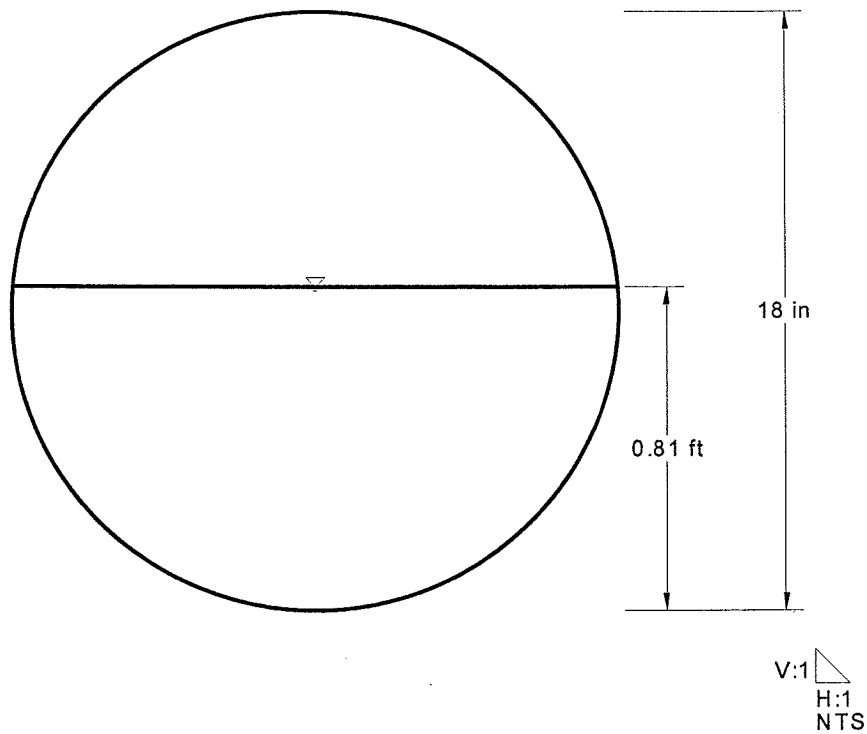
Input Data	
Mannings Coefficient	0.013
Slope	0.002500 ft/ft
Diameter	18 in
Discharge	3.00 cfs

Results	
Depth	0.81 ft
Flow Area	1.0 ft ²
Wetted Perimeter	2.48 ft
Top Width	1.49 ft
Critical Depth	0.66 ft
Percent Full	54.2 %
Critical Slope	0.005129 ft/ft
Velocity	3.07 ft/s
Velocity Head	0.15 ft
Specific Energy	0.96 ft
Froude Number	0.67
Maximum Discharg	5.65 cfs
Discharge Full	5.25 cfs
Slope Full	0.000816 ft/ft
Flow Type	Subcritical

18' rcp
Cross Section for Circular Channel

Project Description	
Worksheet	18
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.013
Slope	0.002500 ft/ft
Depth	0.81 ft
Diameter	18 in
Discharge	3.00 cfs



18" RCP IN DURANGO (NORTH OF WESTCLIFF)
Worksheet for Circular Channel

Project Description	
Worksheet	18
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

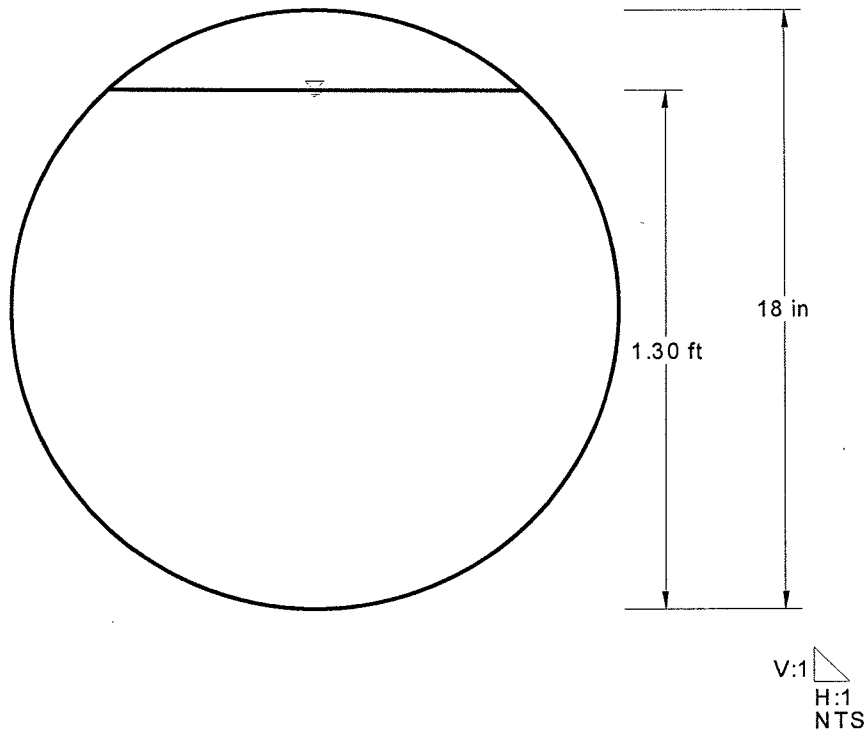
Input Data	
Mannings Coefficient	0.013
Slope	0.003000 ft/ft
Diameter	18 in
Discharge	6.00 cfs

Results	
Depth	1.30 ft
Flow Area	1.6 ft²
Wetted Perimeter	3.58 ft
Top Width	1.03 ft
Critical Depth	0.95 ft
Percent Full	86.5 %
Critical Slope	0.006218 ft/ft
Velocity	3.69 ft/s
Velocity Head	0.21 ft
Specific Energy	1.51 ft
Froude Number	0.52
Maximum Discharg	6.19 cfs
Discharge Full	5.75 cfs
Slope Full	0.003263 ft/ft
Flow Type	Subcritical

18' rcp
Cross Section for Circular Channel

Project Description	
Worksheet	18
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.013
Slope	0.003000 ft/ft
Depth	1.30 ft
Diameter	18 in
Discharge	6.00 cfs



18" RCP IN DURANGO DRIVE (BETWEEN WASHINGTON AND VEGAS DRIVE)

Worksheet for Circular Channel

Project Description	
Worksheet	18
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

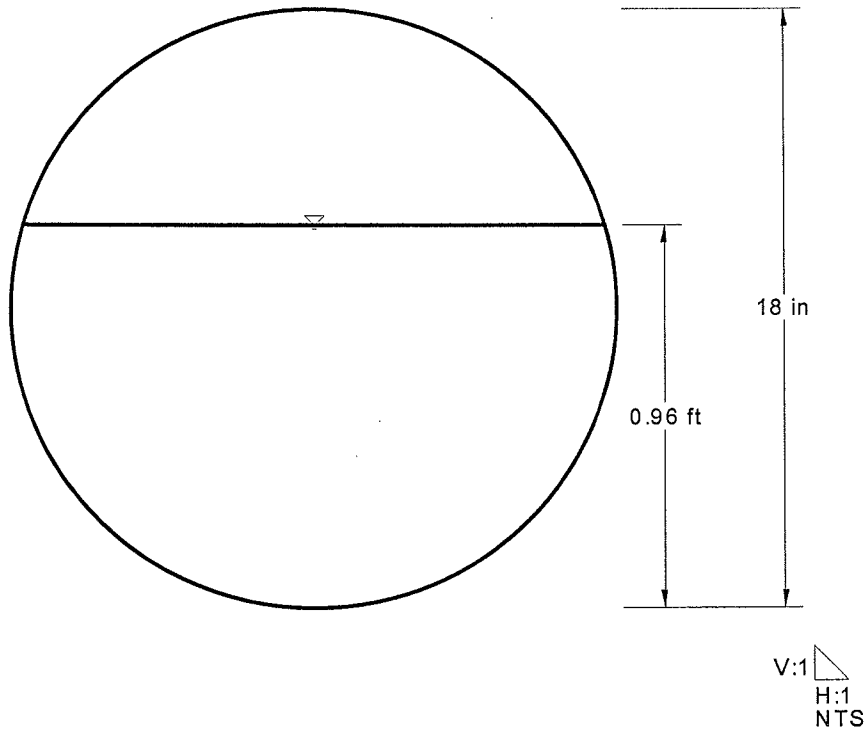
Input Data	
Mannings Coefficient	0.013
Slope	0.005000 ft/ft
Diameter	18 in
Discharge	5.50 cfs

Results	
Depth	0.96 ft
Flow Area	1.2 ft ²
Wetted Perimeter	2.78 ft
Top Width	1.44 ft
Critical Depth	0.90 ft
Percent Full	64.0 %
Critical Slope	0.005990 ft/ft
Velocity	4.60 ft/s
Velocity Head	0.33 ft
Specific Energy	1.29 ft
Froude Number	0.89
Maximum Discharg	7.99 cfs
Discharge Full	7.43 cfs
Slope Full	0.002742 ft/ft
Flow Type	Subcritical

18' rcp
Cross Section for Circular Channel

Project Description	
Worksheet	18
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.013
Slope	0.005000 ft/ft
Depth	0.96 ft
Diameter	18 in
Discharge	5.50 cfs



30" UNDER EAST BOUND OFFRAMP IN SUMMERLIN PKWY

Worksheet for Circular Channel

Project Description	
Worksheet	30
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

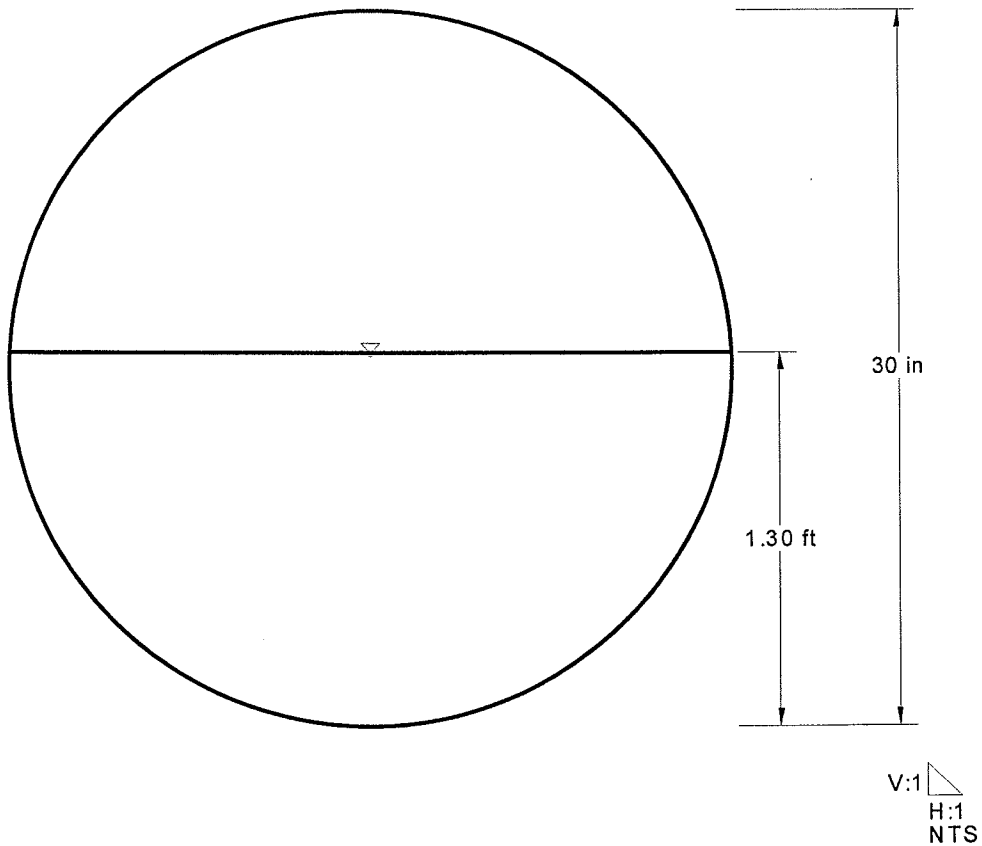
Input Data	
Mannings Coefficient	0.013
Slope	0.002500 ft/ft
Diameter	30 in
Discharge	11.00 cfs

Results	
Depth	1.30 ft
Flow Area	2.6 ft²
Wetted Perimeter	4.03 ft
Top Width	2.50 ft
Critical Depth	1.11 ft
Percent Full	52.1 %
Critical Slope	0.004343 ft/ft
Velocity	4.25 ft/s
Velocity Head	0.28 ft
Specific Energy	1.58 ft
Froude Number	0.74
Maximum Discharg	22.06 cfs
Discharge Full	20.51 cfs
Slope Full	0.000719 ft/ft
Flow Type	Subcritical

30" RCP SUMMERLIN PKWY
Cross Section for Circular Channel

Project Description	
Worksheet	30
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.013
Slope	0.002500 ft/ft
Depth	1.30 ft
Diameter	30 in
Discharge	11.00 cfs



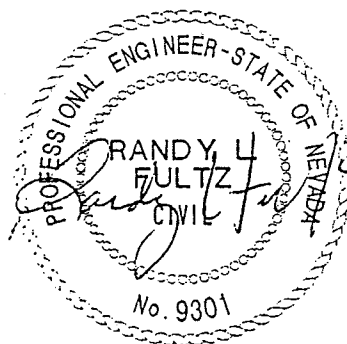
APPENDIX C

Supporting Documents and Reference Material
Summerlin Parkway Study
The Villas Study
Durango Trails Study
Westcliff Study
Vegas Drive Study
Las Vegas City Wide Hydrology Study
Westcliff @ Durango Dur West Partners-Grading Plan
Angel Park Outlet Drain-Plan and Profile

SUMMERLIN PARKWAY DRAINAGE IMPROVEMENTS
RAMPART BOULEVARD TO
BUFFALO CHANNEL

Prepared by:

CITY OF LAS VEGAS FLOOD CONTROL SECTION



June 13, 1997



2.4.1. Existing Facilities

The existing facilities are as follows:

Pt. A - 18-inch RCP, 281 LF, with four (4) NDOT Type 2A Drop Inlets (Husite Parkway plans by G. C. Wallace, Sheet 6 and 17.)

Pt. G - Twin 48-inch RCP Culvert, 463 LF, with four (4) NDOT Type 2A Drop Inlets (Husite Parkway plans by G. C. Wallace, Sheets 9 and 17).

Pt. E - Twin 18-inch RCP Culvert, 260 LF (Buffalo Interchange Plans Sheet C-4).

Pt. F - 18-Inch RCP Culvert, 145 LF, (Buffalo Plans, Sheet C-6).

2 - 18-Inch RCP's, 140 LF and 402 LF, with one (1) NDOT Type 2A Drop Inlet each at Ramp 1 and Ramp 4 of Buffalo Interchange (Sheets C-5 and C-8 and 9 of Buffalo Interchange).

Pt. H - 12-foot x 7-foot RCB.

2.5. Hydraulic Results

The single 18-inch RCP storm drain at PT A has a hydraulic capacity of 11 cfs. Each NDOT Type 2A Drop Inlet has approximately two (2) cfs capacity (See calculations Appendix B). Therefore, the current inlets have sufficient capacity to utilize the entire capacity of the storm drain. There is a narrow drainage basin, 1.15 acre, (SPW2X) along the north side of the Summerlin Parkway that currently is not collected by the storm drain system. This flow currently is draining into the Angel Park North Detention Basin at PT I causing serious erosion around the concrete abutments. The 3 cfs at PT I should be conveyed into the Angel Park North Detention Basin via a concrete flume approximately 2 feet wide (See flow calculations in Appendix B). A concrete splash pad must be constructed at the downstream end of the flume.

The twin 48-inch RCP's at PT C have adequate capacity to convey the entire 100-year flow of 217 cfs (Appendix B). The NDOT Type 2A Drop Inlet at PT G in Summerlin Parkway has a capacity of 3.5 cfs per grate. Therefore, with four (4) grates at PT G, the total flow being captured is about fourteen (14) cfs.

The Buffalo Drive Improvement project has proposed to regrade the area adjacent to PT E so the flow, 451 cfs, will be conveyed north into the proposed 66-inch storm drain. The storm drain was designed to capture the entire flow from PT E. The Buffalo Drive storm drain system is designed for pressure flow and is at capacity. The flow in Summerlin Parkway at PT G, 111 cfs, cannot be collected

Subbasin	Area (acres)	Area (sq. mi.)	Lag Time (hr)	Curve No.
BE	11.97	0.0187	0.158	92
CH	6.69	0.0105	0.136	92
CGA	5.88	0.0092	0.125	92
PC2	7.49	0.0117	0.100	92
SPW2X	1.15	0.0018	0.161	84

2.3. Hydrologic Results

The results of the hydrologic analysis is located in the following Table 2. The flow within the Summerlin Parkway is shown at concentration points PT A, PT G and PT H. Each concentration point located at a storm drainage facility which crosses Summerlin Parkway. Concentration point PT I is located at the point where storm flows are flowing into the Angel Park North Detention Basin. Visible erosion has taken place at this location. Concentration points PT B is located within the drainage channel located along the south side of the Summerlin Parkway. Concentration point PT C is located upstream of the twin 48-inch RCP storm drain which crosses under Summerlin Parkway and relieves a substantial portion of the flow otherwise getting into Summerlin Parkway. Concentration Point D is located just upstream of the confluence to the flow from UD1 and its tributary basins and the flow from the twin 48-in RCP storm drain. Concentration Point E is upstream of the twin 18-inch RCP' storm drain which crosses under Buffalo Drive. Point F is behind the on-ramp (Ramp 1) at the Buffalo interchange. Water is detained here until it is drained out of the 18-inch RCP storm drain.

Table 2 - 10-YEAR AND 100-YEAR FLOWS AT CONCENTRATION POINTS

Concentration Point	10-Year Flow	100-Year Flow
PT A	6	16
PT B	92	201
PT C	67	217
PT D	122	263
PT E	180	451
PT F	33	72
PT G	73	111
PT H	107	178
PT I	1	3

2.4. Hydraulic Criteria

The existing facilities were analyzed for available capacity. The inlet calculations were analyzed using Figure 806 from the Design Manual (Reference 1) adjusted for a 50% clogging factor.

1897
L-28.0
REC
7/23/96

**TECHNICAL DRAINAGE STUDY
FOR
THE VILLAS
AT ANGEL PARK**

Prepared for:
WALTER HOMES LIMITED
906 Alta Oaks
Henderson, Nevada 89014

Prepared by:
Post, Buckley, Schuh & Jernigan, Inc.
901 North Green Valley Parkway Suite #100
Henderson, Nevada 89014

Reference Number 51953.00
July 1996



S#

1897

S INDEX

5029/5035

PN

138-28-101-001

PROJECT The villas @ Angel Park

SUBMITTAL 5th. Submitted. w/CCRFCD



CITY OF LAS VEGAS INTER-OFFICE MEMORANDUM

TO:
Barry Thompson, P.E.
Land Development Services
Department of Public Works

SUBJECT: Technical Drainage Study for:
The Villas at Angel Park
L:\DEPOT\DS\DS1897H.DOC

FILE NO.

DATE:

August 12, 1997

FROM:
Dennis W. Stransky, P.E.
F C Project Manager
Department of Public Works

COPIES TO:
PBS & J, Inc.
Walter Homes
John McNellis, P.E.

HISTORY	DATE RECEIVED	DATE REVIEWED	COMMENTS	REVIEW FEES
1st Submittal	7/23/96	08/05/96	Not Accepted	\$250.00
2nd Submittal	08/16/96	08/23/96	Accepted	\$250.00
CCRCD	10/28/96	10/29/96	Accepted	N/C
3rd Submittal	12/06/96	12/10/96	Accepted	\$100.00
CCRCD	01/09/97	01/10/97	Accepted	N/C
4th Submittal	07/02/97	07/08/97	Accepted	\$100.00
5th Submittal	08/7/97	08/07/97	Accepted	N/C
CCRCD	08/11/97	08/11/97	See Comments Below	N/C
TOTAL FEES				\$700.00

REMARKS:

Revisions to perimeter walls:
The Drainage Study for the subject project has been reviewed and:

☒	is acceptable in concept subject to conformance to all City standards and the following conditions.
☐	must be resubmitted or supplemented including the following:
☐	must have Clark County Regional Flood Control District concurrence

1.

Attached are copies of the proposed revisions to the perimeter walls provided by the engineer. Based on a site visit and conversations with the engineer, the attached revisions are acceptable. It is our understanding the plans must be revised accordingly.

NOTE:

Any future changes to the proposed design (or design assumptions) as outlined in the approved drainage study and attached preliminary grading plan which affect drainage must be addressed in a Drainage Study Amendment and accepted by the City of Las Vegas Flood Control Section. Additionally, conditional acceptance of a drainage study is valid for a period of one (1) year. If the proposed construction has not been completed in that time period, the City of Las Vegas reserves the right to require additional conditions and/or submission and acceptance of a complete drainage study update prior to further construction.

PLANS SENT TO LAND DEVELOPMENT YES (initial) SENT WITH PREVIOUS MEMO

T/R/S 20 S / 62 E / 28
AREA L-28

END OF REMARKS
dws

1897
L28
NYC

C L A R K C O U N T Y
REGIONAL FLOOD CONTROL DISTRICT

RECEIVED

AUG 11 1997

CLV PUBLIC WORKS
FLOOD CONTROL

Gale Wm. Fraser, II, P.E.
General Manager/Chief Engineer

BOARD OF DIRECTORS

Lance M. Malone
Chairman
Clark County

Crescent Hardy
Vice-Chairman
City of Mesquite

Larry Brown
City of Las Vegas

Jan Lavery Jones
City of Las Vegas

Bryan A. Nix
City of Boulder City

John K. Rhodes
City of North Las Vegas

David Wood
City of Henderson

Bruce L. Woodbury
Clark County

August 7, 1997

Mr. Randy Fultz
City of Las Vegas
Department of Public Works
400 East Stewart
Las Vegas, NV 89101

DISTRICT CONCURRENCE: VILLAS AT ANGEL PARK UPDATE

Dear Mr. Fultz:

The District has reviewed the Technical Drainage Study dated June 30, 1997, for the above captioned project as submitted by PBS&J, Inc. In addition the District is in receipt of the Conditional Letter of Acceptance from the City of Las Vegas Department of Public Works dated July 14, 1997.

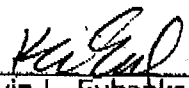
The District concurs with the acceptance of this Technical Drainage Study by the City of Las Vegas Department of Public Works.

The District's review of this project was limited to issues of Regional Flood Control Significance as defined in the Uniform Regulations for the Control of Drainage.

Please be aware that as additional information becomes available and/or restudies of Flood Insurance Studies are performed, the information submitted by PBS&J, Inc. may be superseded. Compliance with the regulatory elements and design standards specified in the Uniform Regulations for the Control of Drainage does not imply a guarantee that properties will be free from flooding or flood damage. No liability is assumed by the District, its officials, or employees for the information, data or conclusions presented by the consulting engineer. We therefore make no warranties, either expressed or implied, in conducting this review.

GALE WM. FRASER II, P.E.
General Manager/Chief Engineer

BY:


Kevin L. Eubanks, P.E.
Assistant General Manager

cc: PBS&J, Inc.

KLE:JHH:mak

FILE: 20-60-28.PBS

**ADDENDUM #1 TO THE
TECHNICAL HYDROLOGY STUDY**

FOR

DURANGO TRAILS

CITY OF LAS VEGAS, NEVADA

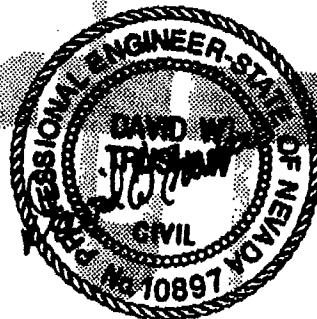
W.O. #4706

Prepared for:

STANPARK HOMES

Submitted to:

**PUBLIC WORKS DEPT.
LAS VEGAS, NEVADA**



12-21-99

CITY OF LAS VEGAS
INTER-OFFICE MEMORANDUM

DATE: December 31, 1994

TO:

Roger Bailey
Land Development Services
Department of Public Works

FROM:

Randy Fultz, P.E. *RF*
Project Manager
Flood Control
Department of Public Works

SUBJECT:

Drainage Study for:
Durango Trails
File No: DS1466B
Date of engineer's Stamp: 12/21/94
Date Received by City: 12/23/94

COPIES TO:

VTN Nevada
John McNellis, P.E.

HISTORY:

1st Submittal: (11/23/94) Not Acceptable
2nd Submittal: (12/31/94) See comments below

REMARKS:

The drainage study for the subject project has been reviewed and

X is acceptable in concept subject to conformance to all City standards and the following conditions:

_____ must be resubmitted or supplemented.

NOTE:

Any future changes to the proposed design (or design assumptions) as outlined in the approved drainage study and attached preliminary grading plan which affect drainage must be addressed in a drainage study addendum and accepted by CLV Flood Control. Additionally, conditional acceptance of a drainage study is valid for a period of one (1) year from date of issuance. If the proposed construction has not been completed in that time period the City of Las Vegas reserves the right to require additional conditions and/or submission and acceptance of a complete drainage study update prior to further construction.

1. A detail of the proposed discharge to Carmen Boulevard from Dusty Creek Street must be shown on the construction drawings.

