

## CHOLLA POWER PLANT BOTTOM ASH MONOFILL

Periodic Run-on And Run-off Control System Plan

October 2021 AECOM Project 60664605

Delivering a better world

Prepared for:

Arizona Public Service 400 North 5<sup>th</sup> Street Phoenix, AZ 85004

Prepared by:

AECOM 7720 North 16th Street, Suite 100 Phoenix, AZ 85020 aecom.com

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## Attachment

Attachment A: AECOM, 2016, Cholla Power Plant, Bottom Ash Monofill, Run-on and Run-off Control System Plan, CH\_RunOO\_001\_20161017, October 17, 2016.

## 1. Introduction

This periodic update to the Run-On and Run-Off Control System Plan for the Bottom Ash Monofill at Cholla Power Plant, operated by Arizona Public Service (APS), has been prepared in accordance with the requirements of Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257) ("the Coal Combustion Residuals [CCR] Rule", or "the Rule") and the specific requirement of 40 CFR § 257.81(c)(4) that "(t)he owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years."

## 2. Methodology

The methodology used to prepare this 2021 Update and Recertification of the Run-on and Runoff Control System Plan for the Bottom Ash Monofill at the Cholla Power Plant is for the certifying Qualified Professional Engineer (QPE) to:

- 1. Perform a documented review of the 5 years of annual inspection reports since 2016;
- 2. Perform a documented review of each major component of the contributing technical information from:
  - a. AECOM, 2016. Cholla Power Plant, Bottom Ash Monofill, Run-on and Run-off Control System Plan, CH\_RunOO\_001\_20161017, October 17, 2016 (hereafter referred to as the "2016 Plan" and incorporated and referenced directly as Attachment A to this document).
- 3. Consider and document whether the 2016 Plan and its conclusions:
  - a. Meet the current reporting requirements of the Rule;
  - b. Reflect the current condition of the structure, as known to the QPE and documented in the annual inspections;
  - c. Are compromised by any identified issues of concern; and
  - d. Are consistent with the standard of care of professionals performing similar evaluations in this region of the country; and
- 4. Identify any additional analyses, investigations, inspections, and/or repairs that should be completed in order to complete this 2021 Recertification.

This report documents the results of these considerations, incorporates the 2016 Plan as an Appendix, identifies any additional technical investigation or evaluations (if needed), and presents an updated certification by the QPE.

## 3. 2017–2021 Annual Inspection Reports

Information relevant to the current adequacy and performance of the run-on and run-off control system were reviewed. No issues were identified during the review that would affect the performance of the system and its compliance, as described in the 2016 Plan, with the requirements of 40 CFR § 257.81(c)(5).

## 4. 2016 Plan – Review by Section

Other than as described in the remainder of this section, the details presented in this section of the 2016 Plan adequately represent current conditions and satisfy the requirements of the Rule.

## 4.1 "Overview"

The details presented in this section of the 2016 Plan adequately represent current conditions and satisfy the requirements of the Rule.

# 4.2 "§257.81 (a)(1)(2) Run-on and Run-off Controls for CCR Landfills"

The 2016 Plan presents the details of a control system to capture and convey the 24-hour, 100year off-site, run-on design storm event. The design storm exceeds the minimum (24-hour, 25year) event required by §257.81 (a)(1).

The review addressed the suitability of the hydrologic basis used for the 2016 Plan. The methods used to estimate the rainfall and losses were based on the Arizona Department of Transportation *Highway Drainage Design Manual* published 1993. A newer manual was released in 2007 that is similar to the original manual. In this application, the 1993 Manual is assessed to be conservative in that it did not account for a reduction in the C-value for smaller return events (such as the 25-year).

The details presented in this section of the 2016 Plan adequately represent current conditions and satisfy the requirements of the Rule.

## 4.3 "§257.81 (b) Run-on and run-off controls for CCR landfills"

The 2016 Plan presents the details of a control system to capture, convey, and store the 24hour, 25-year on-site, run-off design storm event as required by §257.81 (a)(2). As described in the 2016 Plan, there will be no discharge from the on-site retention basin.

The details presented in this section of the 2016 Plan adequately represent current conditions and satisfy the requirements of the Rule.

# 4.4 "§257.81 (c)(1)(2)(3)(4)(5) Run-on and run-off controls for CCR landfills"

The owner or operator continues to acknowledge and will comply with these requirements.

A certification of this Periodic Run-On and Run-Off Control Plan by a QPE is included in this document per the requirement of §257.81 (c)(5).

## 4.5 "§257.81 (d) Run-on and run-off controls for CCR landfills"

The owner or operator continues to acknowledge and will comply with these requirements.

## 5. Recommended Additional Technical Investigations or Evaluations

None identified and none recommended.

## 6. Conclusion

The 2016 Plan and its conclusions meet the current reporting requirements of the Rule, reflect the current condition of the structure as known to the QPE and documented in the annual inspections, are not compromised by any identified issues of concern, and are consistent with the standard of care of professionals performing similar evaluations in this region of the country.

## 7. Limitations

This document is for the sole use of APS on this project only and is not to be used for other projects. In the event that conclusions based upon the data presented in this document are made by others, such conclusions are the responsibility of others.

The Periodic Run-on And Run-off Control System Plan presented in this document is based on the 2016 Plan and relies and incorporates any Limitations expressed in that document.

The Certification of Professional Opinion in this report is limited to the information available to AECOM at the time this Assessment was performed in accordance with current practice and the standard of care. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period. Professional judgments presented herein are primarily based on information from previous reports that have been assumed to be accurate, knowledge of the site, and partly on our general experience with dam safety evaluations performed on other dams.

No warranty or guarantee, either written or implied, is applicable to this work. The use of the word "certification" and/or "certify" in this document shall be interpreted and construed as a

Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

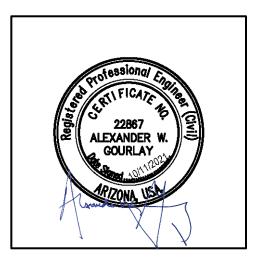
## 8. Certification Statement

#### Certification Statement for:

- Certification Statement 40 CFR § 257.81(c)(5) Periodic Run-on and Run-Off Control System Plan for an Existing CCR Landfill
- CCR Unit: Arizona Public Service; Cholla Power Plant; Bottom Ash Monofill

I, Alexander W. Gourlay, being a Registered Professional Engineer in good standing in the State of Arizona, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in this Periodic Run-On and Run-Off Control System Plan dated October 2021, including the technical content in Attachment A, meets the requirements of 40 CFR § 257.81.

<u>Alexander W. Gourlay, P.E.</u> Printed Name



October 11, 2021 Date

Attachment A:

AECOM, 2016. Cholla Power Plant, Bottom Ash Monofill, Run-on and Run-off Control System Plan, CH\_RunOO\_001\_20161017, October 17, 2016.

ATTACHMENT A

AECOM, 2016. Cholla Power Plant, Bottom Ash Monofill, Run-on and Run-off Control System Plan, CH\_RunOO\_001\_20161017, October 17, 2016.

#### CHOLLA POWER PLANT BOTTOM ASH MONOFILL RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN CH\_RunOO\_001\_20161017

This *Run-on and Run-off Control System Plan* (Plan) document has been prepared specifically for the Bottom Ash Monofill (BAM) at the Cholla Power Plant in accordance with our understanding of the requirements prescribed in §257.81(3)(i) of the Federal Register, Volume 80, Number 74, dated April 17, 2015 (U. S. Government, 2015) for run-on and run-off controls associated with existing Coal Combustion Residual (CCR) landfills. Section §257.81 from the Federal Register is reproduced below for reference purposes. This document serves as the initial run-on and run-off control system plan described in §257.81(3)(i).

The BAM is an existing CCR landfill facility. The location of the BAM is illustrated on Exhibit 1. Calculations prepared previously in support of the facility operation have been referenced and reproduced herein to address the requirements listed.

#### §257.81 Run-on and run-off controls for CCR landfills

(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm; and

(2) A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

(b) Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.

(c) Run-on and run-off control system plan -

(1) *Content of the plan.* The owner or operator must prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (4) of this new section. These plans must document how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section. Each plan must be supported by the appropriate engineering calculations. The owner or operator has completed the initial run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3).

(2) Amendment of the plan. The owner or operator may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility's operating record as required by §257.105(g)(3). The owner or operator must amend the written run-on and run-off control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

(3) Timeframes for preparing the initial plan -

(i) *Existing CCR landfills*. The owner or operator of the CCR unit must prepare the initial run-on and run-off control system plan no later than October 17, 2016.

(ii) *New CCR landfills and any lateral expansion of a CCR landfill.* The owner or operator must prepare the initial run-on and run-off control system plan no later than the date of initial receipt of CCR in the CCR unit.

(4) *Frequency for revising the plan.* The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a periodic run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3).

(5) The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.

(d) The owner or operator of the CCR unit must comply with the record keeping requirements specified in §257.105(g), the notification requirements specified in §257.106(g), and the internet requirements specified in §257.107(g).

| SITE INFORMATION     |  |
|----------------------|--|
| Site Name / Address  | Cholla Power Plant / 4801 Frontage Road, Joseph            |
|                      | City, AZ 86032   |
| Owner Name / Address | Arizona Public Service / 400 North 5 <sup>th</sup> Street, |
|                      | Phoenix, AZ 85004  |
| CCR Unit             | Bottom Ash Monofill (BAM)                                  |
|                      |  |

OVERVIEW

The Bottom Ash Monofill (BAM) located at the Cholla Power Plant is an existing CCR landfill. Construction of the BAM began in the late 1990s. An offsite flow channel system that intercepts and conveys offsite storm water from a 98-acre contributing watershed with outfall to the south is located immediately upstream of the BAM.

This run-on / run-off control plan describes the existing controls that preclude run-on of offsite storm flows from the landfill and the run-off of onsite storm flows from the landfill. Run-on / run-off control systems that prevent flow onto and from active CCR units from a 24-hour, 25-year storm are required. An existing diversion channel located on the perimeter of the BAM was designed and constructed to collect and convey contributing offsite flows in order to fulfill this requirement.

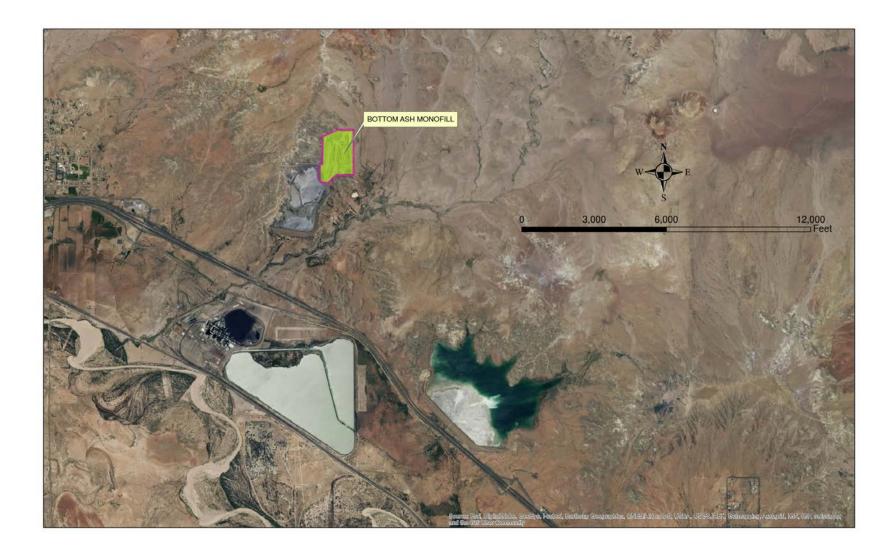


Exhibit 1 – Bottom Ash Monofill (BAM) at Cholla Power Plant Facility

| §257.81 (a)(1)(2) Run-on and run-off controls for CO | CR landfills  |
|--|---|
| (a) The owner or operator of an existing or new      | An offsite flow collection system is constructed on |
| CCR landfill or any lateral expansion of a CCR       | the upstream perimeter of the BAM. This system      |
| landfill must design, construct, operate, and        | captures and conveys the 24-hour, 100-year offsite  |
| maintain:  | / run-on flows produced by the 98-acre offsite      |
| (1) A run-on control system to prevent flow onto     | watershed around the project site and toward one    |
| the active portion of the CCR unit during the peak   | of three historic discharge points. The historic    |
| discharge from a 24-hour, 25-year storm;             | outfall discharge points have been maintained       |
|  | with the use of undersized culverts placed within   |
|  | the offsite flow channel that allow excess flow to  |
|  | overtop the channel at historic discharge points as |
|  | shown on the Cholla Generating Station, Ash         |
|  | Monofill APP Plan (URS 2009 A). This 100-year       |
|  | storm magnitude design exceeds the 24-hour, 25-     |
|  | year requirement shown in §257.81(a)(1). The        |
|  | Cholla Generating Station, Ash Monofill APP Plan    |
|  | is included in Appendix 1.                          |
|  | Estimates of the 24-hour, 100-year run-on peak      |
|  | flows captured and conveyed within the perimeter    |
|  | channel system are based on the <b>Cholla Power</b> |
|  | Plant, Ash Monofill Drainage Study, Preliminary     |
|  | Drainage Report (URS 2009 B). The 24-hour, 100-     |
|  | year offsite peak flows were estimated with the     |
|  | use of the rational method of hydrology for three   |
|  | offsite drainage areas identified below:            |
|  |   |
|  | <ul> <li>OFF1: 23.8 cfs</li> </ul>                  |
|  | <ul> <li>OFF2: 50.7 cfs</li> </ul>                  |
|  | <ul> <li>OFF3: 60.9 cfs</li> </ul>                  |
|  |   |
|  | These 24-hour, 100-year run-on peak flows to the    |
|  | BAM Site are intercepted and conveyed in a          |
|  | trapezoidal channel system characterized by seven   |
|  | sections. The sections include a 10-foot bottom     |
|  | width, 2.5H: 1V side slopes, maximum channel        |
|  | depth of 5 feet, longitudinal slope ranging from    |
|  | 0.5% to 1.04%, and riprap erosion protection        |
|  | lining. The trapezoidal channel segment design      |
|  | and conveyance characteristics by Channel Section   |

|   | include the following:                              |  |  |  |  |
|---|---|--|--|--|--|
|   | Peak Flows:   |  |  |  |  |
|   | <ul> <li>Channel Section 1: 25 cfs</li> </ul>       |  |  |  |  |
|   | <ul> <li>Channel Section 2: 80 cfs</li> </ul>       |  |  |  |  |
|   | <ul> <li>Channel Section 3: 140 cfs</li> </ul>      |  |  |  |  |
|   | <ul> <li>Channel Section 4: 150 cfs</li> </ul>      |  |  |  |  |
|   | <ul> <li>Channel Section 5: 80 cfs</li> </ul>       |  |  |  |  |
|   | <ul> <li>Channel Section 6: 80 cfs</li> </ul>       |  |  |  |  |
|   | <ul> <li>Channel Section 7: 25 cfs</li> </ul>       |  |  |  |  |
|   | <ul> <li>Longitudinal Slope:</li> </ul>             |  |  |  |  |
|   | <ul> <li>Channel Section 1: 0.0089 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Channel Section 2: 0.0104 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Channel Section 3: 0.0050 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Channel Section 4: 0.0100 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Channel Section 5: 0.0100 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Channel Section 6: 0.0100 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Channel Section 7: 0.0050 ft/ft</li> </ul> |  |  |  |  |
|   | <ul> <li>Normal Depth:</li> </ul>                   |  |  |  |  |
|   | <ul> <li>Channel Section 1: 0.73 feet</li> </ul>    |  |  |  |  |
|   | <ul> <li>Channel Section 2: 1.35 feet</li> </ul>    |  |  |  |  |
|   | <ul> <li>Channel Section 3: 2.22 feet</li> </ul>    |  |  |  |  |
|   | <ul> <li>Channel Section 4: 1.91 feet</li> </ul>    |  |  |  |  |
|   | <ul> <li>Channel Section 5: 1.36 feet</li> </ul>    |  |  |  |  |
|   | <ul> <li>Channel Section 6: 1.36 feet</li> </ul>    |  |  |  |  |
|   | <ul> <li>Channel Section 7: 0.86 feet</li> </ul>    |  |  |  |  |
|   | The normal depth calculations for the offsite flow  |  |  |  |  |
|   | channel system, developed as part of the Cholla     |  |  |  |  |
|   | Power Plant, Ash Monofill Drainage Study,           |  |  |  |  |
|   | Preliminary Drainage Report (URS 2009 B) are        |  |  |  |  |
|   | included in Appendix 2.                             |  |  |  |  |
| (a) The owner or operator of an existing or new   | An existing onsite storage basin located at the     |  |  |  |  |
| CCR landfill or any lateral expansion of a CCR    | BAM landfill facility is designed to collect the    |  |  |  |  |
| landfill must design, construct, operate, and     | onsite runoff volume generated by a 25-year, 24-    |  |  |  |  |
| maintain:   | hour storm which is estimated to be 5.2 acre-feet.  |  |  |  |  |
| (2) A run-off control system from the active      | The BAM yields a total 25-year, 24-hour storm       |  |  |  |  |
| portion of the CCR unit to collect and control at | water runoff volume of 5.23 acre-feet from the      |  |  |  |  |
|   |   |  |  |  |  |

| least the water volume resulting from a 24-hour,     | onsite portion of the BAM based on the following  |
|--|---|
| 25-year storm.                                       | parameters:   |
|  | <ul> <li>Surface Area: 47.2 acres</li> <li>Runoff Coefficient: 0.60</li> <li>25-year, 24-hour Precipitation Depth: 2.22 inches</li> </ul>   |
|  | The <b>Cholla Power Plant, Ash Monofill Drainage</b>  |
|  | Study, Preliminary Drainage Report, dated   |
|  | February 2009 indicates that the onsite storm   |
|  | water storage basin adjacent to the BAM provides<br>a volume of 8.3 acre-feet at a depth of 12-feet and<br>a surface area of 1.04 acres. This exceeds the 25-<br>year, 24-hour storm water runoff volume of 5.23<br>acre-feet. The additional volume provided may<br>accommodate sediment in addition to surface<br>water resulting from dust control activities and<br>compaction efforts. |
|  | The storm water runoff and storage volume capacity calculations are included in Appendix 2.   |
| §257.81 (b) Run-on and run-off controls for CCR lan  | dfills  |
| (b) Run-off from the active portion of the CCR unit  | Onsite 25-year, 24-hour storm water runoff  |
| must be handled in accordance with the surface       | produced from the BAM Site is accommodated by   |
| water requirements under §257.3-3.                   | a storm water storage basin contiguous to the<br>BAM and does not discharge into waters of the<br>United States.  |
| §257.81 (c)(1)(2)(3)(4)(5) Run-on and run-off contro | ls for CCR landfills  |
| (c)(1) Content of the plan. The owner or operator    | This Run-on and Run-off Control System Plan   |
| must prepare initial and periodic run-on and run-    | serves as the initial plan prescribed herein.   |
| off control system plans for the CCR unit according  |   |
| to the timeframes specified in paragraphs (c)(3)     |   |
| and (4) of this section. These plans must            |   |
| document how the run-on and run-off control          |   |
| systems have been designed and constructed to        |   |
| meet the applicable requirements of this section.    |   |
| Each plan must be supported by appropriate           |   |

| owner or operator acknowledges and will         |
|---|
|   |
| ply with this requirement.                      |
|   |
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|   |
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|   |
| · · ·   |
| BAM is an existing CCR landfill at Cholla Power |
| it. The run-on and run-off control system plan  |
| escribed and included herein.                   |
| owner or operator acknowledges and will         |
| ply with this requirement.                      |
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| owner or operator acknowledges and will         |
| ply with this requirement.                      |
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| plan is based on the date of completing the           |  |
|---|--|
| previous plan. For purposes of this paragraph         |  |
| (c)(4), the owner or operator has completed a         |  |
| periodic run-on and run-off control system plan       |  |
| when the plan has been placed in the facility's       |  |
| operating record as required by §257.105(g)(3).       |  |
|   |  |
| (c)(5) The owner or operator must obtain a            | Certification by a professional engineer is included |
| certification from a qualified professional engineer  | as an attachment to this document.                   |
| stating that the initial and periodic run-on and run- |  |
| off control system plans meet the requirements of     |  |
| this section.   |  |
|   |  |
| §257.81 (d) Run-on and run-off controls for CCR lan   | dfills   |
| (d) The owner or operator of the CCR unit must        | The owner or operator acknowledges and will          |
| comply with the recordkeeping requirements            | comply with this requirement.                        |
| specified in §257.105(g), the notification            |  |
| requirements specified in §257.106(g), and the        |  |
| internet requirements specified in §257.107(g).       |  |
|   |  |

#### References

U. S. Government, April 17, 2015, Federal Register, Volume 80, Number 74.

URS Corporation, February 2009, Cholla Generating Station, Ash Monofill APP.

URS Corporation, February 2009, *Cholla Power Plant, Ash Monofill Drainage Study, Preliminary Drainage Report.* 

## Certification Statement 40 CFR § 257.81(c)(5) – Initial Run-on and Run-Off Control System Plan for an Existing CCR Landfill

#### CCR Unit: Arizona Public Service; Cholla Power Plant; Bottom Ash Monofill

I, Alexander W. Gourlay, being a Registered Professional Engineer in good standing in the State of Arizona, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in the initial run-on and run-off control system plan dated August, 31, 2016 meets the requirements of 40 CFR § 257.81.

Alexander W. Gourlay, P.E.

Printed Name

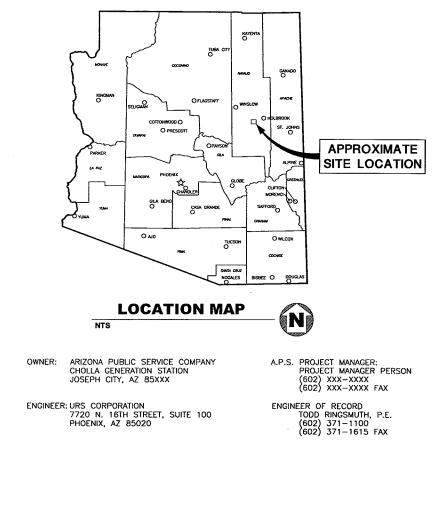
August 31, 2016

Date



#### APPENDIX 1 – CHOLLA GENERATING STATION, ASH MONOFILL APP PLAN

# **ARIZONA PUBLIC SERVICE CHOLLA GENERATING STATION CHOLLA ASH MONOFILL APP JOSEPH CITY, ARIZONA**



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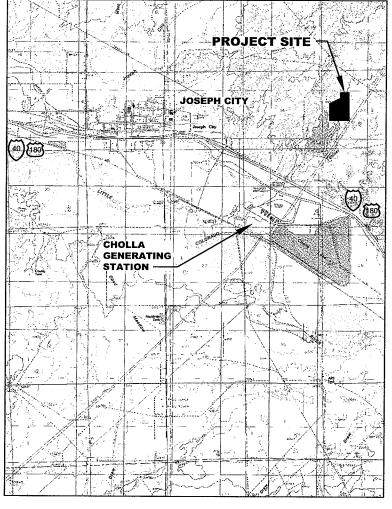
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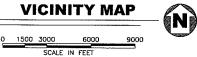
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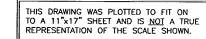
Two marking days before you dig. CALL FOR THE BLUE STAKES

263-1100



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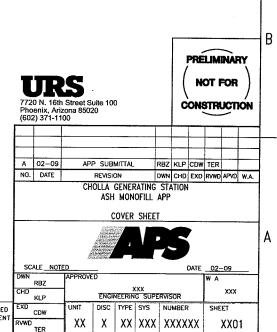






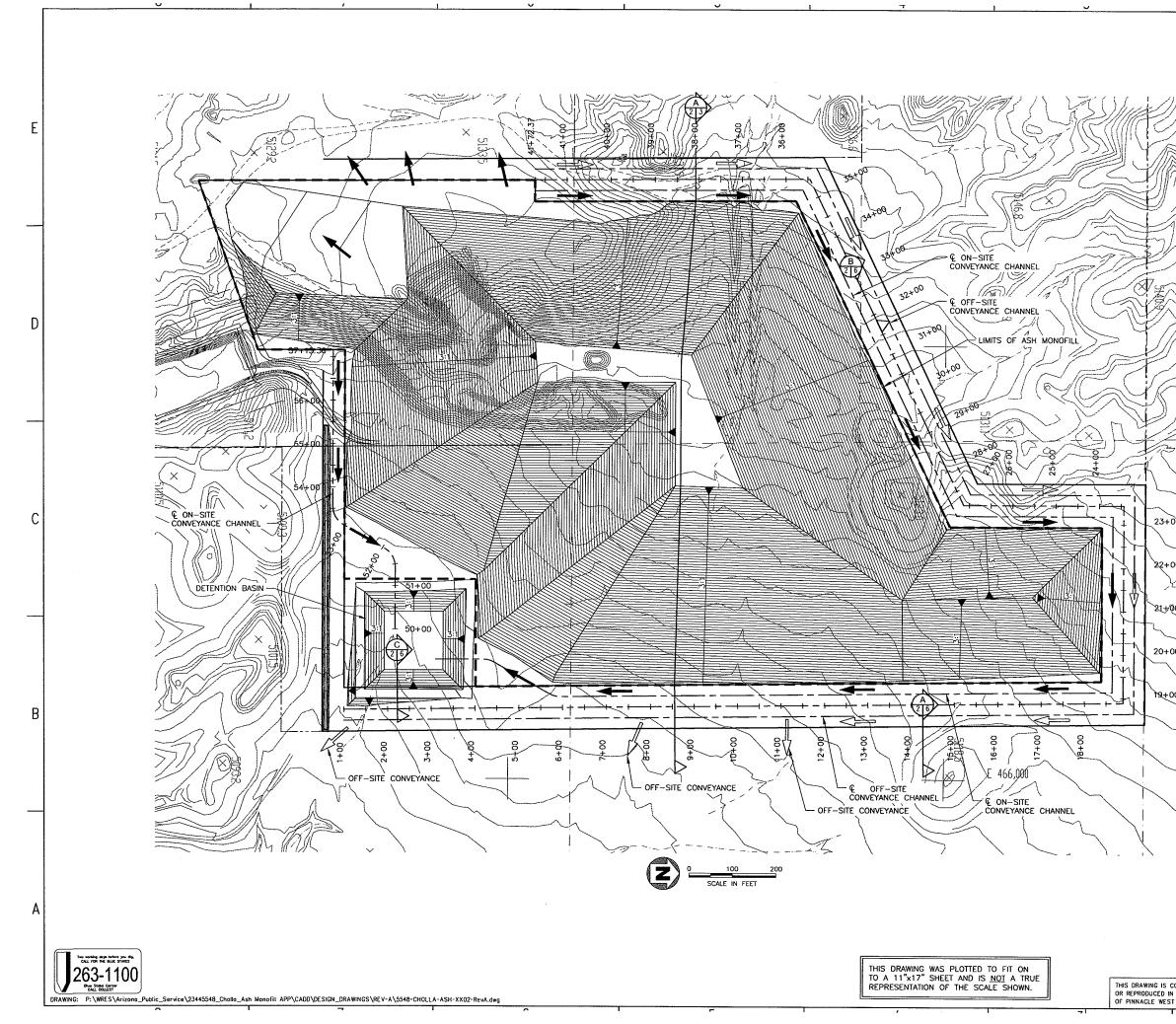
#### **DRAWING INDEX**

| NO.      | REV. | DRAWING TITLE       |
|----------|------|---------------------|
| ASH-XX01 | Α    | COVER SHEET         |
| ASH-XX02 | Α    | GENERAL SITE PLAN   |
| ASH-XX03 | А    | SECTION AND DETAILS |
| ASH-XX04 | А    | PLAN AND PROFILES   |
| ASH-XX05 | А    | PLAN AND PROFILES   |
| ASH-XX06 | А    | SECTION AND DETAILS |
|          |      |                     |

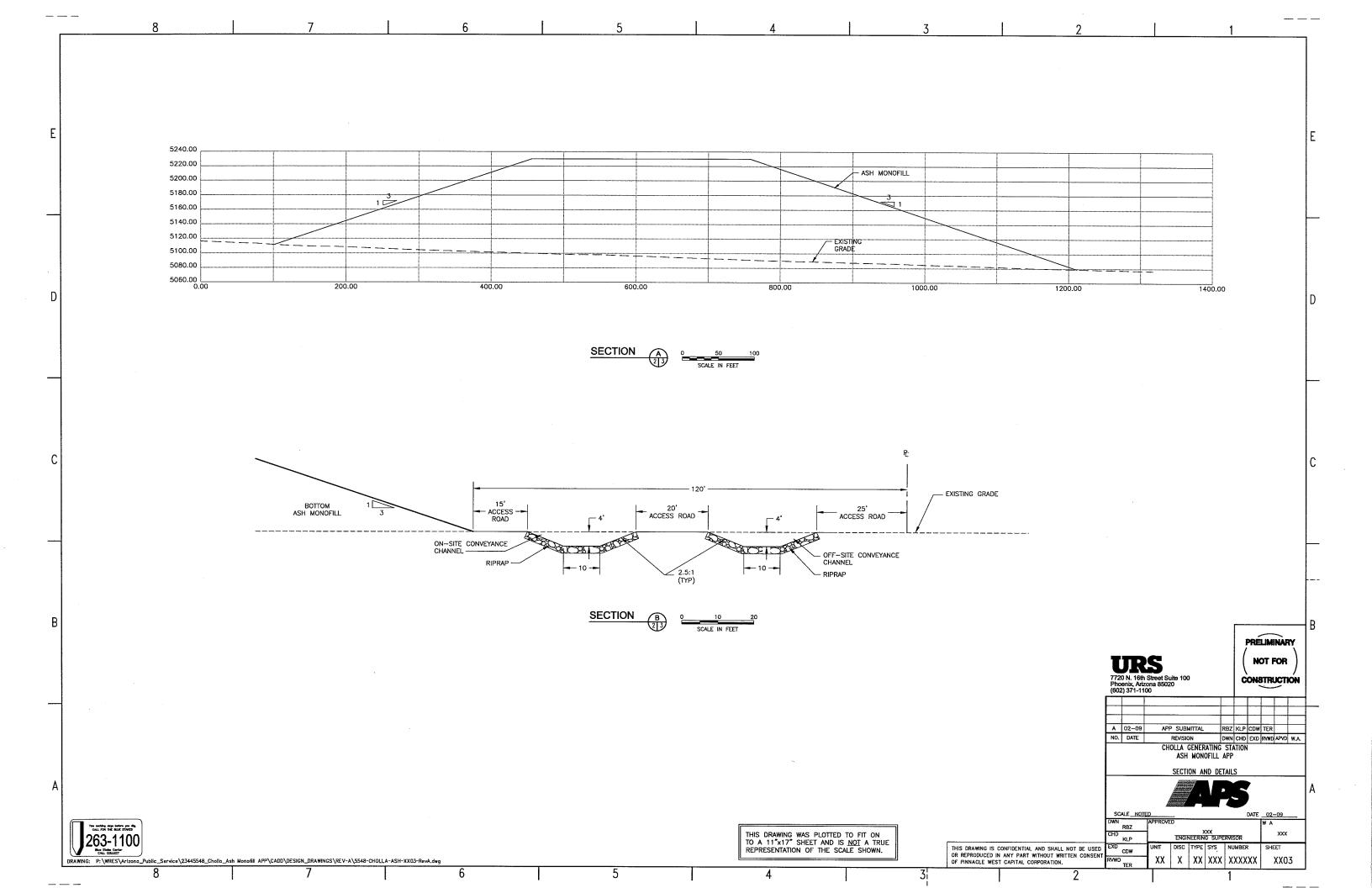


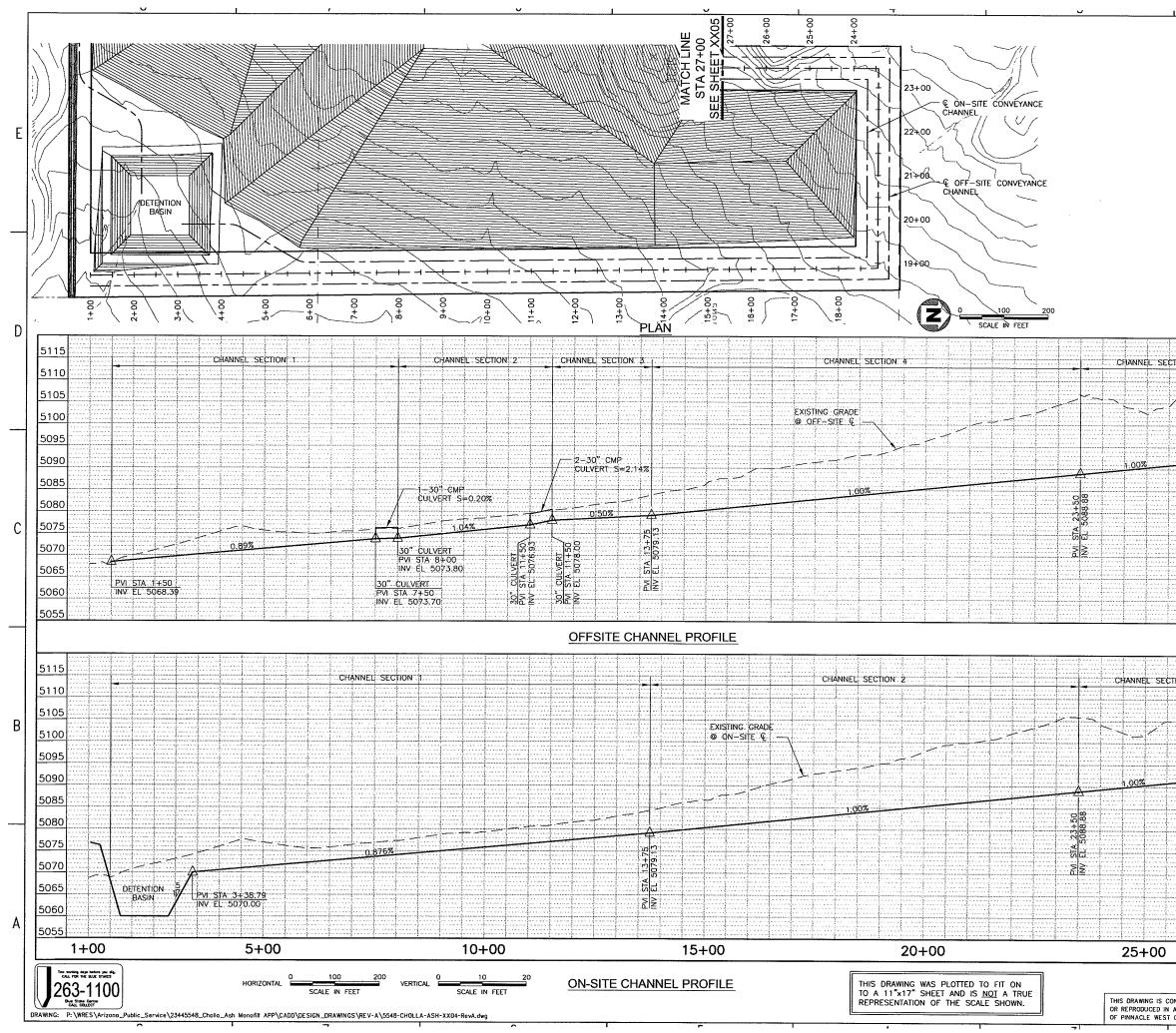
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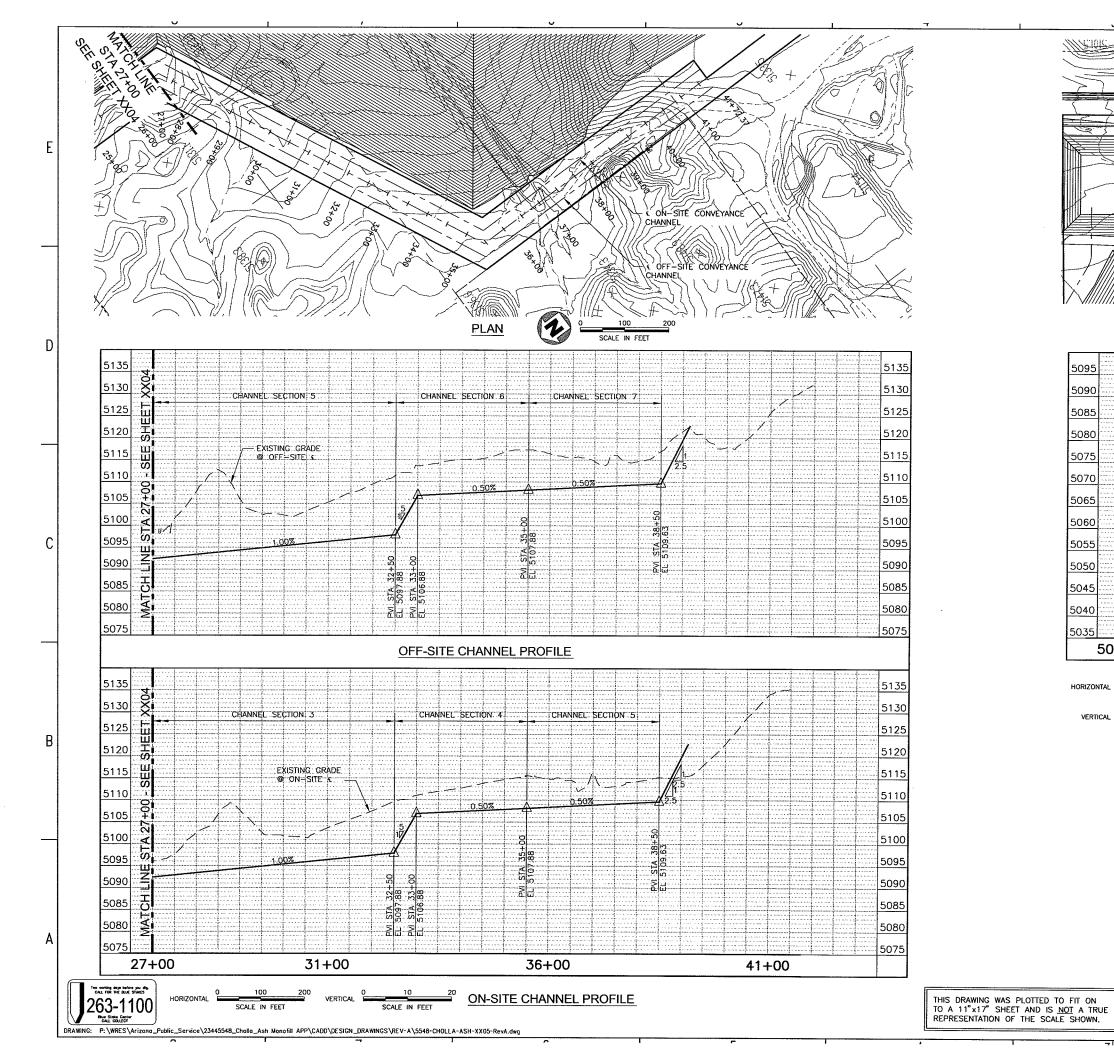
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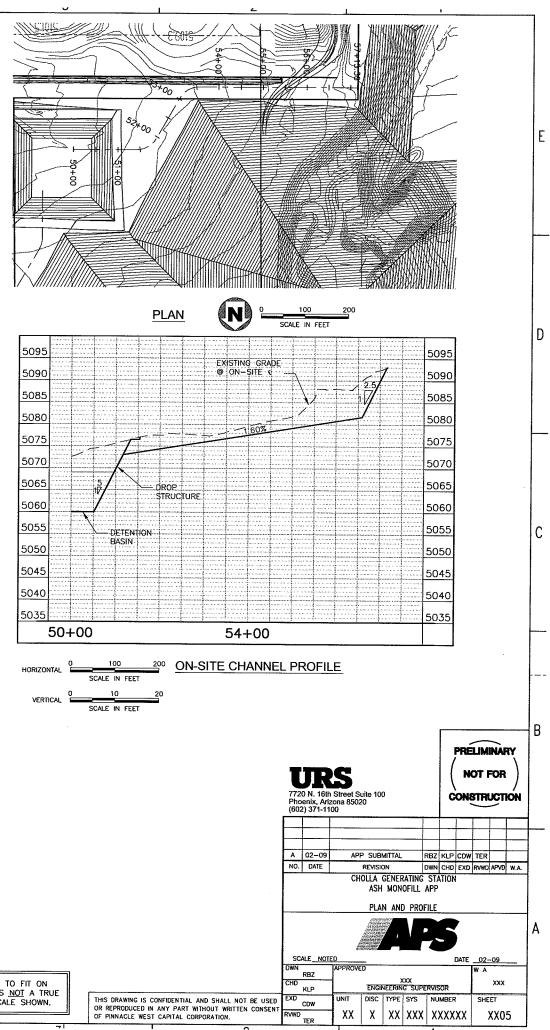


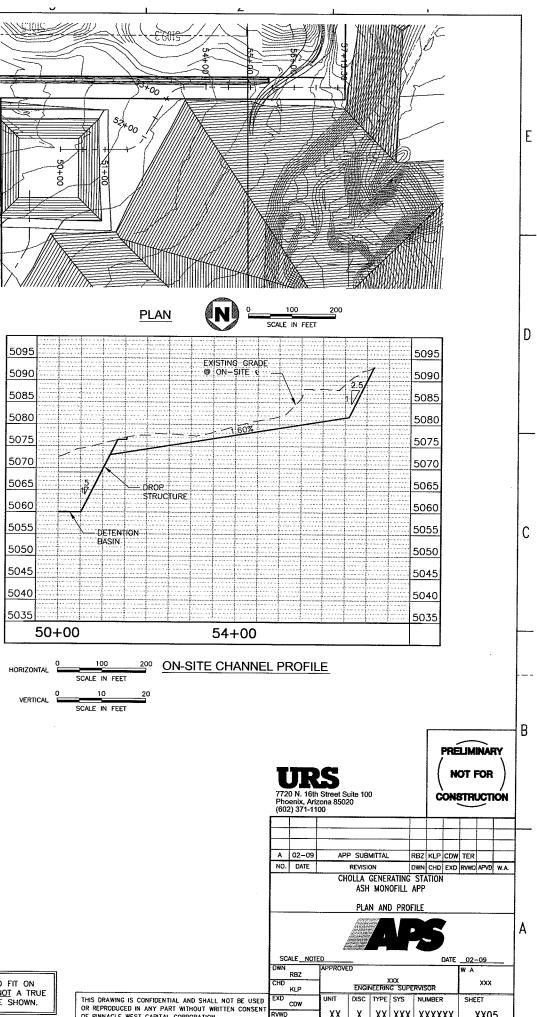


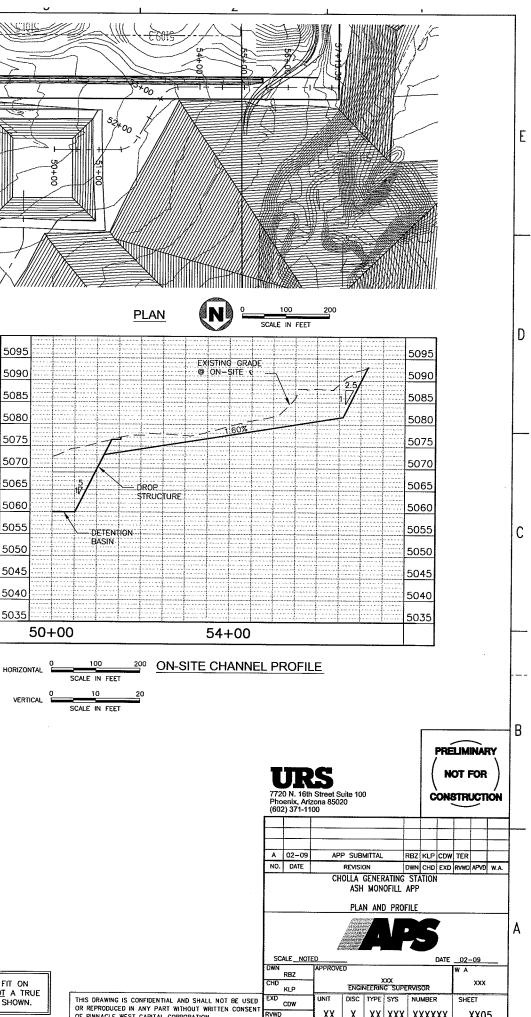
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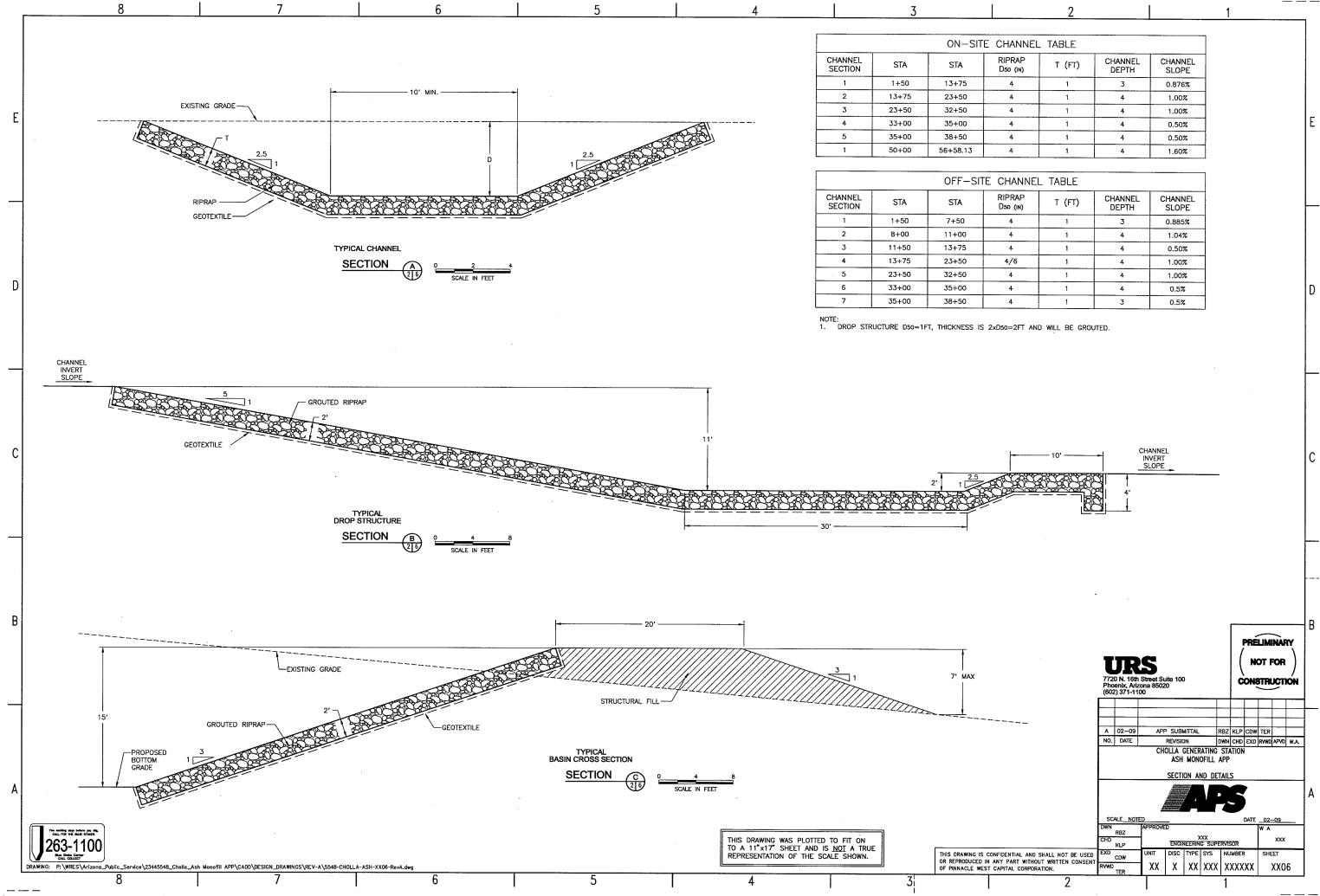
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#### APPENDIX 2 - CHOLLA POWER PLANT, ASH MONOFILL DRAINAGE STUDY, PRELIMINARY DRAINAGE REPORT

#### CHOLLA POWER PLANT ASH MONOFILL DRAINAGE STUDY PRELIMINARY DRAINAGE REPORT

Prepared for NAVAJO COUNTY

URS Job No. 23445548 February 2009

## **Cholla Power Plant - Ash Monofill**

## **Drainage Study**

## **Preliminary Drainage Report**

**Prepared for:** 

Navajo County

This report is based on data, site conditions and other information that are generally applicable as of 2009, and the conclusions and recommendations herein are therefore applicable only to that period.

This report is preliminary and is not to be used as the sole basis for final design or for construction or as a basis for major capital decisions. Further analysis of the study area should be performed prior to any designs or decisions.

Cholla Power Plant Ash Monofill Drainage Study

February 2009

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## **1.0 INTRODUCTION**

This drainage report presents the hydrologic and hydraulic analysis completed for the proposed expansion to the Cholla Generating Station Ash Monofill for the Arizona Public Service (APS). This report will be included as a portion of the revised Aquifer Protection Permit that will be submitted to the Arizona Department of Environmental Quality (ADEQ). The purpose of this analysis was to calculate the pre-development and post-development flows to ensure the proposed design would not increase historic flow amounts and discharge points.

## 1.1 SITE LOCATION AND DESCRIPTION

The Ash Monofill area is in eastern Arizona located on the Arizona Public Service (APS) Cholla Generating Station property, approximately 2.5 miles east of the town of Joseph City, Arizona, as shown in Figure 1. The site covers approximately 50 acres and is north of Interstate 40. The study area encompasses all of the off-site drainage areas for the proposed Ash Monofill, which covers approximately 100 acres.

## 2.0 FEDERAL EMERGENCY MANAGEMENT AGENCY FLOODPLAIN CLASSIFICATION

The project site is located in the flood hazard area represented by Zone X of the National Flood Insurance Program, based on Flood Insurance Rate Map Number 04017C3308E and 04017C3310E, revised September 26, 2008 (see Figure 3). The Zone X classification indicates the following:

Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1-foot with drainage area less than one square mile.

## 3.0 HYDROLOGY

## 3.1 METHODOLOGY

The hydrologic analysis for the Ash Monofill site was computed using the Rational Method based on the *Arizona Department of Transportation Highway Drainage Design Manual, Hydrology (ADOT Drainage Manual)* (ADOT 1993). This methodology can be used to estimate peak discharges and runoff volumes for small, uniform drainage areas that are less than 160 acres

in size. The largest existing or developed drainage basin for this proposed expansion project is approximately 60 acres, which is much less than the 160 acre maximum threshold. The peak discharges and runoff volumes were used to design the offsite and onsite collection system. The topographic and soil data information were collected to assist in the analysis.

## **3.2 TOPOGRAPHY**

Topography was provided by APS at 2-foot contour intervals and by United Stated Geological Survey's topographic maps at 5-foot contour intervals. All topographic data was generated in North American Vertical Datum (NAVD) 1988 for the vertical dimension and in North American Datum 1983, Arizona State Plane East, for the horizontal. The combined survey data were used as guidance for delineating drainage basins (see Figure 4).

## 3.3 SOILS

Soil data was obtained from the Natural Resources Conservation Service (NRCS) online soil survey site (NRCS 2008). There are two existing soil types in the vicinity of the proposed development. The first soil is Gypsiorthids-Torriothents, 5 to 60 percent slopes and the second soil is Brunswick Sandy Clay Loam, 1 to 5 percent slopes. The two soils belong to Hydrologic Soil Group B and this information was used to determine coefficient values for the Rational Method calculations. This information has been included in Appendix B.

## 3.4 HYDROLOGIC MODELING PARAMETERS

The *ADOT Drainage Manual* was used to determine the hydrologic parameters to be used in the Rational Method. A detailed discussion of the hydrologic parameter calculations is provided in the following sections.

## 3.4.1 Rainfall

The 100-year, 24-hour storm event was used as the design storm for the offsite collection system and the 25-year, 24-hour storm was used for the onsite collection system and retention basin. These are the design storms specified for use by ADEQ. The rainfall depths were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (NOAA 2008). This information was used to create a site-specific intensity-duration-frequency (I-D-F) curve that was used in the Rational Method. The 100-year, 24-hour rainfall amount used in the analysis is 2.77 inches and the 25-year, 24-hour rainfall is 2.22 inches. The rainfall information and I-D-F calculation is included in Appendix A.



#### 3.4.2 Drainage Areas

The existing drainage area basin boundaries for the study area are shown in Figure 4. The watershed delineations were performed using the 2-foot and 5-foot contours. The existing information was used to determine the pre-development discharges and historic outfall locations. The design of the proposed expansion will maintain the historic outfall locations and will ensure the post-development flows are below the pre-development flows.

The post-development drainage areas were delineated based on the proposed improvements within the APS property. The post-development drainage basins are shown on Figure 5. The onsite basins will be conveyed by channels to a retention basin and the offsite basins will be routed around the property to their historic outfall locations.

## 3.4.3 Rational Coefficient

The rational coefficients were selected based on the land use and vegetation cover using Figure 2-5 from the *ADOT Drainage Manual* (ADOT 1993). The study area was considered to be Upland Rangeland with a vegetation cover of approximately 10 percent. The soil in the vicinity of the project site belongs to the Hydrologic Soil Type B. Based on this information, the study area was considered to have a rational coefficient of 0.30 for existing conditions. The soil that will be used for the landfill cover will be a clay soil with little or no vegetation. This soil type was selected to minimize rainfall infiltratration into the landfill and will have a rational coefficient of 0.60. This information has been included in Appendix B.

## 3.4.4 Time of Concentration

The time of concentrations for each of the sub-basins was calculated based on Equation 2-2, below, and following parameters from the Rational Method in the *ADOT Drainage Manual* (ADOT 1993):

$$T_c = 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38}$$

Where  $T_c = time$  of concentration in hours

L = length of the longest flow path in feet per mile

 $K_b$  = watershed resistance coefficient

S= slope of the longest flow path in feet per mile

i = average rainfall intensity, in inches per hour, for a duration of rainfall equal to  $T_c$ , unless  $T_c$  is less than 10 minutes, in which case (i) is for a 10-minute duration

A summary of the time of concentration is provided in Table 1 below and in Appendix B.