END OF REMARKS
bt

T/R/S/: 20/60/28
L-28

PROJECT NUMBER: 600-001-942
DATE: August 9, 1994

10

HYDROLOGY STUDY
for
WESTCLIFF & DURANGO
CITY OF LAS VEGAS, NEVADA
APN'S 138-28-401-004

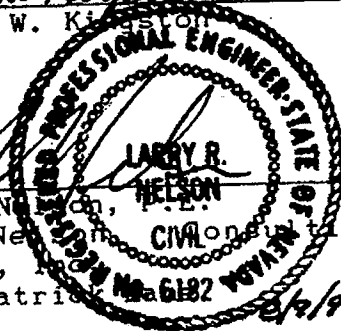
Prepared For: DUR WEST PARTNERS
C/O ALBERT FLANGAS
7385 W. Laredo
Las Vegas, NV 89117
(702) 363-9396

Prepared By:

Alexander W. Kingston
Alexander W. Kingston

Reviewed By:

Larry R. Nelson
Larry R. Nelson, P.E.
L.R. Nelson Consulting
Engineers, Inc.
3035 E. Patricia
Suite #9
Las Vegas, NV 89120
(702) 798-7978



I. GENERAL LOCATION AND DESCRIPTION

A. Purpose

The purpose of this study is to provide the City of Las Vegas Department of Public Works with the technical data needed to evaluate present and future run-off impacting the proposed 5.00 acre residential site located at the Northeast intersection of Westcliff Drive and Durango Drive.

B. Site Location

The site is located within the West half (W 1/2) of the Southwest quarter (SW 1/4) of the Southwest quarter (SW 1/4) of Section 28, Township 20 South, Range 60 East, M.D.M., City of Las Vegas, County of Clark, Nevada. The 5.00 acre site is bounded by a residential site to the North and East. The South boundary is Westcliff Drive, while Durango Drive is the West boundary. Access to the residential site will be from Westcliff and Durango Drive.

C. Property Description and Proposed Development

The site lies at the Northeast intersection of Westcliff Drive and Durango Drive, within the incorporated area of City of Las Vegas, Clark County, Nevada. The natural on-site terrain slopes at approximately 3.00% to the Northeast. All ground cover is sparse desert shrub. Runoff generated from the property is conveyed in a series of shallow gullies which traverse the site (see Figure C-II, Appendix A).

Development of the property is proposed to be in three (3) phases of construction.

D. Regional Flood Control Facilities

No Regional Flood Control facilities are affected by the proposed 5.00 acre development, as shown on Figure B-I in Appendix A (Figure F-10 of the CCRFCD's Master Plan Update).

E. Flood Zone Designation

The entire site is located within a Federal Emergency Management Agency's special flood hazard area, Zone C. The entire site is determined to be outside of the any 100-year flooding, as shown on the enclosed overlay of the Flood Insurance Rate Map for Clark County, Nevada, Panel 1000 of 2035, dated September 29, 1989 (see Figure B-II, Appendix A).

F. Previous Studies

No previous studies are were found on this site or referenced within this study.

II. HYDROLOGIC CRITERIA AND ANALYSIS

Computer

A WYSE 486 (AT compatible) computer was used for this analysis.

Rainfall\Runoff Simulation

The HEC-1 Flood Hydrograph Package developed by the United States Corps of Engineers, dated May 1, 1991, version 4.0.1E was used to determine the flows for this study.

Soils

The soil survey diagram (Figure C-1, Appendix A) in the appendix shows soil types for the project as shown on figure H-10 of the Clark County Regional Flood Control Districts (CCRFCD's) Master Plan. The on-site basins are made up of hydrologic group D soils. SCS curve numbers were determined by using Table 602 (Tables 1 of 4 and 4 of 4) of the CCRFCD's Hydrologic Criteria and Drainage Design Manual. Existing curve numbers for basin EX were obtained by assuming desert shrub in poor condition (see Figure A-1, Appendix A). An SCS Curve Number table has been constructed which indicates curve numbers for both existing and developed conditions, and has been provided in Appendix B (Table I).

Precipitation

Precipitation analysis was based on a 6 hour duration with estimates for the 100 and 10 year events. Precipitation values were obtained from the NOAA Atlas 2, Precipitation Frequency Atlas of the Western United States, Volume VIII, Nevada and modified as per the Clark County Regional Flood Control District Master Plan. The project site is within the McCarran Airport rainfall area. The precipitation values for the major (100 yr.) and minor (10 yr.) events for this study area are 2.77" and 1.58", respectively (see Table II, Appendix B).

Flows

All concerning flows are summarized in Table V of Appendix B and are discussed within the Conclusions portion of this report.

Hydraulic Analysis

Street and channel capacities were determined using the Manning equation and corresponding "n" values as found in Open-Channel Hydraulics published by McGraw-Hill.

III. DRAINAGE BASINS

A. Off-Site Basins

No off-site basins will generate runoff that will impact the Westcliff & Durango project. The area West of Durango Drive is the Angel Park Golf Course - Detention Facility. The detention facility will intercept any flows from the West. Durango Drive will have a high point adjacent to the site that will direct flow to the North and South.

B. On-Site Basins

The on-site basin is comprised of 5.00 total acres and is bounded by developed land to the North and the East, while West of the site is Durango Drive, while Westcliff Drive is the Southern boundary. The site has one basin EX in the present condition. Basin EX slopes to the East at approximately 3.00%, across a sparse desert shrub ground cover (see Figures A-I and C-II, Appendix A). The site is presently generating a 100-year runoff peak rate of 13 cfs.

After development the site will consist of a three (3) lot commercial subdivision site.

IV. PROPOSED CONVEYANCE.

The Westcliff & Durango commercial will be made up of three (3) drainage basins FUT-1, FUT-2 and FUT-3. The site is being subdivided into three commercial lots, this report will analysis the lots as drainage basins that will generate runoff (the individual site grading has not yet been determined). Basin FUT-1 will generate a 100-year flow of 3 cfs. Basin FUT-1 will drain to a entrance that outlets onto Westcliff Drive. Westcliff Drive will convey the 100-year flow of 3 cfs at a depth of 0.26-ft (See Calculation Sheet No. 2, Appendix C) and will have a VxD ratio of 0.68. Basin FUT-2 will generate a 100-year flow of 3 cfs. Basin FUT-2 will drain to a swale (See Calculation Sheet No. 3, Appendix C) that will run along the East side of the lot, the swale will convey flows to Westcliff Drive. Westcliff Drive will convey the 100-year flow of 13 cfs (total site flow) at a depth of 0.39-ft (See Calculation Sheet No. 4, Appendix C) and will have a VxD ratio of 1.48. Basin FUT-3 is generating a 100-year flow rate of 7 cfs and will also drain to the East, there a proposed swale (See

Calculation Sheet No. 5, Appendix C) will convey flows to the South, into basin FUT-2.

V. CONCLUSIONS

Under existing conditions, no off-site basin are generating flows that will impact the Westcliff & Durango site. Development of the site will create three (3) drainage basins FUT-1, FUT-2 and FUT-3. A 100 yr. peak flow of 3 cfs will exit basin FUT-1 onto Westcliff Drive (see Figure D-1, Appendix A). A 100-year peak flow of 3 cfs will drain East in basin FUT-2 to a proposed swale that will exit basin FUT-2 out to Westcliff Drive. Basin Fut-3 will drain 7 cfs East to the proposed swale that will drain into basin FUT-2.

The finish floor elevations for the commercial site will be set off the 100-year water surface generated within the basins that make up the Westcliff & Durango site.

Adequate site protection will be provided by maintaining on-site finished floor elevations a minimum of twice the depth of flow or 18" above the highest adjacent 100 yr. water surface elevation. This will be reflected on the grading plan for the site.

The development of the Westcliff & Durango site will not significantly increase the 100-year stormwater peak. Property downstream of the site will not be adversely affected by this development. The proposed measures presented in this study are in compliance with all current applicable laws and regulations.

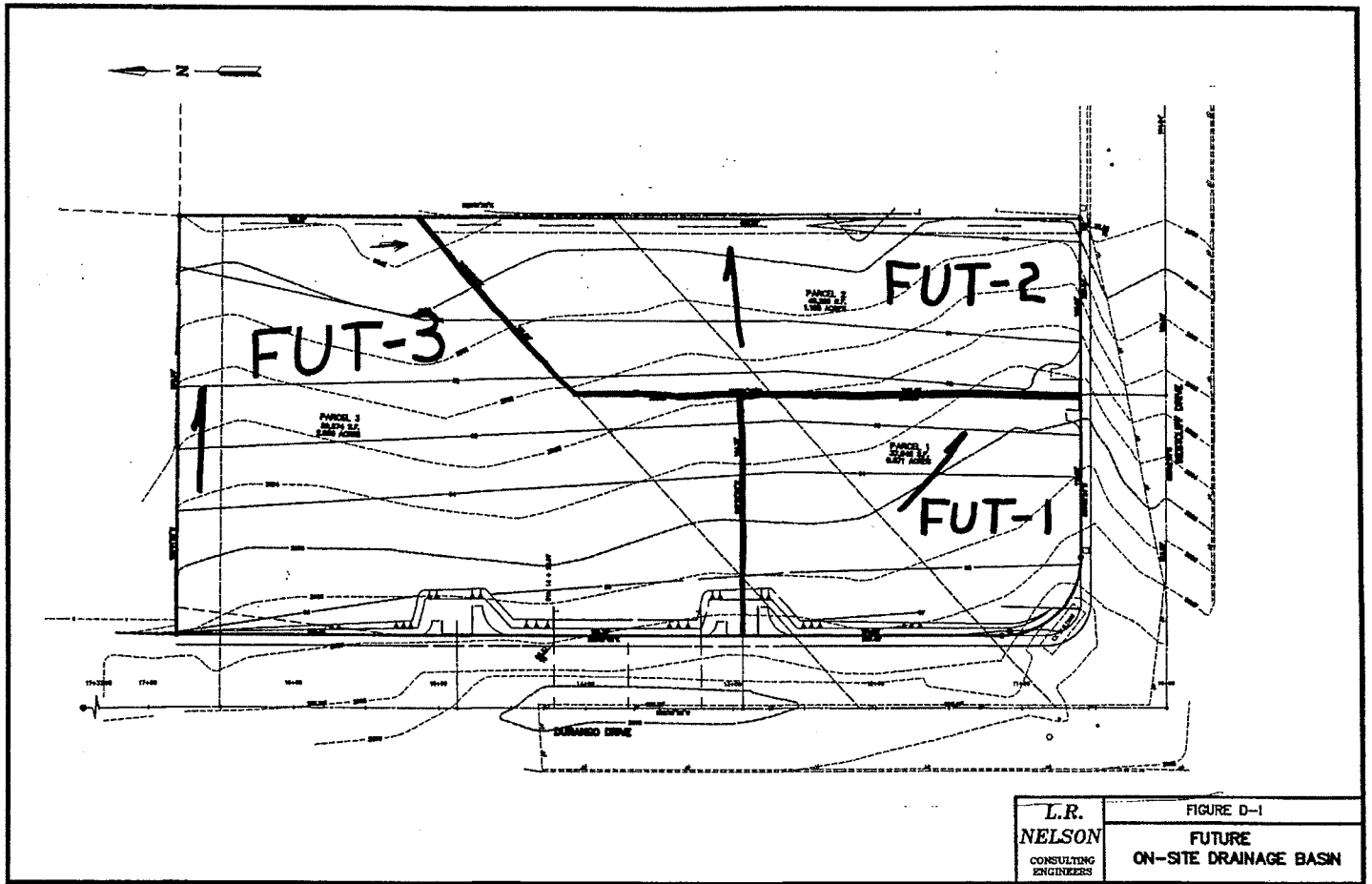


TABLE V

FLOW SUMMARY

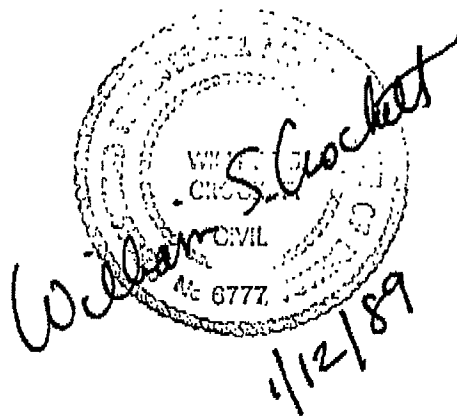
DRAINAGE BASIN	10 YR. FLOW (CFS)	100 YR. FLOW (CFS)
EX	5	13
FUT-1	2	3
FUT-2	2	3
FUT-3	3	7

9

1-28

ANGEL TRAIL APARTMENTS

DRAINAGE STUDY



DELTA ENGINEERING, INC.
4500 W. OAKLEY BOULEVARD
LAS VEGAS, NEVADA 89102
(702)877-0955

JANUARY 12, 1989

ANGEL TRAIL APARTMENTS

DRAINAGE STUDY

INTRODUCTION

This report evaluates the runoff conditions of the site and contributing upstream drainage areas, and provides design recommendations for flood control within the development. The criteria with the results and recommendations presented herein are as follows:

1. The delineation and runoff parameters of the drainage areas are based on existing undeveloped conditions.
2. Husite Parkway which is being constructed along the north edge of the site does not contribute to offsite drainage.
3. The Angel Park Detention Basin retains the 100-year event and only stormwater east of the Basin is considered.
4. The block wall along the west perimeter of the site will allow water from the area of the future overpass and the 5 acres at the northeast corner of Durango and Westcliff to pass through it. ✓

No!
Spillway
Too

PROJECT LOCATION

The proposed project is located at the northeast corner of Durango Drive and Westcliff Drive within the west half (W½) of the Southwest Quarter (SW¼) of the Southwest Quarter (SW¼) of Section 28, T. 20 S., R. 60 E., M.D.M., City of Las Vegas, Nevada.

PROPOSED DEVELOPMENT

The project is a seventeen building, 248 unit apartment complex on 15.7 acres. Husite Parkway is under construction along the north boundary. Westcliff Drive is the south boundary and Durango Drive is the west boundary.

Note developed @ < undeveloped
Page 6

EXISTING SITE CONDITIONS

The project is located below the Angel Park Detention Basin which removes the impact of all drainage areas west of Durango Drive. Figure 1 shows the drainage scheme for the developed state and Figure 2 shows the existing undeveloped state.

The site is crossed in the east-west direction by four washes which may vary in depth from 4 to 25 feet deep. The site has been developed to allow the stormwater from the development to stay in its respective wash. ✓

✓ This area is presently not in a special flood hazard area; see letter dated December 15, 1986 in Appendix A from the Federal Emergency Management Agency.

Figure 1 shows the developed drainage areas. Areas 1 and 6 drain to a point A. Area 2 drains to point B, Area 3 drains to Point C, and areas 4, 5, and 7 drain to Point D.

METHODOLOGY

The quantitative storm flow determination was calculated on an IBM-PAC AT utilizing hydrograph software based on Soil Conservation Service methodology. The theory is explained in detail in Section 4 of the Soil Conservation Service National Engineering Handbook.

A 3-hour rainfall was used to produce the estimated storm runoffs. The rainfall intensities and storm distributions used were taken from a draft copy obtained from the Clark County Regional Flood Control District of their flood manual. The rainfall intensities are as follows:

100 year	-	2.48 inches
25 year	-	1.82 inches
10 year	-	1.39 inches



The delineation of the contributing runoff areas was based on 50-scale topography and site inspections.

A runoff curve number of 89 was used to estimate the hydrologic condition of the undeveloped drainage basin soils, which are of the Cave type. For the developed site a composite curve number of 87 was used. This was formulated from 60% paved or covered (CN = 98) and 40% grassed (CN = 70).

The times of concentration for the drainage areas were calculated using graphs found in Technical Release 55 which relate ground slope, type of cover, and drainage velocity.

SUMMARY

<u>Drainage Area</u> <u>Undeveloped</u>	<u>Area</u> <u>Acres</u>	<u>Drainage Length</u> <u>Feet</u>		<u>Time of</u> <u>Concentration</u> <u>Minutes</u>	<u>Peak Flow CFS</u>		
		<u>Grass</u>	<u>Paved</u>		<u>100-</u> <u>Year</u>	<u>25-</u> <u>Year</u>	<u>10-</u> <u>Year</u>
1	5.9	750	0	12.5	11.4		
2	5.4	780	0	13.0	10.4		
3	7.5	760	0	12.7	14.4		
4	2.9	760	0	12.7	5.6		
<u>Developed</u>							
	21.7				41.8		
1	6.8	165	910	8.8	12.5	7.4	4.3
2	3.0	0	800	5.3	5.7	3.4	2.0
3	1.7	280	0	4.7	3.2	2.0	1.2
4	1.4	0	840	5.6	2.6	1.6	1.0
5	0.8	110	320	4.0	1.5	0.9	0.6
6	0.9	420	0	7.0	1.7	1.0	0.6
7	5.0	900	0	15.0	9.3	5.6	3.2
	19.6				36.5		

SUMMARY ROUTED 100-YEAR STORM FLOWS

<u>POINT</u>	<u>FLOW, CFS</u>	
	<u>UNDEVELOPED</u>	<u>DEVELOPED</u>
A	11.4	13.7
B	10.4	5.7
C	14.4	2.6
D	5.6	12.4
Total	41.8	34.4

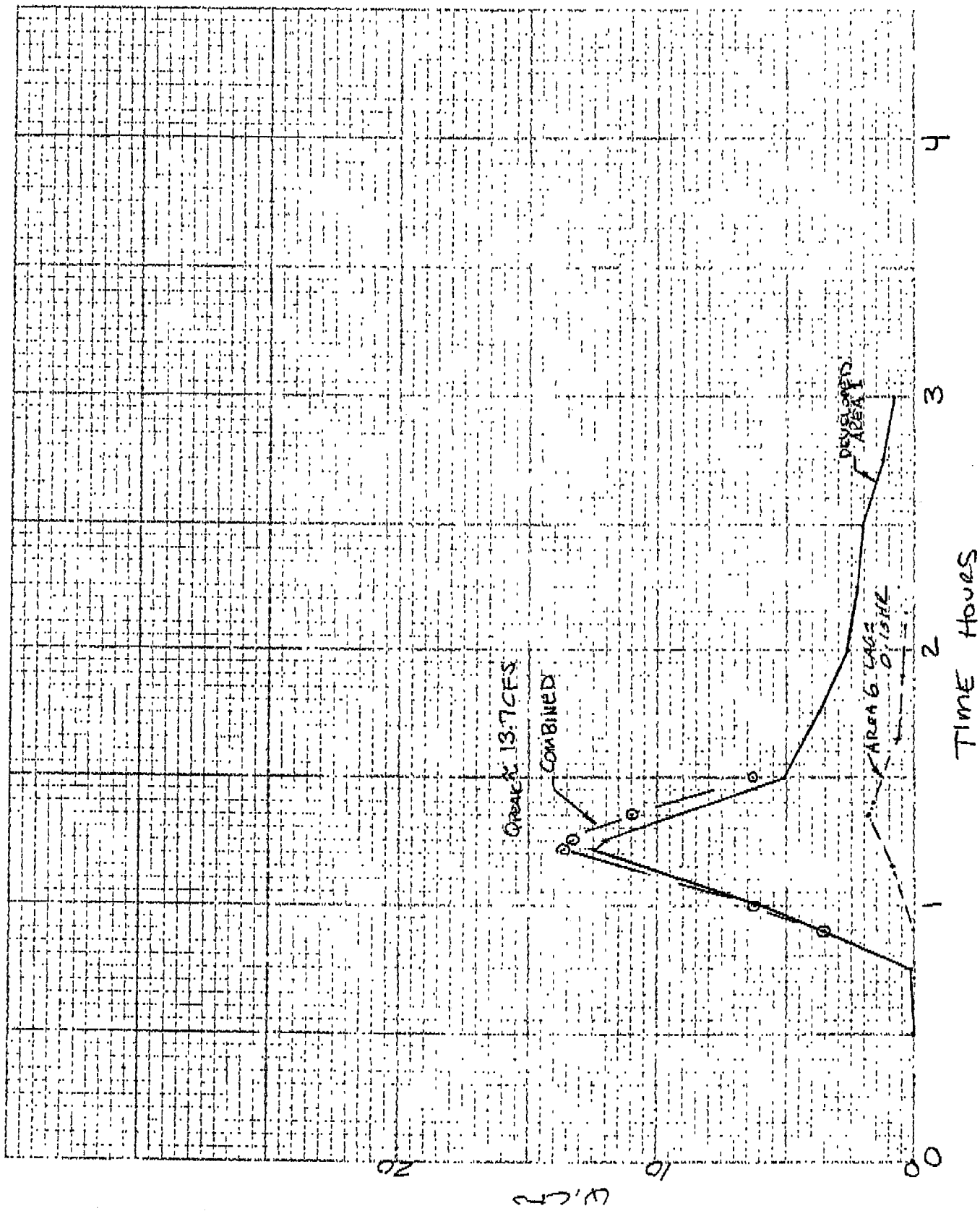
> ?

Appendix B contains calculations. The computer generated hydrographs are not included but are available if required.

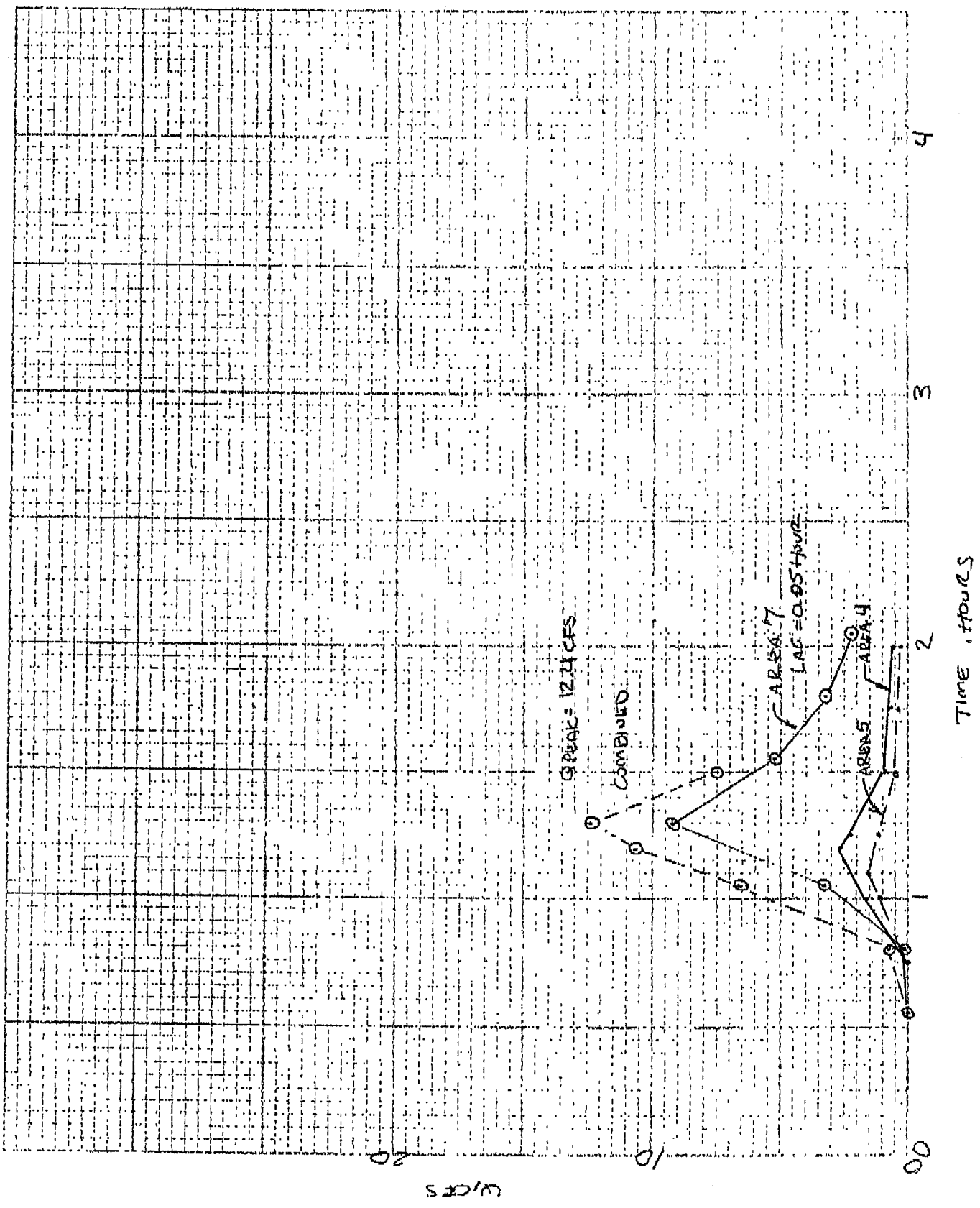
CONCLUSIONS AND RECOMMENDATIONS

The proposed development will have little effect on the storm drainage and overall will slightly reduce the total runoff from the area. The onsite flows are adequately handled within the streets of the project and the storm flows in Westcliff Drive are about 0.2' below the top of curb. Therefore, it is evident that the development of this site will not adversely affect either adjacent or downstream properties or significantly change existing storm flow patterns.