#### Table 1

| Sub-Basin                | L<br>(miles) | Area<br>(ac) | H (feet)<br>(change in elevation<br>along L) | S<br>(feet/mile) | i<br>(inches/<br>hour) | T <sub>c</sub><br>(min) |
|--------------------------|--------------|--------------|--|------------------|------------------------|-------------------------|
| OFF-1 (Pre-Development)  | 0.56         | 39.6         | 129.0  | 229.9            | 4.60                   | 16                      |
| OFF-2 (Pre-Development)  | 0.63         | 49.3         | 135.0  | 215.4            | 4.30                   | 18                      |
| OFF-3 (Pre-Development)  | 0.85         | 59.7         | 166.0  | 194.9            | 3.80                   | 22                      |
| OFF-1 (Post-Development) | 0.26         | 14.1         | 71.0   | 276.3            | 5.73                   | 10                      |
| OFF-2 (Post-Development) | 0.39         | 34.4         | 92.0   | 234.0            | 5.00                   | 13                      |
| OFF-3 (Post-Development) | 0.66         | 49.2         | 126.0  | 189.8            | 4.20                   | 19                      |
| ON-4                     | 0.16         | 8.9          | 144.0  | 928.6            | 4.48                   | 10                      |
| ON-5                     | 0.12         | 13.7         | 127.0  | 1065.4           | 4.48                   | 10                      |
| ON-6                     | 0.16         | 19.9         | 153.0  | 967.5            | 4.48                   | 10                      |
| ON-7                     | 0.09         | 4.7          | 112.0  | 1246.0           | 4.48                   | 10                      |

#### Time of Concentration Summary<sup>1</sup>

SOURCE: Arizona Department of Transportation 1993

NOTE: <sup>1</sup> Based on the Arizona Department of Transportation Highway Drainage Design Manual, Hydrology, Equation 2-2, Time of Concentration Estimation

## 3.5 HYDROLOGIC MODELING RESULTS

The Rational Method model provides the 100-year, 24-hour peak discharges for the offsite basins and the 25-year, 24-hour peak discharges for the onsite drainage basin. The hydrology calculations and Rational Method model are provided in Appendix B, along with the total volume of runoff calculated for each on-site drainage basin. The peak discharge summary is provided Table 2 and in Appendix B. This table confirms that the existing peak flow amounts for basin OFF-1, OFF-2, and OFF-3 will be decreased in the developed condition. The on-site runoff volume is shown in Table 3.

| Sub-Basin                | Rainfall         | Area<br>(acre) | Peak Discharge<br>(cubic feet per second) |
|--------------------------|------------------|----------------|---|
| OFF-1 (Pre-Development)  | 100-yr, 24-hour  | 39.6           | 54  |
| OFF-2 (Pre-Development)  | 100-yr, 24-hour  | 49.3           | 63  |
| OFF-3 (Pre-Development)  | 100-yr, 24-hour  | 59.7           | 67  |
| OFF-1 (Post-Development) | 100-yr, 24-hour  | 14.1           | 24  |
| OFF-2 (Post-Development) | 100-yr, 24-hour  | 34.4           | 51  |
| OFF-3 (Post-Development) | 100-yr, 24-hour  | 49.2           | 61  |
| ON-4                     | 25-year, 24-hour | 8.9            | 24  |
| ON-5                     | 25-year, 24-hour | 13.7           | 37  |
| ON-6                     | 25-year, 24-hour | 19.9           | 54  |
| ON-7                     | 25-year, 24-hour | 4.7            | 13  |

Table 2Peak Discharge Summary Table

#### Table 3

## **Volume Summary Table**

| Sub-Basin | P<br>(inches) | Area<br>(acres) | С    | Volume<br>(acre-feet) |
|-----------|---------------|-----------------|------|-----------------------|
| ON-4      | 2.22          | 8.9             | 0.60 | 0.99                  |
| ON-5      | 2.22          | 13.7            | 0.60 | 1.52                  |
| ON-6      | 2.22          | 19.9            | 0.60 | 2.21                  |
| ON-7      | 2.22          | 4.7             | 0.60 | 0.52                  |
|           | Total Volume: |                 |      |                       |

NOTES: P = 25-year, 24-hour rainfall event; C = rational coefficient



# 4.0 DRAINAGE DESIGN

#### 4.1 OFFSITE COLLECTION SYSTEM

The offsite collection system was designed to capture the offsite flows and route them around the proposed improvements to their historic outlet points. There are three historic outfall points for the existing drainage basins, which are displayed on Figure 4. The offsite collection system consists of rip-rap lined channels, culverts, weirs, and a drop structure.

#### 4.1.1 Offsite Perimeter Channel

The offsite perimeter channel is located within the APS property adjacent to the property line. It has a 10-foot bottom width with 2  $\frac{1}{2}$  to 1 side slopes (H:V). URS field investigation of the proposed site revealed evidence of scour and sediment deposits in existing collection channels due to the nature of the contributing soils. The size and depth of the proposed perimeter channel is small enough that rip-rap can be used for the entire channel cross sectional area. The sizing calculations for the rip-rap channel are located in Appendix C.

The perimeter channel consists of seven sections based on the offsite inflow and historic outflow locations. The normal depth calculations for the channel sections are located in Appendix C. A drop structure along the channel alignment is necessary because the channel was designed to minimize the amount of excavation. The elevation drops nine feet in this structure over a length of fifty feet. The calculation for this drop structure is included in Appendix C.

#### 4.1.2 Historic Outflow Points

Offsite flows in the channels will outlet at the historic outflow locations and the peak flow at these locations will be maintained. Due to the topography of the area, the proposed site layout, and the location of the historic outfalls, culverts were placed in the channel. These culverts reduce the flow in the downstream channel section by allowing excess flows to overtop the channel on the east side maintaining the historic outfall location. A lateral weir is located on the east bank of the channel which allows flow to overtop the channel section. The design of the culverts and weir is located in Appendix C.

#### 4.2 ONSITE COLLECTION SYSTEM

The onsite collection system was designed based on the ultimate developed condition. This design parameter was selected because the peak flows and volumes would be maximized, resulting in a conservative design that eliminates the necessity of an interim design and



construction. The onsite collection system consists of channels, drop structures, and a storage basin. There is a portion of the project site within the proposed improvements that will not drain into the onsite collection system, but will be collected by an existing pond located south of this project.

#### 4.2.1 Onsite Channels

The layout of the onsite channel system parallels the offsite collection system and is shown on Figure 5. The offsite and onsite channels were aligned based on the offset from landfill as well as the property line, which is shown on Figure 6. The onsite channel system will collect and convey the runoff from the 25-year, 24-hour storm to the storage basin located in the southeast corner of the project site. The channel alignments near the onsite storage basin were modified so that they would not flow into the basin at the corners. The channels will empty into the storage basin thru drop structures and a stilling basin. The stilling basin will protect the storage basin floor by dissipating the flow energy from the drop structure. The hydraulic design calculations are included in Appendix C.

#### 4.2.2 Onsite Storage Basin

The onsite storage basin was designed to collect the runoff volume generated by a 25-year, 24-hour storm. That volume is shown in Table 3 as 5.2 acre-feet. The basin depth was increased by 2-feet to account for sediment and the basin will have 2-feet of freeboard. The overall proposed depth of the basin is 12-feet with 3 to 1 side slopes (H:V). An overflow spillway is located on the east side of the basin that will allow the basin to overtop during storms greater than the 25-year, 24-hour storm. The actual storage volume provided by the basin is 8.2 acre-feet. That calculation is provided in Appendix C. Any runoff volume collected in this storage basin will be pumped within 36-hours to the existing pond located south of the project site.

#### 4.3 CONCLUSIONS

The offsite drainage system was design to collect and convey the 100-year, 24-hour peak flow around the project site to the historic outlet points. The post-development peak flow at these discharge points is less than the pre-development flows. The onsite collection system was designed to collect and convey the 25-year, 24-hour peak flow to a storage basin that has the volume capacity for that design storm. The drainage design drawings for the proposed improvements are included in this report.



### **5.0 REFERENCES**

Arizona Department of Transportation (ADOT). 1993. *Highway Drainage Design Manual, Hydrology*. Revision 8-11-94. Report FHWA-AZ93-281. Prepared for the Arizona Department of Transportation by NBS/Lowry Engineers & Planners, Phoenix, Arizona, and George V. Sabol Consulting Engineers, Brighton, Colorado.

Available at:

http://www.azdot.gov/Highways/Roadway\_Engineering/Drainage\_Design/PDF/ADOTHighwayDrainageDesignMa nual\_Hydrology.pdf.

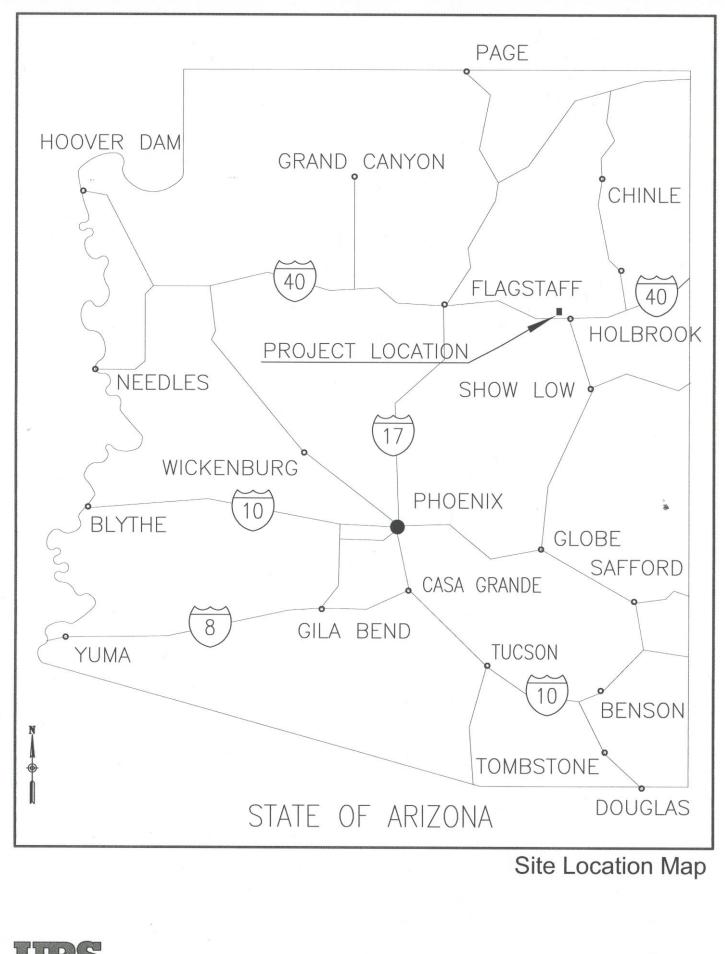
National Oceanic and Atmospheric Administration (NOAA). 2008. NOAA's National Weather Service, Hydrometeorological Design Studies Center, Precipitation Frequency Data Service. NOAA Atlas 14, Arizona. Available at http://hdsc.nws.noaa.gov/hdsc/pfds (accessed January 2009).

United States Department of Agriculture, National Resources Conservation Service (NRCS) 2008. Web Soil Survey. Available at http://websoilsurvey.nrcs.usda.gov/app/ (accessed February 4, 2009).

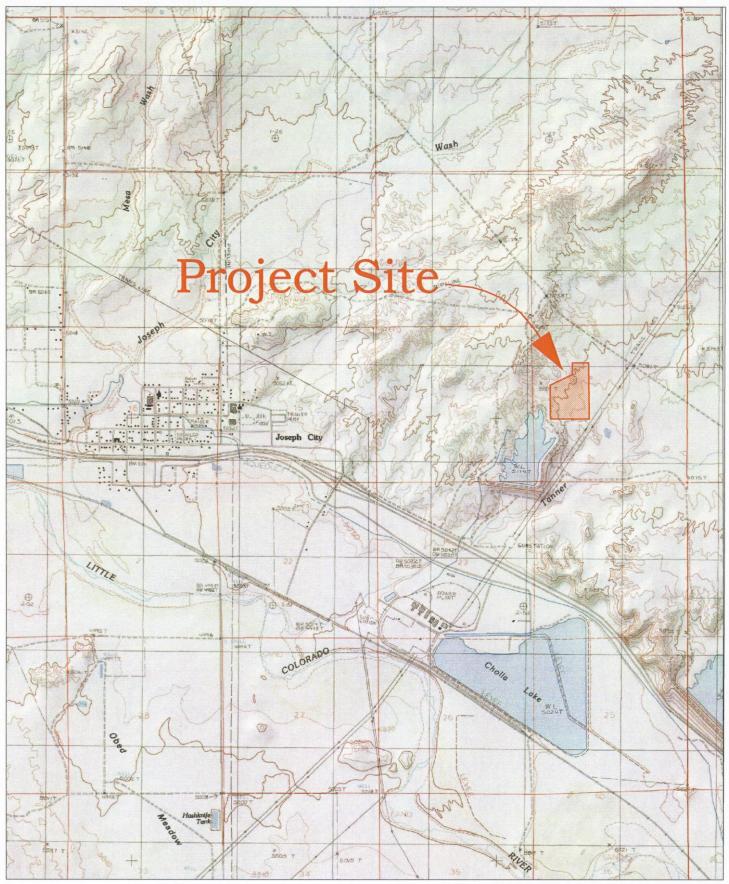


# **FIGURES**

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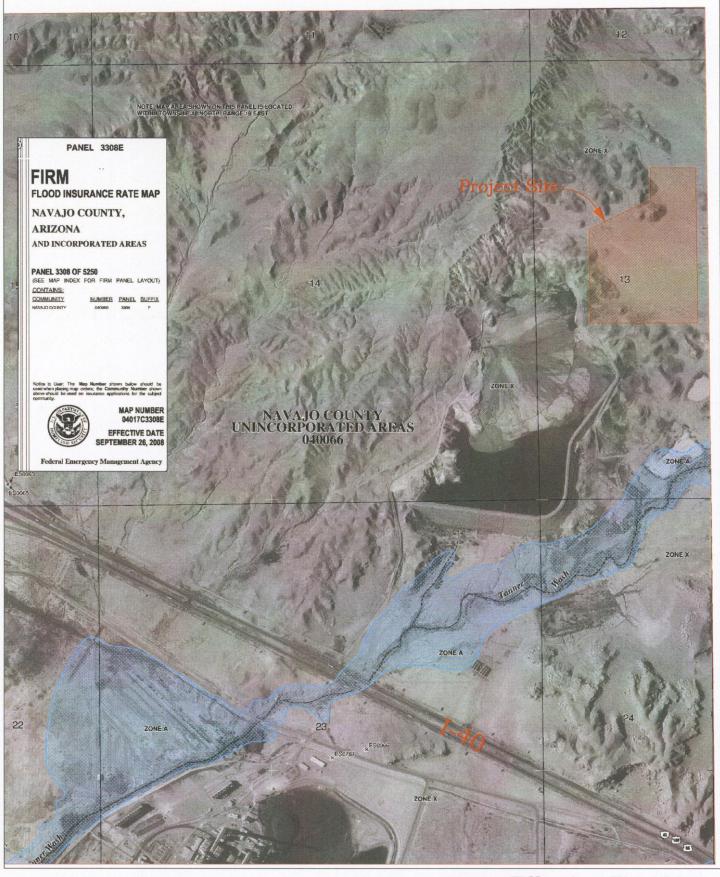
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Site Location Map

Ash Monofill Drainage Study Navajo County



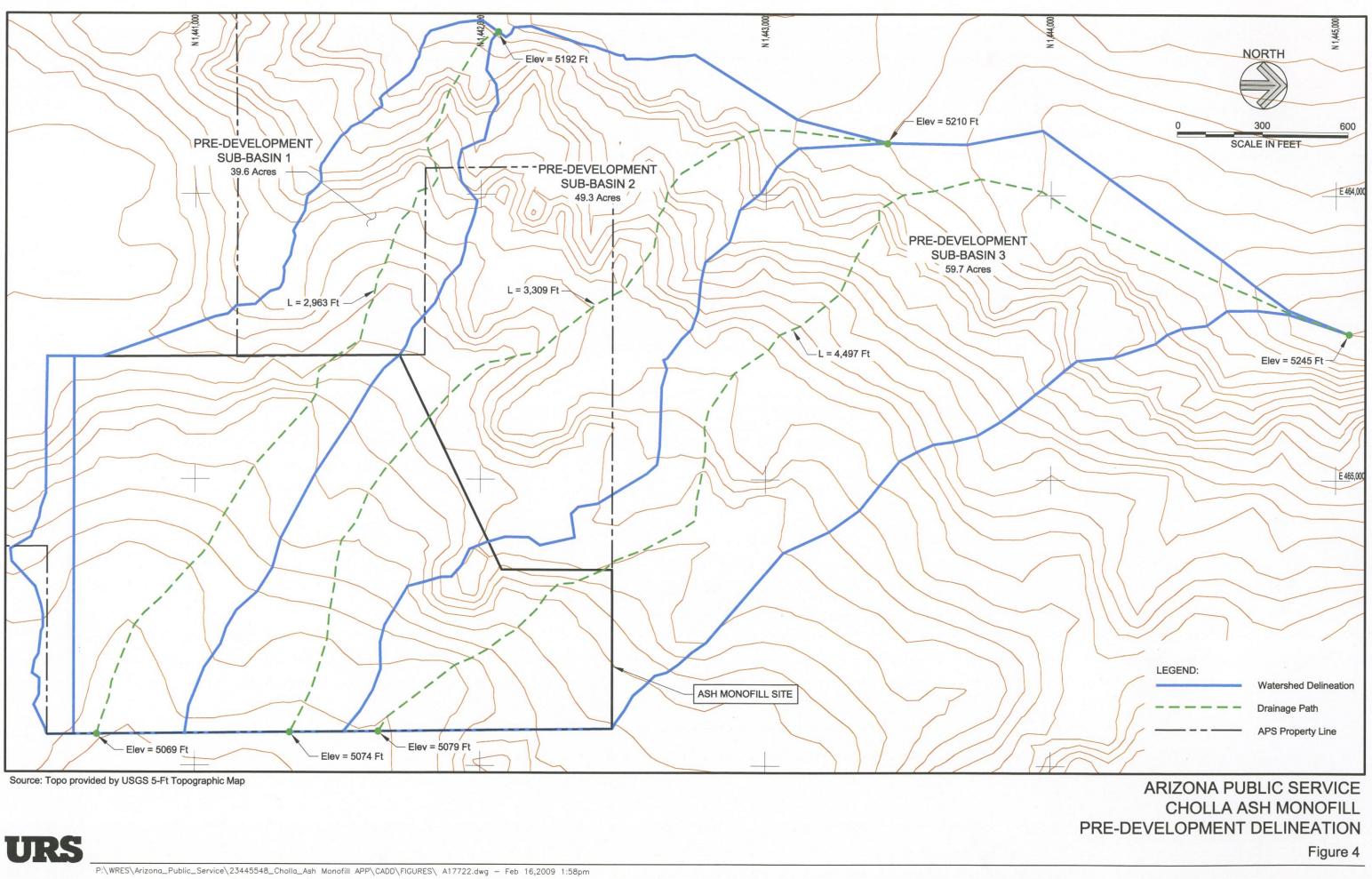
Figure 2



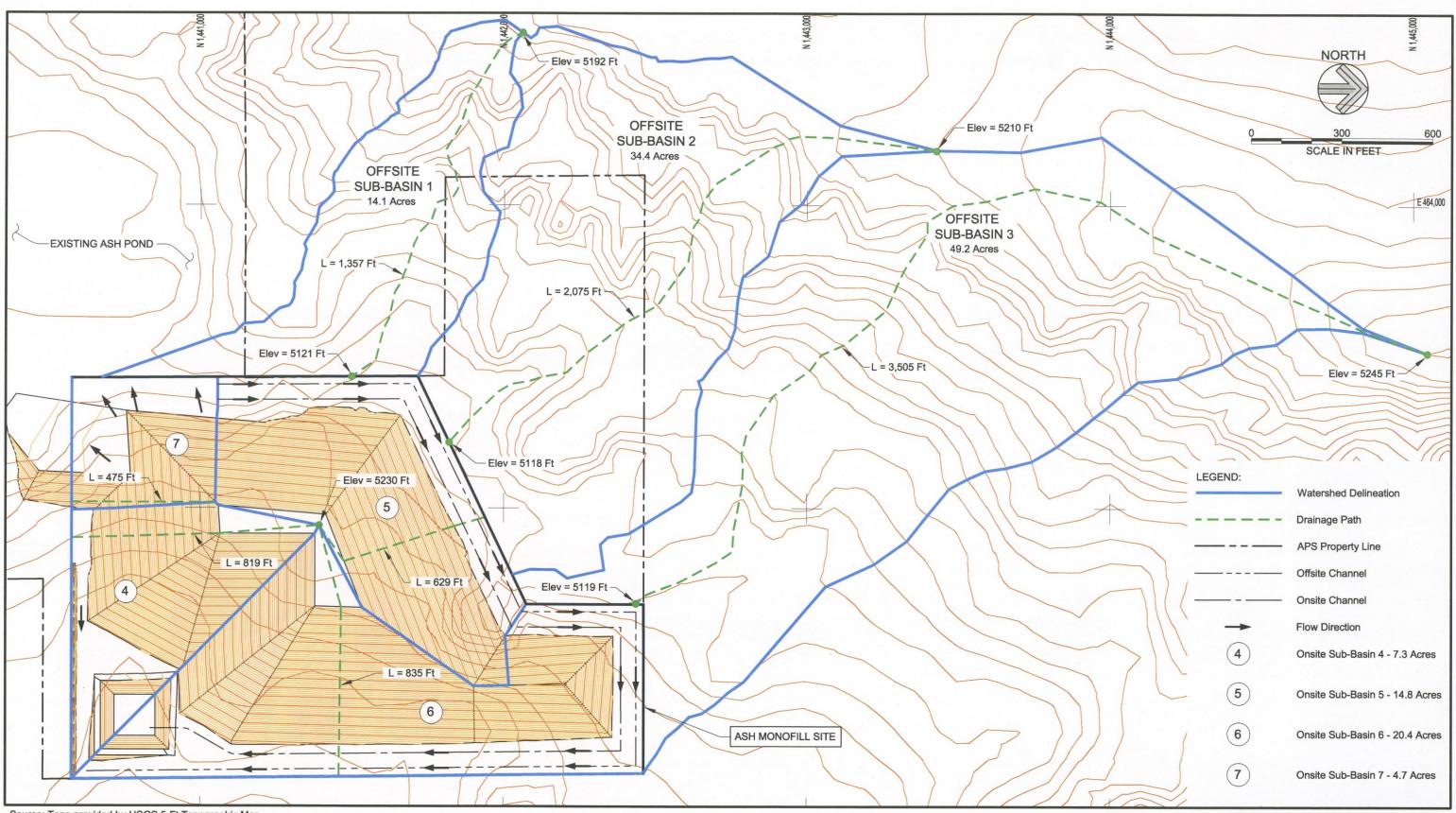


# Effective Firm Map Ash Monofill Drainage Study Navajo County







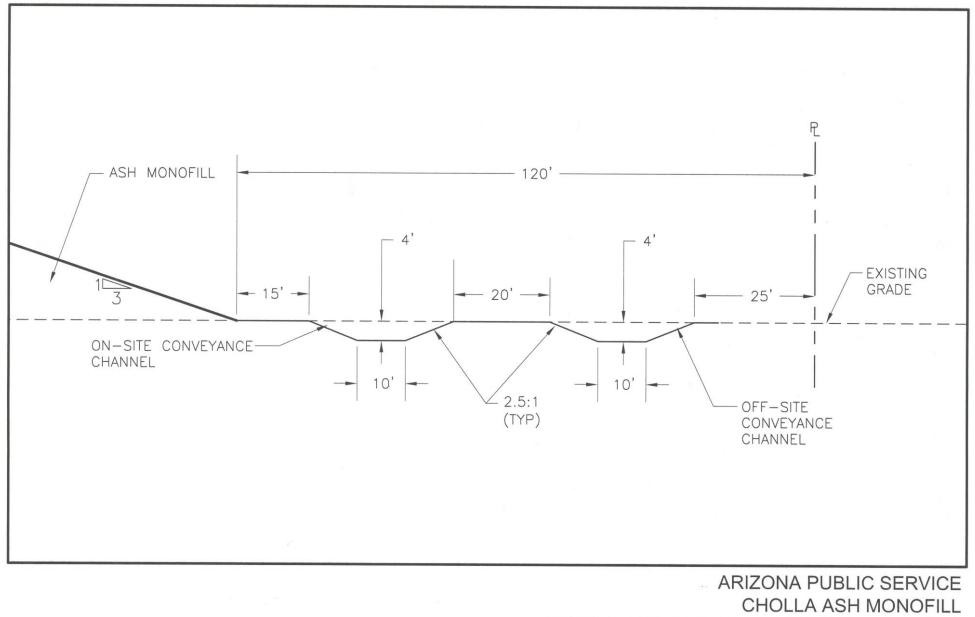


Source: Topo provided by USGS 5-Ft Topographic Map 2-Ft Topographic Map Provided by Arizona Public Service



# ARIZONA PUBLIC SERVICE CHOLLA ASH MONOFILL POST-DEVELOPMENT DELINEATION

Figure 5



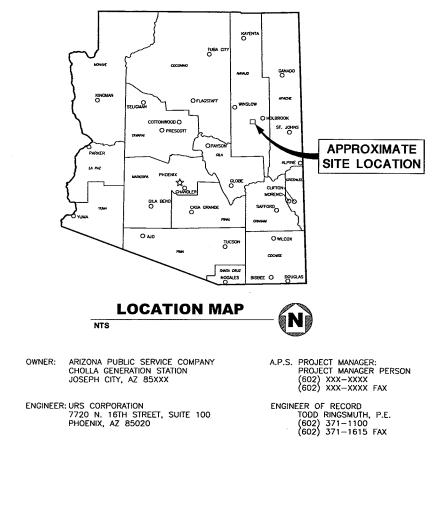
OFFSITE AND ONSITE PERIMETER CHANNELS



# **DRAINAGE DRAWINGS**

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# **ARIZONA PUBLIC SERVICE CHOLLA GENERATING STATION CHOLLA ASH MONOFILL APP JOSEPH CITY, ARIZONA**



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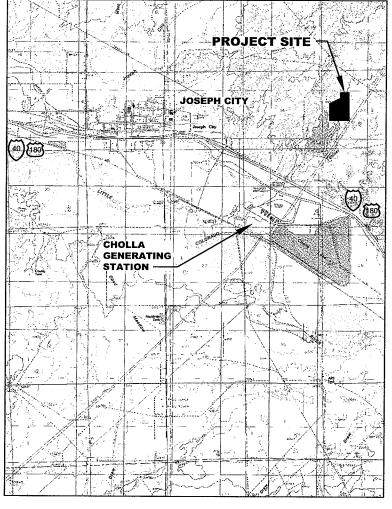
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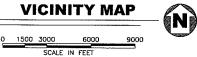
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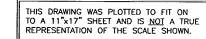
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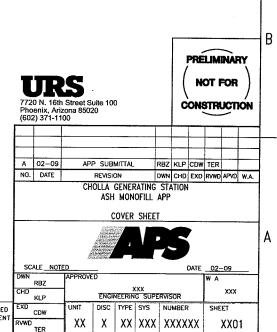