BY WSC DATE 1/10/89 SUBJECT ANGEL TRAIL SHEET NO. OF
 CHKD. BY DATE 100 YEAR OUTLET AT POINT A JOB NO. 880807



BY WSC DATE 1/10/09 SUBJECT ANGLET TRAIL SHEET NO. OF
 CHKD. BY DATE 100 YEAR OUTLET AT POINT D JOB NO. 880802



BY WSC DATE 1/10/89 SUBJECT ANGEL TRAIL SHEET NO. OF
 CHKD. BY DATE OUTLET SIZING JOB NO. P80802

A. $Q_{peak} = 13.7 \text{ CFS}$

USE 1 BLOCK 8" HIGH. ASSUME 6" FLOW

$$Q = CLH^{3/2}$$

C. U.S.D. BROAD CRESTED WEIRS

$$13.7 = 3.0(L)(0.5)^{3/2}$$

$L > 12.91$ TOO LONG

NOW TRY ORIFACE INLET 6" X 6"

$\Delta h = 4"$ NO. 7

$$Q = CA\sqrt{2g\Delta h}$$

$$13.7 \leq 0.7(B)(2(32.2)(\frac{4}{12})^{1/2})^{1/2}$$

$$13.7 < 9.7$$

USE TWO 6" WIDE OPENINGS

B. $Q_{100} = 5.68 \text{ CFS}$

$$Q = CLH^{3/2} \quad 6" \text{ DEPTH} \quad 6" \text{ WIDE}$$

$$Q = 6.34 \text{ CFS} \quad \therefore \quad 1 \times 6" \text{ WIDE OPENING OK}$$

C. $Q_{100} = 3.29 \text{ CFS} \quad \therefore \quad \text{ONLY } 6" \text{ WIDE OPENING OK}$

AREA 4. $Q_{100} = 2.64 \text{ CFS}$

DEPTH = 3" VG. $n = 0.012$

$$S = 1.8\% \quad Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

$$A = 34$$

$$R = \frac{84}{2d+3}$$

$$AR^{2/3} = 0.16$$

$$d \approx 0.2'$$



BY WSC DATE 1/10/89 SUBJECT ANGEL TRAIL

SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____

JOB NO. 880802

DEPTH FLOW IN WESTCLIFF Q_{PEAK} = 124 CFS

$$S = 2.90\%$$

$$S_x = 2.3\%$$

$$Q = \frac{0.56}{h} S_x^{1.67} S^{0.5} T^{2.67}$$

$$n = 0.015$$

$$T = 13.50'$$

$$d = 0.31'$$

Q_{157A} STREET

8

2416
ΔΦ1

Final

Pre-Design Report
Vegas Drive Street Improvements
(Rampart Boulevard to Rainbow Boulevard)

City of Las Vegas
City Engineering Division

30 December 1996
K/J # 967018.01 File 8.1

Kennedy/Jenks Consultants

Water and sewer laterals with the approximate sizes and lengths, will be constructed at the parcels shown in Table 3-2:

**TABLE 3-2
UTILITY LATERAL LOCATIONS**

Assessor Parcel Number Area Owner	Water Lateral		Sewer Lateral		Comments
	Size	Length	Size	Length	
138-29-501-001 83.12 BLM	6 inch	40 feet	8 inch	460 feet	West of Durango
138-28-501-001 20.00 BLM	6 inch	55 feet	8 inch	45 feet	West of Gleeson

Storm Drain Improvements

The project west of the Buffalo Channel has installed a 54" to 66" diameter reinforced concrete pipe (RCP) which is an outfall from the Angel Park Detention Basin into the Buffalo Channel. Various drop inlets are proposed which would also utilize this existing RCP. The proposed drop inlet locations, types and sizes are discussed in Section 7, Recommendations and are shown in Table 4-3.

No storm drain exists east of the Buffalo Channel and in order for the roadway to be in compliance with RTC criteria, a new storm drain is required. It is proposed to construct a 30 to 36 inch RCP along the south side of centerline. The pipe will discharge near the southeast corner of Rock Springs Drive and Vegas Drive which is within Nevada Department of Transportation right-of-way. The RCP will lend easterly for approximately 440 feet, transitioning into a concrete trapezoidal channel for the remaining 280 feet. The channel will discharge at the existing 10 foot wide by 4 foot deep double barrel reinforced concrete box inlet located approximately 240 feet south of Vegas Drive at I-95. The flow will be conveyed under I-95 within the RCB then through the 42 inch corrugated metal pipe which crosses under the Las Vegas Grand Prix property which ties into the bubbler in Rainbow Boulevard.

PROBABLE UTILITY CONFLICTS

As summarized above, the construction of a storm drain mainline, connector pipe, drop inlets and trapezoidal channel are proposed for the project. Any disturbance of existing improvements will cause conflicts. The conflicts can possibly be mitigated by adjusting the depth of the drop inlet boxes. The drop inlet connector pipes on the west of Buffalo Drive will tie into the Angel Park Detention Basin Outfall (APDO). The storm drain connector pipes on the east side of Buffalo Drive will tie into a new storm drain mainline ranging from 30 inch to 36 inch diameter. This mainline will not be constructed as deep as the APDO due to the outfall restraints at the downstream end. Table 3-3 shows areas where under ground facilities will need to be potholed in order to accurately locate the depth of the existing utility:

computer program was used as a check to insure the connector pipes and drop inlet depths were adequately sized.

DROP INLET DESIGN

To determine the placement of drop inlets along Vegas Drive, several concentration points were added. Each of the concentration points represents a change in the tributary area. Hydraulic calculations using FlowMaster (1995) included in Appendix A - Section 5 were performed at each concentration point to insure that the Clark County Standards were met.

The City of Las Vegas requires that the entire 10-year flow be intercepted at intersections with 100-foot right-of-way streets. Both Durango Drive and Buffalo Drive have 100-foot right-of-ways and the 10-year street flow will be intercepted.

The drop inlets used will be equipped with the Neenah Type R3067 LL vane grates and cast iron curb inlets. The number of grates required was determined using the rating curve supplied by Neenah. See Appendix A, Section 5. One Neenah Type R3067 LL grate and hood will be included for nuisance flow at various locations along the alignment. See Table 4-3 for a list of the nuisance drains.

**TABLE 4-3
NUISANCE DRAINS**

I.D. Number	Approx. Station	Location
1	28+00	North side of Vegas Drive @ Durango ✕
2	34+30	South side of Vegas Drive west of Astronomy ✕
3	48+30	South side of Vegas Drive ✕
4	54+75	North side of Vegas Drive @ Cimarron ✕
5	68+60	West side of Gleeson Way @ Vegas ✕
6	70+75	North side of Vegas Drive ✕
7	107+90	North side of Vegas Drive @ Tenaya ✕
8	107+90	South side of Vegas Drive @ Tenaya ✕
9	114+70	South side of Vegas Drive @ Wintergreen ✕
10	115+00	West side of Wintergreen Drive @ Vegas ✕
11	115+50	East side of Wintergreen Drive @ Vegas ✕
12	121+15	North side of Vegas Drive @ Rocksprings ✓
13	122+00	South side of Vegas Drive @ Rocksprings ✓

4.7 SUMMARY OF FLOWS & PROPOSED DRAINAGE FACILITIES

Table 4-4 summarizes the locations, the sizes and types of drop inlets, the 10 and 100-year flow before the drop inlet, the intercepted flows, and the remaining flow after the drop inlets for the proposed and existing drop inlets associated with this project.

Durango Drive

Durango Drive and Basins V-2A and V-2B are undeveloped. As requested by the City, the runoff from basin V-2A will be collected in Vegas Drive west of Durango (D.I. 1A). The runoff from basin V-2B will be collected on the west side of Durango south of Vegas (D.I. 1B).

DURANGO DRIVE - Westcliff Drive to Vegas Drive
Cost Estimate - 50% Submittal

29-Aug-03

Item No.	Item	Unit	Unit Price	RTC		CITY OF LAS VEGAS PARK AND REC.	
				Total Quantity	Total Cost	Total Quantity	Total Cost
200.01	MOBILIZATION AND DEMOBILIZATION	L.S.	\$120,000.00	1	\$120,000.00	0	0
201.01	CLEARING AND GRUBBING	L.S.	\$30,000.00	1	\$30,000.00	0	0
202.01	REMOVE AND SALVAGE SIGN	EA.	\$40.00	36	\$1,440.00	0	0
202.02	REMOVE CURB AND GUTTER	L.F.	\$2.50	1,300	\$3,250.00	0	0
202.03	REMOVE CONCRETE SIDEWALK	S.F.	\$1.00	7,200	\$7,200.00	0	0
202.04	REMOVE CONCRETE DRIVEWAY	S.F.	\$1.10	800	\$880.00	0	0
202.05	REMOVE PULLBOX	EA.	\$10.00	5	\$50.00	0	0
202.06	REMOVE LANDSCAPING	S.F.	\$2.00	30,000	\$60,000.00	0	0
202.07	REMOVE BITUMINOUS SURFACE (2-INCH COLD MILL)	S.Y.	\$2.50	10,500	\$26,250.00	0	0
202.08	REMOVE BITUMINOUS SURFACE	S.Y.	\$7.00	20,000	\$140,000.00	0	0
202.09	REMOVE DROP INLET	EA.	\$1,500.00	3	\$4,500.00	0	0
203.01	ROADWAY EXCAVATION	C.Y.	\$5.00	15,000	\$75,000.00	0	0
203.02	ROADWAY OVER-EXCAVATION AND BACKFILL	C.Y.	\$17.00	2,000	\$34,000.00	0	0
203.03	BORROW EMBANKMENT	C.Y.	\$10.00	175,000	\$1,750,000.00	0	0
211.01	GRAVEL MULCH	S.Y.	\$2.00	20,000	\$40,000.00	0	0
213.01	MODIFY IRRIGATION SYSTEM	L.S.	\$3,000.00	1	\$3,000.00	0	0
302.01	TYPE II AGGREGATE BASE	C.Y.	\$14.00	11,900	\$166,600.00	0	0
305.01	DECORATIVE ROCK	S.Y.	\$3.00	10,000	\$30,000.00	0	0
402.01	PLANTMIX BITUMINOUS SURFACE (5-INCH)	S.Y.	\$5.25	68,000	\$357,000.00	0	0
402.02	PLANTMIX BITUMINOUS SURFACE (3-INCH)	S.Y.	\$5.50	11,100	\$61,050.00	0	0
403.01	PLANTMIX BITUMINOUS OPEN-GRADED SURFACE (3/4-INCH)	S.Y.	\$1.90	79,000	\$150,100.00	0	0
502.01	BRIDGE STRUCTURE - SUMMERLIN PARKWAY	L.S.	2,500,000	1	\$2,500,000.00	0	0
502.02	CONCRETE BARRIER RAIL (TYPE A)	L.F.	\$40.00	1,900	\$76,000.00	0	0
502.03	CONCRETE BARRIER RAIL (TYPE B)	L.F.	\$60.00	1,400	\$84,000.00	0	0
502.04	CONCRETE BARRIER RAIL (TYPE F)	L.F.	\$30.00	100	\$3,000.00	0	0
502.05	PEDESTRIAN UNDERPASS	L.S.	\$250,000.00	0	0	1	\$250,000
502.06	CONCRETE ENCASEMENT	C.Y.	\$150.00	5	\$750.00	0	0
603.01	18-INCH RCP STORM DRAIN (CLASS III)	L.F.	\$65.00	3,000	\$195,000.00	0	0
603.02	24-INCH RCP STORM DRAIN (CLASS III)	L.F.	\$100.00	400	\$40,000.00	0	0
603.03	30-INCH RCP STORM DRAIN (CLASS III)	L.F.	\$90.00	10	\$900.00	0	0
603.04	18-INCH RCP END SECTION	EA.	\$700.00	1	\$700.00	0	0
603.05	24-INCH RCP SAFETY SLOPED END SECTION	EA.	\$1,500.00	1	\$1,500.00	0	0
609.01	MODIFIED TYPE CM2 DROP INLET, (L=7.5-FOOT)	EA.	\$6,500.00	1	\$6,500.00	0	0
609.02	NDOT TYPE 2A DROP INLET	EA.	\$2,500.00	1	\$2,500.00	0	0
609.03	MODIFIED TYPE CM2 DROP INLET, (L=2.5-FOOT)	EA.	\$3,000.00	4	\$12,000.00	0	0
609.04	ADJUST MANHOLE COVER	EA.	\$500.00	8	\$4,000.00	0	0
609.05	TYPE I (48-INCH) STORM DRAIN MANHOLE	EA.	\$3,000.00	7	\$21,000.00	0	0
609.06	MODIFIED TYPE CM2 DROP INLET, (L=15-FOOT)	EA.	\$9,000.00	1	\$9,000.00	0	0
609.07	MODIFIED TYPE CM2 DROP INLET, (L=12.5-FOOT)	EA.	\$7,500.00	1	\$7,500.00	0	0
609.08	MODIFIED NDOT TYPE 2A DROP INLET	EA.	\$6,500.00	1	\$6,500.00	0	0
610.01	RIPRAP	C.Y.	\$60.00	2	\$120.00	0	0
613.01	"L" TYPE CURB AND GUTTER	L.F.	\$8.50	7,500	\$63,750.00	0	0
613.02	CONCRETE SIDEWALK	S.F.	\$3.00	57,000	\$171,000.00	0	0
613.03	COMMERCIAL DRIVEWAY (OPTION B)	S.F.	\$7.00	1,200	\$8,400.00	0	0
613.04	RESIDENTIAL DRIVEWAY	S.F.	\$3.25	550	\$1,787.50	0	0
613.05	"A" TYPE ISLAND CURB	L.F.	\$4.50	9,000	\$40,500.00	0	0
613.06	TACK-ON CONCRETE MEDIAN ISLAND	S.F.	\$4.20	7,000	\$29,400.00	0	0
613.07	TACTILE WARNING PANEL	S.F.	\$25.00	120	\$3,000.00	0	0
616.01	72-INCH CHAIN-LINK FENCE	L.F.	\$8.00	700	\$5,600.00	0	0
616.02	24-FOOT DOUBLE SWING GATE	EA.	\$2,500.00	2	\$5,000.00	0	0
616.03	72-INCH CHAIN-LINK FENCE (REMOVE AND RESET)	EA.	\$10.00	4,000	\$40,000.00	0	0
618.01	GUARDRAIL-BARRIER RAIL CONNECTION (TRIPLE CORRUGATION)	EA.	\$1,500.00	1	\$1,500.00	0	0
618.02	GUARDRAIL TERMINAL (FLARED)	EA.	\$3,000.00	2	\$6,000.00	0	0
618.03	GALVANIZED GUARDRAIL (TRIPLE CORRUGATION) (REMOVE AND RESET)	L.F.	\$30.00	300	\$9,000.00	0	0
619.01	GUIDEPOST	EA.	\$25.00	400	\$10,000.00	0	0
622.01	CONSTRUCTION SURVEYING	L.S.	\$100,000.00	1	\$100,000.00	0	0
623L.01	250-WATT STREET LIGHT ASSEMBLY	EA.	\$2,100.00	65	\$136,500.00	0	0
623L.02	250-WATT STREET LIGHT ASSEMBLY (BRIDGE MOUNTED)	EA.	\$2,500.00	4	\$10,000.00	0	0
623L.03	UNDERPASS LIGHTING FIXTURES	EA.	\$1,500.00	8	\$12,000.00	0	0
623L.04	SERVICE PEDESTAL	EA.	\$2,500.00	5	\$12,500.00	1	\$2,500
623L.05	ELECTRICAL SERVICE CONDUIT	L.F.	\$25.00	1,200	\$30,000.00	40	\$1,000
623L.06	RELOCATE STREET LIGHT	L.S.	\$1,500.00	5	\$7,500.00	0	0
623L.07	NEVADA POWER COMPANY TRANSFORMER	EA.	\$5,000.00	1	\$5,000.00	0	0
623L.08	RELOCATE NEVADA POWER COMPANY SWITCHBOX	EA.	\$150,000.00	1	\$150,000.00	0	0
623L.09	MODIFY EXISTING SERVICE PEDESTAL	EA.	\$750.00	2	\$1,500.00	0	0
623T.01	P-30 PULLBOX (INTERCONNECT)	EA.	\$200.00	32	\$6,400.00	0	0
623T.02	TYPE 200 PULLBOX (INTERCONNECT)	EA.	\$200.00	13	\$2,600.00	0	0
623T.03	TRAFFIC SIGNAL SYSTEM AT DURANGO/WESTCLIFF	L.S.	\$200,000.00	1	\$200,000.00	0	0
623T.04	TRAFFIC SIGNAL SYSTEM AT DURANGO/EB ON RAMP	L.S.	\$180,000.00	1	\$180,000.00	0	0
623T.05	TRAFFIC SIGNAL SYSTEM AT DURANGO/WB OFF RAMP	L.S.	\$180,000.00	1	\$180,000.00	0	0
623T.06	TRAFFIC SIGNAL SYSTEM AT DURANGO/WASHINGTON	L.S.	\$200,000.00	1	\$200,000.00	0	0
623T.07	TRAFFIC SIGNAL SYSTEM AT DURANGO/VEGAS	L.S.	\$200,000.00	1	\$200,000.00	0	0
623T.08	4-INCH CONDUIT (INTERCONNECT)	L.F.	\$7.00	19,500	\$136,500.00	0	0
623T.09	TRAFFIC COUNT STATION	L.S.	\$2,500.00	0	0	0	0
623T.10	RELOCATE AND MODIFY EXISTING SERVICE PEDESTAL	EA.	\$1,500.00	1	\$1,500.00	0	0
623T.11	No. 3-1/2 PULLBOX (STREETLIGHT)	EA.	\$180.00	0	0	0	0
623T.12	No. 5 PULLBOX	EA.	\$180.00	2	\$360.00	0	0
624.01	TRAFFIC CONTROL AND MAINTENANCE	L.S.	\$160,000.00	1	\$160,000.00	0	0
625.01	PORTABLE CHANGEABLE MESSAGE SIGN	DAY	\$90.00	180	\$16,200.00	0	0
625.02	ARROW BOARD	DAY	\$40.00	180	\$7,200.00	0	0
627.01	PERMANENT SIGNS (GROUND MOUNTED)(METAL SUPPORTS)	S.F.	\$25.00	167	\$4,175.00	0	0
627.02	PERMANENT SIGNS (STLT POLE MOUNTED)	S.F.	\$25.00	95	\$2,375.00	0	0
627.03	PERMANENT SIGNS (OVERHEAD PANELS)	S.F.	\$25.00	640	\$16,000.00	0	0
627.04	PERMANENT SIGNS (TIMBER SUPPORTS)	S.F.	\$35.00	450	\$15,750.00	0	0

**DURANGO DRIVE - Westcliff Drive to Vegas Drive
Cost Estimate - 50% Submittal**

29-Aug-03

Item No.	Item	Unit	Unit Price	RTC		CITY OF LAS VEGAS PARK AND REC.	
				Total Quantity	Total Cost	Total Quantity	Total Cost
627.05	RELOCATE SIGN	E.A.	\$100.00	21	\$2,100.00	0	0
627.06	RELOCATE OVERHEAD DYNAMIC MESSAGE SIGN	E.A.	\$75,000.00	1	\$75,000.00	0	0
627.07	OVERHEAD SIGN STRUCTURE (CANTILEVERED)	E.A.	\$40,000.00	4	\$160,000.00	0	0
627.08	OVERHEAD SIGN STRUCTURE (BRIDGE)	E.A.	\$5,000.00	1	\$5,000.00	0	0
628.01	PREFORMED MARKING FILM (24-INCH SOLID WHITE)	L.F.	\$15.00	2,000	\$30,000.00	0	0
628.02	PREFORMED MARKING FILM ARROWS	E.A.	\$250.00	66	\$16,500.00	0	0
628.03	PREFORMED MARKING FILM "ONLY"	E.A.	\$375.00	40	\$15,000.00	0	0
628.04	PREFORMED MARKING FILM BIKE LEGEND DELINEATION AND LEGEND	E.A.	\$475.00	16	\$7,600.00	0	0
628.05	PREFORMED MARKING FILM (VARIES)	S.F.	\$8.00	125	\$1,000.00	0	0
628.06	MEDIAN NOSE PAINT	S.F.	\$1.50	950	\$1,425.00	0	0
628.07	LIQUID PAVEMENT MARKER (8-INCH WHITE)	L.F.	\$1.00	10,000	\$10,000.00	0	0
628.08	LIQUID PAVEMENT MARKER (8-INCH YELLOW)	L.F.	\$1.00	7,000	\$7,000.00	0	0
628.09	LIQUID PAVEMENT MARKER (12-INCH WHITE)	L.F.	\$1.50	2,500	\$3,750.00	0	0
628.10	LIQUID PAVEMENT MARKER (6-INCH WHITE)	L.F.	\$1.00	12,000	\$12,000.00	0	0
629.01	ADJUST WATER VALVE BOX	E.A.	\$300.00	15	\$4,500.00	0	0
629.02	ADJUST BLOW-OFF AND RISER ASSEMBLY	E.A.	\$300.00	1	\$300.00	0	0
629.03	ADJUST FIRE HYDRANT	E.A.	\$750.00	1	\$750.00	0	0
629.04	RELOCATE TEST STATION	E.A.	\$500.00	3	\$1,500.00	0	0
629.05	RELOCATE AVAR	E.A.	\$2,000.00	3	\$6,000.00	0	0
629.06	ADJUST WATER VALVE VAULT	E.A.	\$2,000.00	2	\$4,000.00	0	0
629.07	RELOCATE WATER METER AND BACKFLOW PREVENTION DEVICE	E.A.	\$1,500.00	1	\$1,500.00	0	0
629.08	RELOCATE IRRIGATION METER AND SERVICE PEDESTAL	E.A.	\$2,500.00	1	\$2,500.00	0	0
630.01	6-INCH PVC SANITARY SEWER LATERAL	L.F.	\$50.00	36	\$1,800.00	0	0
633.01	NON-REFLECTIVE PAVEMENT MARKERS	E.A.	\$1.50	2,500	\$3,750.00	0	0
633.02	REFLECTIVE PAVEMENT MARKERS	E.A.	\$2.70	1,700	\$4,590.00	0	0
637.01	DUST CONTROL	L.S.	\$30,000.00	1	\$30,000.00	0	0
637.02	NPDES DISCHARGE PERMIT	L.S.	\$1,000.00	1	\$1,000.00	0	0
637.03	PRE-EMERGENT HERBICIDE	ACRE	\$400.00	26	\$10,400.00	0	0
640.01	MSE WALL, BACKFILL, SIDEWALK, SCREENWALL, AND BARRIER RAIL	S.F.	\$55.00	12,500	\$687,500.00	0	0
640.02	SCREEN WALL	S.F.	\$20.00	14,000	\$280,000.00	0	0
640.03	CONCRETE MASONRY UNIT RETAINING WALL	S.F.	\$60.00	2,200	\$132,000.00	0	0
SUBTOTAL					\$9,738,753		\$253,500
20% CONTINGENCIES					\$1,947,751		\$50,700
TOTAL					\$11,686,503		\$304,200

**RESPONSE TO COMMENTS
ON THE
30% DRAINAGE REPORT
AND 30% IMPROVEMENTS**

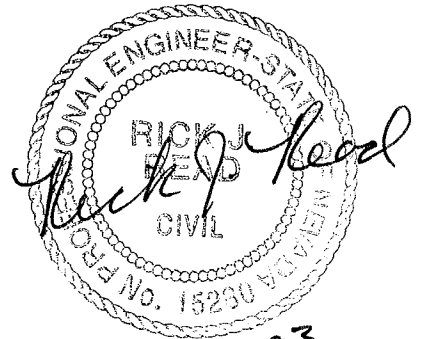
**DURANGO DRIVE – WESTCLIFF DRIVE
TO VEGAS DRIVE**

412.416

August 2003

Prepared for:

**City Of Las Vegas
731 South Fourth Street
Las Vegas, Nevada 89101
Phone: (702) 229-6541
Fax: (702) 382-8551**



**8-29-03
Exp. 12-31-03**

Prepared by:

**G. C. Wallace, Inc.
1555 South Rainbow Boulevard
Las Vegas, Nevada 89146
Phone: (702) 804-2000
Fax: (702) 804-2299**

DRAINAGE STUDY INFORMATION FORM

412.416

Name of Development: Durango Dr. from Westcliff Dr. To Vegas Dr. Date: August 2003

Location of Development: a) Descriptive (Cross Streets): North/South: Durango Dr East/West: Westcliff/Vegas Dr.
 b) Sect. 28, 29 Twn. 20S Rng. 60E

Name of Owner: City of Las Vegas Assessors Parcel No: 138-28-301-001

Telephone: 229-6541 Facsimile No: _____

Address: 731 South Fourth Street
Las Vegas Nevada 89101

Contact Person - Name Rick Read, P.E. Telephone No: (702) 804-2000

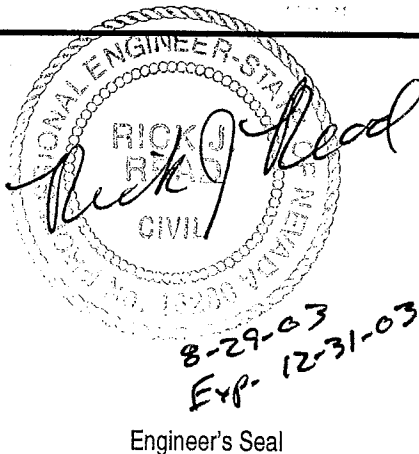
Firm: G. C. Wallace, Inc.

Address: 1555 South Rainbow Boulevard; Las Vegas, NV 89146

Type of Land Development / Land Disturbance Process:

☐	Rezoning	☐	Subdivision Map	☐	Clearing and Grading Only
☐	Parcel Map	☐	Planned Unit Development	☒	Other (Please specify below)
☐	Large Parcel Map	☐	Building Permit	☐	Street Improvements

- Total Owned Land Area: At Site: 12 acres Being Developed / Disturbed: 12 acres
- Is a portion or all of the subject property located in a designated FEMA Flood Hazard Area? Yes* ☒ No ☐
- Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? ☒ Yes ☐ No
- Proposed type of development: (Residential, Commercial, etc.)? Street Improvements
- Approximate upstream land area which drains to the subject site? 30 ± acres
- Has the site drainage been evaluated in the past? ☒ YES ☐ NO If yes, please identify documentation:
Technical Drainage Study for the Villas at Angel Park PBS & J 7/96
Pre-Design Report Vegas Dr. Street Imp. Kennedy/Jenks Consultants 1/96
- If known, please briefly identify the proposed discharge point(s) of runoff from the site:
Storm drain in Vegas Drive and in Westcliff Drive
- Briefly describe your proposed schedule for the subject project: ASAP



Submit this form as part of the required drainage study to the local entity which has jurisdiction over the subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

*Review and concurrence of the Clark County Regional Flood Control District is required.

Revision	Date

Local Entity File No. _____

REFERENCE:

STANDARD FORM 1



G. C. WALLACE, INC.
Engineers / Planners / Surveyors

G. C. WALLACE, PE/SE, PLS
JAMES A. DUDDLESTEN, PE
MICHAEL D. ROSS, PE
CHRISTOPHER W. ANDERSON, PE
CALVIN L. BLACK, PE, PLS
BENJAMIN C. SMITH, PE
SCOTT R. PLUMMER, PE
E. ROBERT PETERSON

THOMAS P. DYSON, PE
KENNETH M. HANIFAN, PE
DOUGLAS M. HANKEL
DONALD A. HASELHOFF, PE, CEM
BERT A. HUGHES, PE
RICKEY D. HUNSAKER, PE, LC
NOEL C. LAUGHLIN, PE
MARVIN W. MAIZE
DANNY S. McFADDEN, PE
S. WILLIAM NEIGHBORS, PE
THOMAS R. NICHOLS, PE
FREDERICK W. ORBAN, PLS
JERRY E. PRUITT, PE
BRIAN L. SCHMIDT, PE
JERRY J. SLATER, PE
JEFF W. STAYTON, PE
JOHN R. TOBIN, PE, PTOE
HOWARD K. VANDER MEER, PE, WRS
G. IRA WALLACE, PE
EUGENE W. WRIGHT, PE

JIM B. BAKKEDAH, PE
JOSEPH A. BODROG, PLS
ERIC J. GALVAN
RANDALL K. GREMLICH, PE
PASCAL HAYES, PE/SE
J. P. HIGGINS, PLS, WRS
DANNY E. HILL, PLS
DAPHNE L. HOFFMAN
DONALD L. HOTCHKISS JR., PE
RANDY W. MROWICKI, PLS
JOHNNIE R. PATE JR., PE, PTOE
SAUNDRA L. VANCE, CCS, CCCA
JOHN M. WALKER, PE
CHRISTOPHER R. ZRINYI, PE

FAYSAL ARIDI, PE
JOHN T. BROWN, PE
PATRICK S. BYRD, PE
MARY A. CARR, PE
ROY D. CLARK, PE
RICHARD G. CLARKE
HEIDI A. DEXHEIMER, PE
G. QUINCY EDWARDS, PE
MARK J. FAILLA, PE
JOHN FITCH, PE
PAUL F. FRITZ
ERIC G. GILES, PE
BRIJ M. GULATI, PE, PTOE
KEITH HATTON, PE
GABRIEL A. HERRERA, PE
GERALD L. HOLTON, PLS
BILL HUNTER, PE
RUSSELL D. JAMISON, PLS
JOSH JOHNSON, PE
KAYANN JONGSMA, PE
TODD N. KELLEY, PE
FRED KHANBOLOUKI, PE
SCOTT R. LANDERMAN, PLS
ANDRE R. LEONARD, PE
PAUL R. LOHMAN, PE
MICHAEL J. LUDWIG, PE
JEFFERY J. McBRIDE, PE
WILLIAM METCALF
MATTHEW D. MEYER, PE
WILLIAM J. MEYER, PE
RIMAH I. NAZZAL, PE/SE
GIA D. NGUYEN, PE
BRENT D. PARRISH
RICK J. READ, PE
BRADFORD G. ROCKWELL, PE
CHRISTOPHER B. SMITH, PE
DENNIS W. SOLANO, PLS
TODD STEADHAM, PE
HUAGAO (HUGO) TAN, PE
CHURAIRAT (ANN) TANAKUL, PE
KEVIN L. TOMLINSON, PE
F. EDUARDO VILLALOBOS, PE/SE
PAUL J. VILLALUZ, PE
KEVIN W. WALLACE, PLS
GLENN B. WATANABE, PE
STEPHEN L. WEATHERMAN, PE
MANSON W. WONG, PE, PTOE

AFFILIATE OFFICE IN
SACRAMENTO, CA

412.416

August 29, 2003

Dan Keating, P.E.
Engineering Project Manager
City of Las Vegas
731 South Fourth Street
Las Vegas, Nevada 89101

**Subject: Response to Comments on the Durango Drive –
Westcliff Drive to Vegas Drive 30% Drainage Report and
30% Improvements**

Dear Mr. Keating:

The purpose of this letter is to address the comments from the City of Las Vegas (CLV), dated July 16, 2003, regarding the above-referenced project. The comments are individually addressed as follows:

Comment: "1. The low point in Durango at the Washington Avenue intersection will require that the 10-year flow be intercepted at this sag point. The concept of grading a portion of sub-basin ULT4 to the Washington Avenue intersection (discussed during the May 27, 2003 review meeting) will revise the flows at the intersection, while reducing the flows going through the pedestrian underpass. Revise the hydrology to account for this change and discuss the flow impacts to this project."

Response: In meetings and correspondence with Dan Keating of CLV and G. C. Wallace, Inc. (GCW) it has been decided that the area that consists of Subbasin ULT4 will be graded to drain north to the Durango Drive/Washington Avenue intersection. If all of Subbasin ULT4 is graded to drain to the low point, there will be a 10-year storm flow of approximately 12 cfs (9 cfs in the west half of the street improvements and 3 cfs in the east half) and a 100-year storm flow of approximately 25 cfs (20 cfs in the west half of the street improvements and 5 cfs in the east half).

Under this scenario, the proposed 18-inch RCP storm drain system that drains north to the 39-foot drop inlet at the Durango Drive/Vegas Drive intersection will not have the capacity to convey the entire 10-year storm flow. The



G. C. WALLACE, INC.

Engineers/Planners/Surveyors

City of Las Vegas
Engineering Planning
August 29, 2003
Page 2

412.416

capacity of the 18-inch RCP storm drain system will be exceeded by approximately 2 cfs. The 2 cfs of the 10-year storm flow will bypass the drop inlet on the east side of the intersection and flow east in Washington Avenue. Washington Avenue has the capacity to convey approximately 50 cfs in one-half of the street during a 10-year storm and still maintain a 12-foot dry lane. After review of the *Technical Drainage Study for Washington/Bufalo Park* it was determined that the proposed park downstream is draining approximately 12 cfs during a 10-year storm event into Washington Avenue. The additional 2 cfs that will bypass the inlet on the east side of Durango will, therefore, not have a negative affect on Washington Avenue downstream. A normal depth 10-year storm capacity calculation for Washington Avenue is enclosed.

The 100-year storm flow at the low point in Durango Drive will also exceed the capacity of the 18-inch storm drain system, and the runoff that is not intercepted and conveyed in the storm drain system (~10 cfs) will overtop the crown of Durango Drive at a depth of approximately 2 inches and drain east in Washington Avenue. Washington Avenue has the capacity to convey this flow without exceeding the major street criteria described in the CCRFCD Manual or adversely impacting any downstream properties or facilities.

Under interim conditions there will be a 10-year storm flow of 16 cfs at the Durango Drive/Washington Avenue intersection (13 cfs in the west half of the street improvements and 3 cfs on the east). The proposed 12.5-foot Type CM D. I. on the west half of the street will intercept the 10-year storm flow at a depth of 0.5 feet, which provides a 12-foot dry lane in a 10-year storm event under interim conditions. Ten (10) cfs of the 13 cfs will drain north within the 18-inch RCP storm drain in Durango Drive to the Vegas Drive intersection. The remaining 3 cfs will bubble out of the drop inlet on the east side of the street. The top of grate of the proposed 7.5-foot Type CM D. I. on the east side of the intersection is 0.3 feet lower than the top of grate of the 12.5-foot Type CM D. I. on the west side of Durango and once the 18-inch RCP is filled to capacity the additional 3 cfs of runoff intercepted on the west side of the street will bubble out of the drop inlet at the lower elevation. The 3 cfs will bubble out of the 5-foot Type CM D.I. at an elevation of approximately 0.05 feet. Under this condition (10-year storm interim conditions) all of the runoff on the east side of Durango Drive will bypass the drop inlet and drain east in Washington Avenue.

Under interim conditions there will be a 100-year storm flow of 31 cfs at the Durango Drive/Washington Avenue intersection (26 cfs in the west half of the street improvements and 5 cfs on the east). The proposed 12.5-foot Type CM D. I. on the west half of the street will not intercept the 100-year interim conditions storm flows. The 100-year storm flow at the low point in



G. C. WALLACE, INC.

Engineers/Planners/Surveyors

City of Las Vegas

Engineering Planning

August 29, 2003

Page 3

412.416

Durango Drive will exceed the capacity of the 18-inch storm drain system, and the runoff that is not intercepted and conveyed in the storm drain system (~21 cfs) would overtop the crown of Durango Drive at a depth of approximately 3 inches and drain east in Washington Avenue. Washington Avenue has the capacity to convey this flow without exceeding the major street criteria described in the CCRFCD Manual or adversely impacting any downstream properties or facilities. Schematic drawings and calculations for the above-mentioned scenarios are included in the Appendix.

Comment: "2. The concept of eliminating the 18-inch storm drain in Durango, just north of Westcliff (discussed during the May 27, 2003 review meeting) is approved in concept provided that the study addresses the amount of flow and the capacity of the existing inlets at the Westcliff intersection."

Response: The 18-inch RCP storm drain between Westcliff Drive and Summerlin Parkway has been eliminated. In addition, a driveway is being provided to the asphalt concrete parking lot on the west side of Durango Drive across from Westcliff Drive. There are three (3) existing 4-foot Type "A" drop inlets at the location where the driveway entrance is being constructed. Two of the existing Type "A" drop inlets will be removed and two 2.5-foot Type CM drop inlets will be placed at the curb returns of the driveway entrance. There will be a 100-year and 10-year storm flow of 17 cfs and 9 cfs (ULT 7 plus 1/2 of ULT6), respectively, at the sump condition on the west side of Durango Drive. The combination of two 2.5-foot Type CM drop inlets and one Type "A" drop inlet will intercept the 10-year storm flow at a depth of approximately 0.3 feet, which provides a 12-foot dry lane. The 100-year storm flow will be intercepted at a depth of 0.5 feet. Durango Drive between Westcliff Drive and Summerlin Parkway also meets all CCRFCD Manual criteria for a major street. Revised street flow calculations and drop inlet calculations are enclosed in the Appendix.

Comment: "3. A 10-year flow summary exhibit must be provided showing the concentration points, the allowable dry-lane criteria street flows and the amount of the 10-year flow conveyed within the proposed storm drain and the remaining street flow."

Response: Figure 8 (enclosed) is a summary exhibit of the 10-year interim storm flows in the streets and in the proposed storm drain system. The ultimate 10-year storm flows are lower and, therefore, interim conditions is the worst case.

Comment: "4. The Engineer must continue to coordinate the Durango Drive improvements with the proposed Park improvements. The pedestrian tunnel under Durango (at the southwest corner of the park site) must be



G. C. WALLACE, INC.

Engineers/Planners/Surveyors

City of Las Vegas
Engineering Planning
August 29, 2003
Page 4

412.416

shown to coordinate design elevations."

Response: Noted.

Comment: "5. Provide detailed grading of the improvements along the Summerlin Parkway. The location of the on and off ramps impacts the existing drainage. Provide detailed design of the proposed Summerlin Parkway facilities and size the system to convey the 100-year flow at the ramps."

Response: The proposed storm drain facilities in the Summerlin Parkway alignment have been sized to convey the 100-year storm flows. An NDOT Type 2A drop inlet will intercept the 100-year storm runoff (1/2 of Subbasin ULT5) at a ponding depth of 0.6 feet and convey the intercepted runoff downstream under the proposed east bound on ramp. The downstream storm drain is proposed to be an 18-inch RCP. A 6-foot long Modified NDOT Type 2A drop inlet will intercept the 100-year storm runoff (Subbasin ULT8) at a ponding depth of 1.0 feet and convey the intercepted runoff downstream under the proposed west bound off ramp. The downstream storm drain is proposed to be a 24-inch RCP. Inlet calculations are enclosed in the Appendix. The storm drain systems in Summerlin Parkway have not been profiled for this submittal. HGL's will be calculated and drafted onto the plans for the next submittal.

Comment: "6. The proposed storm drain system pipe sizes must be evaluated based upon the 10-year flow conveyed within the pipes. The inlet capacities and the storm drain lateral sizes will be reviewed for compliance with the RTC drainage criteria based upon on inlet and outlet control at the next submittal."

Response: The proposed storm drain facilities in Durango Drive are sized to convey the 10-year storm ultimate conditions storm flows. Drop inlet calculations are enclosed in the Appendix. A detailed description of the runoff that is intercepted by the drop inlets is addressed in Response to Comments No. 1. The Type CM drop inlet calculations in a sump condition are based on the interception rate of the grates only with no clogging factor applied. The curb opening portion of the drop inlet is provided as a clogging factor for the drop inlet. The Type CM drop inlet calculations for inlets on a continuous grade take into account the interception of runoff for the grate and curb opening with a 50 percent clogging factor applied. All storm drains have been sized based on normal depth calculations. Standard Form 6 spreadsheets and HGL's on the plans will be provided for the next submittal.

Comment: "7. The Engineer must label the 10-year flow within the laterals and pipes and provide the HGL on the storm drain plan and profile sheets as a part of the



G. C. WALLACE, INC.

Engineers/Planners/Surveyors

City of Las Vegas
Engineering Planning
August 29, 2003
Page 5

412.416

90% submittal."

Response: The 10-year flow and HGL's will be provided in the 90% submittal.

Comment: "8. Revise Figure 7, Storm Drain Facilities to reflect the revised storm drain system proposed for this project."

Response: Figure 7 has been revised to reflect the revised storm drain and drop inlet layout.

Comment: "9. Detailed intersection grading plans for the Durango/Washington intersection must be provided with the 90% plans."

Response: The Durango Drive/Washington Avenue intersection grading will be provided with the 90% plans.

Comment: "10. Provide details of the Manholes, Neenah cast iron type drop inlets (maximum 9-feet long) and the modified Type C inlets with the 90% plans. Type A or B inlets are no longer allowed. Label the revised inlet sizes on the plan sheets."

Response: The proposed manholes and NDOT Type 2A drop inlet are referenced to standard drawings on the plans. A detail of the Type CM drop inlets and Modified NDOT Type 2A inlets are provided in the plans. The revised inlet sizes and types are called out in the plans and shown on the revised drainage study figures.

Comment: "11. The Engineer should acquire utility pothole information as soon as practical to determine additional constraints on the storm drain system design. Consideration on utility relocations and impacts must be identified."

Response: Pothole information and storm drain constraints are being identified at this time and will be complete for the 90% submittal.

Comment: "12. The existing and proposed utility crossings of the storm drain must be shown on the storm drain plan and profiles sheets and on the lateral profiles."

Response: Utility crossings will be provided in the 90% submittal.



G. C. WALLACE, INC.

Engineers/Planners/Surveyors

City of Las Vegas

Engineering Planning

August 29, 2003

Page 6

412.416

If you have any questions or require additional information, please contact us at 804-2000.

Very truly yours,

G. C. WALLACE, INC.

Rick J. Read, P.E.
Project Manager
Flood Control Division

RJR:jj

Encl.

pc: Jerry E. Pruitt, GCW
John Tobin, GCW

APPENDIX

Street Flow Calculations

Drop Inlet Calculations

Figure 8

Revised Figure 7

Hydraulic calculations for the Washington/Durango Intersection

SECT C - WEST (10-YEAR) SUBBASIN ULT7 PLUS 1/2 ULT6

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTC-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.005000 ft/ft
Discharge	9.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.54 ft
Elevation Range	0.00 to 1.39
Flow Area	4.3 ft ²
Wetted Perimeter	23.3328 ft
Top Width	22.7830 ft
Actual Depth	0.54 ft
Critical Elevation	0.52 ft
Critical Slope	0.006805 ft/ft
Velocity	2.11 ft/s
Velocity Head	0.07 ft
Specific Energy	0.61 ft
Froude Number	0.86
Flow Type	Subcritical

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

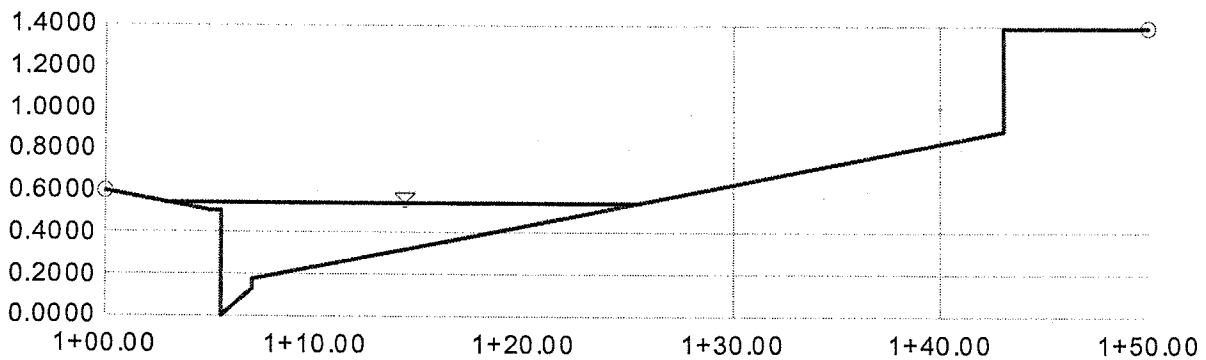
Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

CROSS SECTION C WEST (10-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTC-WEST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.005000 ft/ft
Water Surface Elevation	0.54 ft
Elevation Range	0.00 to 1.39
Discharge	9.00 cfs



V:10.0
H:1
NTS

SECT C - EAST (10-YEAR) 1/2 ULT6 **Worksheet for Irregular Channel**

Project Description	
Worksheet	SECTC-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.005000 ft/ft
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Flow Area	1.8 ft ²
Wetted Perimeter	13.1584 ft
Top Width	12.7162 ft
Actual Depth	0.39 ft
Critical Elevation	0.37 ft
Critical Slope	0.007768 ft/ft
Velocity	1.71 ft/s
Velocity Head	0.05 ft
Specific Energy	0.44 ft
Froude Number	0.81
Flow Type	Subcritical

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

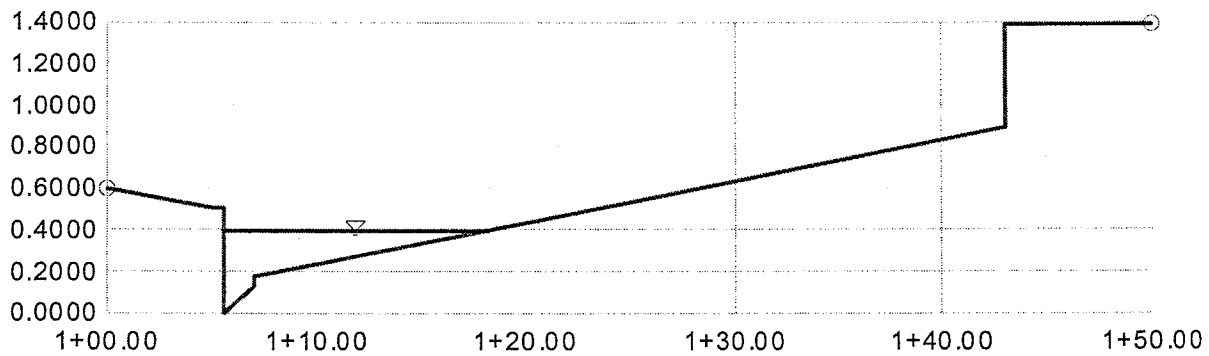
Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

CROSS SECTION C EAST (10-YEAR)

Cross Section for Irregular Channel

Project Description	
Worksheet	SECTC-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.005000 ft/ft
Water Surface Elevation	0.39 ft
Elevation Range	0.00 to 1.39
Discharge	3.00 cfs



V:10.0
H:1
NTS

SECT B EAST (10-YEAR) (SUBBASIN ULT3) Worksheet for Irregular Channel

Project Description	
Worksheet	SECTB(10) EAST
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.050000 ft/ft
Discharge	3.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 1.39
Flow Area	0.7 ft ²
Wetted Perimeter	7.9812 ft
Top Width	7.6415 ft
Actual Depth	0.29 ft
Critical Elevation	0.37 ft
Critical Slope	0.007769 ft/ft
Velocity	4.17 ft/s
Velocity Head	0.27 ft
Specific Energy	0.56 ft
Froude Number	2.40
Flow Type	Supercritical

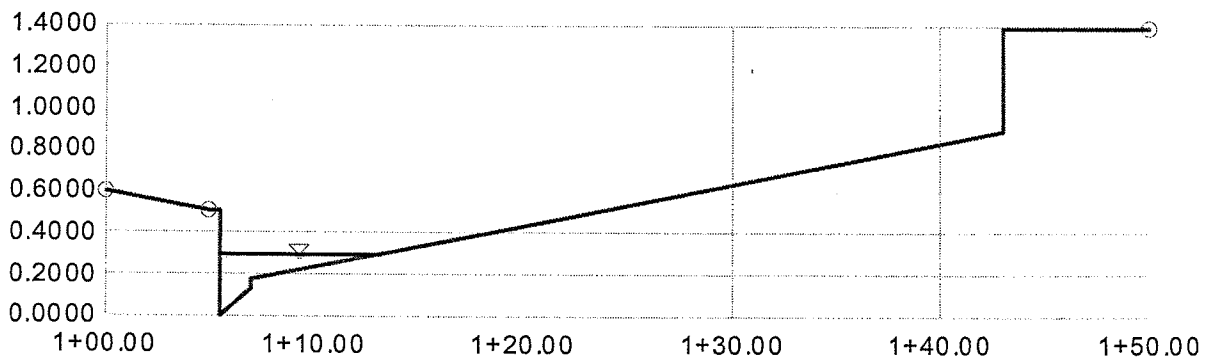
Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+05.00	0.025
1+05.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

SECT B EAST (10-YEAR)
Cross Section for Irregular Channel

Project Description	
Worksheet	SECTB(10) EAST
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.016
Slope	0.050000 ft/ft
Water Surface Elevation	0.29 ft
Elevation Range	0.00 to 1.39
Discharge	3.00 cfs



V:10.0
H:1
NTS

SECT A-EAST (10-YEAR)

Worksheet for Irregular Channel

Project Description	
Worksheet	SECTA-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Slope	0.015000 ft/ft
Discharge	4.00 cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

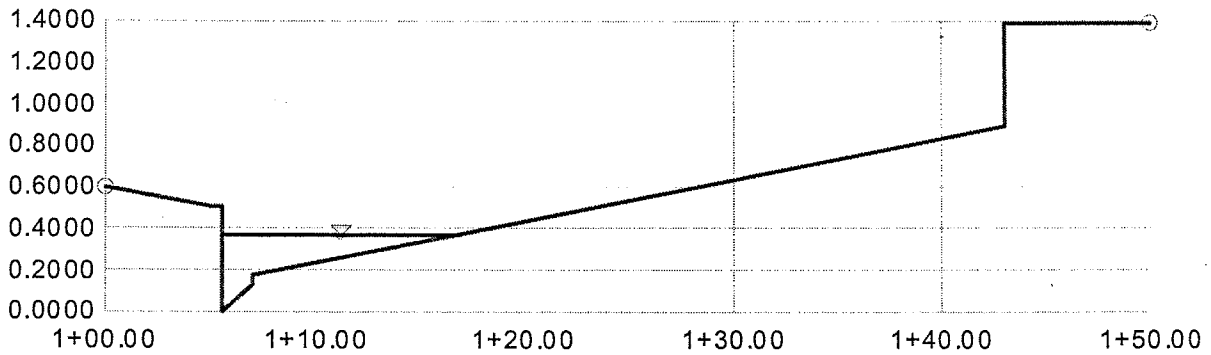
Results	
Mannings Coefficient	0.016
Water Surface Elevation	0.37 ft
Elevation Range	0.00 to 1.39
Flow Area	1.4 ft ²
Wetted Perimeter	11.8143 ft
Top Width	11.3988 ft
Actual Depth	0.37 ft
Critical Elevation	0.40 ft
Critical Slope	0.007479 ft/ft
Velocity	2.79 ft/s
Velocity Head	0.12 ft
Specific Energy	0.49 ft
Froude Number	1.39
Flow Type	Supercritical

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+43.00	0.8900
1+43.00	1.3900
1+50.00	1.3900

SECT A-EAST (10-YEAR) **Cross Section for Irregular Channel**

Project Description	
Worksheet	SECTA-EAST(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth
Section Data	
Mannings Coefficient	0.016
Slope	0.015000 ft/ft
Water Surface Elevation	0.37 ft
Elevation Range	0.00 to 1.39
Discharge	4.00 cfs



V:10.0
H:1
NTS

WASHINGTON CAPACITY CALCULATION

Worksheet for Irregular Channel

10-year 12foot dry Lane

Project Description	
Worksheet	washington(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Slope	0.010000 ft/ft
Water Surface Elevation	0.79 ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.016
Elevation Range	0.00 to 1.03
Discharge	51.32 cfs
Flow Area	12.0 ft ²
Wetted Perimeter	38.7428 ft
Top Width	38.0000 ft
Actual Depth	0.79 ft
Critical Elevation	0.87 ft
Critical Slope	0.005379 ft/ft
Velocity	4.26 ft/s
Velocity Head	0.28 ft
Specific Energy	1.07 ft
Froude Number	1.33
Flow Type	Supercritical