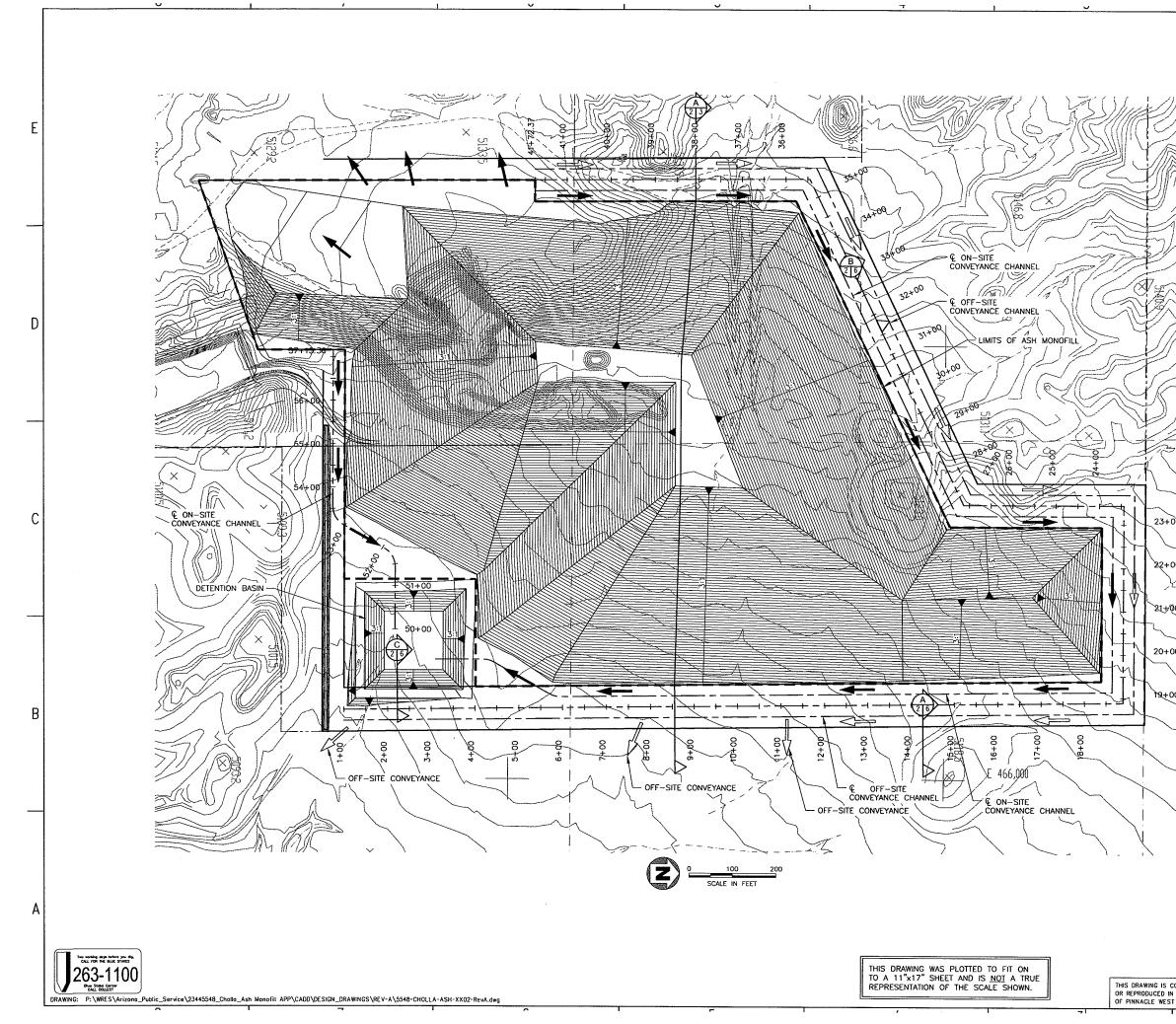
#### **DRAWING INDEX**

| NO.      | REV. | DRAWING TITLE       |
|----------|------|---------------------|
| ASH-XX01 | Α    | COVER SHEET         |
| ASH-XX02 | Α    | GENERAL SITE PLAN   |
| ASH-XX03 | А    | SECTION AND DETAILS |
| ASH-XX04 | А    | PLAN AND PROFILES   |
| ASH-XX05 | А    | PLAN AND PROFILES   |
| ASH-XX06 | А    | SECTION AND DETAILS |
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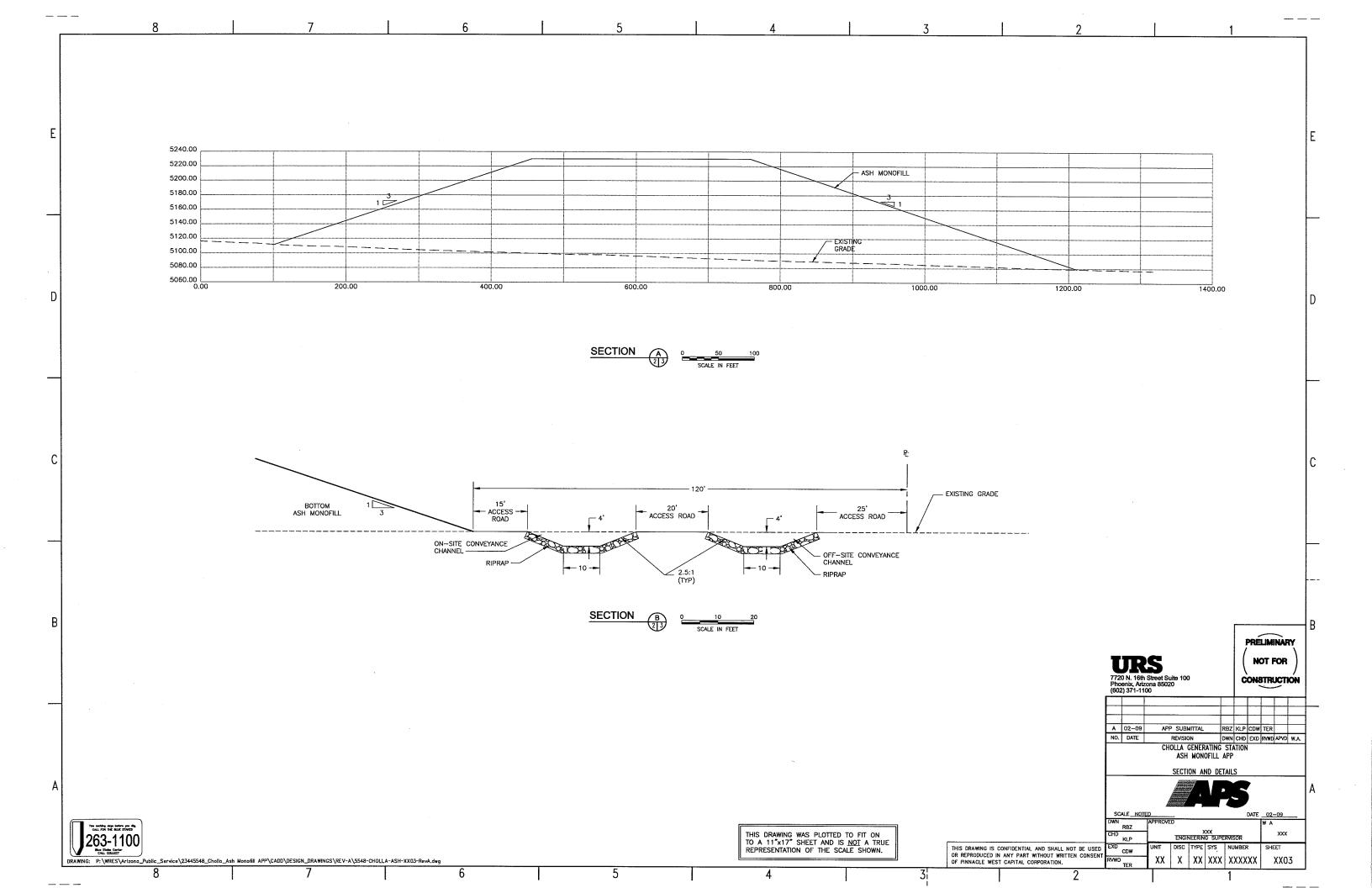


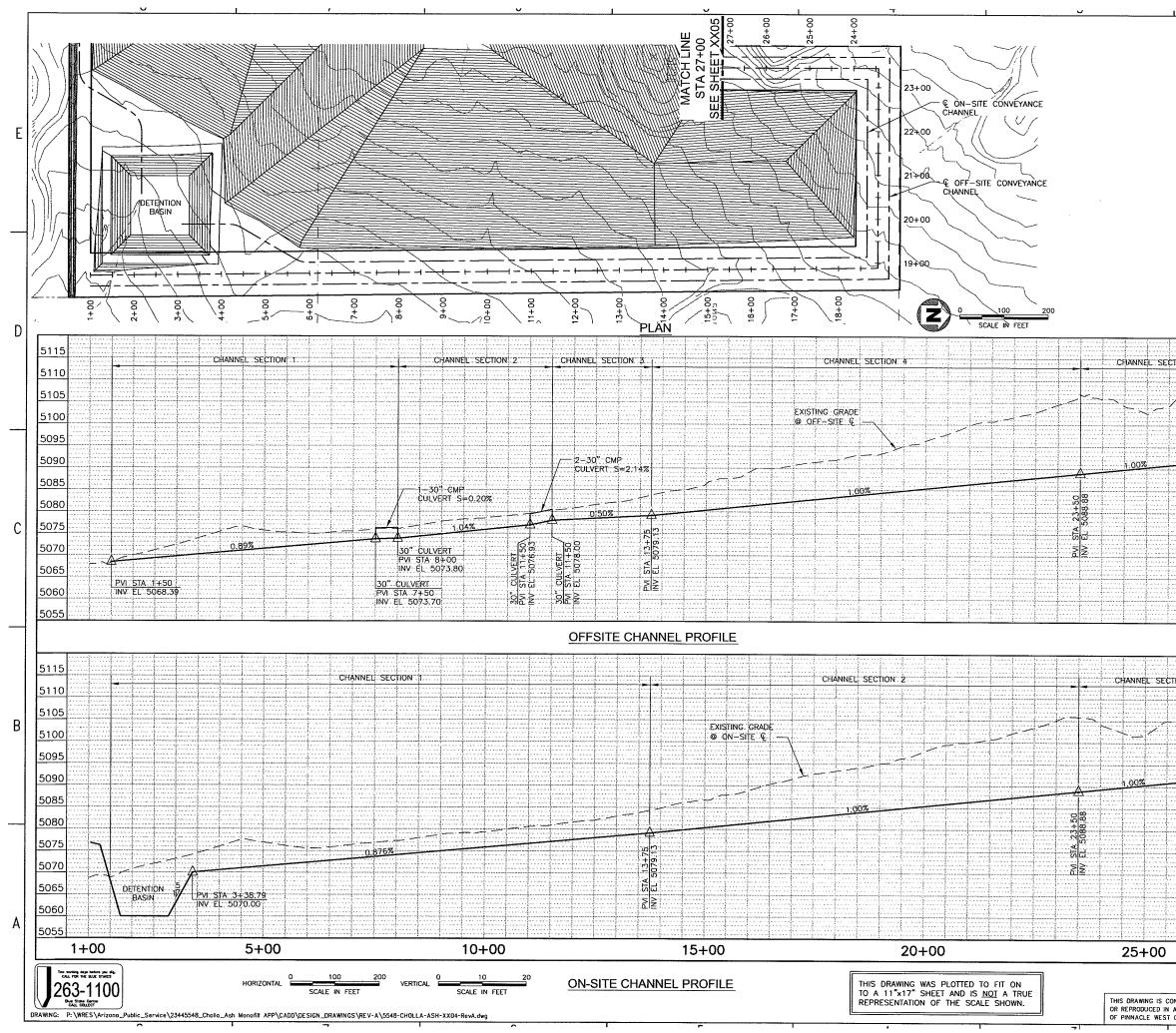
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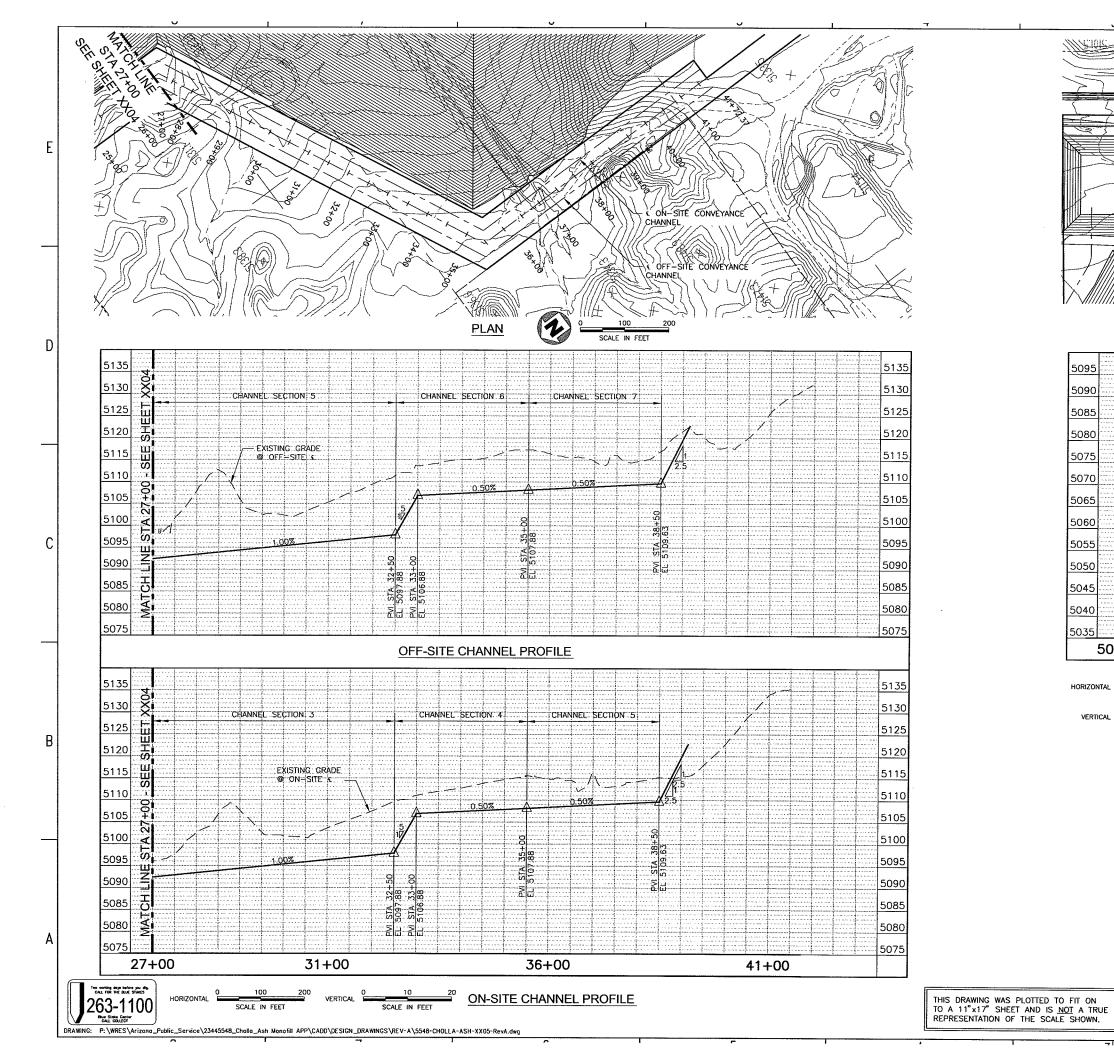
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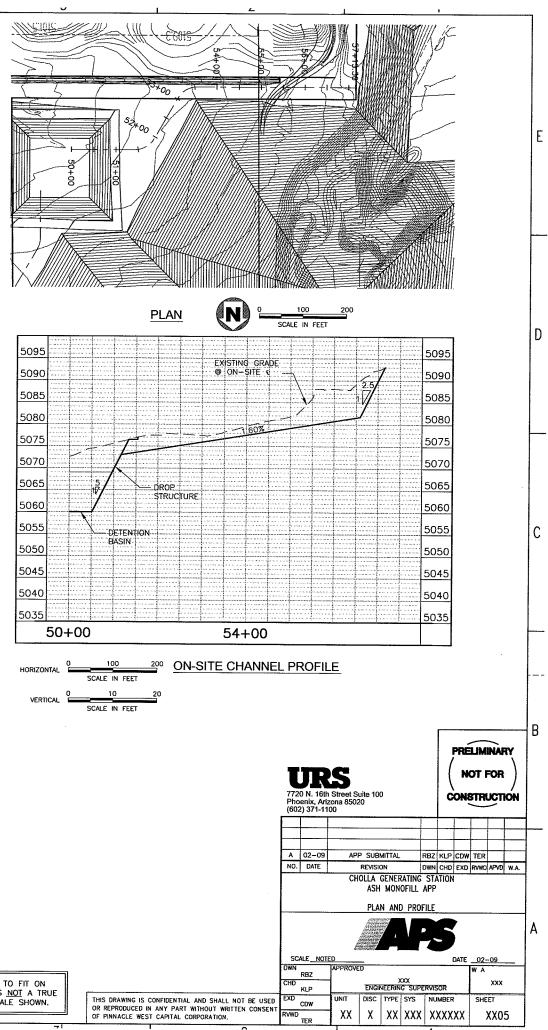


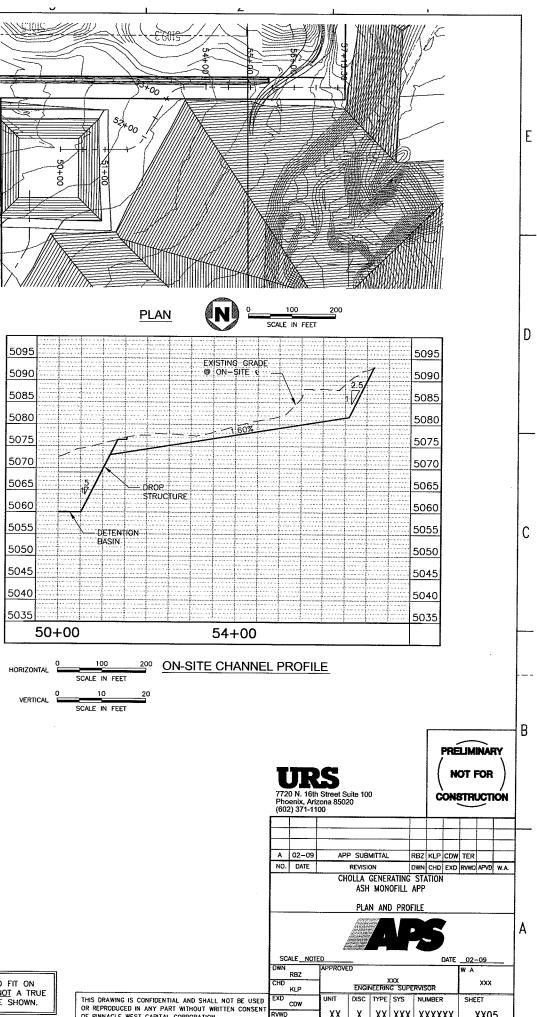


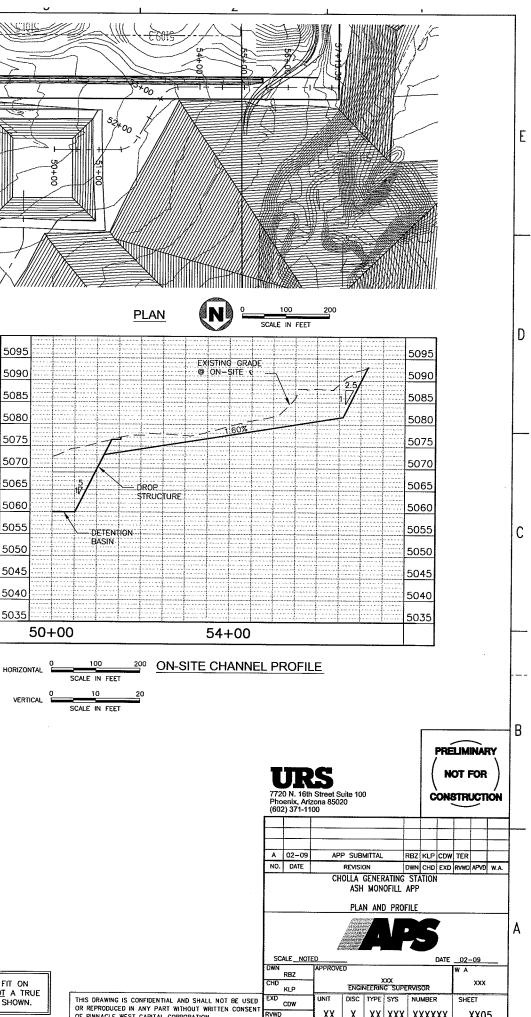
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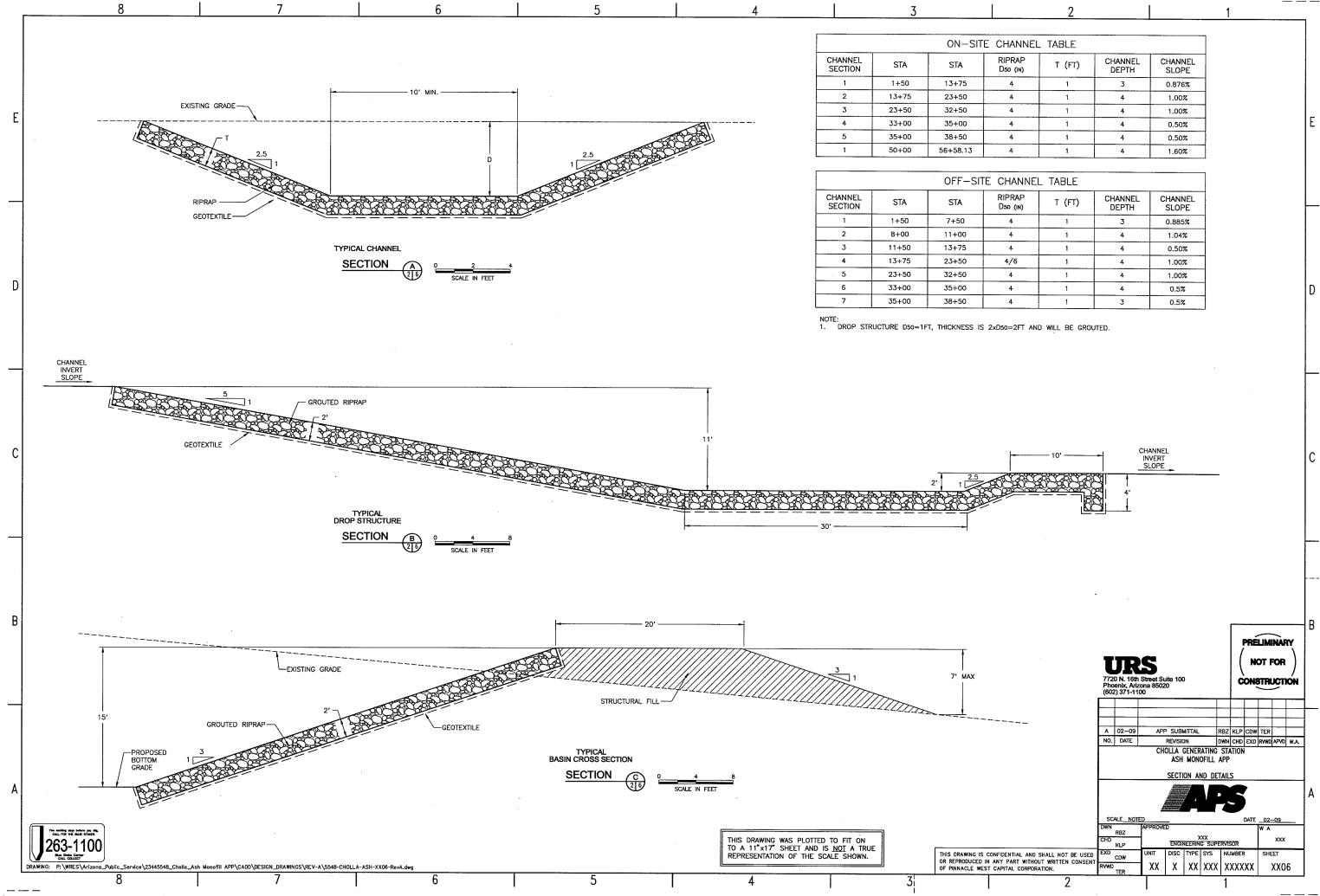
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# **APPENDIX** A

# **RAINFALL CALCULATIONS**

#### CALCULATION COVER SHEET

| Client: Arizona Public Service   | Project Name:   | Cholla                | Ash Monofill      |
|--|-----------------|-----------------------|-------------------|
| Project/Calculation Number: 23445548   |                 |                       |                   |
| Title: Rainfall Data for the Rational Method   |                 |                       |                   |
| Total Number of Pages (including cover sheet): 24  |                 |                       |                   |
| Total Number of Computer Runs:   |                 |                       |                   |
| Prepared by: Michelle C. West, EIT Mille I. a.   | ind             | Date:                 | 2/3/2009          |
| Checked by: Danette Lucas, EIT WANTER U  | cas             | Date:                 | 2/5/2009          |
| Description and Purpose:<br>The purpose of this calculation was to determine the rain<br>calculation package.<br>Included in this package is the rainfall data including I-D-F<br>as well as the I-D-F curves.   |                 |                       |                   |
| Design Basis/References/Assumptions<br>The rainfall data was based on NOAA Atlas 14, and the rainfall<br>The NOAA data was located based on Latitude and Longitu<br>Dam near the project area.<br>The I-D-F worksheet and I-D-F curve printouts were generate<br>P:\WRES\Arizona_Public_Service\23445548_Cholla_Ash M<br>Design\Hydrology\ADOT IDF-Rainfall-Data.xls | ide coordinates | for the (<br>spreads) | Cholla Bottom Ash |
| Remarks/Conclusions/Results:<br>See attached worksheets  |                 |                       |                   |
| Calculation Approved by: Project   | ct Manager/Date |                       |                   |
| Revision No.: Description of Revision:   | Ap              | proved                | by:               |

Project Manager/Date

# RAINFALL DATA CALCULATION CHOLLA ASH MONOFILL HYDROLOGY ANALYSIS CHOLLA GENERATING STATION ARIZONA PUBLIC SERVICE

#### **Problem Statement**

The object of this calculation is to determine the rainfall data required in the Rational Method calculation package for the hydrology analysis of the proposed Cholla Ash Monofill.

The Rainfall Data was calculated using the procedure outlined in the Arizona Department of Transportation (ADOT) Highway Drainage Design Manual Hydrology.

#### **Required Deliverables**

- I-D-F worksheets and I-D-F curves for use with the Rational Method as required by the ADOT method.
- Rainfall intensity and depth for 100-year storm event, 24-hour duration.

#### Data Available

- Cholla Bottom Ash Dam location (Latitude 34.97 N, Longitude 110.29 W)
- NOAA Atlas 14 Rainfall Data for site specific latitude and longitude
- Arizona Zone Rainfall Map

#### **Results**

The printout I-D-F worksheets and I-D-F curves were generated from the following Excel spreadsheet are attached:

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#### **REFERENCES**

NOAA Atlas 14 Point Precipitation Frequency Estimates. <u>www.noaa.gov</u>.

ADOT Highway Drainage Design Manual Hydrology. March 1993.