Calculation Messages:

Water elevation exceeds lowest end station by 0.19 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
1+00.00	1+50.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
1+00.00	0.6000
1+05.00	0.5000
1+05.50	0.5000
1+05.50	0.0000
1+07.00	0.1300
1+07.00	0.1700
1+50.00	1.0300

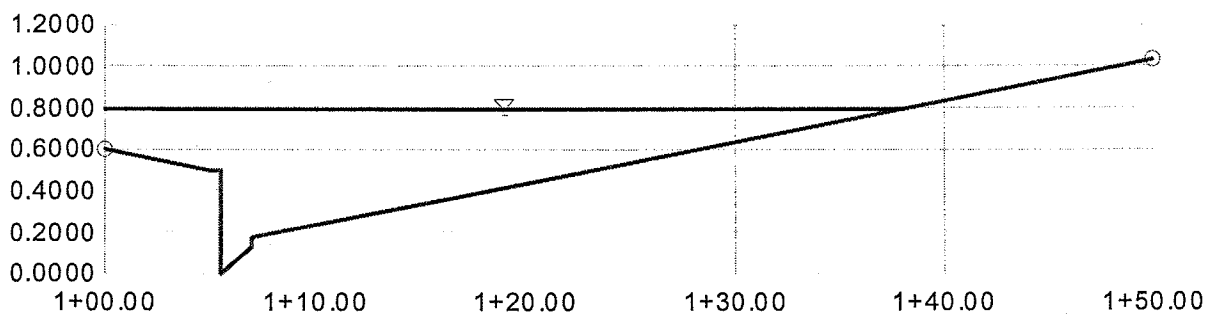
WASHINGTON CALCULATION

Cross Section for Irregular Channel

10 year - 12 foot dry lane

Project Description	
Worksheet	washington(10)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data	
Mannings Coefficient	0.016
Slope	0.010000 ft/ft
Water Surface Elevation	0.79 ft
Elevation Range	0.00 to 1.03
Discharge	51.32 cfs



V:10.0
H:1
NTS

100-year

Type A Drop Inlet Sizing in a Sump 4' TYPE "A" D.I. AT WESTCLIFF	
Known:	
D_p = Ponding depth at inlet (ft)	0.5
W = Gutter Width (ft)	1.50
L_c = Length of curb opening (ft)	4.00
H_c = Curb opening height (ft)	0.547
C_{wc} = Weir coefficient for curb opening	2.3
C_{wg} = Weir coefficient for grate	3.0
C_o = Orifice coefficient	0.67
R_o = Grate opening factor	0.60
C_{fc} = Clogging factor for curb opening (%)	50
Curb Opening Capacity Calculations	
P_c = Active curb opening weir length (acowl) = $L_c + 1.8 * W$ (ft)	6.70
P_{ac} = Adjusted acowl = $L_c + 1.8 * (1 - C_{fc}/100) * W$ (ft)	5.35
A_c = curb opening area (coa) = $L_c * H_c$ (ft ²)	2.19
A_{ac} = Adjusted coa = $A_c * (1 - C_{fc}/100)$ (ft ²)	1.09
C = check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} = Flow int'd by curb opening (cfs)	4.9
If "weir" controls $Q_{ic} = C_{wc} * P_{ac} * D_p^{1.5}$ If "orifice" controls $Q_{ic} = C_o * A_{ac} * (64.4 * D_p * H_c / 2)^{0.5}$	

10-year

Type A Drop Inlet Sizing in a Sump	
4' TYPE "A" D.I. AT WESTCLIFF	
Known:	
D_p = Ponding depth at inlet (ft)	0.4
W = Gutter Width (ft)	1.50
L_c = Length of curb opening (ft)	4.00
H_c = Curb opening height (ft)	0.547
C_{wc} = Weir coefficient for curb opening	2.3
C_{wg} = Weir coefficient for grate	3.0
C_o = Orifice coefficient	0.67
R_o = Grate opening factor	0.60
C_{fc} = Clogging factor for curb opening (%)	50
Curb Opening Capacity Calculations	
P_c = Active curb opening weir length (acowl) = $L_c + 1.8 * W$ (ft)	6.70
P_{acl} = Adjusted acowl = $L_c + 1.8 * (1 - C_{fc} / 100) * W$ (ft)	5.35
A_c = curb opening area (coa) = $L_c * H_c$ (ft ²)	2.19
A_{aca} = Adjusted coa = $A_c * (1 - C_{fc} / 100)$ (ft ²)	1.09
C = check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} = Flow int'd by curb opening (cfs)	3.3
If "weir" controls $Q_{ic} = C_{wc} * P_{acl} * D_p^{1.5}$	
If "orifice" controls $Q_{ic} = C_o * A_{aca} * (64.4 * D_p * H_c / 2)^{0.5}$	

100-year

Modified Type C Drop Inlet Sizing in a Sump

2.5' DROP INLETS @ WESTCLIFF

Known:

D_p =	Ponding depth at inlet (ft)	0.5
W =	Gutter Width (ft)	1.50
L_g =	Length of grate (ft)	2.50
L_c =	Length of curb opening (ft)	2.50
H_c =	Curb opening height (ft)	0.547
C_{wc} =	Weir coefficient for curb opening	2.3
C_{wg} =	Weir coefficient for grate	3.0
C_o =	Orifice coefficient	0.67
R_o =	Grate opening factor	0.60
C_{fg} =	Clogging factor for grate (%)	0
C_{fc} =	Clogging factor for curb opening (%)	0

Grate Capacity Calculations

P_g =	Active grate weir length (agwl) = $2*W + L_g$ (ft)	5.50
P_{agi} =	Adjusted agwl = $2*(1 - C_{fg}/100)*W + L_g$ (ft)	5.50
A_g =	Grate area = $W*L_g$ (ft ²)	3.75
A_{aga} =	Adjusted open grate area = $A_g*R_o*(1 - C_{fg}/100)$ (ft ²)	2.25
C =	check - If $D_p < 1.792*A_g/P_{agi}$; weir; else orifice	weir
Q_{ig} =	Flow intercepted by grate (cfs) If "weir" controls $Q_{ig} = C_{wg}*P_{agi}*D_p^{1.5}$ If "orifice" controls $Q_{ig} = C_o*A_{aga}*(64.4*D_p)^{0.5}$	5.8

Curb Opening Capacity Calculations

P_c =	Active curb opening weir length (acowl) = $L_c + 1.8*W$ (ft)	5.20
P_{aci} =	Adjusted acowl = $L_c + 1.8*(1 - C_{fc}/100)*W$ (ft)	5.20
A_c =	curb opening area (coa) = L_c*H_c (ft ²)	1.37
A_{aca} =	Adjusted coa = $A_c*(1 - C_{fc}/100)$ (ft ²)	1.37
C =	check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} =	Flow int'd by curb opening (cfs) If "weir" controls $Q_{ic} = C_{wc}*P_{aci}*D_p^{1.5}$ If "orifice" controls $Q_{ic} = C_o*A_{aca}*(64.4*D_p*H_c/2)^{0.5}$	4.2

Total Inlet Calculations

Q_t =	Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	10.1
q =	Interception per unit length = Q_t/L_g (cfs/ft)	4.0

10-year

Modified Type C Drop Inlet Sizing in a Sump

2.5' DROP INLETS @ WESTCLIFF

Known:

D_p =	Ponding depth at inlet (ft)	0.3
W =	Gutter Width (ft)	1.50
L_g =	Length of grate (ft)	2.50
L_c =	Length of curb opening (ft)	2.50
H_c =	Curb opening height (ft)	0.547
C_{wc} =	Weir coefficient for curb opening	2.3
C_{wg} =	Weir coefficient for grate	3.0
C_o =	Orifice coefficient	0.67
R_o =	Grate opening factor	0.60
C_{fg} =	Clogging factor for grate (%)	0
C_{fc} =	Clogging factor for curb opening (%)	0

Grate Capacity Calculations

P_g =	Active grate weir length (agwl) = $2*W + L_g$ (ft)	5.50
P_{agi} =	Adjusted agwl = $2*(1 - C_{fg}/100)*W + L_g$ (ft)	5.50
A_g =	Grate area = $W*L_g$ (ft ²)	3.75
A_{aga} =	Adjusted open grate area = $A_g*R_o*(1 - C_{fg}/100)$ (ft ²)	2.25
C =	check - If $D_p < 1.792*A_g/P_{agi}$; weir; else orifice	weir
Q_{ig} =	Flow intercepted by grate (cfs) If "weir" controls $Q_{ig} = C_{wg}*P_{agi}*D_p^{1.5}$ If "orifice" controls $Q_{ig} = C_o*A_{aga}*(64.4*D_p)^{0.5}$	3.3

Curb Opening Capacity Calculations

P_c =	Active curb opening weir length (acowl) = $L_c + 1.8*W$ (ft)	5.20
P_{aci} =	Adjusted acowl = $L_c + 1.8*(1 - C_{fc}/100)*W$ (ft)	5.20
A_c =	curb opening area (coa) = L_c*H_c (ft ²)	1.37
A_{aca} =	Adjusted coa = $A_c*(1 - C_{fc}/100)$ (ft ²)	1.37
C =	check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} =	Flow int'd by curb opening (cfs) If "weir" controls $Q_{ic} = C_{wc}*P_{aci}*D_p^{1.5}$ If "orifice" controls $Q_{ic} = C_o*A_{aca}*(64.4*D_p - H_c/2)^{0.5}$	2.4

Total Inlet Calculations

Q_{ti} =	Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	5.6
q =	Interception per unit length = Q_{ti}/L_g (cfs/ft)	2.3

Modified Type C Drop Inlet Sizing on a C. G.

DROP INLET EAST SIDE OF DURANGO (SECT B

Known:

Q_s =	Half Street flow (cfs)	3.0
S_o =	Longitudinal slope (ft/ft)	0.050
n =	Manning's roughness coef	0.016
V_s =	Flow velocity (fps)	4.2
D =	Flow depth (ft)	0.29
S_x =	Street transverse slope (ft/ft)	0.02
W =	Gutter Width (ft)	1.5
D_s =	Gutter Depression (in)	2.0
L_g =	Length of grate (ft)	7.5
L_c =	Length of curb opening (ft)	7.50
C_{rg} =	Clogging factor for grate (%)	50
C_{rc} =	Clogging factor for curb opening (%)	50

Grate Capacity Calculations

R_f =	Frontal flow factor = $1 - 0.09 \cdot (V_s - V_o)$ if $V_s > V_o$; else $R_f = 1$	1.00
V_o =	Splash over velocity = $p + q \cdot L_g \cdot r \cdot L_g^2 + s \cdot L_g^3$ (fps)	8.71
E_o =	Grate flow ratio = Q_w / Q_s	0.51
Q_w =	Frontal flow = $Q_s - Q_x$	1.54
Q_x =	Side flow = $0.56 / n \cdot (S_x^{1.67} \cdot T_x^{2.67} \cdot S_o^{0.5})$ (cfs)	1.5
T_x =	Side flow spread $(D - D_{sfeet}) / S_x$ (ft)	6.17
R_s =	Side flow factor = $1 / (1 + (0.15 \cdot V_s^{1.8}) / (S_x \cdot ((1 - C_{rg} / 100) \cdot L_g)^{2.3}))$	0.17
Q_{ig} =	Flow intercepted = $[R_f \cdot E_o + R_s \cdot (1 - E_o)] \cdot Q_s$	1.8

* $p=1.76$; $q=3.12$; $r=0.45$; $s=0.03$ (based on Bar P 1-1/8 grate)

Curb Opening Capacity Calculations

S_e =	Equivalent cross slope = $S_x + S_w \cdot E_o$ (ft/ft)	0.077
S_w =	Gutter cross slope = D_{sfeet} / W	0.111
L_t =	Total interception $L = 0.60 \cdot Q_s^{0.42} \cdot S_o^{0.30} \cdot (1 / n \cdot S_e)^{0.6}$ (ft)	21.59
Q_{ic} =	Flow intercepted = $(1 - (1 - (1 - C_{rc} / 100) \cdot L_c / L_t)^{1.8}) \cdot Q_s$ (cfs)	0.9

Total Inlet Calculations

Q_{ti} =	Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	2.7
Q_{tq} =	Flow bypass = $Q_s - Q_{ti}$ (cfs)	0.34
q =	Interception per unit ratio = Q_{ti} / L_g (cfs/ft)	0.35
E_q =	Efficiency = $(Q_{ti} / Q_s) \cdot 100$	89%

Modified Type C Drop Inlet Sizing in a Sump

12.5-ft drop inlet at STA 73+84 (Durango West)

Known:

D_p =	Ponding depth at inlet (ft)	0.5
W =	Gutter Width (ft)	1.50
L_g =	Length of grate (ft)	12.50
L_c =	Length of curb opening (ft)	12.50
H_c =	Curb opening height (ft)	0.547
C_{wc} =	Weir coefficient for curb opening	2.3
C_{wg} =	Weir coefficient for grate	3.0
C_o =	Orifice coefficient	0.67
R_o =	Grate opening factor	0.60
C_{fg} =	Clogging factor for grate (%)	0
C_{fc} =	Clogging factor for curb opening (%)	0

Grate Capacity Calculations

P_g =	Active grate weir length (agwl) = $2*W + L_g$ (ft)	15.50
P_{agi} =	Adjusted agwl = $2*(1 - C_{fg}/100)*W + L_g$ (ft)	15.50
A_g =	Grate area = $W * L_g$ (ft ²)	18.75
A_{aga} =	Adjusted open grate area = $A_g * R_o * (1 - C_{fg}/100)$ (ft ²)	11.25
C =	check - If $D_p < 1.792 * A_{ag}/P_{agi}$; weir; else orifice	weir
Q_{ig} =	Flow intercepted by grate (cfs) If "weir" controls $Q_{ig} = C_{wg} * P_{agi} * D_p^{1.5}$ If "orifice" controls $Q_{ig} = C_o * A_{aga} * (64.4 * D_p)^{0.5}$	16.4

Curb Opening Capacity Calculations

P_c =	Active curb opening weir length (acowl) = $L_c + 1.8 * W$ (ft)	15.20
P_{aci} =	Adjusted acowl = $L_c + 1.8 * (1 - C_{fc}/100) * W$ (ft)	15.20
A_c =	curb opening area (coa) = $L_c * H_c$ (ft ²)	6.84
A_{aca} =	Adjusted coa = $A_c * (1 - C_{fc}/100)$ (ft ²)	6.84
C =	check - If $D_p < H_c$; weir; else orifice	weir
Q_{ic} =	Flow int'd by curb opening (cfs) If "weir" controls $Q_{ic} = C_{wc} * P_{aci} * D_p^{1.5}$ If "orifice" controls $Q_{ic} = C_o * A_{aca} * (64.4 * D_p * H_c/2)^{0.5}$	12.4

Total Inlet Calculations

Q_{ti} =	Total flow intercepted = $Q_{ig} + Q_{ic}$ (cfs)	28.8
q =	Interception per unit length = Q_{ti}/L_g (cfs/ft)	2.3

100-year storm flow

Grate Inlet Headwater Depth Calculation NDOT TYPE 2A DROP INLET EAST BOUND ON RAMP	
Known:	
Q=	Flow (cfs) 6.0
W=	Width of Grate (ft) 2.00
L=	Length of Grate (ft) 3.00
D=	Diameter of Circle (in)
Cf=	Clogging Factor (%) 50
Weir Conditions:	
$H_w = (Q / (C_w * P))^{2/3}$	
Cw=	Weir Coefficient 2.70
P=	Perimeter of grate (ft) 10.0
Pc=	Perimeter (w/clogging) (ft) 5.0
Hw=	Headwater depth (ft) 0.58
Orifice Conditions:	
$H_w = (Q / (C_o * A_c))^2 / 2 * g$	
Co=	Orifice Coefficient 0.67
Ag=	Grate Area (ft ²) 6.00
Gf=	Grate Opening Factor 0.67
Ac=	Grate Open Area (w/ clogging) (ft ²) 2.01
Hw=	Headwater depth (ft) 0.31
Worst Case Scenario Occurs Under Weir Conditions	
Headwater Depth = 0.58 ft with grate	

100-YEAR

Grate Inlet Headwater Depth Calculation

MODIFIED NDOT TYPE 2A DROP INLET

WEST BOUND OFFRAMP

Known:

Q=	Flow (cfs)	21.0
W=	Width of Grate (ft)	2.00
L=	Length of Grate (ft)	6.00
D=	Diameter of Circle (in)	
Cf=	Clogging Factor (%)	50

Weir Conditions:

$$H_w = (Q / (C_w * P))^{2/3}$$

Cw=	Weir Coefficient	2.70
P=	Perimeter of grate (ft)	16.0
Pc=	Perimeter (w/clogging) (ft)	8.0
Hw=	Headwater depth (ft)	0.98

Orifice Conditions:

$$H_w = (Q / (C_o * A_c))^2 / 2 * g$$

Co=	Orifice Coefficient	0.67
Ag=	Grate Area (ft ²)	12.00
Gf=	Grate Opening Factor	0.67
Ac=	Grate Open Area (w/ clogging) (ft ²)	4.02
Hw=	Headwater depth (ft)	0.94

Worst Case Scenario Occurs Under Weir Conditions

Headwater Depth = 0.98 ft with grate

CLIENT Durango Drive / Warrington Avenue JOB NO. _____

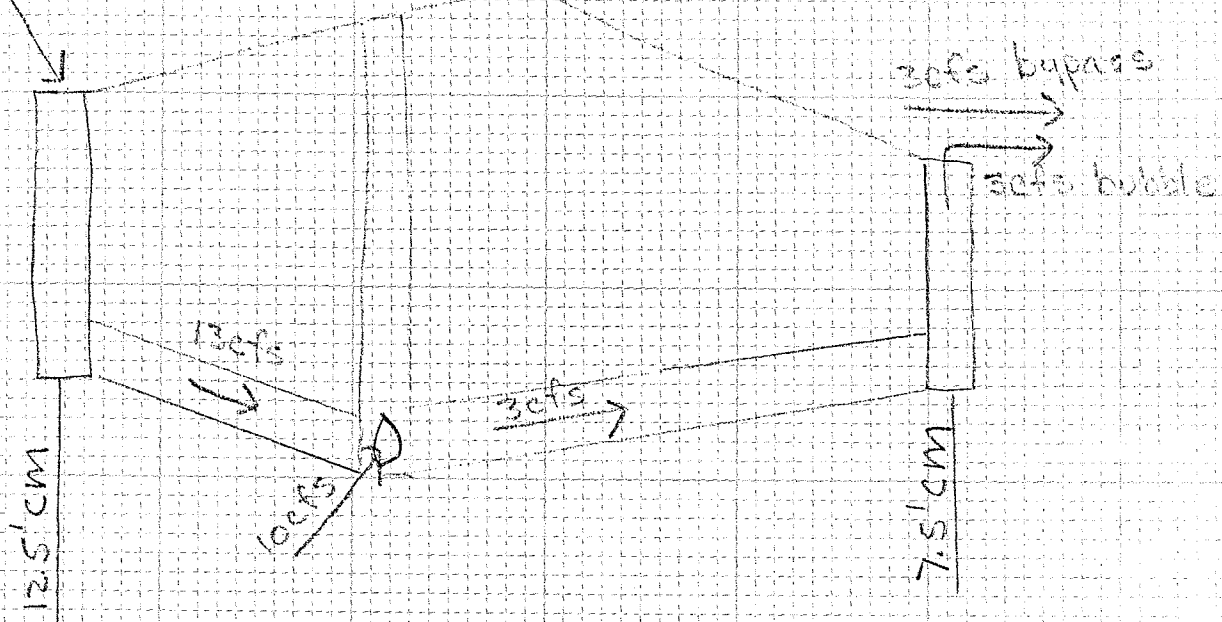
DATE _____

CALC BY _____

DESCRIPTION _____ CHECKED BY _____

10-year interim

13 cfs intercepted



grate area for 7.5' Type cm D.I.

$$4.5' \times 7.5' (\text{grate}) = 11.25 \text{ ft}^2$$

$$.67 (\text{open area of grate}) \times 11.25 \text{ ft}^2 = 7.5 \text{ ft}^2$$

$$Q = VA$$

$$Q = 3 \text{ cfs}$$

$$A = 7.5 \text{ ft}^2$$

$$V = \frac{3 \text{ ft}^3/\text{s}}{7.5 \text{ ft}^2} = .4 \text{ ft/s}$$

10-year storm will bubble out at a depth of $\approx .05'$

$$\text{Velocity} = \frac{V^2}{2g} = \frac{.4^2}{64.4} = .0025 \text{ ft}$$



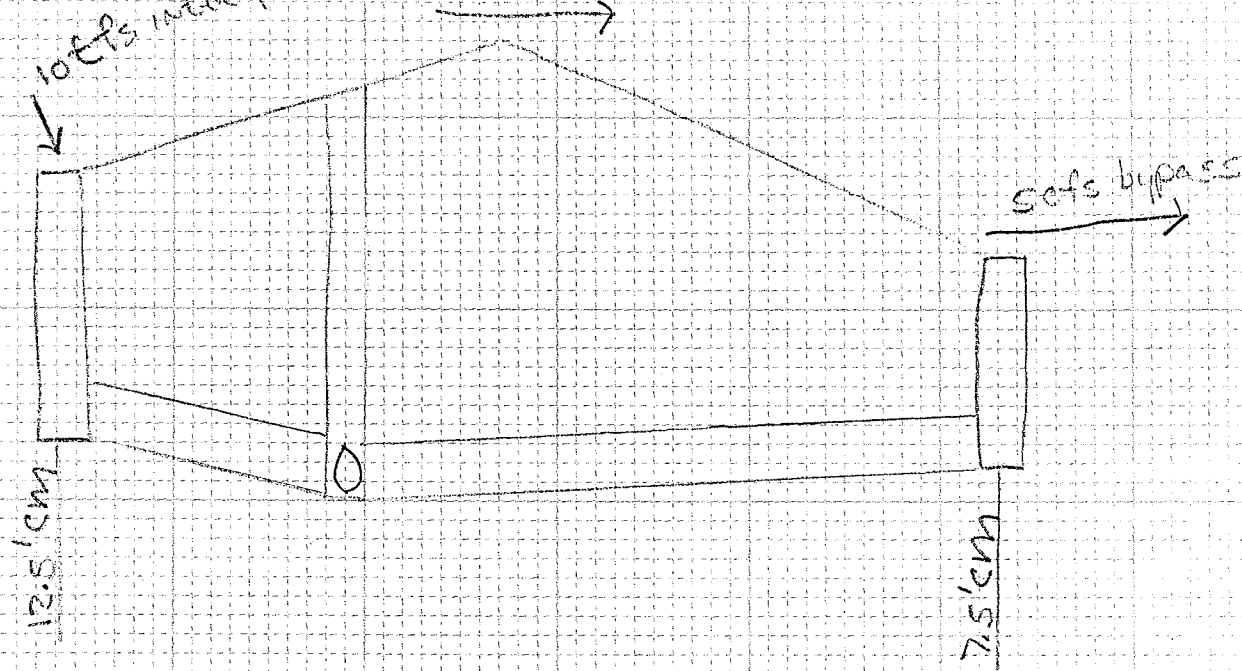
100-year Interim conditions

26 cfs on west

5 cfs on east

10 cfs intercepted

16 cfs spill over crown



16 cfs spill over crown

$$Q = CLH^{3/2}$$

$$16 = 3(50)H^{3/2}$$

$$\left(\frac{16}{150}\right)^{2/3} = H = .22' \approx 3''$$

CLIENT Durango Drive / Washington Avenue JOB NO 412.416

CALC BY _____

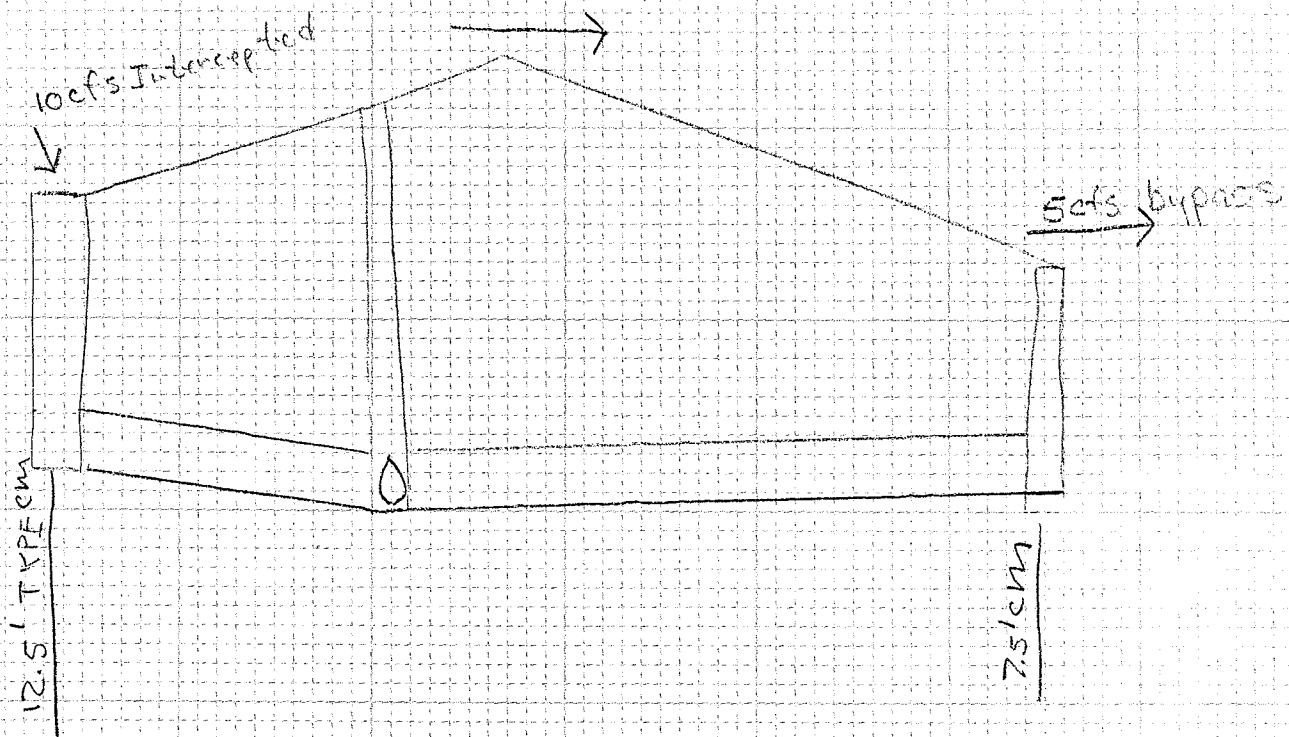
DESCRIPTION _____ CHECKED BY _____

100-year ultimate conditions ($Q_{100} = 25 \text{ cfs}$)