# **WORKSHEETS**

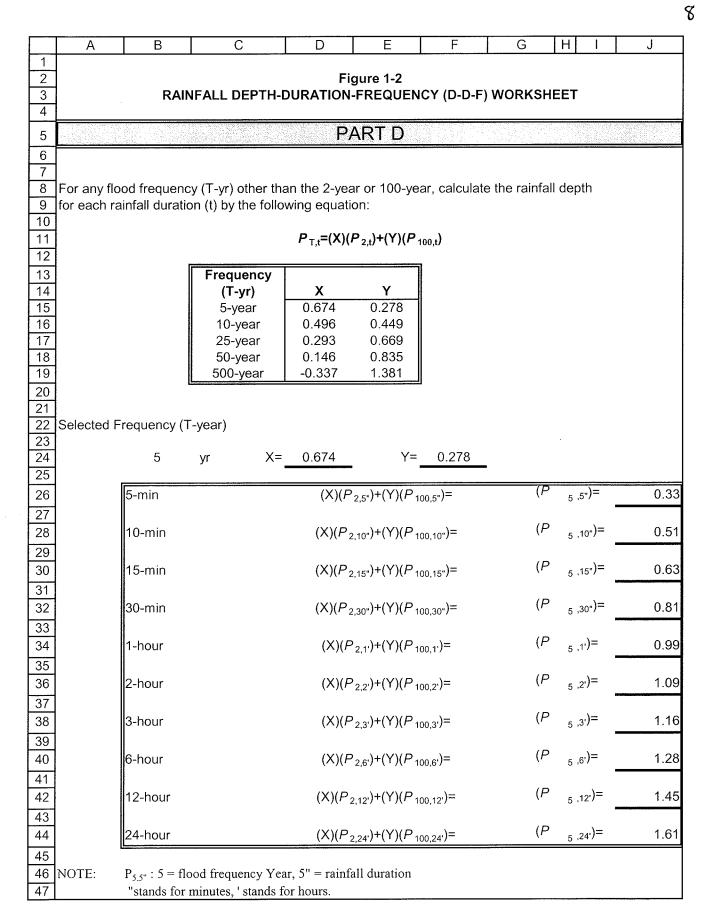
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| 6<br>7   | Location/Station<br>Designer | Jose<br>MC\ | eph City   | /, AZ                  |                        |                          |            | Checker   | DRL      |                      |      |
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| 13<br>14 | Determine rainfall           | deni        | ths fron   | n Pre                  | cinitatio              | n Data (N                | ۵۵۵        | Atlas 14) |          |                      |      |
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| 16       | 2-year, 6-hour               |             |            |                        |                        |                          |            |           |          | P <sub>2,6'=</sub>   | 0.96 |
| 17       | 2-year, 24-hour              |             |            |                        |                        |                          |            |           |          | P <sub>2,24'=</sub>  | 1.25 |
| 18       | 100-year, 6-hour             |             |            |                        |                        |                          |            |           |          | P 100,6'=            | 2.28 |
| 19       | 100-year, 24-hour            |             |            |                        |                        |                          |            |           |          | P 100,24'=           | 2.77 |
| 20       |                              |             |            |                        |                        |                          |            |           |          |                      |      |
| 21       |                              | an an an    |            |                        |                        | PAR                      | ΤB         |           |          |                      |      |
| 22       |                              |             |            |                        |                        |                          |            |           |          |                      |      |
| 23<br>24 | Compute the follo            | wing        | :          |                        |                        |                          |            |           |          |                      |      |
|          | 2-year, 1-hour               |             |            | 0.011                  | +0.942(                | $P_{2,c})^2$             |            |           |          | P <sub>2,1'=</sub>   | 0.68 |
| 26       | ,,                           |             |            |                        | (P <sub>2</sub>        |                          |            |           |          | <b>2</b> , 1         | 0.00 |
| 27       | 100-year, 1-hour             |             | 0.         | 494+                   | <u>0.755(</u> <i>F</i> | _                        |            |           |          | P 100,1'=            | 1.91 |
| 28       |                              |             |            |                        | (P <sub>100</sub>      | · ,                      |            |           |          | •                    |      |
| 29       | 2-year, 2-hour               |             | 0.3        | 41(P                   |                        | 59(P <sub>2.1'</sub> )   |            | ·         |          | P <sub>2,2'=</sub>   | 0.78 |
| 30       | 2-year, 3-hour               |             |            |                        | ,                      | 31(P <sub>2,1</sub> )    |            |           |          | P <sub>2,3'=</sub>   | 0.84 |
| 31       | 2-year, 12-hour              |             |            |                        |                        | $00(P_{2,24'})$          |            |           |          | P <sub>2,12'=</sub>  | 1.11 |
| 32       | 100-year, 2-hour             |             |            |                        |                        | 59(P <sub>100,1'</sub> ) | )          |           |          | P <sub>100,2'=</sub> | 2.04 |
| 33       | 100-year, 3-hour             |             | 0.569      | )<br>(P <sub>100</sub> | <sub>0,6'</sub> )+0.43 | 31(P <sub>100,1'</sub> ) | )          |           |          | P 100,3'=            | 2.12 |
| 34       | 100-year, 12-hour            |             | 0.500      | (P <sub>100</sub>      | , <sub>6'</sub> )+0.50 | 00(P <sub>100,24</sub>   | )          |           |          | P 100,12'=           | 2.53 |

|          | A                                | В           | С              | D  | E                      | F            | G       | Н                                       |                              |
|----------|----------------------------------|-------------|----------------|--|------------------------|--------------|---------|---|------------------------------|
| 1        |                                  | Α           | RIZONA I       | DEPARTM  | IENT OF                | TRANS        | PORT    | ATION                                   |                              |
| 2        |                                  |             | Н              | YDROLO   | GIC DES                | IGN DA       | ТА      |   |                              |
| 3        | ]                                |             |                |  |                        |              |         |   |                              |
| 4        | Project No.                      | 23445       |                |  |                        | _            |         |   |                              |
| 5        | Project Name<br>Location/Station |             | Power Plant -  | Ash Fill                                       |                        | _Date        | 39847   |   |                              |
| 7        | Location/Station                 | MCW         | n City, AZ     |  |                        | Checker      | DPI     |   | 161 - 4                      |
| 8        |                                  |             |                |  |                        |              | DICE    |   |                              |
| 9        | ]                                |             |                |  | Figure 1-2             |              |         |   |                              |
| 10<br>11 |                                  | F           | RAINFALL DE    | PTH-DURATIC                                    | ON-FREQUE              | NCY (D-D-I   | -) WORK | SHEET                                   |                              |
| <u> </u> |                                  | 4.15 (J.F.) |                |  |                        |              |         | 1.5.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1 |                              |
| 12<br>13 |                                  |             |                | PART   | A - FORM               | ULAS         |         |   |                              |
|          | Determine rainfall depths        | from isc    | pluvial maps ( |  | av Drainade F          | )esian Man   |         | andix B)                                |                              |
| 15       |                                  |             | plana napo (   | , BOT Highwe                                   | ay brainage L          | 200igir Mari |         | anuix D).                               |                              |
| 16       | 2-year, 6-hour                   |             |                |  |                        |              |         | P <sub>2,6'=</sub>                      | 0.96                         |
| 17       | 2-year, 24-hour                  |             |                |  |                        |              |         | P <sub>2,24'=</sub>                     | 1.25                         |
| 18       | 100-year, 6-hour                 |             |                |  |                        |              |         | P 100,6'=                               | 2.28                         |
| 19       | 100-year, 24-hour                |             |                |  |                        |              |         | P 100,24'=                              | 2.77                         |
| 20       |                                  |             |                |  |                        |              | ······  |   |                              |
| 21       |                                  |             |                | PART E   | 3 - FORM               | ULAS         |         |   |                              |
| 22       |                                  |             |                |  |                        |              |         |   |                              |
| 23<br>24 | Compute the following:           |             |                |  |                        |              |         |   |                              |
|          | 2-year, 1-hour                   |             | 0.0            | 011+0.942(P2                                   | ) <sup>2</sup>         |              |         | P                                       | =(-0.011+(0.942*116^2)/117)  |
| 26       |                                  |             | 0.0            | (P <sub>2.24'</sub> )                          |                        |              |         | · 2,1'=                                 | -(-0.011+(0.942 110.2)/117)  |
|          | 100-year, 1-hour                 |             | 0.49           | (' 2,24')<br>94+ <u>0.755(P</u> <sub>100</sub> |                        |              |         | P 100 1/-                               | =0.494+(0.755*118^2)/19      |
| 28       |                                  |             | 0.1            | (P <sub>100,24'</sub> )                        |                        |              |         | , 100,1=                                | -0.434 (0.733 110 2)/119     |
|          | 2-year, 2-hour                   |             | 0.341          | (P <sub>2.6'</sub> )+0.659(a                   |                        |              |         | Par                                     | =0.341*\$I\$16+0.659*\$I\$25 |
|          | 2-year, 3-hour                   |             |                | (P <sub>2.6'</sub> )+0.431( <i>i</i>           |                        |              |         |   | =0.569*\$I\$16+0.431*\$I\$25 |
|          | 2-year, 12-hour                  |             |                | (P <sub>2.6</sub> )+0.500(F                    |                        |              |         |   | =0.5*\$ \$16+0.5*\$ \$17     |
|          | 100-year, 2-hour                 |             |                | ⊃ <sub>100.6'</sub> )+0.659(/                  |                        |              |         |   | =0.341*\$ \$18+0.659*\$ \$27 |
|          | 100-year, 3-hour                 |             |                | ⊃ <sub>100.6'</sub> )+0.431( <i>)</i>          |                        |              |         |   | =0.569*\$I\$18+0.431*\$I\$27 |
| 34       | 100-year, 12-hour                |             | 0.500(F        | P <sub>100.6</sub> )+0.500( <i>F</i>           | ⊃ <sub>100,24</sub> ,) |              |         |   | =0.5*\$ \$18+0.5*\$ \$19     |

| <b></b>  | A         | В             | С                   | D                      | I E I  | F                     | G            | Н |  |
|----------|-----------|---------------|---------------------|------------------------|--|-----------------------|--------------|---|--|
| 1        |           |               | <b></b>             |                        |  | <u> </u>              |              | L |  |
| 2        |           |               |                     | Figure                 |  |                       |              |   |  |
| 3        |           | RAINFAL       | L DEPTH-DUR         | ATION-FRI              | EQUENCY ([                                   | D-D-F) WOR            | RKSHEET      |   |  |
|          |           |               |                     |                        |  |                       |              |   |  |
| 5        |           |               |                     | F                      | PART C                                       |                       | 6            |   |  |
| 7        | Determine | e the short-d | uration rainfall zo | one ( <b>Fiaur</b>     | e 1-1):                                      |                       |              |   |  |
| 8        |           |               |                     | ···· (· · <b>g</b> -·· | /.   |                       |              |   |  |
| 9        |           |               |                     | Zone =                 | 6  |                       |              |   |  |
| 10       | Determine | the short d   | uration rainfall ra | tios (Table            | 1_1).  |                       |              |   |  |
| 12       | Determine |               |                     |                        | <b>;                                    </b> |                       |              |   |  |
| 13       |           |               | Duration            |                        | Ra   |                       |              |   |  |
| 14       |           |               | (Minutes)           |                        | Year   | 100-\                 |              |   |  |
| 15<br>16 |           |               | 5<br>10             | A=<br>B=               | 0.35<br>0.54                                 | E=<br>F=              | 0.32<br>0.50 |   |  |
| 17       |           |               | 15                  | C=                     | 0.65   | G=                    | 0.62         |   |  |
| 18       |           |               | 30                  | D=                     | 0.83   | H=                    | 0.81         |   |  |
| 19<br>20 |           |               |                     |                        |  |                       |              |   |  |
| 20       |           |               |                     |                        |  |                       |              |   |  |
| 22       |           |               |                     |                        |  |                       |              |   |  |
| 23       | Compute I | the following | :                   |                        |  |                       |              |   |  |
| 24       |           | 2-year, 5-m   | nin                 | *******                | (A)(P <sub>2,1'</sub> )=                     | P <sub>2,5"=</sub>    | 0.24         | 1 |  |
| 26       |           | 2-year, 0-m   | 1111                |                        | (~)(* 2,1')-                                 | • 2,5 =               | 0.24         |   |  |
| 27       |           | 2-year, 10-   | min                 |                        | (B)(P <sub>2,1'</sub> )=                     | P <sub>2,10"=</sub>   | 0.37         |   |  |
| 28       |           |               |                     |                        | ,  | -                     |              |   |  |
| 29       |           | 2-year, 15-   | min                 |                        | (C)(P <sub>2,1'</sub> )=                     | P <sub>2,15"=</sub>   | 0.44         |   |  |
| 30       |           |               |                     |                        |  | -<br>-                | 0.5          |   |  |
| 31       |           | 2-year, 30-   | min                 |                        | (D)(P <sub>2,1'</sub> )=                     | P <sub>2,30"</sub> =  | 0.57         |   |  |
| 32<br>33 |           | 100-year, 5   | 5-min               |                        | (E)(P <sub>100,1'</sub> )=                   | P <sub>100,5"=</sub>  | 0.61         |   |  |
| 34       |           |               |                     |                        | <b>ν</b> -/ <b>ν</b> 100,17                  | 100,0 -               | 0.01         |   |  |
| 35       |           | 100-year, 1   | I0-min              |                        | (F)(P <sub>100,1'</sub> )=                   | P <sub>100,10"=</sub> | 0.96         |   |  |
| 36       |           |               |                     |                        |  | -                     |              |   |  |
| 37       |           | 100-year, 1   | I5-min              |                        | (G)(P <sub>100,1'</sub> )=                   | P <sub>100,15"=</sub> | 1.18         |   |  |
| 38       |           |               |                     |                        |  | -<br>-                |              |   |  |
| 39       |           | 100-year, 3   | 30-min              |                        | (H)(P <sub>100,1</sub> )=                    | P <sub>100,30"=</sub> | 1.55         |   |  |

|  | A            | В                         | С                        | D                             | E   | F                     | G   | Н |             |
|--|--------------|---------------------------|--------------------------|-------------------------------|---|-----------------------|---|---|-------------|
| 1<br>2<br>3<br>4   |              |                           | F                        | AINFAL                        | Figure 1-2<br>L DEPTH-DURATION-FREQUENCY (D-D-  | F) WORK               | SHEET   | ε |             |
| 5  |              |                           |                          |                               | PART C - FORMULA  | S                     |   |   |             |
| 6<br>7<br>8<br>9   | Determine th | ne short-duration ra      | infall zone ( <b>Fig</b> | j <b>ure 1-1</b> ):<br>Zone = |   |                       |   |   | <del></del> |
| 10<br>11<br>12   | Determine th | e short duration ra<br>آآ |                          |                               |   |                       |   |   |             |
| 13   |              |                           | Duration                 |                               |   | atio                  |   |   |             |
| 14   |              |                           | (Minutes)<br>5           | A=                            | 2-Year<br>=IF(\$E\$9=6,0.35,IF(\$E\$9=8,0.34,"NG"))   | E=                    | <b>100-Year</b><br>=IF(\$E\$9=6,0.32,IF(\$E\$9=8,0.3,"NG"))   |   |             |
| 10<br>17<br>18   | Compute the  |                           | 10<br>15<br>30           | B=<br>C=<br>D=                | =IF(\$E\$9=6,0.54,IF(\$E\$9=8,0.51,"NG"))<br>=IF(\$E\$9=6,0.65,IF(\$E\$9=8,0.62,"NG"))<br>=IF(\$E\$9=6,0.83,IF(\$E\$9=8,0.82,"NG")) |                       | =IF(\$E\$9=6,0.5,IF(\$E\$9=8,0.46,"NG"))<br>=IF(\$E\$9=6,0.62,IF(\$E\$9=8,0.59,"NG"))<br>=IF(\$E\$9=6,0.81,IF(\$E\$9=8,0.8,"NG")) |   |             |
| 19   |              | Ľ                         |                          |                               | -ii (\u00e920,0.03,ii (\u00e920,0.02, iii ())   | 11                    | -IF(\$E\$3-0,0.01,IF(\$E\$3-0,0.0, NG ))  |   |             |
| 21   |              |                           |                          |                               |   |                       |   |   |             |
| 23<br>24   | Compute the  | following:                |                          |                               |   |                       |   |   |             |
|  |              | 2-year, 5-min             | <u></u>                  | dite                          | (A)(P <sub>2,1</sub> )=   | P <sub>2,5"=</sub>    | =E15*'Parts A & B'!I25  |   |             |
| 27   |              | 2-year, 10-min            |                          |                               | (B)(P <sub>2,1'</sub> )=  | P <sub>2,10"=</sub>   | =E16*'Parts A & B'!\$I\$25  |   |             |
| 29   |              | 2-year, 15-min            |                          |                               | (C)(P <sub>2,1</sub> )=   | P <sub>2,15"=</sub>   | =E17*'Parts A & B'!\$I\$25  |   |             |
| 31   |              | 2-year, 30-min            |                          |                               | (D)(P <sub>2.1</sub> )=   | P <sub>2,30"=</sub>   | =E18*'Parts A & B'!\$I\$25  |   |             |
| 25<br>26<br>27<br>28<br>29<br>30<br>31<br>32<br>33<br>34<br>35<br>36<br>37<br>38<br>39 |              | 100-year, 5-min           |                          |                               | (E)(P <sub>100.1</sub> )=   | P <sub>100.5"=</sub>  | ='Parts A & B'!I27*'Part C'!G15   |   |             |
| 35   |              | 100-year, 10-min          |                          |                               | (F)(P <sub>100.1</sub> )=   | P <sub>100.10"=</sub> | ='Parts A & B'!\$I\$27*'Part C'!G16   |   |             |
| 37   |              | 100-year, 15-min          |                          |                               | (G)(P <sub>100.1</sub> )=   | P <sub>100,15"=</sub> | ='Parts A & B'!\$I\$27*'Part C'!G17   |   |             |
| 38<br>39   |              | 100-year, 30-min          |                          |                               | (H)(P <sub>100,1'</sub> )=  | P <sub>100,30"=</sub> | ='Parts A & B'!\$I\$27*'Part C'!G18   |   |             |



|          | A           | В              | C                 |                | D                      | E                         | F                     |         | G          | H   |     | J    |
|----------|-------------|----------------|-------------------|----------------|------------------------|---------------------------|-----------------------|---------|------------|---|-----|------|
| 1        |             |                |                   |                | Fi                     | gure 1-2                  |                       |         |            |   |     |      |
| 3        |             | RAI            |                   | PTH-D          |                        | -FREQUE                   | NCY (D-D-             | F) WC   | RKSI       | HEET  |     |      |
| 4        |             |                |                   |                |                        |                           |                       |         |            |   |     |      |
| 5        |             |                |                   | and the second | <u>بط</u>              | ART D                     |                       |         |            |   |     |      |
| 6<br>7   |             |                |                   |                |                        |                           |                       |         |            |   |     |      |
|          |             | od frequenc    |                   |                |                        |                           | ear, calcul           | ate the | e rainfa   | all depth   | I   |      |
| 9<br>10  | for each ra | infall duratio | on (t) by the     | e follow       | /ing equati            | on:                       |                       |         |            |   |     |      |
| 11       |             |                |                   |                | P <sub>T,t</sub> =(X)( | P <sub>2,t</sub> )+(Y)(P  | 100,t)                |         |            |   |     |      |
| 12<br>13 |             |                | Eroguo            |                |                        |                           | ח                     |         |            |   |     |      |
| 14       |             |                | Frequer<br>(T-yr) | -              | х                      | Y                         |                       |         |            |   |     |      |
| 15       |             |                | 5-yea             | r [            | 0.674                  | 0.278                     |                       |         |            |   |     |      |
| 16<br>17 |             |                | 10-уеа<br>25-уеа  |                | 0.496<br>0.293         | 0.449<br>0.669            |                       |         |            |   |     |      |
| 18       |             |                | 50-yea            | ar             | 0.146                  | 0.835                     |                       |         |            |   |     |      |
| 19<br>20 |             |                | 500-ye            | ar [           | -0.337                 | 1.381                     |                       |         |            |   |     |      |
| 21       |             |                |                   |                |                        |                           |                       |         |            |   |     |      |
| 22       | Selected Fi | requency (T    | -year)            |                |                        |                           |                       |         |            |   |     |      |
| 24       |             | 10             | yr                | X=_            | 0.496                  | Y=                        | 0.449                 | _       |            |   |     |      |
| 25       | ſ           | - ·            |                   |                |                        |                           |                       |         | (F         | <u> </u>  |     |      |
| 26<br>27 |             | 5-min          |                   |                | (X)(P                  | <sub>2,5"</sub> )+(Y)(P   | 100,5" <b>)</b> =     |         | (/         | , <sub>10 ,5"</sub> )                                       | -   | 0.39 |
| 28       |             | 10-min         |                   |                | (X)(P <sub>2</sub>     | <sub>2,10"</sub> )+(Y)(P  | <sub>100,10"</sub> )= |         | (F         | <b>7</b><br>10 ,10'   | .)= | 0.61 |
| 29       |             |                |                   |                |                        |                           |                       |         |            |   |     |      |
| 30<br>31 |             | 15-min         |                   |                | (X)(P <sub>2</sub>     | <sub>2,15"</sub> )+(Y)(P  | <sub>100,15"</sub> )= |         | ( <i>F</i> | ס<br>10 ,15'  | .)= | 0.75 |
| 32       |             | 30-min         |                   |                | (X)(P <sub>2</sub>     | <sub>2,30"</sub> )+(Y)(P  | 100 30")=             |         | (F         | <b>7</b><br>10 ,30"   | .)= | 0.98 |
| 33       |             |                |                   |                |                        |                           | 100,00 /              |         |            |   |     |      |
| 34       |             | 1-hour         |                   |                | (X)(P                  | 2,1')+(Y)(P               | 100,1' <b>)</b> =     |         | (F         | י <sub>10, 1</sub> י) <sup>י</sup>                          | =   | 1.20 |
| 35<br>36 |             | 2-hour         |                   |                | (X)(P                  | ' <sub>2,2'</sub> )+(Y)(P | 100 21)=              |         | (F         | ר<br><sub>10 ,2'</sub> ):                                   |     | 1.30 |
| 37       |             |                |                   |                | (*)(*                  | 2,27 (1)(7)               | 100,27                |         |            | 10 12 1   |     | 1.00 |
| 38       |             | 3-hour         |                   |                | (X)( <i>P</i>          | ' <sub>2,3'</sub> )+(Y)(P | <sub>100,3'</sub> )=  |         | (F         | ר <sub>10 ,3'</sub> ):<br>10 ,3'                            |     | 1.37 |
| 39<br>40 |             | 6-hour         |                   |                | (Y)(D                  | ' <sub>2,6'</sub> )+(Y)(P | )=                    |         | (F         | ,   | =   | 1.50 |
| 40       |             | o-noui         |                   |                | (^)(                   | 2,677177                  | 100,6'7               |         | ١,         | י <sub>10,6</sub> , אין |     | 1.50 |
| 42       |             | 12-hour        |                   |                | (X)(P <sub>2</sub>     | <sub>2,12'</sub> )+(Y)(P  | 100,12')=             |         | (P         | 10 ,12'   | )=  | 1.68 |
| 43       |             | 04 5           |                   |                | ~~~~                   |                           | ,                     |         | / 5        |   |     | 1.0- |
| 44       |             | 24-hour        |                   |                | (X)(P <sub>2</sub>     | <sub>2,24'</sub> )+(Y)(P  | <sub>100,24'</sub> )= |         | (P         | 10 ,24'   | )=  | 1.86 |

|          | A           | В                                 | С                   | D                        | E                                      | F  | G            | H                        | J    |
|----------|-------------|-----------------------------------|---------------------|--------------------------|--|--|--------------|--------------------------|------|
| 1        |             |                                   |                     | Fi                       | gure 1-2                               |  |              |                          |      |
| 3        |             | RAIN                              | IFALL DEPTH-I       |                          |  | ICY (D-D-F)                                      | WORKSH       | IEET                     |      |
| 4        |             |                                   |                     |                          |  |  | 20 M         |                          |      |
| 5        |             | en solection des<br>Transferences | 17. RADIA A         | <u> </u>                 | ARTD                                   | 7.4996 S. H. |              |                          |      |
| 6        |             |                                   |                     |                          |  |  |              |                          |      |
| 7<br>8   | For any flo | od freguenc                       | ;y (T-yr) other tha | an the 2-vea             | ar or 100-ve                           | ar. calculate                                    | e the rainfa | ll depth                 |      |
| 9        | -           | •                                 | on (t) by the follo |                          |  |  |              |                          |      |
| 10       |             |                                   |                     |                          |  | ,  |              |                          |      |
| 11       |             |                                   |                     | $P_{T,t} = (\Lambda)(I)$ | P <sub>2,t</sub> )+(Y)( <i>P</i>       | 100,t)   |              |                          |      |
| 13       |             |                                   | Frequency           |                          |  |  |              |                          |      |
| 14       |             |                                   | (T-yr)              | X                        | Y                                      |  |              |                          |      |
| 15<br>16 |             |                                   | 5-year<br>10-year   | 0.674<br>0.496           | 0.278<br>0.449                         |  |              |                          |      |
| 17       |             |                                   | 25-year             | 0.293                    | 0.669                                  |  |              |                          |      |
| 18       |             |                                   | 50-year             | 0.146                    | 0.835                                  |  |              |                          |      |
| 19<br>20 |             |                                   | 500-year            | -0.337                   | 1.381                                  |  |              |                          |      |
| 21       |             |                                   |                     |                          |  |  |              |                          |      |
|          | Selected F  | requency (T                       | -year)              |                          |  |  |              |                          |      |
| 23<br>24 |             | 25                                | yr X=               | 0.293                    | Y=                                     | 0.669  |              |                          |      |
| 25       |             |                                   |                     |                          |  |  | •            |                          |      |
| 26       |             | 5-min                             |                     | (X)(P                    | <sub>2,5"</sub> )+(Y)(P <sub>1</sub>   | <sub>00,5"</sub> )=                              | (P           | ( <sub>25 ,5"</sub> )=   | 0.48 |
| 27       |             |                                   |                     | 00/0                     |  | ,  | (P           | ) —                      | 0.75 |
| 28       |             | 10-min                            |                     | (X)(P <sub>2</sub>       | <sub>',10"</sub> )+(Y)(P <sub>1</sub>  | 00,10")=   | (/           | 25 ,10")=                | 0.75 |
| 29<br>30 |             | 15-min                            |                     | (X)(P                    |  |  | (P           | )=( <sub>25 ,15"</sub> ) | 0.92 |
| 31       |             |                                   |                     |                          | ,157 (1777)                            | 00,137   |              | 25 110 /                 |      |
| 32       |             | 30-min                            |                     | (X)(P <sub>2</sub>       | <sub>,30"</sub> )+(Y)(P <sub>1</sub>   | <sub>00,30"</sub> )=                             | (P           | =( <sub>25,30</sub> ")=  | 1.20 |
| 33       |             |                                   |                     |                          |  |  | (0           | · · · · ·                |      |
| 34       |             | 1-hour                            |                     | (X)(P                    | ' <sub>2,1'</sub> )+(Y)(P <sub>1</sub> | <sub>00,1'</sub> )=                              | ( <i>P</i>   | )= <sub>25 ,1</sub> )=   | 1.48 |
| 35<br>36 |             | 2-hour                            |                     | (X)(P                    | ' <sub>2,2'</sub> )+(Y)(P <sub>1</sub> | =<br>=   | (P           | <sub>25 ,2'</sub> )=     | 1.59 |
| 37       |             |                                   |                     | (71)(7                   | 2,27 (17,7 1                           | 00,27  | ,            | 20 ,4 /                  |      |
| 38       |             | 3-hour                            |                     | (X)(P                    | ' <sub>2,3'</sub> )+(Y)(P <sub>1</sub> | =( <sub>00,3'</sub> )=                           | ( <i>P</i>   | , <sub>25 ,3</sub> ,)=   | 1.67 |
| 39       |             |                                   |                     |                          |  |  |              |                          |      |
| 40       | :           | 6-hour                            |                     | (X)(P                    | 2,6')+(Y)(P <sub>1</sub>               | <sub>00,6'</sub> )=                              | (P           | )= <sub>25 ,6</sub> ,)=  | 1.81 |
| 41<br>42 |             | 12-hour                           |                     | (Y)/D                    | <sub>2.12'</sub> )+(Y)(P <sub>1</sub>  | )=   | (P           | <sub>25 ,12'</sub> )=    | 2.01 |
| 42       |             | n∠-nour                           |                     | (^)()                    | 2,127 ግር ካሊም 1                         | 00,12'7  | \*<br>\*     | 25,127                   | 2.01 |
| 43       |             | 24-hour                           |                     | (X)(P                    | <sub>2,24'</sub> )+(Y)(P <sub>1</sub>  | <sub>00,24'</sub> )=                             | (P           | =<br>25 ,24')=           | 2.22 |

|                 | A                              | В   | С                   | D                       | Е                                | F                                    | =            |                    | G           | Н                     | 1                 |         | J    |
|-----------------|--------------------------------|---|---------------------|-------------------------|----------------------------------|--------------------------------------|--------------|--------------------|-------------|-----------------------|-------------------|---------|------|
| 1               |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 2               | -                              |   |                     |                         | gure 1-2                         |                                      |              |                    | DVO         |                       |                   |         |      |
| 3<br>4          |                                | RAI   | NFALL DEPTH-        | DURATION                | FREQUE                           | ENCY (D                              | )-D-F        | ) WO               | RKS         | HEEI                  |                   |         |      |
| 5               |                                |   |                     | P/                      | ART D                            | e i composi ca                       |              | (C. Puello         | E. 71. \ 5. |                       |                   |         |      |
| 6               | 1961 D. S. G. M. C. M. D. DOM. |   |                     |                         |                                  |                                      | essan in Co. | 1910 - 1917 - 1917 |             |                       |                   |         |      |
| 7               | -                              |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 8               | For any flo                    | od frequend                                       | cy (T-yr) other th  | an the 2-yea            | ar or 100-                       | year, cal                            | culat        | e the              | rainfa      | all dep               | th                |         |      |
| 9               | for each ra                    | infall durati                                     | on (t) by the follo | wing equation           | on:                              |                                      |              |                    |             |                       |                   |         |      |
| 10              |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 11              |                                |   |                     | P <sub>⊤,t</sub> =(X)(I | <sup>2</sup> ,t)+(Y)(            | P <sub>100,t</sub> )                 |              |                    |             |                       |                   |         |      |
| 12              |                                |   | I <u></u>           |                         |                                  | _                                    |              |                    |             |                       |                   |         |      |
| 13              |                                |   | Frequency           |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 14              |                                |   | (T-yr)              | X                       | Y                                |                                      |              |                    |             |                       |                   |         |      |
| 15<br>16        |                                |   | 5-year              | 0.674<br>0.496          | 0.278<br>0.449                   |                                      |              |                    |             |                       |                   |         |      |
| 17              |                                |   | 10-year<br>25-year  | 0.490                   | 0.669                            |                                      |              |                    |             |                       |                   |         |      |
| 18              |                                |   | 50-year             | 0.146                   | 0.835                            |                                      |              |                    |             |                       |                   |         |      |
| 19              |                                |   | 500-year            | -0.337                  | 1.381                            |                                      |              |                    |             |                       |                   |         |      |
| 20              |                                |   | L                   |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 21              |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 22              | Selected F                     | requency (1                                       | Г-year)             |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 23              |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 24              |                                | 50  | yr X=               | 0.146                   | Ŷ                                | ′= 0.8                               | 35           | -                  |             |                       |                   |         |      |
| 25              |                                | 7 <sup>111111111111111111111111111111111111</sup> |                     |                         |                                  |                                      |              |                    | ,           |                       |                   |         |      |
| 26              |                                | 5-min   |                     | (X)(P                   | <sub>2,5"</sub> )+(Y)( <i>H</i>  | ⊃ <sub>100,5"</sub> )=               |              |                    | (F          | ⊃<br><sub>50</sub> ,5 | <sub>5"</sub> )=  |         | 0.55 |
| 27              |                                |   |                     |                         |                                  |                                      |              |                    |             | _                     |                   |         |      |
| 28              |                                | 10-min  |                     | (X)(P <sub>2</sub>      | <sub>.10"</sub> )+(Y)( <i>I</i>  | > <sub>100,10"</sub> )=              | =            |                    | ( <i>F</i>  | 50 , <sup>2</sup>     | <sub>10"</sub> )= |         | 0.85 |
| 29              |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 30              |                                | 15-min  |                     | (X)(P <sub>2</sub>      | <sub>,15"</sub> )+(Y)( <i>H</i>  | ⊃ <sub>100,15"</sub> )=              | :            |                    | (F          | 5, 50                 | 15" <b>)</b> =    |         | 1.05 |
| 31              |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 32              |                                | 30-min  |                     | (X)(P <sub>2</sub>      | <sub>,30"</sub> )+(Y)( <i>F</i>  | ⊃ <sub>100,30"</sub> )=              | :            |                    | ( <i>F</i>  | ⊃<br>50,3             | 30")=             |         | 1.38 |
| 33              |                                |   |                     |                         |                                  |                                      |              |                    |             |                       |                   |         |      |
| 34              |                                | 1-hour  |                     | (X)(P                   | <sub>2,1'</sub> )+(Y)( <i>F</i>  | > <sub>100.1'</sub> )=               |              |                    | ( <i>F</i>  | <b>&gt;</b><br>50 ,1  | ı <sup>.</sup> )= |         | 1.70 |
| 35              |                                |   |                     |                         | _,                               | ,                                    |              |                    |             |                       |                   |         |      |
| 36              |                                | 2-hour  |                     | (X)(P                   | <sub>2,2'</sub> )+(Y)( <i>F</i>  | ⊃ <sub>100 2'</sub> )=               |              |                    | (F          | <b>&gt;</b> 50 ,2     | <sub>2'</sub> )=  |         | 1.81 |
| 37              |                                |   |                     |                         | _,_ / \ /\                       | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |              |                    |             | 00 /                  |                   |         |      |
| 38              |                                | 3-hour  |                     | (X)(P                   | <sub>2,3'</sub> )+(Y)( <i>F</i>  | ⊃ <sub>100 3'</sub> )=               |              |                    | (F          | <b>)</b><br>50,3      | .)=               |         | 1.89 |
| 39              |                                |   |                     | Nº 7/1                  | 2,37 \`/\'                       | 100,57                               |              |                    |             | 50 14                 | -                 | <b></b> |      |
| 40              |                                | 6-hour  |                     | (X)(P                   | <sub>2.6'</sub> )+(Y)( <i>F</i>  | - 100 cl)=                           |              |                    | (F          | ⊃<br>50,€             | ;·)=              |         | 2.04 |
| 41              |                                |   |                     | (**)(*                  | 2,07 \'/\'                       | 100,67                               |              |                    | ``          | 50,0                  | , ,               |         | 2.04 |
| 41              |                                | 12-hour   |                     | (X)/D                   | , <sub>12'</sub> )+(Y)( <i>F</i> | >)-                                  |              |                    | (F          | <b>&gt;</b><br>50,1   | )=                |         | 2.27 |
|                 |                                |   |                     | (^)( <sup>[]</sup> 2    | ,12'7 ' \ ד\ ל                   | 100,12' <b>/</b>                     |              |                    | ζ,          | 50 ,1                 | 21                |         | 2.21 |
| 101             |                                | •   |                     |                         |                                  |                                      |              |                    |             | -                     |                   |         |      |
| <u>43</u><br>44 |                                | 24-hour   |                     |                         | , <sub>24'</sub> )+(Y)(F         | י ר                                  |              |                    | (F          | <del>ک</del> , 50     | )                 |         | 2.50 |

|          | A           | В           | С                                     | D                       | E                                | F                     | G           | H                        | J    |
|----------|-------------|-------------|---------------------------------------|-------------------------|----------------------------------|-----------------------|-------------|--------------------------|------|
| 1        |             |             | · · · · · · · · · · · · · · · · · · · |                         |                                  |                       |             |                          |      |
| 2        |             | RAI         | NFALL DEPTH                           |                         | gure 1-2<br>-FREQUE              | NCY (D-D-F            | WORKS       | НЕЕТ                     |      |
| 4        |             |             |                                       |                         |                                  |                       |             |                          |      |
| 5        |             |             |                                       | P/                      | ART D                            |                       |             |                          |      |
| 6        |             |             |                                       |                         |                                  |                       |             |                          |      |
| 7        | For any flo | od frequenc | ;y (T-yr) other tl                    | han the 2-ves           | ar or 100-v                      | ear calculate         | e the rainf | all denth                |      |
|          |             |             | on (t) by the foll                    |                         |                                  |                       |             | anueptii                 |      |
| 10       |             |             |                                       | 5 -00/                  |                                  |                       |             |                          |      |
| 11<br>12 |             |             |                                       | P <sub>⊺,t</sub> =(X)(I | P <sub>2,t</sub> )+(Y)( <i>F</i> | <b>7</b> 100,t)       |             |                          |      |
| 13       |             |             | Frequency                             |                         |                                  | ٦                     |             |                          |      |
| 14       |             |             | (T-yr)                                | X                       | Y                                |                       |             |                          |      |
| 15<br>16 |             |             | 5-year<br>10-year                     | 0.674 0.496             | 0.278<br>0.449                   |                       |             |                          |      |
| 17       |             |             | 25-year                               | 0.293                   | 0.669                            |                       |             |                          |      |
| 18       |             |             | 50-year                               | 0.146                   | 0.835                            |                       |             |                          |      |
| 19<br>20 |             | l           | 500-year                              | -0.337                  | 1.381                            |                       |             |                          |      |
| 20       |             |             |                                       |                         |                                  |                       |             |                          |      |
|          | Selected F  | requency (T | -year)                                |                         |                                  |                       |             |                          |      |
| 23<br>24 |             | 500         | yr X≖                                 | -0.337                  | Y=                               | = 1.381               |             |                          |      |
| 25       |             | 000         | yı X                                  | -0.001                  | 1-                               |                       |             |                          |      |
| 26       |             | 5-min       |                                       | (X)(P                   | <sub>2,5"</sub> )+(Y)(P          | <sub>100,5"</sub> )=  | (7          | ⊃ <sub>500 ,5"</sub> )=  | 0.76 |
| 27       |             |             |                                       |                         |                                  |                       |             | _                        |      |
| 28       |             | 10-min      |                                       | (X)(P <sub>2</sub>      | <sub>,10"</sub> )+(Y)(P          | <sub>100,10"</sub> )= | ()          | ⊃ <sub>500 ,10"</sub> )= | 1.20 |
| 29<br>30 |             | 15-min      |                                       | (Y)(D                   | <sub>.15"</sub> )+(Y)(P          | )—                    | (1          | ⊃ <sub>500 ,15"</sub> )= | 1.49 |
| 31       |             |             |                                       | (\(\)(1 2               | ,15"/ ' ( ' <b>/ /</b> '         | 100,15"/              | ζ.          | 500 ,15")                | 1.49 |
| 32       |             | 30-min      |                                       | (X)(P <sub>2</sub>      | <sub>,30"</sub> )+(Y)(P          | <sub>100,30"</sub> )= | (7          | ⊃ <sub>500 ,30"</sub> )= | 1.95 |
| 33       |             |             |                                       |                         | -                                |                       |             |                          |      |
| 34       |             | 1-hour      |                                       | (X)(P                   | <sub>2,1'</sub> )+(Y)(P          | <sub>100,1</sub> .)=  | (F          | ⊃ <sub>500 ,1</sub> .)=  | 2.41 |
| 35<br>36 |             | 2-hour      |                                       | (Y\(D                   | <sub>2.2'</sub> )+(Y)(P          | )-                    | (F          | ⊃ <sub>500 ,2'</sub> )=  | 2.55 |
| 37       |             |             |                                       | (^)(P                   | 2,2'7 ' ( ' )( <i>F</i>          | 100,2' <b>/</b>       | (*          | 500 ,2'7-                | 2.00 |
| 38       |             | 3-hour      |                                       | (X)(P                   | <sub>2,3'</sub> )+(Y)(P          | <sub>100,3'</sub> )=  | ( <i>F</i>  | ⊂ <sub>500 ,3'</sub> )=  | 2.65 |
| 39       |             |             |                                       |                         |                                  |                       |             |                          |      |
| 40       |             | 6-hour      |                                       | (X)(P                   | <sub>2,6'</sub> )+(Y)(P          | <sub>100,6'</sub> )=  | (F          | ⊃ <sub>500,6</sub> .)=   | 2.83 |
| 41<br>42 |             | 12-hour     |                                       |                         | )±\/\/\/D                        | )_                    | ( <i>F</i>  | > .)-                    | 0.44 |
| 42       |             | 12-110UI    |                                       | (^)( <sup>P</sup> 2     | <sub>,12'</sub> )+(Y)(P          | 100,12' <b>/</b>      | (7          | 5 <sub>500 ,12</sub> .)= | 3.11 |
| 44       |             | 24-hour     |                                       | (X)(P <sub>2</sub>      | , <sub>24'</sub> )+(Y)(P         | <sub>100,24'</sub> )= | (F          | P <sub>500 ,24'</sub> )= | 3.40 |

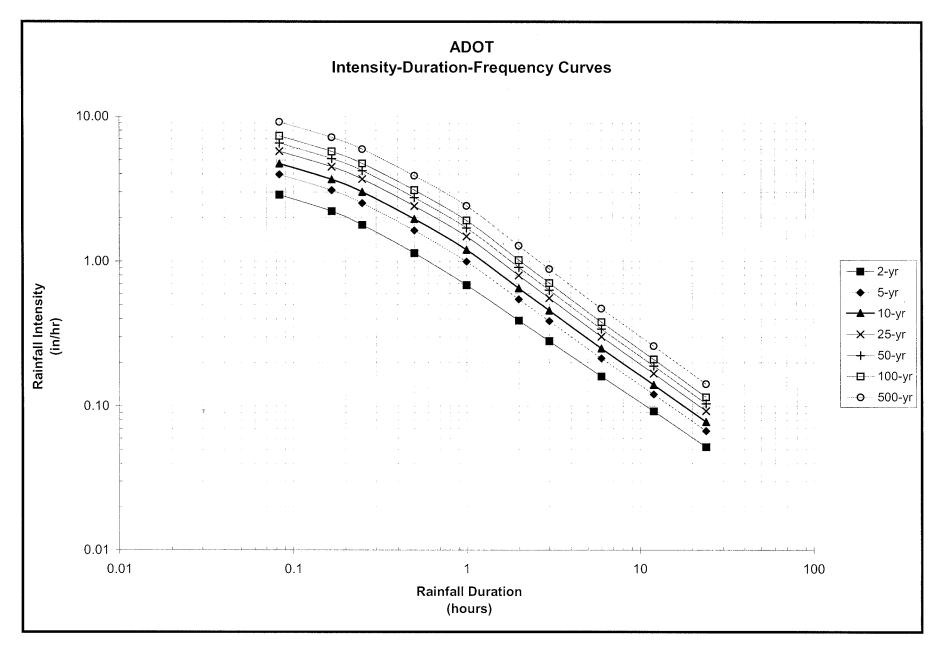
| 1  | A I                          | В         | С                  | [   | D   |   | EF                      | GHI  |                                | J                                       |
|--|------------------------------|-----------|--------------------|---|---|---|-------------------------|--|--------------------------------|---|
| 2  |                              |           |                    |   | RAINFALL DE                                   | Figure 1-2<br>PTH-DURATION-FREQUENCY (D-D |                         | т  |                                |   |
| 4  |                              | • 46.11 2 |                    |   |   | •   |                         |  |                                |   |
| 5  | · .                          |           |                    |   |   | PART D - FORMULAS                         |                         |  |                                |   |
| 7  | For any flood frequency (    | L-vr) oth | er than the 2-     | year or 100-year, calculate the rainfall de | oth   |   |                         |  |                                |   |
| 9  | for each rainfall duration ( | t) by the | following equ      | ation:                                      | spin  |   |                         |  |                                |   |
| 10<br>11   |                              |           |                    |   | $P_{\tau,t}=(X)(P_{2,t})+(Y)$                 | (P <sub>100,t</sub> )                     |                         |  |                                |   |
| 12   |                              | Γ         | Frequency          | <u> </u>                                    |   |   | ······                  |  |                                |   |
| 14<br>15   |                              |           | (T-yr)<br>5-year   | 0.674                                       | X   |   | Y<br>0.278              |  |                                |   |
| 16   |                              |           | 10-year<br>25-year | 0.496<br>0.293                              |   |   | 0.449<br>0.669          |  |                                |   |
| 18   |                              |           | 50-year            | 0.146                                       |   |   | 0.835                   |  |                                |   |
| 20   |                              | L         | 500-year           | -0.337                                      |   |   | 1.381                   |  |                                |   |
| 21<br>22   | Selected Frequency (T-ye     | ar)       |                    |   |   |   |                         |  |                                |   |
| 23<br>24   | 50                           | )<br>y    | rr X=              | =IF(\$B\$24=5,D15,IF(\$B\$24=10,D16,IF(     | (\$B\$24=25.D17.IF(\$B\$24                    | I=50 D18 IE(\$B\$24=500 D19 "NG"))))      | ) Y= =!F/\$             | R\$24=5 E15 E(\$R\$24=                     | 10 516 5/88924-25 517 5/85     | \$24=50,E18,IF(\$B\$24=500,E19,"NG")))) |
| 25   | 5-r                          |           |                    |   |   |   | <u>/</u> · · · · · · (0 |  |                                |   |
| 20   | -r                           | nin       |                    |   | (X)(P <sub>2.5</sub> -)+(Y)( <i>i</i>         | D 100.5")=                                |                         | (P =\$B\$24 .5-)=                          | =\$D\$24*'Part C'!G25+'Part D  | !\$F\$24*'Part C'!G33                   |
| 28   | 10                           | min       |                    |   | (X)(P <sub>2.10</sub> -)+(Y)( <i>i</i>        | D 100,10")=                               |                         | (P <sub>=\$B\$24</sub> .10 <sup>-</sup> )= | =\$D\$24*'Part C'!G27+'Part D  | !\$F\$24*'Part C'!G35                   |
| 30   | 15                           | min       |                    |   | (X)(P <sub>2.15</sub> -)+(Y)( <i>I</i>        | D 100,15°)=                               |                         | (P)=                                       | =\$D\$24*'Part C'!G29+'Part D  | !\$F\$24*'Part C'!G37                   |
| 32   | 30                           | min       |                    |   | $(X)(P_{2,30^{\circ}})+(Y)(P_{2,30^{\circ}})$ | D <sub>100,30</sub> -)=                   |                         | (P <sub>-\$B\$24</sub> .30")=              | =\$D\$24*'Part C'!G31+'Part D  | !\$F\$24**Part C'!G39                   |
| 34<br>35   | 1-1                          | юцг       |                    |   | $(X)(P_{2,v})+(Y)(h)$                         | D <sub>100,1</sub> )=                     |                         | (P <sub>*\$8\$24</sub> )=                  | =\$D\$24*'Parts A & B'!I25+'Pa | rt D'!\$F\$24*'Parts A & B'!I27         |
| 36<br>37   | 2-1                          | iour      |                    |   | $(X)(P_{2,2})+(Y)(I)$                         | D <sub>100.Z</sub> )=                     |                         | (P)=                                       | =\$D\$24*'Parts A & B'!I29+'Pa | rt D'!\$F\$24**Parts A & B'!I32         |
| 38   | 3-1                          | our       |                    |   | $(X)(P_{2,3'})+(Y)(X)$                        | =( <sub>100.3</sub> )=                    |                         | (P)=                                       | =\$D\$24*'Parts A & B'!I30+'Pa | rt D'!\$F\$24**Parts A & B'!I33         |
| 40   | 6-r                          | iour      |                    |   | $(X)(P_{2,6})+(Y)(A)$                         | D 100.6')=                                |                         | (P   | =\$D\$24*'Parts A & B'!I16+'Pa | rt D'!\$F\$24*'Parts A & B'!I18         |
| $\begin{array}{c} 12\\ 13\\ 14\\ 15\\ 16\\ 17\\ 20\\ 21\\ 22\\ 23\\ 24\\ 25\\ 26\\ 27\\ 28\\ 29\\ 30\\ 31\\ 32\\ 33\\ 34\\ 35\\ 36\\ 37\\ 38\\ 39\\ 40\\ 41\\ 42\\ 43\\ 34\\ 44\\ \end{array}$ | 12-                          | hour      |                    |   | (X)(P <sub>2.12</sub> )+(Y)(A                 | D 100.12)=                                |                         | (P _==5B\$2412')=                          | =\$D\$24*'Parts A & B'!I31+'Pa | rt D'!\$F\$24*'Parts A & B'!I34         |
| 44   | 24                           | hour      |                    |   | (X)(P <sub>2,24</sub> )+(Y)(A                 | ₽ <sub>100,24</sub> ;)=                   |                         | (P <sub>=\$B\$24</sub>                     | =\$D\$24*'Parts A & B'!I17+'Pa | rt D'!\$F\$24*'Parts A & B'!I19         |

|          | A   | В                       | С              | D          | E            | F                 | G      | Н    | l             | J |  |
|----------|---|-------------------------|----------------|------------|--------------|-------------------|--------|------|---------------|---|--|
| 1        |   |                         |                |            |              |                   |        |      |               |   |  |
| 2        |   |                         |                |            |              |                   |        |      |               |   |  |
| 3<br>4   | RAINFALL DEPTH-DURATION-FREQUENCY (D-D-F) WORKSHEET |                         |                |            |              |                   |        |      |               |   |  |
|          |   | netrationan a an tairea | age verse form |            | <b>.</b>     |                   |        |      | eans fairteac |   |  |
| 5        | Systematics   |                         |                |            | PAF          |                   |        |      |               |   |  |
| 6        |   |                         |                |            |              |                   |        |      |               |   |  |
| 7        |   |                         |                | _          |              |                   |        |      |               |   |  |
| 8        | Tabulate t  | he rainfall De          | epth-Durat     | ion-Freque | ncy statisti | cs below:         |        |      |               |   |  |
| 9        |   |                         |                |            |              |                   |        |      |               |   |  |
| 10<br>11 |   |                         |                |            |              |                   |        |      |               |   |  |
|          |   | li                      |                |            | Dalatal      | I Danatha In      | Lashaa |      |               | 1 |  |
| 12<br>13 |   |                         |                |            |              | l Depth, In       |        |      |               |   |  |
| 13       |   | Duration                | 2              | 5          | 10           | uency, In `<br>25 | 50     | 100  | 500           |   |  |
| 15       |   | 5-min                   | 0.24           | 0.33       | 0.39         | 0.48              | 0.55   | 0.61 | 0.76          |   |  |
| 16       |   | 10-min                  | 0.24           | 0.55       | 0.61         | 0.40              | 0.85   | 0.96 | 1.20          |   |  |
| 17       |   | 15-min                  | 0.44           | 0.63       | 0.75         | 0.92              | 1.05   | 1.18 | 1.49          |   |  |
| 18       |   | 30-min                  | 0.57           | 0.81       | 0.98         | 1.20              | 1.38   | 1.55 | 1.95          |   |  |
| 19       |   | 1-hour                  | 0.68           | 0.99       | 1.20         | 1.48              | 1.70   | 1.91 | 2.41          |   |  |
| 20       |   | 2-hour                  | 0.78           | 1.09       | 1.30         | 1.59              | 1.81   | 2.04 | 2.55          |   |  |
| 21       |   | 3-hour                  | 0.84           | 1.16       | 1.37         | 1.67              | 1.89   | 2.12 | 2.65          |   |  |
| 22       |   | 6-hour                  | 0.96           | 1.28       | 1.50         | 1.81              | 2.04   | 2.28 | 2.83          |   |  |
| 23       |   | 12-hour                 | 1.11           | 1.45       | 1.68         | 2.01              | 2.27   | 2.53 | 3.11          |   |  |
| 24       |   | 24-hour                 | 1.25           | 1.61       | 1.86         | 2.22              | 2.50   | 2.77 | 3.40          |   |  |
| 25       |   |                         |                |            |              |                   |        |      |               |   |  |
| 26       |   |                         |                |            |              |                   |        |      |               |   |  |
| 27       |   |                         |                |            |              |                   |        |      |               |   |  |
| 28       |   |                         |                |            |              |                   |        |      |               |   |  |
| 29       |   |                         |                |            |              |                   |        |      |               |   |  |

|                            | А        | В            | С   | D                                     | E                      | F                      | G                      | Н                  | 1                      | J |  |  |  |  |
|----------------------------|----------|--------------|---|---------------------------------------|------------------------|------------------------|------------------------|--------------------|------------------------|---|--|--|--|--|
| 1                          |          |              |   |                                       |                        | Figure 4.0             |                        |                    |                        |   |  |  |  |  |
| 3                          |          |              | Figure 1-2<br>RAINFALL DEPTH-DURATION-FREQUENCY (D-D-F) WORKSHEET |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
| 4                          |          |              |   | •                                     |                        |                        | D-1 / WORKONEET        |                    |                        |   |  |  |  |  |
| 5                          |          |              |   |                                       | PAR                    | T E - FORMULAS         |                        |                    | 승규는 것이 가운데요. 것이        |   |  |  |  |  |
| 6                          |          |              |   | · · · · · · · · · · · · · · · · · · · |                        |                        |                        |                    |                        |   |  |  |  |  |
| 7                          |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
|                            | Tabulate | the rainfall | Depth-Duration-Freq   | uency statistics below:               |                        |                        |                        |                    |                        |   |  |  |  |  |
| 9                          |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
| 10<br>11                   |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
|                            |          |              | 1   | Rainfall Depth, In Inches             |                        |                        |                        |                    |                        |   |  |  |  |  |
| 12<br>13                   |          |              |   |                                       |                        | Frequency, In Yea      |                        |                    |                        | - |  |  |  |  |
| 14                         |          | Duration     |   | 5                                     | 10                     | 25                     | 50                     | 100                | 500                    |   |  |  |  |  |
| 15<br>16                   |          | 5-min        | ='Part C'!G25   | ='Part D, 5-yr'!J26                   | ='Part D, 10-yr'!\$J26 | ='Part D, 25-yr'!\$J26 | ='Part D, 50-yr'!\$J26 | ='Part C'!G33      | ='Part D, 500-yr '!J26 | 1 |  |  |  |  |
| 16                         |          | 10-min       | ='Part C'!G27   | ='Part D, 5-yr'!J28                   | ='Part D, 10-yr'!\$J28 | ='Part D, 25-yr'!\$J28 | ='Part D, 50-yr'!\$J28 | ='Part C'!G35      | ='Part D, 500-yr '!J28 |   |  |  |  |  |
| 17                         |          | 15-min       | ='Part C'!G29   | ='Part D, 5-yr'!J30                   | ='Part D, 10-yr'!\$J30 | ='Part D, 25-yr'!\$J30 | ='Part D, 50-yr'!\$J30 | ='Part C'!G37      | ='Part D, 500-yr '!J30 |   |  |  |  |  |
| 18<br>19                   |          | 30-min       | ='Part C'!G31   | ='Part D, 5-yr'!J32                   | ='Part D, 10-yr'!\$J32 | ='Part D, 25-yr'!\$J32 | ='Part D, 50-yr'!\$J32 | ='Part C'!G39      | ='Part D, 500-yr '!J32 |   |  |  |  |  |
| 19                         |          | 1-hour       | ='Parts A & B'!125  | ='Part D, 5-yr'!J34                   | ='Part D, 10-yr'!\$J34 | ='Part D, 25-yr'!\$J34 | ='Part D, 50-yr'!\$J34 | ='Parts A & B'!127 | ='Part D, 500-yr '!J34 |   |  |  |  |  |
| 20                         |          | 2-hour       | ='Parts A & B'!129  | ='Part D, 5-yr'!J36                   | ='Part D, 10-yr'!\$J36 | ='Part D, 25-yr'!\$J36 | ='Part D, 50-yr'!\$J36 | ='Parts A & B'!132 | ='Part D, 500-yr '!J36 |   |  |  |  |  |
| 21                         |          | 3-hour       | ='Parts A & B'!I30  | ='Part D, 5-yr'!J38                   | ='Part D, 10-yr'!\$J38 | ='Part D, 25-yr'!\$J38 | ='Part D, 50-yr'!\$J38 | ='Parts A & B'!133 | ='Part D, 500-yr '!J38 |   |  |  |  |  |
| 22                         |          | 6-hour       | ='Parts A & B'!I16  | ='Part D, 5-yr'!J40                   | ='Part D, 10-yr'!\$J40 | ='Part D, 25-yr'!\$J40 | ='Part D, 50-yr'!\$J40 | ='Parts A & B'!118 | ='Part D, 500-yr '!J40 |   |  |  |  |  |
| 20<br>21<br>22<br>23<br>24 |          | 12-hour      | ='Parts A & B'!I31  | ='Part D, 5-yr'!J42                   | ='Part D, 10-yr'!\$J42 | ='Part D, 25-yr'!\$J42 | ='Part D, 50-yr'!\$J42 | ='Parts A & B'!134 | ='Part D, 500-yr '!J42 |   |  |  |  |  |
|                            |          | 24-hour      | ='Parts A & B'!117  | ='Part D, 5-yr'!J44                   | ='Part D, 10-yr'!\$J44 | ='Part D, 25-yr'!\$J44 | ='Part D, 50-yr'!\$J44 | ='Parts A & B'!119 | ='Part D, 500-yr '!J44 |   |  |  |  |  |
| 25                         |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
| 26                         |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
| 25<br>26<br>27<br>28<br>29 |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
| 28                         |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |
| 29                         |          |              |   |                                       |                        |                        |                        |                    |                        |   |  |  |  |  |