20 cfs on west

5 cfs on east

10 cfs spill over crown

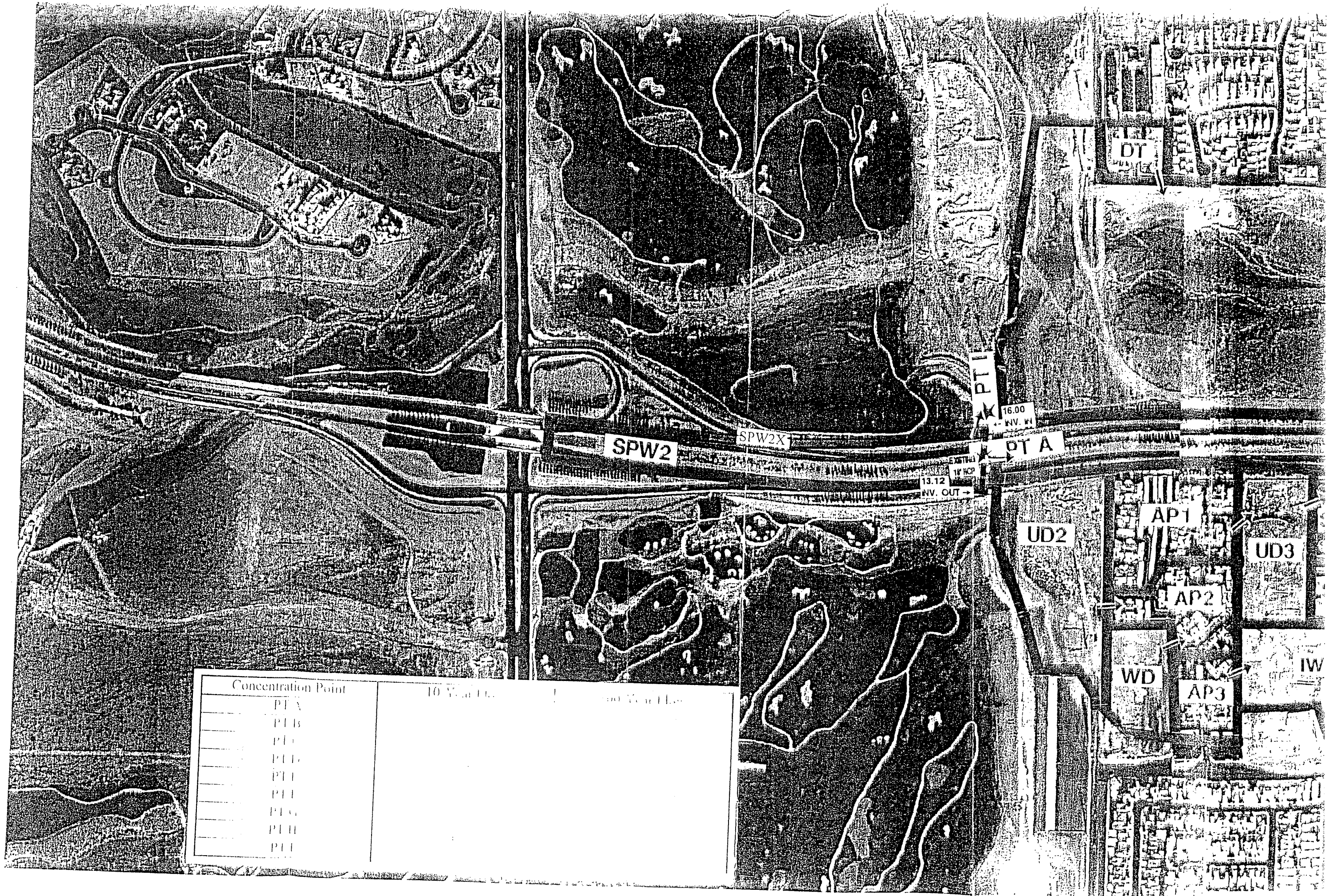


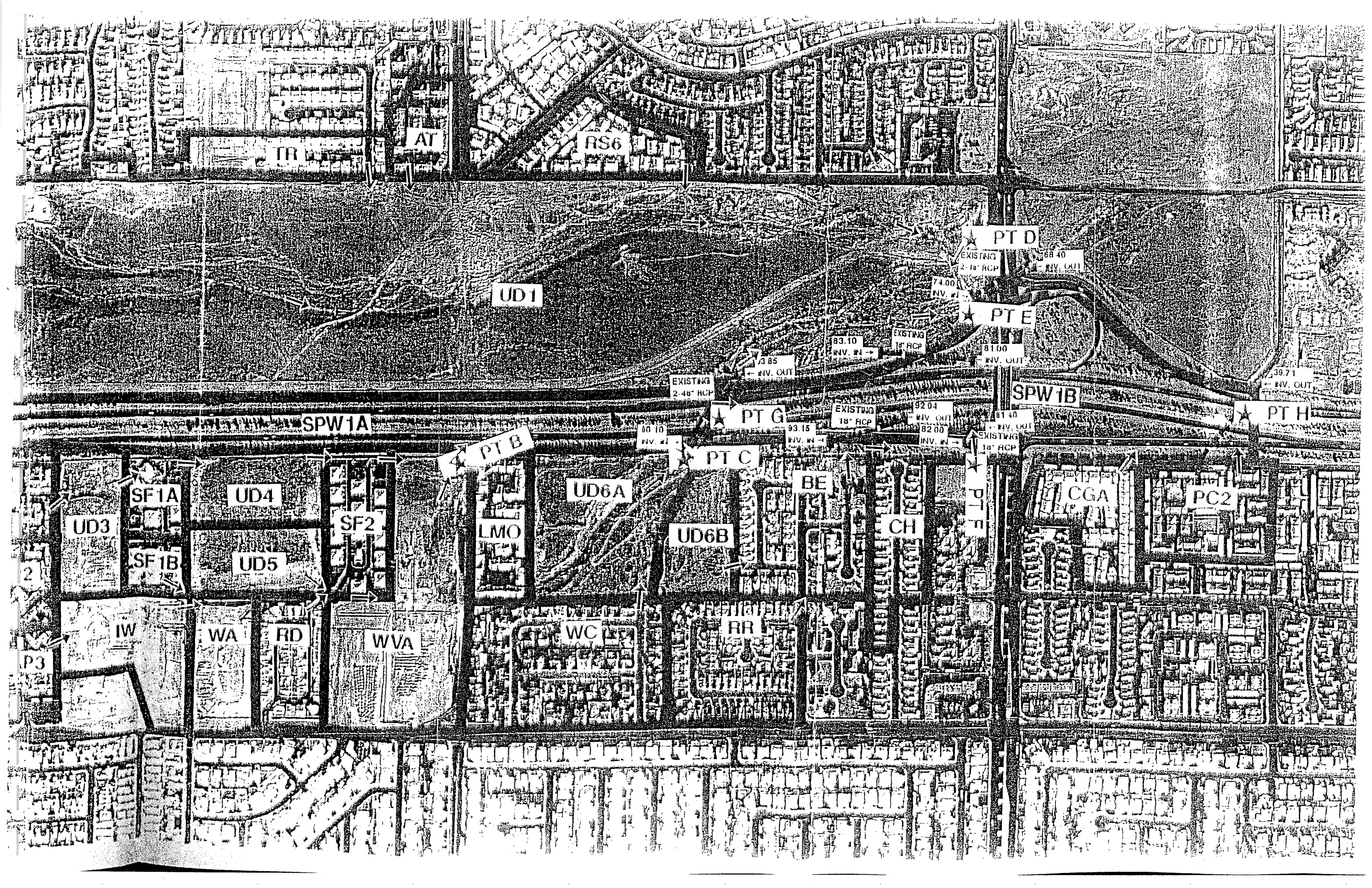
10 cfs spill over crown

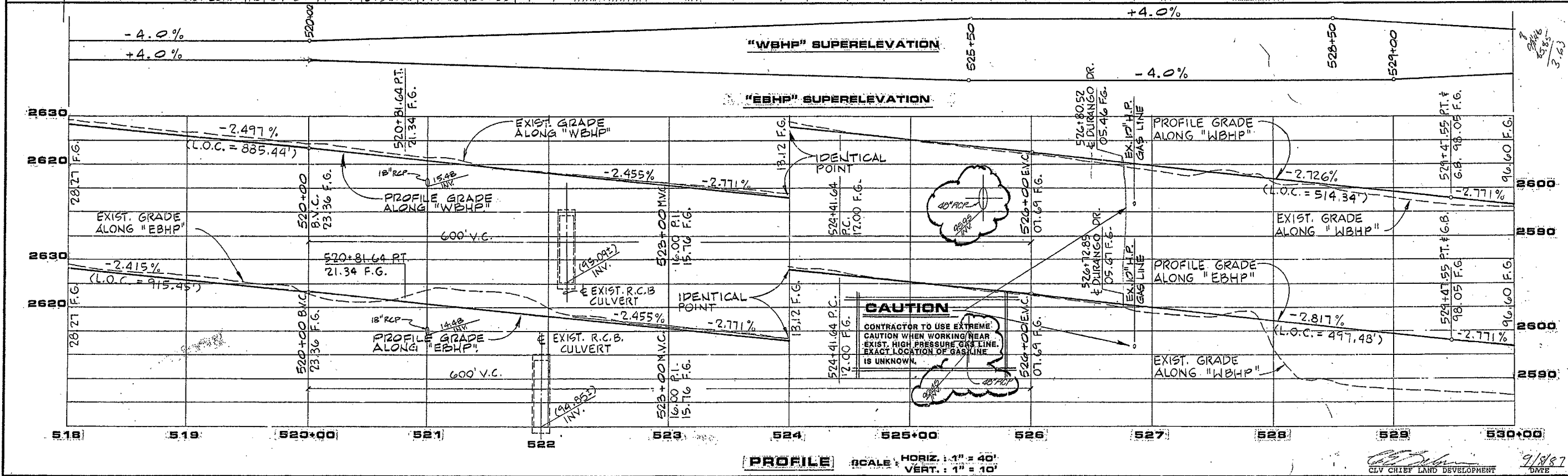
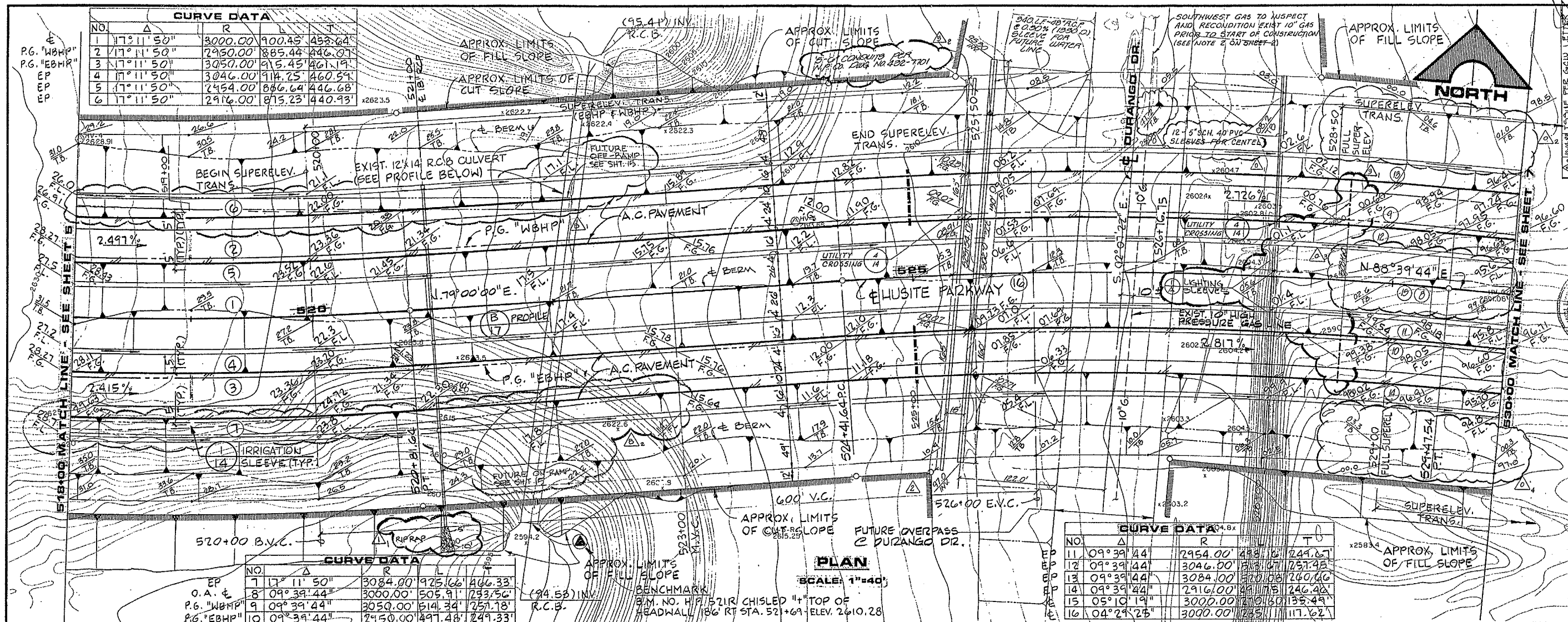
$$Q = CLH^{3/2}$$

$$10 = 3(50)H^{3/2}$$

$$\left(\frac{10}{150}\right)^{2/3} = H = .16' \approx 2''$$







REVISIONS

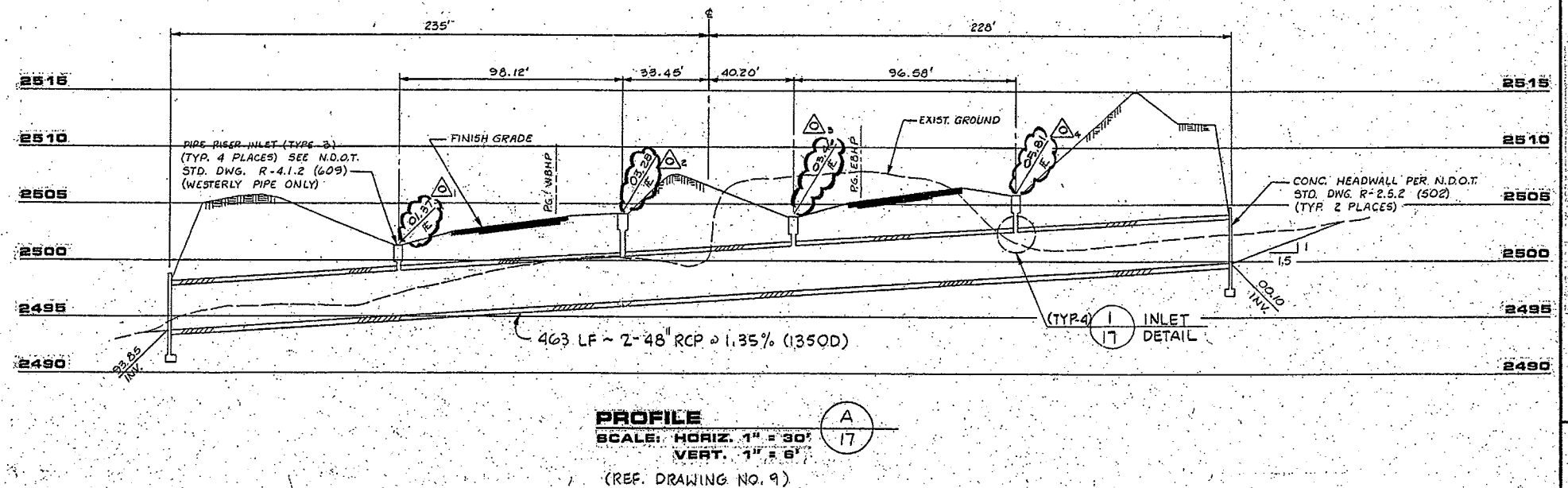
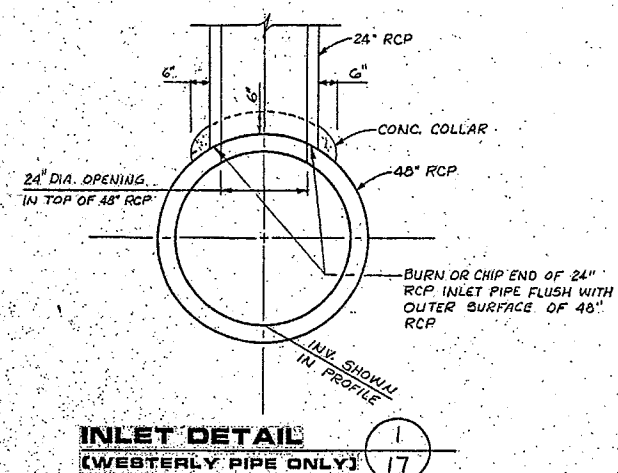
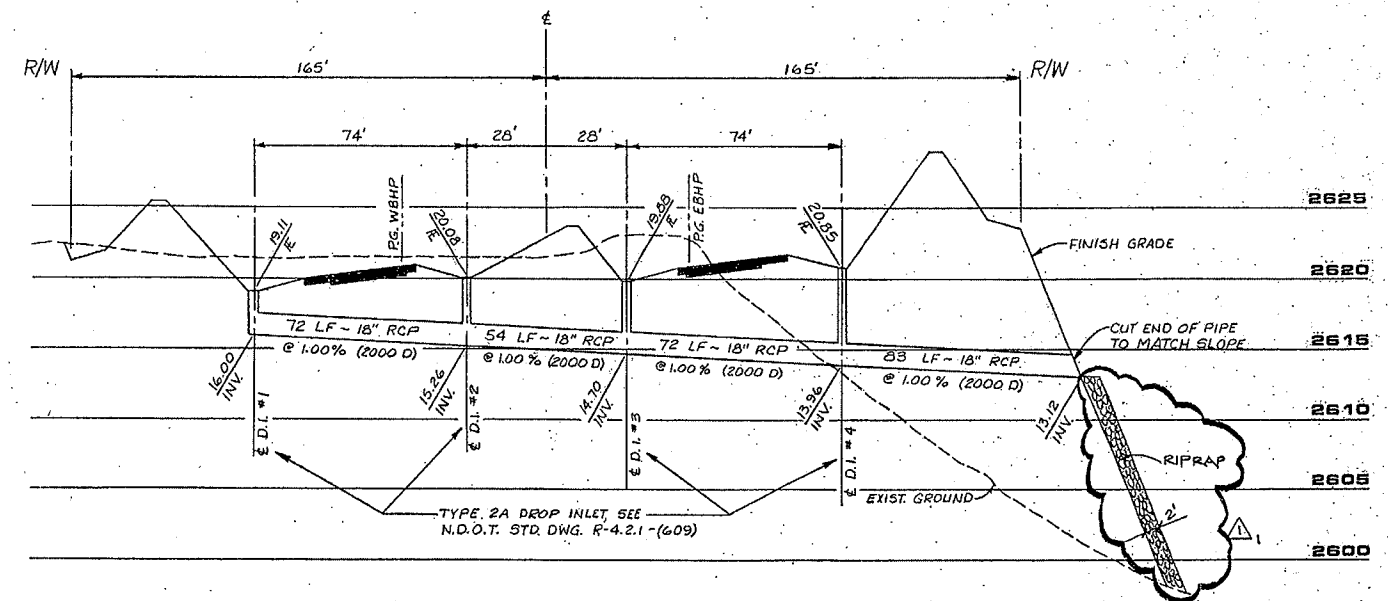
REV.	DATE	DESCRIPTION
1	10/18/87	ISSUED FOR BIDDING
2	11/18/87	ISSUE ADDENDA NO. 1 TO BIDDING
3	12/18/87	ISSUE FOR CONSTRUCTION
4	01/18/88	ISSUE FOR CONSTRUCTION
5	02/18/88	ISSUE FOR CONSTRUCTION

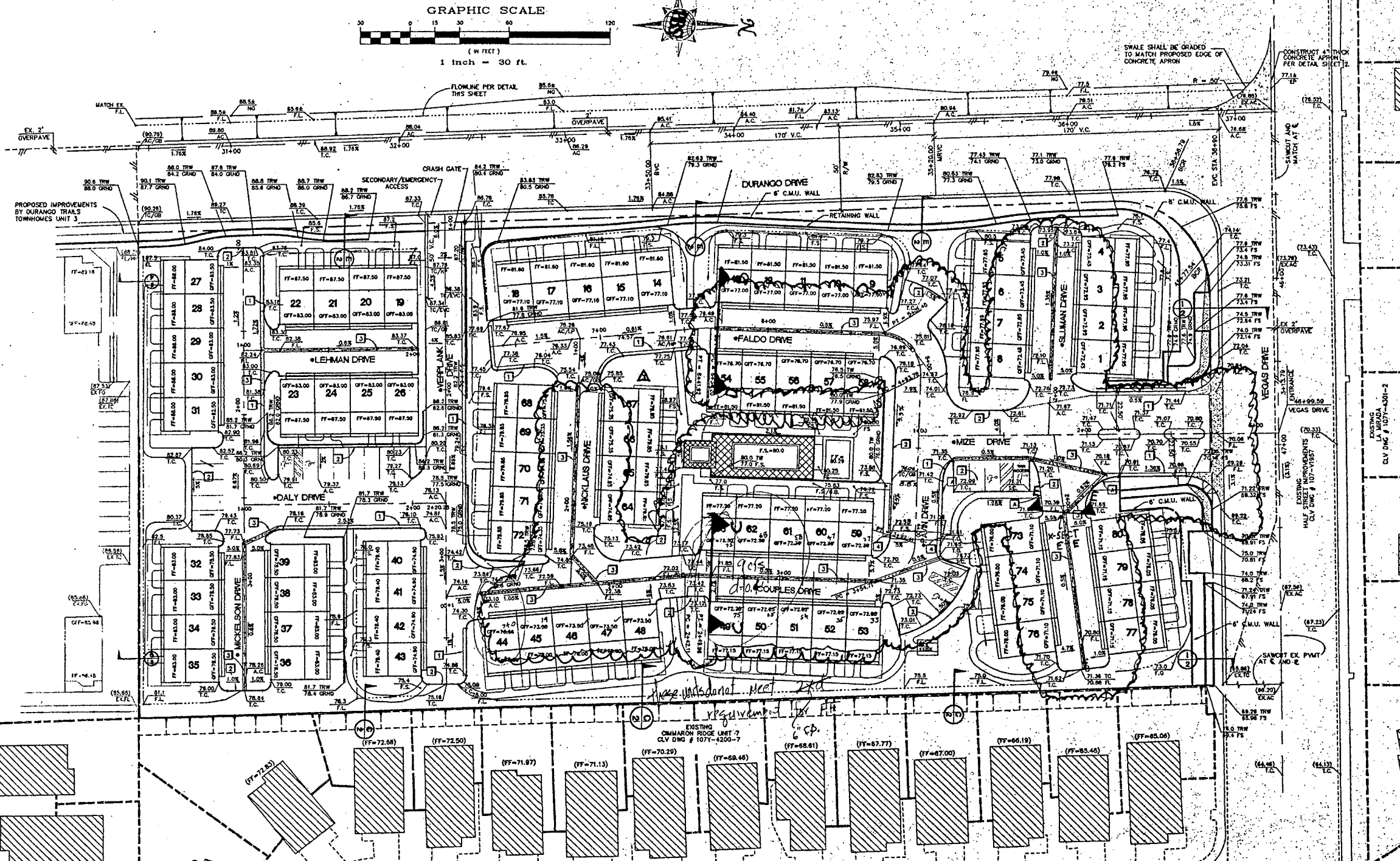
APPROVED FOR CONSTRUCTION

HOWARD HUGHES PROPERTIES
HUSITE PARKWAY
PLAN'S PROFILE
STA. 518+00 TO STA. 530+00

G.C. WALLACE, INC.
Engineering/Architecture

SHEET 6
OF 20 SHEETS





A CONSTRUCT ACCESS RAMP PER DETAIL ABOVE

**** MAHARAJA'S SHALL BE PROVIDED ON ACCESS RAMP WHERE SLOPES EXCEED 5%**

***NOTE: ALL INTERIOR STREETS ARE PRIVATE.**

CONSTRUCTION NOTES

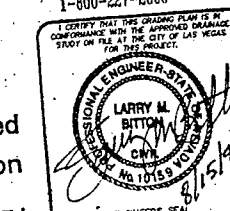
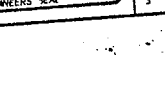
1. CONSTRUCT "L" TYPE CURB & GUTTER PER CLARK COUNTY AREA STANDARD DWG. NO. 218.
2. CONSTRUCT "A" TYPE CURB PER CLARK COUNTY STANDARD DRAWING NO. 220.
3. CONSTRUCT 2' CONCRETE CROSS GUTTER PER DETAIL SHEET
4. CONSTRUCT DEPRESSIONED CURB AT SIDEWALK TOP OF SIDEWALK TO BE FLUSH WITH ASPHALTIC CONC. PAVING

Call before you Dig
This grading plan is a part of drainage study.