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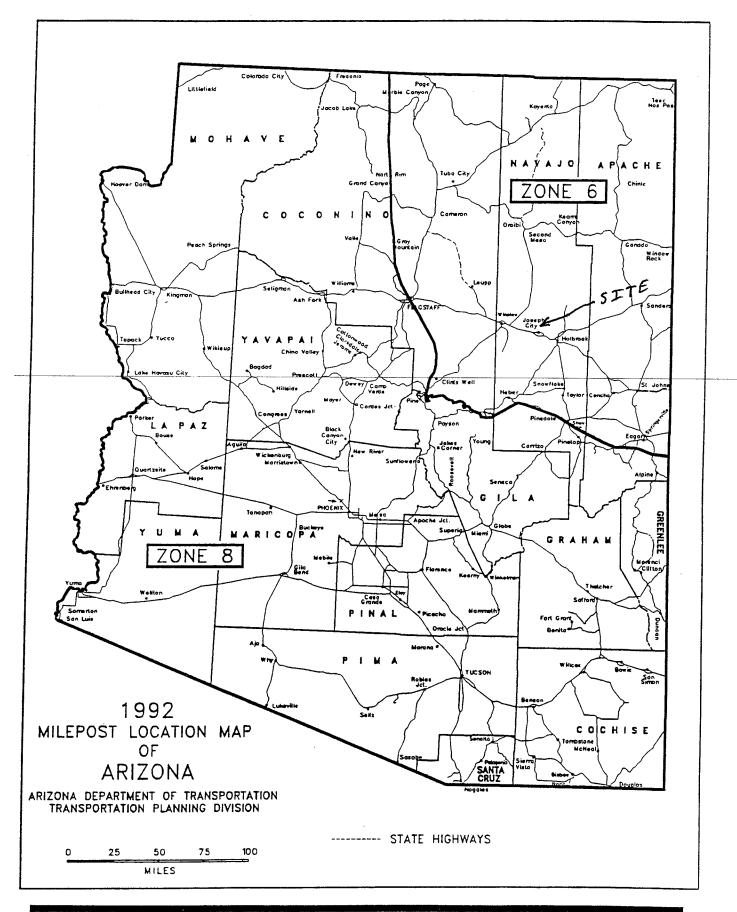
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# **REFERENCES**

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Hydrology\Rainfall Data Calc-draft.doc

FIGURE 1-1 SHORT-DURATION RAINFALL RATIO ZONES FOR ARIZONA



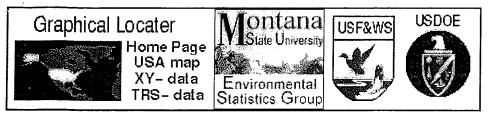
| Abitibi Co.            | Abitibi Consolidated Snowflake Division | lake Division                                      |              |               |           |        |          | ·            |   |
|------------------------|---|--|--------------|---------------|-----------|--------|----------|--------------|---|
| State ID               | NID                                     | Dam Name   | Hazard Class | Location      | Dam Type  | Height | Capacity | Dam Size     | Rea. IDF  |
| 09.35                  | AZ00227                                 | Ash Lagoons  | Low          | S21,T13N,R19E | Earth     | 25     | 451      | Small        | 100-vear  |
| 09.36                  | AZ00231                                 | Mill Pond  | Low          | S17,T13N,R19E | Earth     | 30     | 2200     | Intermediate |   |
| Arizona G              | Arizona Game & Fish Department          | irtment  |              |               |           |        |          |              |   |
| State ID               | DID                                     | Dam Name   | Hazard Class | Location      | Dam Type  | Height | Capacity | Dam Size     | Rea. IDF  |
| 09.20                  | AZ00042                                 | Black Canyon                                       | High         | S24,T11N,R15E | Earth     | 60     | 1581     | Intermediate | 0.5 PMF   |
| 09.19                  | AZ00051                                 | Fool Hollow  | High         | S12.T10N.R21E | Earthrock | 60     | 3217     | Intermediate | 0.5 PMF   |
| Arizona P <sub>1</sub> | ublic Service Con                       | Arizona Public Service Company, Cholla Power Plant |              |               |           |        |          |              |   |
| State ID               | NID                                     | Dam Name   | Hazard Class | Location      | Dam Type  | Height | Capacity | Dam Size     | Req. IDF  |
| 09.27                  | AZ00178                                 | Cholla Bottom Ash Pond                             | High         | S13,T18N,R19E | Earth     | 73     | 2200     | Intermediate |   |
| 09.28                  | AZ00179                                 | Cholla Fly Ash Pond                                | High         | S30,T18N,R20E | Earth     | 80     | 18000    | Intermediate |   |
| Arizona Pı             | ublic Service Com                       | Arizona Public Service Company, Phoenix Office     |              |               |           |        |          |              |   |
| State ID               | <b><i>dIN</i></b>                       | Dam Name   | Hazard Class | Location      | Dam Type  | Height | Capacity | Dam Size     | Req. IDF  |
| 09.29                  | AZ00180                                 | Cholla Cooling Pond                                | Significant  | S26,T18N,R19E | Earth     | 13     | 2200     | Small        |   |
| City of Show Low       | ом Гом                                  |  |              |               |           |        |          |              |   |
| State ID.              | DID                                     | Dam Name   | Hazard Class | Location      | Dam Type  | Height | Capacity | Dam Size     | Rea. IDF  |
| 09.13                  | AZ00023                                 | Jaques   | High         | S10,T9N,R22E  | Earth     | 65     | 6000     | Intermediate |   |
| City of Winslow        | nslow                                   |  |              |               |           |        |          |              |   |
| State ID               | DID                                     | Dam Name   | Hazard Class | Location      | Dam Type  | Height | Capacity | Dam Size     | Rea. IDF  |
| 09.03                  | AZ00057                                 | Clear Creek #1                                     | Low          | S10,T18N,R16E | Masonry   | 7      | 350      | Small        | A second s |
| Page 24 of 37          |   |  | •            |               |           |        |          |              | 19  |

Navajo Abitibi Conso

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Graphical Locater Result



# The selected location is:

Latitude/Longitude 34.9584°N, 110.2784°W (34°, 57', 30.4" N; 110°, 16', 42.3" W) The legal description is: Arizona, Gila & Salt River Meridian T18N,R19E,sec13.

The elevation is 1554 m (5098 ft) The gradient is: 0.0 percent There is no aspect direction. The local roughness is: 0.0 or flat The location as decimal degrees (X,Y;Z) = -110.2784, 34.9584; 1554 m

The state and county are Arizona: Navajo County 4017 The HUC is Middle Little Colorado 15020008; Place point in HUC The Omernik ecoregion is Arizona/New Mexico Plateau (less typical) 22 The 1:100,000 map (if available); Switch to TerraServer Zoom on that location with radius = 2 km; 5 km; 10 km; 20 km; 30 km; custom.

# Nearby named places (in order by distance)

- 1. Cholla Cooling Pond Dam; Arizona: Navajo Co. -110.2774, 34.9550 at a distance of 391 m
- 2. Cholla Fly Ash Pond; Arizona: Navajo Co. -110.2674, 34.9600 at a distance of 1023 m
- 3. Cholla Fly Ash Pond Dam; Arizona: Navajo Co. -110.2674, 34.9600 at a distance of 1023 m
- 4. Cholla Bottom Ash Pond; Arizona: Navajo Co. -110.2890, 34.9667 at a distance of 1332 m
- 5. Cholla Bottom Ash Pond Dam; Arizona: Navajo Co. -110.2890, 34.9667 at a distance of 1332 m
- 6. Cholla Power Generating Plant; Arizona: Navajo Co. -110.2979, 34.9394 at a distance of 2759 m
- 7. Cholla Lake; Arizona: Navajo Co. -110.2838, 34.9306 at a distance of 3125 m
- 8. The Old Fort Historical Monument; Arizona: Navajo Co. -110.3210, 34.9558 at a distance of 3898 m
- 9. Joseph City Elementary School; Arizona: Navajo Co. -110.3318, 34.9647 at a distance of 4923 m
- 10. Joseph City High School; Arizona: Navajo Co. -110.3318, 34.9653 at a distance of 4933 m

# The 7.5 minute series topographic maps for that area

| Humpy Camp<br>Well | Blairs Spring    | Lee Mountain  |
|--------------------|------------------|---------------|
| Apache Butte       | Joseph City      | Holbrook      |
| Chimney<br>Canyon  | Saunders<br>Draw | Porter Canyon |

6

# NOAA 14 TABLES

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Precipitation Frequency Data Server



## **POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14**



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#### Arizona 34.9667 N 110.289 W 5200 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley NOAA, National Weather Service, Silver Spring, Maryland, 2006

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| xtracted: Thu Jan 22 2009 |  |
|---------------------------|--|
|---------------------------|--|

| Cor             | nfiden          | ce Lim           | iits             | ][ _ Se          | easona           | lity       | [           | cation      | Maps         |              | Other        | Info.           | ][ GI                  | S data                  | Ma                      | aps                     | Docs                    | [F                      | Return to Sta |
|-----------------|-----------------|------------------|------------------|------------------|------------------|------------|-------------|-------------|--------------|--------------|--------------|-----------------|------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|---------------|
|                 |                 |                  |                  |                  | Pre              | cipita     | tion 1      | Frequ       | iency        | Estin        | nates        | (inch           | es)                    |                         |                         |                         |                         |                         |               |
| ARI*<br>(years) | <u>5</u><br>min | <u>10</u><br>min | <u>15</u><br>min | <u>30</u><br>min | <u>60</u><br>min | 120<br>min | <u>3 hr</u> | <u>6 hr</u> | <u>12 hr</u> | <u>24 hr</u> | <u>48 hr</u> | <u>4</u><br>day | <u>7</u><br><u>day</u> | <u>10</u><br><u>day</u> | <u>20</u><br><u>day</u> | <u>30</u><br><u>day</u> | <u>45</u><br><u>day</u> | <u>60</u><br><u>day</u> |               |
| 1               | 0.18            | 0.27             | 0.33             | 0.45             | 0.55             | 0.63       | 0.68        | 0.77        | 0.88         | 1.00         | 1.12         | 1.25            | 1.43                   | 1.57                    | 2.04                    | 2.39                    | 2.87                    | 3.30                    |               |
| 2               | 0.23            | 0.34             | 0.43             | 0.58             | 0.71             | 0.81       | 0.86        | 0.96        | 1.09         | 1.25         | 1.40         | 1.55            | 1.77                   | 1.96                    | 2.54                    | 2.97                    | 3.56                    | 4,09                    | E             |
| 5               | 0.31            | 0.47             | 0.58             | 0.78             | 0.96             | 1.07       | 1.11        | 1.21        | 1.36         | 1.57         | 1.74         | 1.92            | 2.18                   | 2.40                    | 3.09                    | 3.61                    | 4.32                    | 4.92                    |               |
| 10              | 0.37            | 0.57             | 0.70             | 0.94             | 1.17             | 1.29       | 1.33        | 1.43        | 1.57         | 1.83         | 2.01         | 2.22            | 2.51                   | 2.74                    | 3.52                    | 4.08                    | 4.89                    | 5.54                    |               |
| 25              | 0.47            | 0.71             | 0.88             | 1.19             | 1.47             | 1.62       | 1.65        | 1.74        | 1.87         | 2.19         | 2.39         | 2.63            | 2.95                   | 3.20                    | 4.07                    | 4.68                    | 5.60                    | 6.31                    |               |
| 50              | 0.55            | 0.83             | 1.03             | 1.38             | 1.71             | 1.89       | 1.91        | 2.00        | 2.10         | 2.47         | 2.68         | 2.95            | 3.29                   | 3.54                    | 4.48                    | 5.12                    | 6.11                    | 6.85                    |               |
| 100             | 0.63            | 0.96             | 1.19             | 1.60             | 1.99             | 2.18       | 2.20        | 2.28        | 2.34         | 2.77         | 2.98         | 3.29            | 3.63                   | 3.88                    | 4.88                    | 5.54                    | 6.59                    | 7.35                    | E             |
| 200             | 0.72            | 1.10             | 1.36             | 1.84             | 2.27             | 2.50       | 2.52        | 2.59        | 2.61         | 3.07         | 3.29         | 3.62            | 3.98                   | 4.21                    | 5.26                    | 5.94                    | 7.03                    | 7.81                    |               |
| 500             | 0.85            | 1.30             | 1.61             | 2.17             | 2.69             | 2.97       | 2.99        | 3.04        | 3.08         | 3.49         | 3.70         | 4.08            | 4.44                   | 4.66                    | 5.75                    | 6.43                    | 7.56                    | 8.35                    |               |
| 1000            | 0.96            | 1.46             | 1.81             | 2.44             | 3.02             | 3.35       | 3.38        | 3.43        | 3.47         | 3.81         | 4.02         | 4.43            | 4.79                   | 4.99                    | 6.11                    | 6.78                    | 7.91                    | 8.70                    |               |

\* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.

Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

|                  |      | 4         |           |           |           | L .        |         | of the<br>Frequ |          |          |          |          |          |           |           |           |           |           |
|------------------|------|-----------|-----------|-----------|-----------|------------|---------|-----------------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|
| ARI**<br>(years) |      | 10<br>min | 15<br>min | 30<br>min | 60<br>min | 120<br>min | 3<br>hr | 6<br>hr         | 12<br>hr | 24<br>hr | 48<br>hr | 4<br>day | 7<br>day | 10<br>day | 20<br>day | 30<br>day | 45<br>day | 60<br>day |
| 1                | 0.20 | 0.31      | 0.38      | 0.51      | 0.64      | 0.73       | 0.77    | 0.86            | 0.97     | 1.09     | 1.22     | 1.35     | 1.54     | 1.70      | 2.19      | 2.56      | 3.08      | 3.53      |
| 2                | 0.26 | 0.40      | 0.49      | 0.66      | 0.82      | 0.93       | 0.98    | 1.08            | 1.22     | 1.36     | 1.52     | 1.67     | 1.91     | 2.11      | 2.73      | 3.18      | 3.82      | 4.37      |
| 5                | 0.35 | 0.54      | 0.67      | 0.90      | 1.11      | 1.23       | 1.27    | 1.36            | 1.51     | 1.70     | 1.88     | 2.07     | 2.35     | 2.58      | 3.32      | 3.85      | 4.62      | 5.25      |
| 10               | 0.43 | 0.65      | 0.81      | 1.09      | 1.34      | 1.48       | 1.51    | 1.60            | 1.74     | 1.98     | 2.18     | 2.39     | 2.70     | 2.94      | 3.77      | 4.35      | 5.21      | 5.89      |
| 25               | 0.54 | 0.82      | 1.01      | 1.36      | 1.69      | 1.85       | 1.87    | 1.94            | 2.07     | 2.37     | 2.58     | 2.83     | 3.18     | 3.43      | 4.36      | 4.99      | 5.95      | 6.70      |
| 50               | 0.62 | 0.95      | 1.18      | 1.59      | 1.96      | 2.15       | 2.17    | 2.23            | 2.32     | 2.67     | 2.90     | 3.17     | 3.54     | 3.79      | 4.80      | 5.46      | 6.49      | 7.27      |
| 100              | 0.73 | 1.10      | 1.37      | 1.84      | 2.28      | 2.49       | 2.50    | 2.55            | 2.60     | 2.99     | 3.22     | 3.53     | 3.91     | 4.16      | 5.22      | 5.91      | 7.00      | 7.80      |
| 200              | 0.83 | 1.27      | 1.57      | 2.12      | 2.62      | 2.87       | 2.88    | 2.91            | 2.91     | 3.32     | 3.56     | 3.90     | 4.29     | 4.53      | 5.64      | 6.34      | 7.46      | 8.30      |
| 500              | 0.99 | 1.51      | 1.87      | 2.52      | 3.12      | 3.42       | 3.43    | 3.44            | 3.48     | 3.78     | 4.02     | 4.41     | 4.80     | 5.01      | 6.18      | 6.88      | 8.04      | 8.89      |
| 1000             | 1.12 | 1.71      | 2.12      | 2.85      | 3.52      | 3.88       | 3.90    | 3.91            | 3.95     | 4.15     | 4.38     | 4.81     | 5.20     | 5.39      | 6.58      | 7.26      | 8.43      | 9.27      |

\* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.

\*\* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.

Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

|                  |       |           |           |           |           | ver bo<br>cipita |         |         |          |          |          |          |          |           |           |           |           |           |
|------------------|-------|-----------|-----------|-----------|-----------|------------------|---------|---------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|
| ARI**<br>(years) | 1 . 1 | 10<br>min | 15<br>min | 30<br>min | 60<br>min | 120<br>min       | 3<br>hr | 6<br>hr | 12<br>hr | 24<br>hr | 48<br>hr | 4<br>day | 7<br>day | 10<br>day | 20<br>day | 30<br>day | 45<br>day | 60<br>day |
| 1                | 0.15  | 0.23      | 0.29      | 0.39      | 0.48      | 0.56             | 0.60    | 0.69    | 0.80     | 0.93     | 1.04     | 1.16     | 1.33     | 1.47      | 1.90      | 2.24      | 2.69      | 3.09      |
| 2                | 0.20  | 0.30      | 0.37      | 0.50      | 0.62      | 0.71             | 0.76    | 0.86    | 0.99     | 1.16     | 1.29     | 1.44     | 1.65     | 1.82      | 2.36      | 2.78      | 3.34      | 3.83      |
|                  |       |           |           |           |           |                  |         |         |          |          |          |          |          |           |           |           |           |           |

### Precipitation Frequency Data Server

### Page 2 of 4

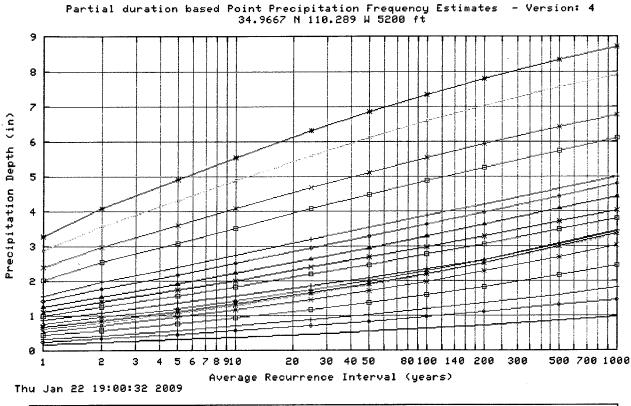
| 5    | 0.27 | 0.41 | 0.51 | 0.68 | 0.84 | 0.94 | 0.98 | 1.09 | 1.23 | 1.45 | 1.61 | 1.79 | 2.03 | 2.24 | 2.88 | 3.38 | 4.05 | 4.62 | 22 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----|
| 10   | 0.32 | 0.49 | 0.61 | 0.82 | 1.01 | 1.13 | 1.17 | 1.27 | 1.42 | 1.69 | 1.86 | 2.07 | 2.33 | 2.56 | 3.28 | 3.82 | 4.58 | 5.19 |    |
| 25   | 0.40 | 0.61 | 0.75 | 1.01 | 1.25 | 1.39 | 1.43 | 1.54 | 1.67 | 2.01 | 2.20 | 2.44 | 2.74 | 2.97 | 3.79 | 4.38 | 5.24 | 5.91 |    |
| 50   | 0.46 | 0.70 | 0.87 | 1.17 | 1.45 | 1.60 | 1.64 | 1.75 | 1.86 | 2.26 | 2.46 | 2.73 | 3.04 | 3.28 | 4.16 | 4.78 | 5.71 | 6.41 |    |
| 100  | 0.53 | 0.80 | 0.99 | 1.34 | 1.65 | 1.83 | 1.86 | 1.97 | 2.05 | 2.51 | 2.72 | 3.02 | 3.35 | 3.58 | 4.51 | 5.16 | 6.15 | 6.87 |    |
| 200  | 0.59 | 0.90 | 1.12 | 1.51 | 1.87 | 2.06 | 2.09 | 2.19 | 2.26 | 2.77 | 2.98 | 3.31 | 3.65 | 3.88 | 4.86 | 5.52 | 6.56 | 7.29 |    |
| 500  | 0.69 | 1.04 | 1.29 | 1.74 | 2.15 | 2.39 | 2.42 | 2.52 | 2.56 | 3.12 | 3.33 | 3.68 | 4.05 | 4.26 | 5.27 | 5.94 | 7.04 | 7.78 |    |
| 1000 | 0.76 | 1.15 | 1.43 | 1.93 | 2.38 | 2.64 | 2.69 | 2.78 | 2.81 | 3.38 | 3.59 | 3.97 | 4.34 | 4.54 | 5.58 | 6.25 | 7.37 | 8.10 |    |

\* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than.

\*\* These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.

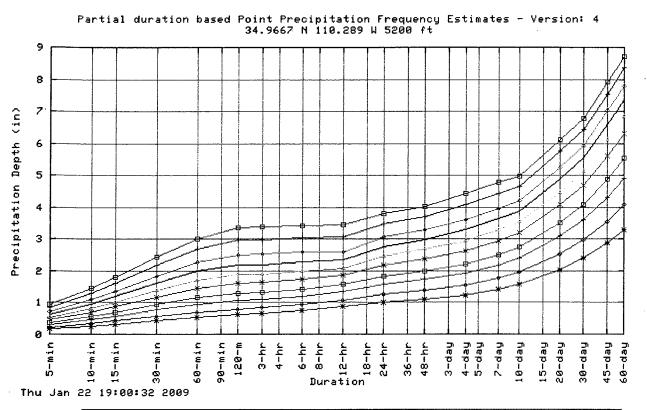
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Text version of tables



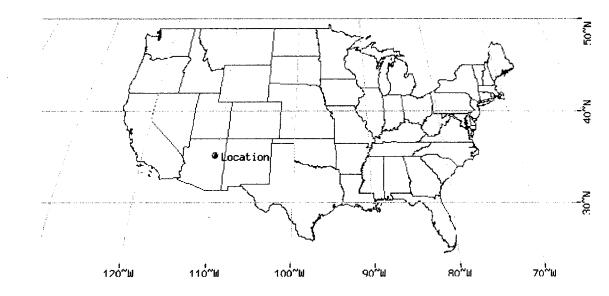
| Duration                |                                       |                       |                        |
|-------------------------|---------------------------------------|-----------------------|------------------------|
| 5-min                   | i i i i i i i i i i i i i i i i i i i | 48-hr                 | 30-day - <del>×-</del> |
| 10-min -+               | 3-hr <del>-*</del>                    | 4-day 🛥               | 417 (BB) (MM)          |
| 15-min 🕂                | 6-hr -+-                              | 7-day —•—             | 60-day <del>*</del>    |
| 30-min - <del>0</del> - | 12-hr —                               | 10-day —              | _                      |
| 60-min -*-              | 24-hr ——                              | 20-day <del>-0-</del> |                        |

1/22/2000



| Average Recurrence Interval |   |
|-----------------------------|---|
| (years)                     |   |
| 1 -*-                       | nani ni<br>™iti<br>ninggiyanany           |
| 2 🛶                         | 100 —                                     |
| 5 -+                        | 200                                       |
| 10                          | 500                                       |
| 25 —————                    | 500 <del>- 1</del><br>1000 <del>- 0</del> |
|                             |   |

## Maps -

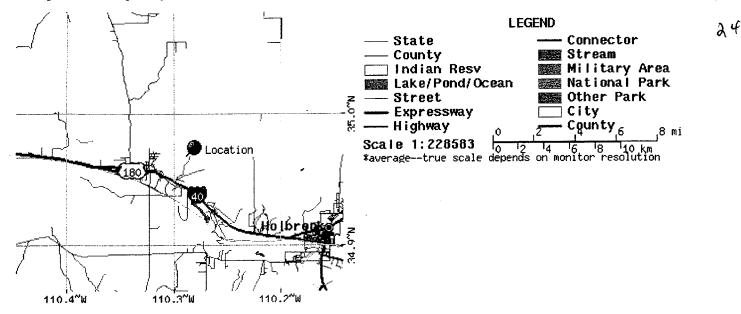


These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.

http://bdsc.puss.poag.gov/cgi\_bin/bdsc/buildout.perl?type=nf&units=us&series=nd&statename=ARIZON 1/22/2000

#### Precipitation Frequency Data Server



### Other Maps/Photographs -

<u>View USGS digital orthophoto quadrangle (DOQ)</u> covering this location from TerraServer; USGS Aerial Photograph may also be available

from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the <u>USGS</u> for more information.

#### Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

#### **Climate Data Sources -**

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information

about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,

please refer to NOAA Atlas 14 Document.

Using the National Climatic Data Center's (NCDC) station search engine, locate other climate stations within:

+/-30 minutes ... OR... +/-1 degree of this location (34.9667/-110.2890). Digital ASCII data can be obtained directly from NCDC.

Find <u>Natural Resources Conservation Service (NRCS)</u> SNOTEL (SNOwpack TELemetry) stations by visiting the <u>Western Regional Climate Center's state-specific SNOTEL station maps</u>.

Hydrometeorological Design Studies Center DOC/NOAA/National Weather Service 1325 East-West Highway Silver Spring, MD 20910 (301) 713-1669 Questions?: <u>HDSC.Questions@noaa.gov</u>

<u>Disclaimer</u>

## **APPENDIX B**

HYDROLOGY

# **ON-SITE HYDROLOGY**

#### **EXHIBIT 4.7-2**

#### 

**CALCULATION COVER SHEET** 

Description and Purpose:

The purpose of this calculation is to estimate the peak flows required for the offsite and onsite drainage channel design, and to calculate the runoff volume for the onsite drainage detention basin.

The Rational Method and inputs were calculated in an excel spreadsheet. This package contains the input calculations and reference material used to determine C values,  $K_b$  values and  $T_c$  values. The Rainfall data included in this package is provided in the Rainfall Data calculation package.

The Peak Flow printouts were generated from an excel spreadsheet located:

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel

Design\Hydrology\Calculations\Rational Method\ADOT-IDF-Cholla-Ash-Monofill\_2-9-09.xls

Design Basis/References/Assumptions

The drainage basins and flow paths that the rational method calculation are based on are located in the following CADD files:

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Hydrology\ Topo Base mcw working.dwg

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Hydrology\X-5548-SitePlan onsite mcw working.dwg

Figures are included which show the proposed development area, the offsite and onsite drainage basin delineations, and the longest flowpaths for each basin.