I CERTIFY THAT THIS GRADING PLAN IS IN
 ACCORDANCE WITH THE CITY ENGINEER'S SURVEY
 AND THE CITY ENGINEER'S SURVEY
 FOR CBND PROJECT.
 17 and ACCEPTED
 Page 1 Of 7

 6/20/17
 ENGINEER'S SEAL

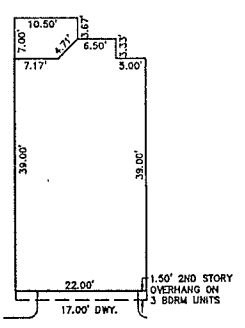
Job Number 5833	Drawn by BEM	Scale AS SHOWN	THE VILLAS AT ANGEL PARK WALL PLAN		WALTER HOMES	 POST, BUCKLEY, SCHLAF & JERNICAN 501 N. Green Valley Parkway Hendersonville, NC 28034 Tel: 703.627.7275 Fax: 703.627.7200	ADDRESS · PLANNING · SURVEYING · CONSTRUCTION SERVICES No. REVISIONS	Date Invt. Appr.	Date
			Checked by MFP	File No.					
Sheet Number 1 OF 1	Date								



101114

LEGEND

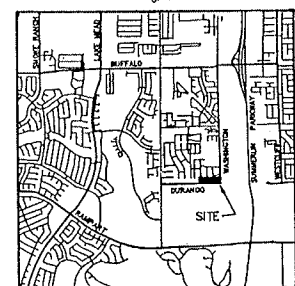
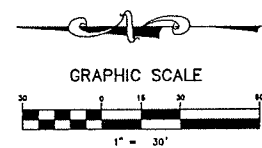
- 27 LOT NUMBER
- 4 BLOCK NUMBER
- 2400 CONTOUR LINE (1' INTERVAL)
- FG FINISH GRADE
- FL FLOW LINE
- TC TOP OF CURB
- TRC TOP OF ROLL CURB
- BC BACK OF CURB
- BCR BEGIN CURB RETURN
- EX EXISTING
- VG VALLEY CUTTER
- SCARP AREA
- CONCRETE BLOCK WALL
- NG NATURAL GROUND
- TF TOP OF FOOTING
- 28 RETAINING WALL
- 29 GRADE BREAK
- 42.1 PAD GRADE
- PC POINT OF CURVATURE
- PT POINT OF TANGENCY
- PRC POINT OF REVERSE CURVATURE
- PCC POINT OF COMPOUND CURVATURE
- 0.5% DIRECTION AND RATE OF SLOPE
- BVC BEGIN VERTICAL CURVE
- MVC MID-POINT OF VERTICAL CURVE
- EVC END VERTICAL CURVE
- PRVC POINT OF REVERSE VERTICAL CURVE
- EXISTING WALL



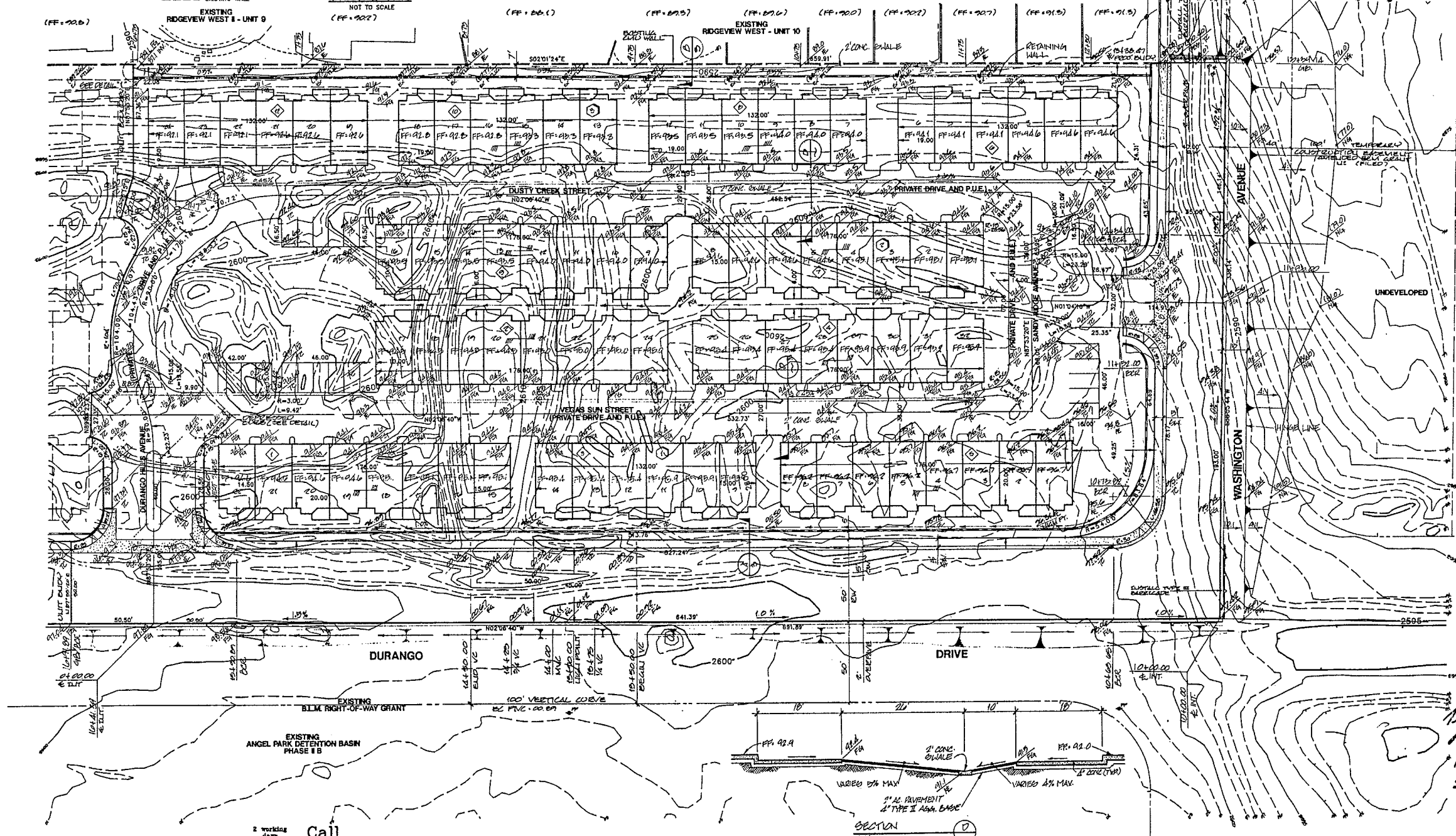
TYPICAL UNIT
NOT TO SCALE

GENERAL NOTES

- ALL GRADES SHOWN HEREON ARE TO ROUGH GRADE ONLY AND ARE 0.30 FEET LOW TO ALLOW FOR LANDSCAPING EXCEPT T.C., F.L., AND F.G. WHICH ARE TO FINISH GRADES.
- ALL LOTS ARE TO BE F.H.A. TYPE "A" DRAINAGE UNLESS OTHERWISE NOTED.
- SEE IMPROVEMENT PLANS FOR STREET SECTIONS AND DETAILS. SEE FINAL MAP FOR EXACT BEARINGS AND DISTANCES.
- CONTRACTORS SHALL VERIFY ALL CONDITIONS AND DIMENSIONS AND SHALL REPORT ALL DISCREPANCIES TO THE ENGINEER PRIOR TO THE COMMENCEMENT OF WORK.
- ALL GRADING AND SITE PREPARATION SHALL CONFORM TO THE REQUIREMENTS OF THE GEOTECHNICAL INVESTIGATION PREPARED BY: TERRACON CONSULTANTS WESTERN, LLC, PEO# 117 0415300 DATED OCTOBER 20, 2004.
- ALL WORK PERFORMED OUTSIDE OF THE PROJECT BOUNDARY AND ON PRIVATE PROPERTY SHALL NOT BE PERFORMED UNTIL WRITTEN PERMISSION AND EASEMENT HAVE BEEN OBTAINED FROM THE OFFSITE OWNER.
- ALL WORK PERFORMED WITHIN PUBLIC RIGHT-OF-WAY AND OUTSIDE OF THE PROJECT BOUNDARY SHALL BE PERFORMED UNDER A SEPARATE ENCROACHMENT PERMIT ISSUED BY THE CONTROLLING AUTHORITY.
- MINIMUM FINISH FLOOR ELEVATION = PAD ELEVATION +1.0'.



LOCATION MAP



BENCHMARK
CENTERLINE TO CENTERLINE OF WASHINGTON
AND DURANGO FND. 3" BLM BRASS CAP 1/4
29/28 1957.
ELEVATION = 2597.20

Call before you Dig
1-800-227-2800

SECTION
N48

This G.P. is
part of the
12/23/94
submittal
BT
12/7/94

I CERTIFY THAT THIS GRADING PLAN IS
IN CONFORMANCE WITH THE APPROVED
DRAINAGE STUDY ON FILE AT THE CITY
OF LAS VEGAS FOR THIS PROJECT.

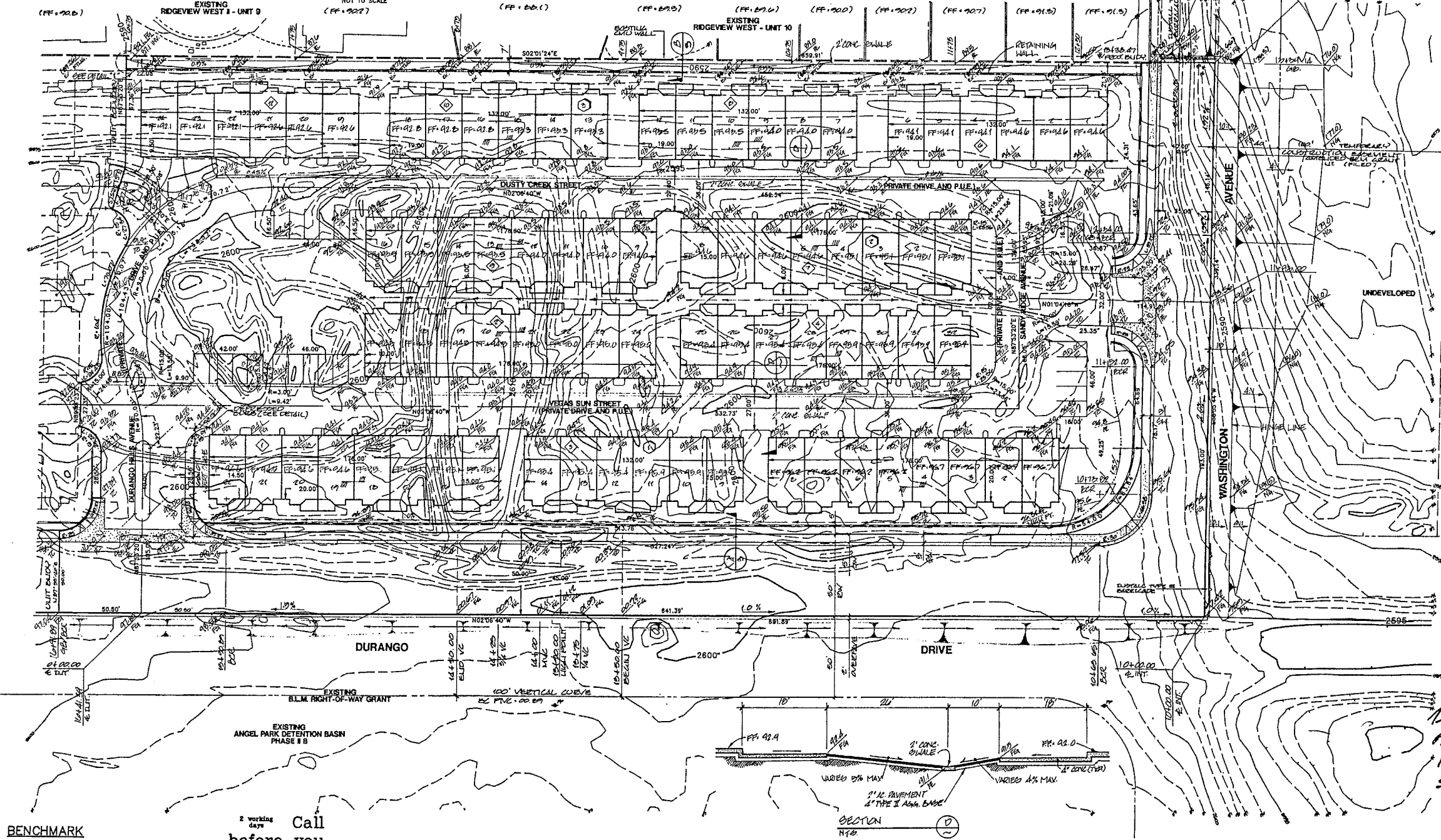
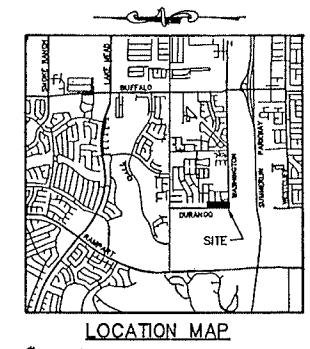
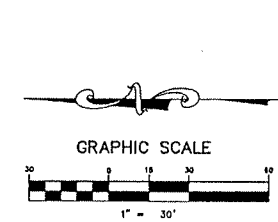
STANPARK HOMES		CITY OF LAS VEGAS, NEVADA	
CONSULTING ENGINEERS		PLANNERS • LAND SURVEYORS	
2727 SOUTH RAINBOW BOULEVARD		LAS VEGAS, NEVADA 89102-5148	
PHONE (702) 873-7550 FAX (702) 362-2557			
PROJECT		TITLE	
DURANGO TRAILS TOWNHOMES		ROUGH GRADING PLAN	
UNIT 1			
NO. 4706-1		DATE NOV. 1994	
BY		SCALE 1"=30'	
DATE		SHEET 2 OF 10 SHEETS	

LEGEND

27	LOT NUMBER	RETAINING WALL	
4	BLOCK NUMBER	OB	GRADE BREAK
1400	CONTOUR LINE (1' INTERVAL)	42.1	PAD GRADE
FG	FINISH GRADE	PC	POINT OF CURVATURE
FL	FLOW LINE	PT	POINT OF TANGENCY
TC	TOP OF CURB	PRC	POINT OF REVERSE CURVATURE
TRC	TOP OF ROLL CURB	PCC	POINT OF COMPOUND CURVATURE
BC	BACK OF CURB		DIRECTION AND RATE OF SLOPE
BOR	BEGIN CURB RETURN	BVC	BEGIN VERTICAL CURVE
EX	EXISTING	MVC	Mid-POINT OF VERTICAL CURVE
VG	VALLEY GUTTER	EVC	END VERTICAL CURVE
	SCARP AREA	PRVC	POINT OF REVERSE VERTICAL CURVE
	CONCRETE BLOCK WALL		EXISTING WALL
NG	NATURAL GROUND		
TF	TOP OF FOOTING		

TYPICAL UNIT
NOT TO SCALE

- GENERAL NOTES**
- ALL GRADES SHOWN HEREON ARE TO ROUGH GRADE ONLY AND ARE 0.30 FEET LOW TO ALLOW FOR LANDSCAPING EXCEPT T.C., F.L., AND F.G. WHICH ARE TO FINISH GRADES.
 - ALL LOTS ARE TO BE F.H.A. TYPE "A" DRAINAGE UNLESS OTHERWISE NOTED.
 - SEE IMPROVEMENT PLANS FOR STREET SECTIONS AND DETAILS. SEE FINAL MAP FOR EXACT BEARINGS AND DISTANCES.
 - CONTRACTORS SHALL VERIFY ALL CONDITIONS AND DIMENSIONS AND SHALL REPORT ALL DISCREPANCIES TO THE ENGINEER PRIOR TO THE COMMENCEMENT OF WORK.
 - ALL GRADING AND SITE PREPARATION SHALL CONFORM TO THE REQUIREMENTS OF THE GEOTECHNICAL INVESTIGATION PREPARED BY: TERESA COLUCCI TAYLOR, WESTECH, INC., PROJECT # 99-05309
 - DATED 02/02/99
 - ALL WORK PERFORMED OUTSIDE OF THE PROJECT BOUNDARY AND ON PRIVATE PROPERTY SHALL NOT BE PERFORMED UNTIL WRITTEN PERMISSION AND EASEMENT HAVE BEEN OBTAINED FROM THE OFFSITE OWNER.
 - ALL WORK PERFORMED WITHIN PUBLIC RIGHT-OF-WAY AND OUTSIDE OF THE PROJECT BOUNDARY SHALL BE PERFORMED UNDER A SEPARATE ENCROACHMENT PERMIT ISSUED BY THE CONTROLLING AUTHORITY.
 - MINIMUM FINISH FLOOR ELEVATION = PAD ELEVATION +1.0'.

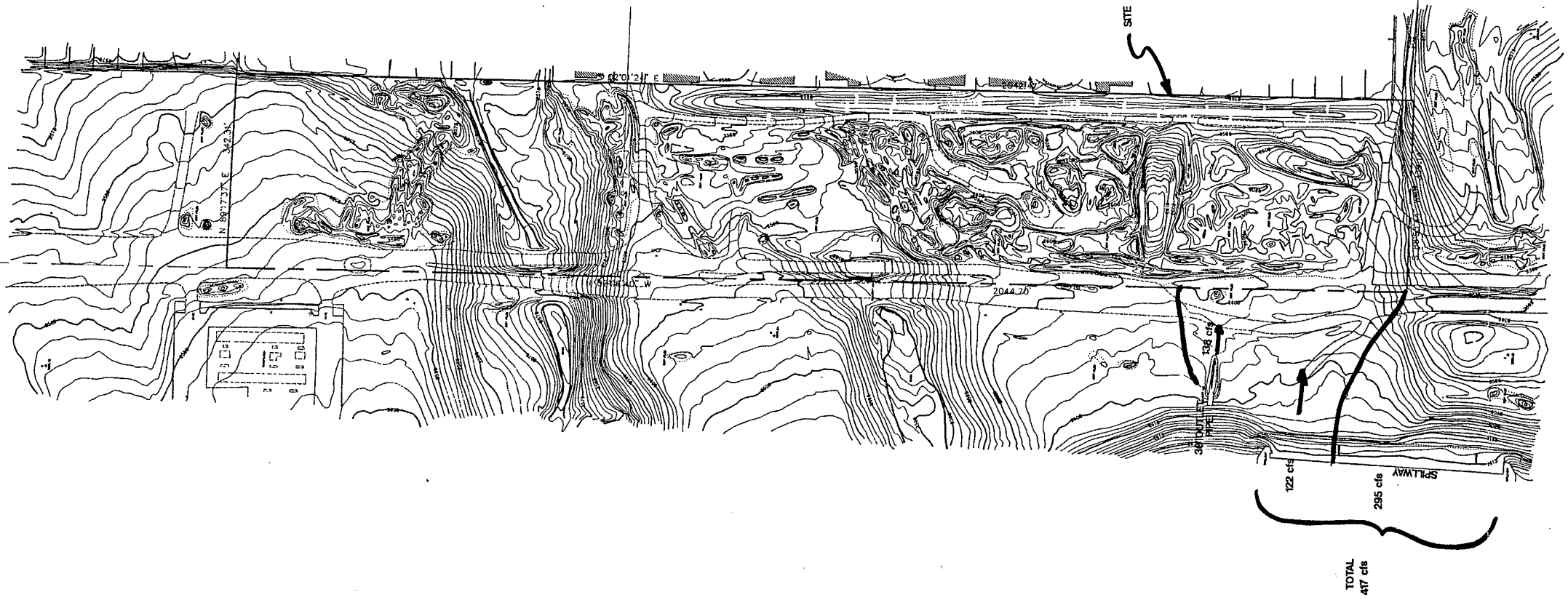


BENCHMARK
CENTERLINE TO CENTERLINE OF WASHINGTON AND DURANGO FND. 3" BLM BRASS CAP 1/4 29/28 1957.
ELEVATION = 2597.20

Call before you Dig
1-800-827-2600

I CERTIFY THAT THIS GRADING PLAN IS IN CONFORMANCE WITH THE APPROVED DRAINAGE STUDY ON FILE AT THE CITY OF LAS VEGAS FOR THIS PROJECT.

STANPARK HOMES CITY OF LAS VEGAS, NEVADA		CONSULTING ENGINEERS • PLANNERS • LAND SURVEYORS 2727 SOUTH RAINBOW BOULEVARD LAS VEGAS, NEVADA 89102-5148 PHONE (702) 873-7550 FAX (702) 362-2597	
PROJECT DURANGO TRAILS TOWNHOMES UNIT 1		DATE NOV. 1994	
TITLE ROUGH GRADING PLAN		SCALE 1"=30'	
BY JAMES A. THOMAS CIVIL ENGINEER NO. 9705 WYOMING ST. LAS VEGAS, NV 89102		SHEET 2 of 10 SHEETS	



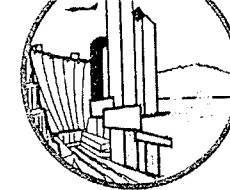
PRINTED
NOV 23 1994
VTN NEVADA

FIGURE 4

WO NO. 4706
BY T.Z.
DATE 7/08/94
SCALE 1" = 100'
SHEET 1 OF 1 SHEETS

TITLE
EXISTING ONSITE DRAINAGE BASIN MAP
PROJECT
WASHINGTON AND DURANGO

vtm nevada
CONSULTING ENGINEERS • PLANNERS • LAND SURVEYORS
2727 SOUTH RAINBOW BOULEVARD
LAS VEGAS, NEVADA 89102-5148 PHONE (702) 873-7550 FAX (702) 362-2597



City of Las Vegas

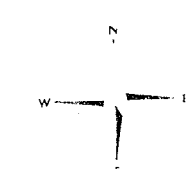
CITY - WIDE HYDROLOGY ANALYSIS

LEGEND

- EXISTING REGIONAL DETENTION BASINS
- PROPOSED REGIONAL DETENTION BASINS
- EXISTING LOCAL DETENTION BASINS
- EXISTING REGIONAL BRIDGES
- PROPOSED REGIONAL BRIDGES
- EXISTING LOCAL BRIDGES
- EXISTING REGIONAL CULVERT
- PROPOSED REGIONAL CULVERT
- EXISTING LOCAL CULVERT
- EXISTING REGIONAL PIPELINE
- PROPOSED REGIONAL PIPELINE
- EXISTING LOCAL PIPELINE
- EXISTING REGIONAL CHANNEL
- PROPOSED REGIONAL CHANNEL
- EXISTING LOCAL CHANNEL
- EXISTING REGIONAL DIKE/LEEVE
- PROPOSED REGIONAL DIKE/LEEVE
- EXISTING LOCAL DIKE/LEEVE
- EXISTING STORM WATER PUMPING STATION
- PROPOSED BELTWAY ALIGNMENT

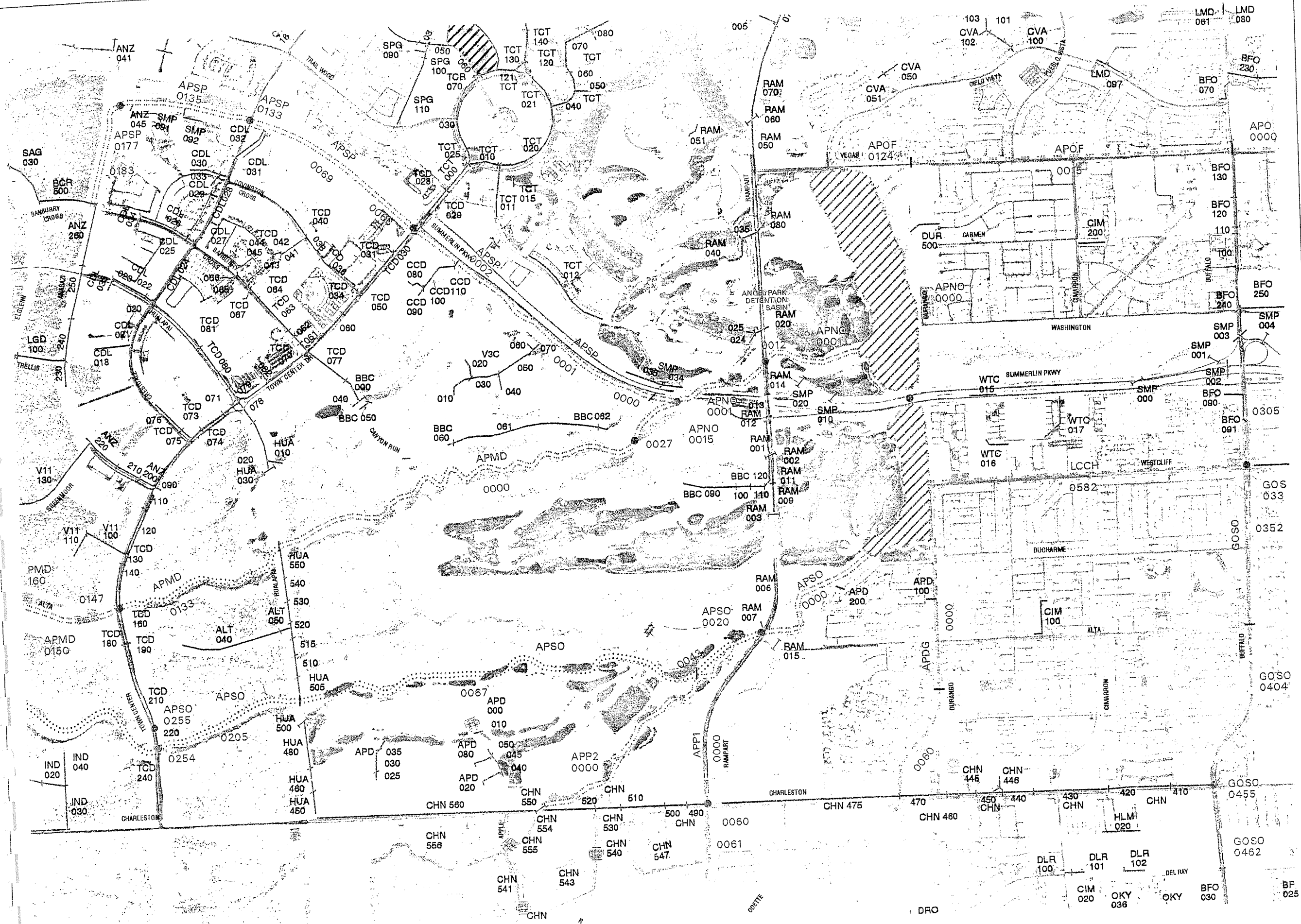
FIGURE F-12

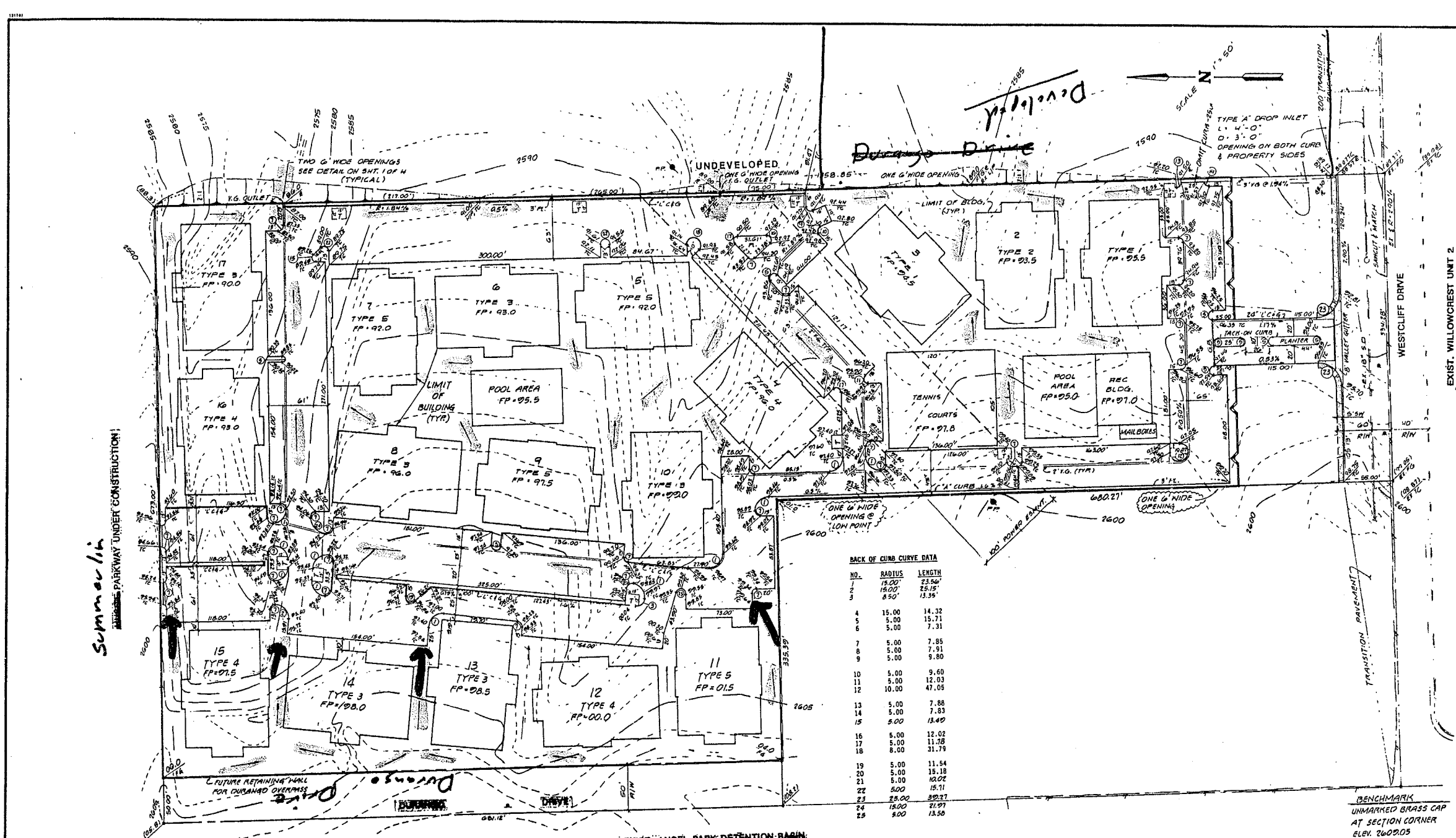
1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	



Scale: 1 inch = 1600 feet

FLOOD CONTROL FACILITIES





Summa Lin

BACK OF CURB CURVE DATA

NO.	RADIUS	LENGTH
1	15.00	23.56
2	15.00	25.15
3	8.50	13.35
4	15.00	14.32
5	5.00	15.71
6	5.00	7.31
7	5.00	7.85
8	5.00	7.91
9	5.00	9.80
10	5.00	9.60
11	5.00	12.03
12	10.00	47.05
13	5.00	7.88
14	5.00	7.83
15	5.00	13.49
16	5.00	12.02
17	5.00	11.78
18	8.00	31.19
19	5.00	11.54
20	5.00	15.18
21	5.00	10.02
22	5.00	15.11
23	25.00	30.27
24	15.00	21.91
25	5.00	13.50

APPROXIMATE PAVING QUANTITIES

4" AC AND 4" TYPE II	3942 SY
2" AC AND 4" TYPE II	18,800 SY
24" "L" TYPE CURB & GUTTER	2100 LF
"A" CURB	6700 LF
CONCRETE VALLEY GUTTER	4500 SF
4" CONCRETE SIDEWALK	1,465 SF
TYPE I	886 CY

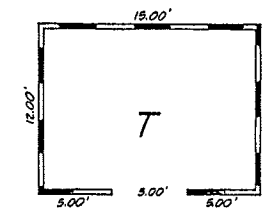
ESTIMATED EXCAVATION QUANTITIES

CUT	33,330 CY
LESS 20% SHRINKAGE	6,666 CY
FILL AVAILABLE	26,664 CY
FILL REQUIRED	61,890 CY
COMPACTED IMPORT REQUIRED	35,226 CY

LEGEND

G.B.	GRADE BREAK
T.C.	TOP OF CURB
S/W	SIDEWALK
B S/W	BACK OF SIDEWALK
R/W	RIGHT-OF-WAY
B/C	BACK OF CURB
C&G	CURB & GUTTER
H/P	HIGH POINT
FTG.	FOOTING
F.G.	FINISH GRADE
V.G.	VALLEY GUTTER
R=0.5%	ROAD GRADIENT
98.0	FINISH PAD
EX.	EXISTING
FL	FLOW LINE

PL.	SCARP
S/B	EXISTING POWER POLE
L.P.	EXISTING STORM DRAIN
F.P.	EXISTING CONTOUR LINE
TYPE 1	BLOCK WALL
17	PLANTER
	SETBACK
	LOW POINT
	FINISH PAD
	BUILDING TYPE
	BUILDING N°
	"A" CURB
	24" "L" TYPE C&G
	DIRECTION OF SURFACE FLOW



- TYP. TRASH ENCLOSURE**
PER LANDSCAPE ARCHITECTS PLANS.
- CONTRACTOR SHALL PROVIDE POSITIVE DRAINAGE OUT OF ENCLOSURE BY ANY MEANS.
 - ENCLOSURES ALONG EAST R IN PARKING LOT SHALL BE PLACED AT LIP OF CURB AND GUTTER.
 - REMOVE CURB AS REQUIRED TO ACCESS ENCLOSURES LOCATED IN PLANTERS.

APPROVAL
CITY ENGINEER
DATE

ALL DISTANCES SHOWN ARE B/C'S LENGTHS
17 BLDGS. (TOTAL 246 UNITS) ON 15.7+ ACRES (GROSS)

EXIST. WILLOWCREST UNIT 2

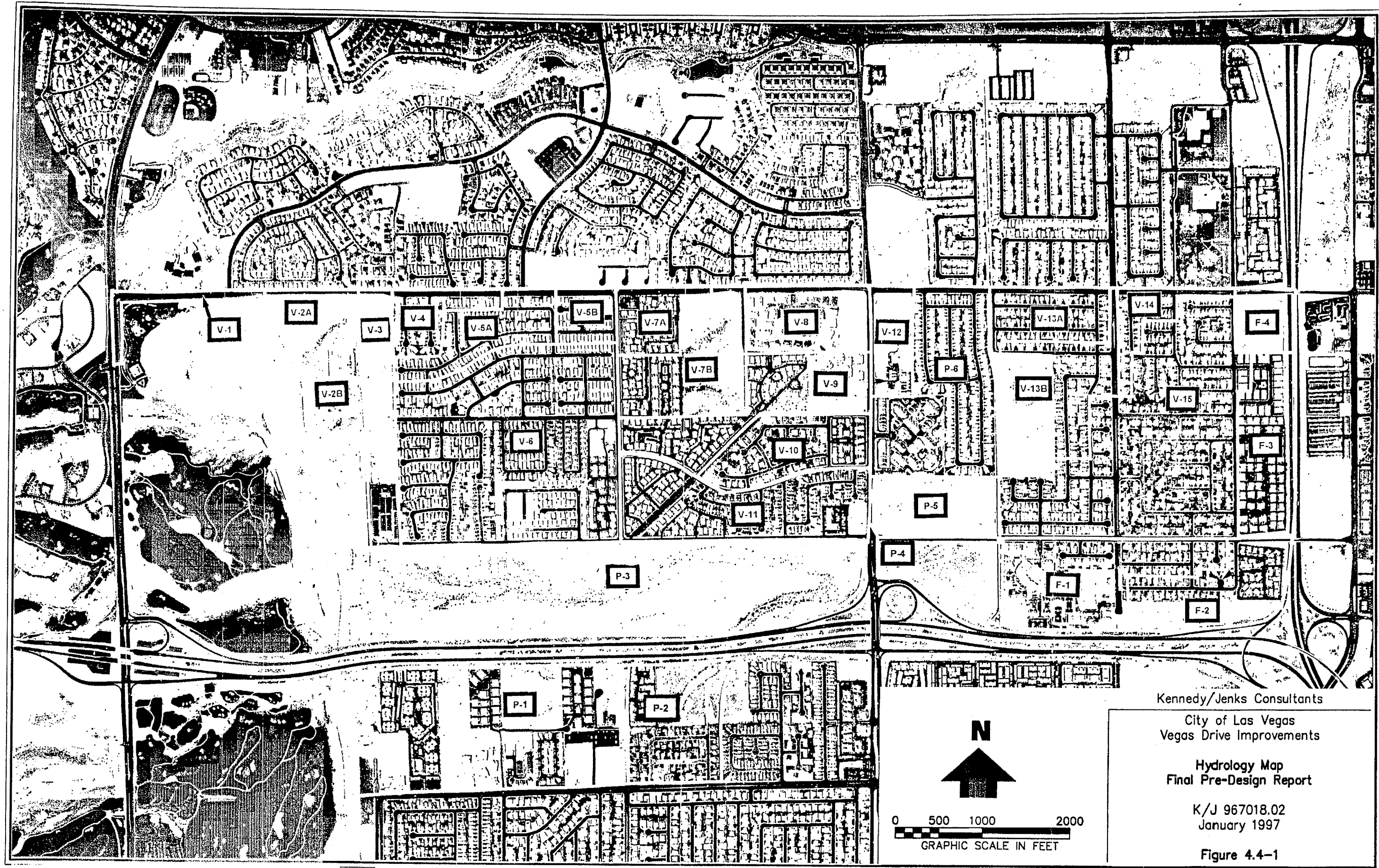
DELTA ENGINEERING INC.
LAND SURVEYING & PLANNING
450 WEST DAVEY BLVD. LAS VEGAS, NEVADA 89102
PHONE 772-877-0885

GRADING & PAVING PLAN
ANGEL PARK APARTMENTS
ANGEL PARK ASSOCIATES
CITY OF LAS VEGAS, CLARK COUNTY, NEVADA

SHEET No.
2 of 4

107-V1644

Call before you Dig.
1-800-227-2600
UNDERGROUND SERVICE AGENCY



1997 CITY OF LAS VEGAS CITY-WIDE HYDROLOGY ANALYSIS

LEGEND

REGIONAL STREAM NAME DESIGNATOR	AABB
PARENT STREAM NAME	
STREAM NAME	
REGIONAL ID / RIVER MILE	0000
DISTANCE ABOVE	
CONFLUENCE WITH PARENT STREAM	
MILES	
TENTHS OF A MILE	
LOCAL STREAM NAME DESIGNATOR	AAB
LOCAL ID NUMBER	000
EXISTING FACILITY	E
PROPOSED OR MODIFIED FACILITY	P
CONTINGENCY LEVEL:	
MASTER PLAN	P1
FACILITY PLAN	P2
PRELIMINARY DESIGN	P3
DESIGN	P4
BOTTOM WIDTH	W
DEPTH	D
SIDE SLOPE, H:V	SS
CORRUGATED METAL PIPE	CMP
CULVERT	
CORRUGATED METAL ARCH	CMAP
PIPE CULVERT	
REINFORCED CONCRETE BOX	RCB
RCB CULVERT	RCBC
REINFORCED CONCRETE PIPE	RCP
RCP CULVERT	RCPC
REINFORCED CONCRETE	RCACP
ARCH PIPE CULVERT	
GENERAL COMMENT	G1
FACILITY SPECIFIC COMMENT	S1

NOTES:

FLOW = 100 YEAR DESIGN FLOW
(REGIONAL FACILITIES)
FLOW = FACILITY CAPACITY
(LOCAL FACILITIES)

FLOOD CONTROL FACILITIES INVENTORY

SHEET F-12

PBS&J, INC

ID	ID No.	E/P	Plan No.	Facility Desc
REGIONAL FACILITIES				
APDG	0000	E	107-V1649 / V1660	ANGEL PARK - DURANGO
APDG	0060	E	107-V1649 / V1660	84" RCP
				72" RCP
APMD	0000	E	1996 Master Plan Update	ANGEL PARK - MIDDLE BRANCH
APMD	0027	E	107V-2464	Natural Wash
APMD	0133	P1	1996 Master Plan Update	1: 12' x 10' & 2: 12' x 2' RCBC
APMD	0147	E	107-V2425	Conc Chnl 5.5'D 40'W 2:1 SS
APMD	0150	E	731-62	3: 12' x 8' RCBC
				Conc Chnl 40'W 7.5'D 2:1 SS
APNO	0000	E	731-49A	ANGEL PARK NORTH
APNO	0000	E	731-49A	Angel Park Detention Basin
APNO	0000	E	731-49A	12' x 14' x 380' RCB Culvert
APNO	0000	E	731-49A	42" RCP Emergency Outlet
APNO	0001	E	1996 Master Plan Update	33" RCP Emergency Outlet
APNO	0012	E	107-V1735 / V2088	Unlined Chnl
APNO	0015	E	1996 Master Plan Update	3: 12' x 10' RCBC @ Rampart
				2: 14' x 14' RCBC, Bridge
APOF	0000	E	731-49	ANGEL PARK OUTFALL
APOF	0015	E	731-49	66" RCP
APOF	0124	E	731-49	60" RCP
				54" RCP
APP1	0000	E	107-V2088	ANGEL PARK - PECCOLE 1
APP1	0060	E	327-V223	72" RCP
APP1	0061	E	327-Y4070-1	2: 60" RCP @ Charleston
				54" RCP
APP2	0000	E	1996 Master Plan Update	ANGEL PARK - PECCOLE 2
				Grass Chnl
APSO	0000	E	1996 Master Plan Update	ANGEL PARK - SOUTH BRANCH
APSO	0020	E	107-V2088	Existing Wash
APSO	0043	P1	1996 Master Plan Update	2: 12' x 12' RCBC @ Alta
APSO	0067	P1	1996 Master Plan Update	Gabion Chnl 7.5'D 25'W 2:1 SS
APSO	0205	P1	1996 Master Plan Update	Gabion Chnl 5.5'D 60'W 2:1 SS
APSO	0254	E	107-V2369	Gabion Chnl 5.5'D 25'W 2:1 SS
APSO	0255	E	107-V2369	2: 8' x 8' RCBC @ Town Center Driv
				24' x 12' Arch Culvert @ Town Cent
APSP	0000	E	107-V1571	ANGEL PARK - SUMMERLIN PARK
APSP	0001	E	107-V1571	Concrete Chute Drop 30'W 6'D
APSP	0002	E	565-199	Unlined Chnl w/Gabion Drops 20'W
APSP	0066	E	107-V2121	Unlined Channel 50'W Depth varies
APSP	0069	E	565-199	5: 8' x 4' RCBC @ Town Center Driv
APSP	0133	E	731-59A	Conc Chnl 6'D 10'W 2:1 SS
APSP	0135	E	731-59A	3: 9' x 4' RCBC @ Crestdale
APSP	0177	E	731-59A	Conc Chnl 6'D 10'W 2:1 SS
APSP	0183	E	731-59A	9' x8' RCBC @ Anasazi
				Conc Chnl 6'D 10'W 2:1 SS
GOSO	0305	E	107-V1753	GOWAN SOUTH FACILITIES
GOSO	0336	E	107-V1753	12' x 7' RCB
GOSO	0352	E	107-V2140	12' x 7' RCB @ Westcliff
GOSO	0404	E	107-V2140	2: 8' x 5' RCB
GOSO	0455	E	107-V1648	8' x 4' RCB
GOSO	0462	E	107-V2140	2: 12' x 4' RCBC @ Charleston Blvd
				12' x 4' RCB
LCCH	0582	E	650.14-7	LAS VEGAS CREEK CHANNEL
				24" RCP

1997 CITY OF LAS VEGAS CITY-WIDE HYDROLOGY ANALYSIS

LEGEND

REGIONAL STREAM NAME DESIGNATOR AAB
PARENT STREAM NAME
STREAM NAME

REGIONAL ID / RIVER MILE 0000
DISTANCE ABOVE
CONFLUENCE WITH PARENT STREAM
MILES
TENTHS OF A MILE

LOCAL STREAM NAME DESIGNATOR AAB

LOCAL ID NUMBER 000

EXISTING FACILITY E

PROPOSED OR MODIFIED FACILITY P

CONTINGENCY LEVEL:

MASTER PLAN P1

FACILITY PLAN P2

PRELIMINARY DESIGN P3

DESIGN P4

BOTTOM WIDTH W

DEPTH D

SIDE SLOPE, H:V SS

CORRUGATED METAL PIPE CMP
CULVERT

CORRUGATED METAL ARCH CMAP
PIPE CULVERT

REINFORCED CONCRETE BOX RCB

RCB CULVERT RCBC

REINFORCED CONCRETE PIPE RCP

RCP CULVERT RCPC

REINFORCED CONCRETE RCACP
ARCH PIPE CULVERT

GENERAL COMMENT G1

FACILITY SPECIFIC COMMENT S1

NOTES:

FLOW = 100 YEAR DESIGN FLOW
(REGIONAL FACILITIES)

FLOW = FACILITY CAPACITY
(LOCAL FACILITIES)

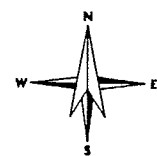
FLOOD CONTROL FACILITIES INVENTORY

SHEET F-12

PBS&J, INC

ID	ID No.	E/P	Plan No.	Facility Description	Fac Length	Slope (%)
LOCAL FACILITIES						
ALT	040	E	107V-2509	36" RCP	1,527	2.40
ALT	050	E	107V-2509	34" x 53" ECP	98	2.00
ANZ	041	E	107Y-4141-47	18" RCP	260	1.86
ANZ	045	E	107Y-4381	24" RCP	300	0.50
ANZ	200	E	107V-2310	48" RCP	214	1.20
ANZ	210	E	107V-2310	36" RCP	439	
ANZ	220	E	107V-2310	30" RCP	764	0.924
ANZ	230	E	107V-2493	42" RCP	191	
ANZ	240	E	107V-2493	60" RCP	676	
ANZ	250	E	107V-2493	66" RCP	861	
ANZ	260	E	107V-2493	72" RCP	1,195	
APD	000	E	107V-2448	24" Wide Arch Bridge	100	
APD	010	E	107V-2448	42" RCP	60	0.74
APD	020	E	107Y-4438-L12	24" RCP	228	1.00
APD	025	E	107Y-4438-L12	24" RCP	82	1.00
APD	030	E	107Y-4438-L12	30" RCP	412	1.18
APD	035	E	107Y-4438-L12	36" RCP	150	0.45
APD	040	E	327Y-4438-12A-1	18" RCP	82	0.50
APD	045	E	327Y-4438-12A-1	24" RCP	276	0.90
APD	050	E	327Y-4438-12A-1	30" RCP	207	2.74
APD	080	E	307Y-4438-12A-1	24" RCP	370	2.32
APD	100	E	107-Y4289-3	18" RCP	116	
APD	200	E	107-Y4289-2	18" RCP	190	
BBC	000	E	107-V2355	60" RCP	654	1.67
BBC	040	E	107-V2355	15" RCP	152	0.50
BBC	050	E	107-V2355	24" x 12" Arch Culvert	98	0.50
BBC	060	E	107-V2426	18" RCP	99	3.03
BBC	061	E	107-V2426	24" RCP	2,775	2.25
BBC	062	E	107-V2426	42" RCP	310	3.00
BBC	090	E	107V-2464	36" RCP	1,000	2.00
BBC	100	E	107V-2464	60" RCP	293	0.90
BBC	110	E	107V-2464	66" RCP	146	0.90
BBC	120	E	107V-2464	66" RCP	324	0.90
BCR	500	E	307Y-4463-1A	60" RCP	940	
BFO	030	E	107-V2140	12" x 4" RCB Drain	625	
BFO	070	E	107-V1877	42" RCP	308	
BFO	071	E	107Y-4182	42" RCP	531	
BFO	090	E	107-Y4305	18" RCP	703	0.45
BFO	091	E	107-Y4305	18" RCP	91	0.50
BFO	100	E	107-V2314	24" RCP	481	1.16
BFO	110	E	107-V2314	30" RCP	98	1.00
BFO	120	E	107-V2314	36" RCP	509	0.40
BFO	130	E	107-V2314	48" RCP	809	0.50
BFO	230	E	107-V2314	42" RCP	542	0.52
BFO	240	E	107-V2314	66" RCP	120	6.08
BFO	250	E	107-V2314	72" RCP	105	1.27
BFO	260	E	107-V2314	66" RCP	1,226	1.27
CCD	080	E	327Y-4480	36" RCP	418	3.00
CCD	090	E	327Y-4480	30" RCP	121	7.50
CCD	100	E	327Y-4480	42" RCP	487	3.00
CCD	110	E	327Y-4480	48" RCP	47	2.00
CDL	018	E	715-94	30" RCP	622	4.36
CDL	020	E	107V-2289 & 2259	36" RCP	230	4.32
CDL	021	E	107V-2289	30" RCP	751	2.09
CDL	022	E	107V-2259	36" RCP	84	3.41
CDL	023	E	107V-2259	24" RCP	643	0.035
CDL	024	E	107V-2259	42" RCP	1,211	1.89
CDL	025	E	107Y-4294-1-3	30" RCP	100	0.90
CDL	026	E	107Y-4294-1-3	24" RCP	452	0.90
CDL	027	E	107Y-4294-1-3	42" RCP	305	4.04
CDL	028	E	107Y-4294-1-3	48" RCP	936	1.60
CDL	029	E	107Y-4294-1-3	30" RCP	80	1.25
CDL	030	E	107Y-4294-1-3	24" RCP	634	3.50
CDL	031	E	107Y-4294-1-3	48" RCP	327	2.16
CDL	032	E	107Y-4294-1-3	72" RCP	759	1.25
CDL	033	E	107Y-4394	24" RCP	262	3.00
CDL	034	E	107Y-4427-1	24" RCP	167	3.00
CDL	035	E	107Y-4420-4	24" RCP	233	1.23
CHN	410	E	107-V1648	54" RCP	634	
CHN	420	E	107-V1648	48" RCP	1,185	
CHN	430	E	107-V1648	42" RCP	1,179	
CHN	440	E	107-V1648	36" RCP	527	
CHN	445	E	107-V2251	19" x 30" HE RCP	108	0.25
CHN	446	E	107-V2251	30" RCP	249	0.25
CHN	450	E	107-V1648	30" RCP	250	
CHN	460	E	107-V1648	24" RCP	430	
CHN	470	E	107-V1648	21" RCP	587	
CHN	475	E	107-V1697	18" RCP	2,800	

Gowan Watershed - South



SCALE: 1 INCH = 4000 FEET

FIGURE 6-2