Remarks/Conclusions/Results: See attached printouts.

Calculation Approved by:

Project Manager/Date

Revision No.:

Description of Revision:

Approved by:

Project Manager/Date

#### URS

## RATIONAL METHOD CALCULATION CHOLLA ASH MONOFILL HYDROLOGY ANALYSIS CHOLLA GENERATING STATION ARIZONA PUBLIC SERVICE

#### **Problem Statement**

The object of this calculation is to calculate the peak flows required for the onsite and offsite drainage channel design of the proposed Cholla Ash Monofill, and to calculate the volume required for the detention basin for the onsite drainage.

The peak flows for the drainage basins were calculated using the procedure outlined in the Arizona Department of Transportation (ADOT) Highway Drainage Design Manual Hydrology.

#### **Required Deliverables**

- Times of Concentration and Peak flows for each drainage basin, both offsite pre-development (100-year, 24-hour storm event) and onsite post-development (25-year, 24-hour storm event).
- Volume of runoff for onsite post-development detention basin.

#### Data Available

- Rainfall Data provided in Rainfall Data Calculation package
- I-D-F Data and Curves provided in Rainfall Data Calculation package
- Drainage Area (Total pre-development drainage area is approximately 150 acres, total postdevelopment offsite drainage area is approximately 98 acres, see Fig 1)
- USDA NRCS web soil survey report for hydrologic soil group ratings by soil map unit to provide basis for C value.
- Tables from ADOT Highway Drainage Design Manual Hydrology providing C values and  $K_{\rm b}$  values for the calculation
- Contour Data provided by USGS (5-foot contours) and Arizona Public Service (2-foot contours)
- Proposed Ash Monofill contour data.

#### **Results**

The printouts of the offsite and onsite peak flows were generated from the following Excel spreadsheet are attached:

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Hydrology\Calculations\Rational Method\ADOT-IDF-Cholla-Ash-Monofill 2-9-09.xls

The total runoff volume for the onsite post-development drainage basins is 5.5 acre feet, including the proposed area of the detention basin itself.

#### **REFERENCES**

ADOT Highway Drainage Design Manual Hydrology. March 1993.

URS Corporation. Rainfall Data Calculation Package. Cholla Ash Monofill. 2009.

USDA NRCS. Web Soil Survey. Soil Properties and Qualities, Hydrologic Soil Group. Accessed February 4, 2009. <u>http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx</u>

# **WORKSHEETS**

#### Cholla Ash Monofill Cholla Generating Station Arizona Public Service

|    |          |      | Ariz          | ona Publi     | c Service     |          |      |      |
|----|----------|------|---------------|---------------|---------------|----------|------|------|
|    | A        | С    | D             | E             | F             | G        | Н    |      |
| 1  |          |      |               |               |               |          |      |      |
| 2  |          | ſ    |               |               | Rainfall      |          |      |      |
| 3  |          |      | Return Fi     | requency      | Depth         |          |      |      |
| 4  |          |      |               |               | (inches)      |          |      |      |
| 5  |          | ľ    | 2-year,       | 6-hour        | 0.96          |          |      |      |
| 6  |          | ľ    | 2-year, 2     |               | 1.25          |          |      |      |
| 7  |          | ľ    | 100-year      |               | 2.28          |          |      |      |
| 8  |          |      | 100-year      |               | 2.77          |          |      |      |
| 9  |          | L    |               |               |               |          |      |      |
| 10 |          | Shor | t-Duration Ra | infall Zone = | 6             |          |      |      |
| 11 |          |      |               |               |               |          |      |      |
| 12 |          | AD   | OT RAINFAL    | L INTENSIT    | Y-DURATION    | FREQUENC | Y    |      |
| 13 |          |      |               |               | I-D-F TABLE   |          |      |      |
| 14 |          |      |               |               |               |          |      |      |
| 15 |          |      | Rai           | nfall Intensi | ty (inches/ho | ur)      |      |      |
| 16 | Duration |      |               | Frequenc      | y (N-year)    |          |      |      |
| 17 |          | 2    | 5             | 10            | 25            | 50       | 100  | 500  |
| 18 | 5-min    | 2.87 | 3.97          | 4.72          | 5.75          | 6.55     | 7.34 | 9.17 |
| 19 | 10-min   | 2.21 | 3.09          | 3.67          | 4.48          | 5.11     | 5.73 | 7.17 |
| 20 | 15-min   | 1.78 | 2.52          | 3.01          | 3.69          | 4.22     | 4.74 | 5.95 |
| 21 | 30-min   | 1.13 | 1.63          | 1.95          | 2.40          | 2.75     | 3.10 | 3.89 |
| 22 | 1-hour   | 0.68 | 0.99          | 1.20          | 1.48          | 1.70     | 1.91 | 2.41 |
| 23 | 2-hour   | 0.39 | 0.55          | 0.65          | 0.80          | 0.91     | 1.02 | 1.28 |
| 24 | 3-hour   | 0.28 | 0.39          | 0.46          | 0.56          | 0.63     | 0.71 | 0.88 |
| 25 | 6-hour   | 0.16 | 0.21          | 0.25          | 0.30          | 0.34     | 0.38 | 0.47 |
| 26 | 12-hour  | 0.09 | 0.12          | 0.14          | 0.17          | 0.19     | 0.21 | 0.26 |
| 27 | 24-hour  | 0.05 | 0.07          | 0.08          | 0.09          | 0.10     | 0.12 | 0.14 |
| 28 |          |      |               |               |               |          |      |      |
| 29 |          | А    | DOT RAINFA    | LL DEPTH-     | DURATION-F    | REQUENCY |      |      |
| 30 |          |      | SIT           | E SPECIFIC    | D-D-F TABL    | Ξ        |      |      |
| 31 |          |      |               |               |               |          |      |      |
| 32 |          |      |               | Rainfall De   | pth (inches)  |          |      |      |
| 33 | Duration |      |               | Frequenc      | y (N-year)    |          |      |      |
| 34 |          | 2    | 5             | 10            | 25            | 50       | 100  | 500  |
| 35 | 5-min    | 0.24 | 0.33          | 0.39          | 0.48          | 0.55     | 0.61 | 0.76 |
| 36 | 10-min   | 0.37 | 0.51          | 0.61          | 0.75          | 0.85     | 0.96 | 1.20 |
| 37 | 15-min   | 0.44 | 0.63          | 0.75          | 0.92          | 1.05     | 1.18 | 1.49 |
| 38 | 30-min   | 0.57 | 0.81          | 0.98          | 1.20          | 1.38     | 1.55 | 1.95 |
| 39 | 1-hour   | 0.68 | 0.99          | 1.20          | 1.48          | 1.70     | 1.91 | 2.41 |
| 40 | 2-hour   | 0.78 | 1.09          | 1.30          | 1.59          | 1.81     | 2.04 | 2.55 |
| 41 | 3-hour   | 0.84 | 1.16          | 1.37          | 1.67          | 1.89     | 2.12 | 2.65 |
| 42 | 6-hour   | 0.96 | 1.28          | 1.50          | 1.81          | 2.04     | 2.28 | 2.83 |
| 43 | 12-hour  | 1.11 | 1.45          | 1.68          | 2.01          | 2.27     | 2.53 | 3.11 |
| 44 | 24-hour  | 1.25 | 1.61          | 1.86          | 2.22          | 2.50     | 2.77 | 3.40 |

#### Cholla Ash Monofill Cholla Generating Station Arizona Public Service

|    | Cholla Generating Station |              |               |            |              |           |               |            |  |  |  |
|----|---------------------------|--------------|---------------|------------|--------------|-----------|---------------|------------|--|--|--|
|    |                           | <b>,</b>     |               | zona Publi |              | <b>x</b>  |               |            |  |  |  |
|    | А                         | C            | D             | E          | F            | G         | Н             |            |  |  |  |
| 45 |                           |              |               |            |              |           |               |            |  |  |  |
| 46 | Procedure In              | termediate C | alculations:  |            |              |           |               |            |  |  |  |
| 47 |                           |              |               |            |              |           |               |            |  |  |  |
| 48 |                           |              | Rainfall Dept | h (inches) |              |           | Rainfall Dept | h (inches) |  |  |  |
|    | 2-year, 1-hour            |              | 0.68          |            | 2-year, 5-mi | n         | 0.24          |            |  |  |  |
|    | 2-year, 2-hour            |              | 0.78          |            | 2-year, 10-m | nin       | 0.37          |            |  |  |  |
|    | 2-year, 3-hour            |              | 0.84          |            | 2-year, 15-m | nin       | 0.44          |            |  |  |  |
|    | 2-year, 6-hour            |              | 0.96          |            | 2-year, 30-m | nin       | 0.57          |            |  |  |  |
|    | 2-year, 12-hoι            |              | 1.11          |            | 100-year, 5- | min       | 0.61          |            |  |  |  |
|    | 2-year, 24-hou            |              | 1.25          |            | 100-year, 10 | -min      | 0.96          |            |  |  |  |
|    | 100-year, 1-ho            |              | 1.91          |            | 100-year, 15 | i-min     | 1.18          |            |  |  |  |
|    | 100-year, 2-ho            |              | 2.04          |            | 100-year, 30 | -min      | 1.55          |            |  |  |  |
|    | 100-year, 3-ho            |              | 2.12          |            |              |           |               |            |  |  |  |
|    | 100-year, 6-hc            |              | 2.28          |            |              |           |               |            |  |  |  |
|    | 100-year, 12-h            |              | 2.53          |            |              |           |               |            |  |  |  |
|    | 100-year, 24-h            | our          | 2.77          |            |              |           |               |            |  |  |  |
| 61 |                           |              |               |            |              |           |               |            |  |  |  |
|    | Procedure Lo              | ok-up Tables | <u>s:</u>     |            |              |           |               |            |  |  |  |
| 63 |                           |              |               |            | 7            |           | 1             |            |  |  |  |
| 64 |                           | Duration     |               | Ratio      | _            | Frequency |               | ent Ratio  |  |  |  |
| 65 |                           | (Minutes)    | 6             | 8          | 4            | (N-yr)    | Х             | Y          |  |  |  |
| 66 |                           | 5            | 0.35          | 0.34       |              | 5         | 0.674         | 0.278      |  |  |  |
| 67 |                           | 10           | 0.54          | 0.51       |              | 10        | 0.496         | 0.449      |  |  |  |
| 68 |                           | 15           | 0.65          | 0.62       |              | 25        | 0.293         | 0.669      |  |  |  |
| 69 |                           | 30           | 0.83          | 0.82       |              | 50        | 0.146         | 0.835      |  |  |  |
| 70 |                           | 5            | 0.32          | 0.30       |              | 500       | -0.337        | 1.381      |  |  |  |
| 71 |                           | 10           | 0.50          | 0.46       |              |           |               |            |  |  |  |
| 72 |                           |              | 15 0.62 0.59  |            |              |           |               |            |  |  |  |
| 73 |                           | 30           | 0.81          | 0.80       |              |           |               |            |  |  |  |
| 74 |                           |              |               |            |              |           |               |            |  |  |  |

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Cholla Ash Monofill Cholla Generating Station Arizona Public Service IDF DATA FORMULAS

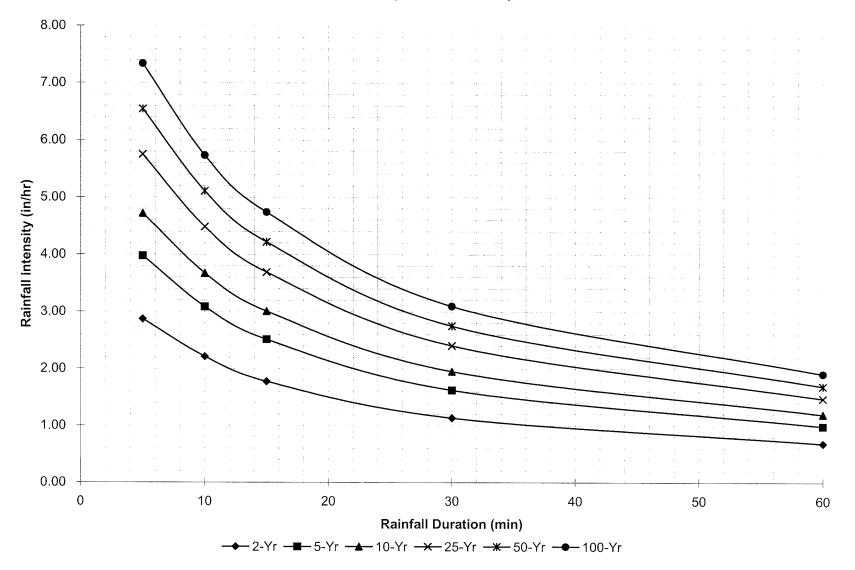
|  | A  | С                        | D  |  |  |  |
|--|--|--------------------------|--|--|--|--|
| 1  |  | <u>~</u>                 |  | É  | FF   | G  |
| 2<br>3<br>4<br>5<br>6<br>7<br>8<br>9<br>10<br>11<br>12<br>13         | ]  |                          |  |  |  | ······································   |
| 3  | 4  |                          | Return   | Frequency  | Rainfall   |  |
| 4  | ļ  |                          |  |  | Depth<br>(inches)  |  |
| 5  | ł  |                          | 2-yea  | r, 6-hour  | 0.96   |  |
| - <del>0</del> 7   | ł  |                          | 2-year   | r, 24-hour   | 1.25   |  |
| 8  | 1  |                          |  | ar, 6-hour   | 2:28   |  |
| 9  |  |                          | 100-yea  | ar, 24-hour  | 2.77   |  |
| 10   | i  |                          |  |  |  |  |
| 11   |  |                          |  | Short-Duration Rainfall Zone   | = <b>6</b>   |  |
| 12   |  |                          |  |  |  |  |
| 13   |  |                          |  |  |  |  |
| 14   |  |                          |  |  |  |  |
| 14<br>15<br>16<br>17<br>18<br>19                                     | _  |                          |  |  |  |  |
| 16   | Duration   |                          |  |  |  |  |
| 10   | 5-min  | 2                        | 5  | 10   | 25   | 50   |
| 19   | 10-min   | =C35/\$B18<br>≈C36/\$B19 |  | =E35/\$B18   | =F35/\$B18   | =G35/\$B18   |
| 20   | 15-min   | =C30/\$B19<br>=C37/\$B20 | =D36/\$B19   | =E36/\$B19   | =F36/\$B19   | =G36/SB19  |
| 20<br>21   | 30-min   | =C37/\$B20<br>=C38/\$B21 | =D37/\$B20   | =E37/\$B20   | =F37/\$B20   | ≈G37/\$B20   |
| 22   | 1-hour   | =C39/\$B22               | =D38/\$B21<br>=D39/\$B22   | =E38/\$B21   | =F38/\$B21   | ≈G38/\$B21   |
| 23   | 2-hour   | =C40/\$B23               | =D39/3622<br>=D40/\$B23  | =E39/\$B22   | =F39/\$B22   | =G39/SB22  |
| 23<br>24   | 3-hour   | =C41/SB24                | =D40/3823<br>=D41/\$B24  | =E40/\$B23   | =F40/\$B23   | =G40/\$B23   |
| 25   | 6-hour   | =C42/\$B25               | =D41/3624<br>=D42/\$B25  | =E41/\$B24   | =F41/\$B24   | =G41/\$B24   |
| 25<br>26   | 12-hour  | =C43/\$B26               | =D43/\$826   | =E42/\$B25   | =F42/\$B25   | =G42/\$B25   |
| 27   | 24-hour  | =C44/\$B27               | =D44/\$B27   | =E43/\$B26   | =F43/\$B26   | =G43/\$B26   |
| 28<br>29<br>30<br>31   |  |                          |  | =E44/\$B27   | =F44/\$B27   | =G44/\$B27   |
| 29   |  |                          |  |  |  |  |
| 30   |  |                          |  |  |  |  |
| 31   |  |                          |  |  |  |  |
| 32   |  |                          |  |  |  | •  |
| 32<br>33<br>34   | Duration   |                          |  |  |  |  |
| 34   |  | 2                        | 5  | 10   | 25   |  |
| 35   | 5-min  | ≈H48                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$H48)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$H52) | =(VLOOKUP(E\$34,\$G\$65:\$I\$69,2)*\$H48)+(VLOOKUP(E\$34,\$G\$65:\$I\$69,3)*\$H52) |  | 50   |
| 36   | <u>10-min</u>                                      | ≈H49                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$H49)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$H53) | =(VLOOKUP(E\$34,SG\$65:\$I\$69,2)*\$H49)+(VLOOKUP(E\$34,SG\$65:\$I\$69,3)*\$H53)   | =(VLOOKUP(F\$34,\$G\$65;\$I\$69,2)*\$H48)+(VLOOKUP(F\$34,\$G\$65;\$I\$69,3)*\$H52)   | =(VLOOKUP(G\$34,\$G\$65:\$I\$69,2)*\$H48)+(VLOOKUP(G\$34,\$G\$65:\$I\$69   |
| 37   | 15-min   | ≈H50                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$H50)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$H54) | =(VLOOKUP(E\$34,\$G\$65;\$I\$69,2)*\$H50)+(VLOOKUP(E\$34,\$G\$65;\$I\$69,3)*\$H54) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$H49)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$H53)<br>=(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$H50)+(VLOOKUP(F\$34,\$G\$66:\$I\$69,3)*\$H54) | =(VLOOKUP(G\$34,\$G\$65:\$I\$69,2)*\$H49)+(VLOOKUP(G\$34,\$G\$65:\$I\$69   |
| 38   | 30-min   | =H51                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$H55) | =(VLOOKUP(E\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(E\$34,\$G\$65:\$I\$69,3)*\$H55) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$H54)<br>=(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$H55) | =(VLOOKUP(G\$34,\$G\$65:\$I\$69,2)*\$H50)+(VLOOKUP(G\$34,\$G\$65:\$I\$66   |
| 39<br>40<br>41   | 1-hour   | =D48                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$D48)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$D54) | =(VLOOKUP(E\$34,\$G\$65;\$I\$69,2)*\$D48)+(VLOOKUP(E\$34,\$G\$65;\$I\$69,3)*\$D54) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D48)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D54)   | =(VLOOKUP(G\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(G\$34,\$G\$65:\$I\$69   |
| 40   | 2-hour   | =D49                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$D55) | =(VLOOKUP(E\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(E\$34,\$G\$65:\$I\$69,3)*\$D55) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D55)   | =(VLOOKUP(G\$34,\$G\$65;\$I\$69,2)*\$D48)+(VLOOKUP(G\$34,\$G\$65;\$I\$69   |
| 41   | 3-hour   | =D50                     | -(VEOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$D56)  | =(VLOOKUP(E\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(E\$34,\$G\$65;\$I\$69,3)*\$D56) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D50)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D56)   | =(VLOOKUP(G\$34,\$G\$65;\$I\$69,2)*\$D49)+(VLOOKUP(G\$34,\$G\$65;\$I\$69   |
|  | 6-hour<br>12-hour                                  | =D51                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$D51)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$D57) | =(VLOOKUP(E\$34,\$G\$65:\$I\$69,2)*\$D51)+(VLOOKUP(E\$34,\$G\$65:\$I\$69,3)*\$D57) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$D51)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D57)   | =(VLOOKUP(G\$34,\$G\$65;\$ \$69,2)*\$D50)+(VLOOKUP(G\$34,\$G\$65;\$ \$69   |
| 43<br>44   |  | =D52<br>=D53             | -(VEOOKUP(D\$34,3G\$65:\$I\$69,2) \$D52)+(VEOOKUP(D\$34,\$G\$65:\$I\$69,3) \$D58)  | =(VLOOKUP(E\$34,\$G\$65;\$I\$69,2)*\$D52)+(VLOOKUP(E\$34,\$G\$65;\$I\$69,3)*\$D58) | =(VLOOKUP(F\$34,\$G\$65:\$I\$69,2)*\$D52)+(VLOOKUP(F\$34,\$G\$65:\$I\$69,3)*\$D58)   | ={VLOOKUP{G\$34,\$G\$65;\$ \$69,2)*\$D51}+{VLOOKUP{G\$34,\$G\$65;\$ \$66<br>={VLOOKUP{G\$34,\$G\$65;\$ \$69,2}*\$D52}+{VLOOKUP{G\$34,\$G\$65;\$ \$66 |
| 45   | 24-1100I   | =053                     | =(VLOOKUP(D\$34,\$G\$65:\$I\$69,2)*\$D53)+(VLOOKUP(D\$34,\$G\$65:\$I\$69,3)*\$D59) |  |  | =(VLOOKUP(G\$34,\$G\$65:\$I\$69,2)*\$D53)+(VLOOKUP(G\$34,\$G\$65:\$I\$69   |
|  | Procedure Inter                                    | mediate Calc             | ulatione:  |  |  | -(*EOOROF(G\$34,5G\$05:51509,2) 3D33)+(*EOOROF(G\$34,5G\$05:51565  |
| 47   | toogaal a meet                                     | mediate date             |  |  |  |  |
|  | -year, 1-hour                                      |                          | =-0.011+(0.942"(\$F\$5^2)/\$F\$6)  |  |  |  |
|  | -year, 2-hour                                      |                          | =0.341*(\$F\$5)+0.659*(\$D\$48)  |  | 2-year, 5-min  |  |
| 50 2   | -year, 3-hour                                      |                          | =0.569*(\$F\$5)+0.431*(\$D\$48)  |  | 2-year, 10-min   |  |
| 51 2   | -year, 6-hour                                      |                          | =F5  |  | 2-year, 15-min   |  |
| 52 2   | -year, 12-hour                                     |                          | =0.5*(\$F\$5)+0.5*(\$F\$6)   |  | 2-year, 30-min   |  |
| 53.2   | -year, 24-hour                                     |                          | ≈F6  |  | 100-year, 5-min  |  |
| 54 1   | 00-year, 1-hour                                    |                          | =0.494+(0.755*(\$F\$7^2)/\$F\$8)   |  | 100-year, 10-min   |  |
| 55 1   | 00-year, 2-houi                                    |                          | =0.341*(\$F\$7)+0.659*(\$D\$54)  |  | 100-year, 15-min   |  |
| 56 1   | 00-year, 2-hou<br>00-year, 3-hou<br>00-year, 6-hou |                          | =0.569*(\$F\$7)+0.431*(\$D\$54)  |  | 100-year, 30-min   |  |
| 57 1   | 00-year, 6-houi                                    |                          | =F7  |  |  |  |
| 58 1   | 00-year, 12-hoi                                    |                          | =0.5*(\$F\$7)+0.5*(\$F\$8)   |  |  |  |
|  | 00-year, 24-hoi                                    |                          | =F8  |  |  |  |
| 60   |  |                          |  |  | ·  |  |
| 62 P   | rocedure Look-                                     | up Lables:               |  |  |  |  |
| 62<br>63<br>64<br>65<br>66<br>67<br>68<br>69<br>70<br>71<br>72<br>73 | г  | Duration                 |  |  |  |  |
| 64   |  | (Minutes)                | Zone F   | Ratio  | ז  | Frequency  |
| 65   | -  |                          | 0.35   | 3  |  | (N-уг)   |
| 66   |  | 1                        |  | ).34   |  | 5  |
| 67   |  |                          |  | 0.51   |  | 10   |
| 68   |  |                          |  | 0.62   |  | 25   |
| 69   | 15   |                          |  | 9.82<br>9.3  |  | 50   |
| 70   | 1  |                          |  | J.3<br>J.46  |  | 500  |
| 71   |  | 1                        |  | .59  |  |  |
| 72   | 3  |                          | °  | .8   |  |  |
| 73   |  |                          |  |  |  |  |
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|   |   |  |
|   | 400   | 500  |
|   | 100   | 500  |
|   | =H35/\$B18<br>=H36/\$B19  | =135/\$B18   |
|   | =H37/\$B20  | =I36/\$B19<br>=I37/\$B20   |
|   | =H38/\$B21  | =138/\$B21   |
|   | =H39/\$B22  | =139/\$822   |
|   | =H40/\$B23  | =140/\$823   |
|   | =H41/\$B24  | =l41/\$B24   |
|   | =H42/\$B25  | =142/\$825   |
|   | =H43/\$B26  | =143/\$B26   |
| -   | =H44/\$B27  | =I44/\$B27   |
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|   |   | that when a second s  |
|   | 100   | 500  |
| \$I\$69,3)*\$H52)   | =H52  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H48)+(VLOOKUP(I\$34,\$G\$65:\$I\$69,3)*\$H52)   |
| \$I\$69,3)*\$H53)   | =H53  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H49)+(VLOOKUP(I\$34,\$G\$65:\$I\$69,3)*\$H52)   |
|   |   | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H50)+(VLOOKUP(I\$34,\$G\$65:\$I\$69,3)*\$H54)   |
| \$I\$69,3)*\$H54)   | =H54  |  |
|   | =H55  |  |
| \$I\$69,3)*\$H55)<br>\$I\$69,3)*\$D54)  |   | <pre>(VLOOKUP(IS34,SS655(SS69,2)*IS1)+(VLOOKUP(IS34,SG565(SI569,3)*SI55)<br/>=(VLOOKUP(IS34,SS65(SS69,2)*IS1)+(VLOOKUP(IS34,SG565(SI569,3)*SI55)<br/>=(VLOOKUP(IS34,SG565(SI569,2)*SD44)+(VLOOKUP(IS34,SG565(SI569,3)*SD54)</pre>  |
| \$I\$69,3)*\$H55)<br>\$I\$69,3)*\$D54)<br>\$I\$69,3)*\$D55)   | =H55<br>≈D54<br>≂D55  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$G\$65:\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$D48)+(VLOOKUP(I\$34,\$G\$65:\$I\$69,3)*\$D54)<br>=(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65:\$I\$69,3)*\$D55)   |
| \$ \$69,3)*\$H55)<br>\$ \$69,3)*\$D54)<br>\$ \$69,3)*\$D55)<br>\$ \$69,3)*\$D56)  | =H55<br>=D54<br>=D55<br>=D56  | =(VLOOKUP(I\$34,SG\$65:SI\$69,2)*SH51)+(VLOOKUP(I\$34,SG\$65:SI\$69,3)*SH55)<br>=(VLOOKUP(I\$34,SG\$65:SI\$69,2)*SD48)+(VLOOKUP(I\$34,SG\$65:SI\$69,3)*SD54)<br>=(VLOOKUP(I\$34,SG\$65:SI\$69,2)*SD49)+(VLOOKUP(I\$34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(I\$34,SG\$65:SI\$69,2)*SD50)+(VLOOKUP(I\$34,SG\$65:SI\$69,3)*SD56)   |
| \$1\$69,3)*\$H54)<br>\$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D57)                         | =H55<br>≈D54<br>≈D55<br>≈D56<br>=D57  | =(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$C\$65:\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$C\$65:\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$C\$65:\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$C\$65:\$I\$59,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D51)+(VLOOKUP(I\$34,\$C\$65:\$I\$59,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D51)+(VLOOKUP(I\$34,\$C\$65:\$I\$59,3)*\$D56)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D52)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)  | =H55<br>≈D54<br>≈D55<br>≈D56<br>=D57  | =(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$C\$65:\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$C\$65:\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$C\$65:\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$C\$65:\$I\$59,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D51)+(VLOOKUP(I\$34,\$C\$65:\$I\$59,3)*\$D56)<br>=(VLOOKUP(I\$34,\$C\$65:\$I\$69,2)*\$D51)+(VLOOKUP(I\$34,\$C\$65:\$I\$59,3)*\$D56)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D52)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D52)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59  | =(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$H51)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$H55)<br>=(VLOOKUP(I\$34,\$G\$65:\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D49)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D56)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D50)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)<br>=(VLOOKUP(I\$34,\$G\$65;\$I\$69,2)*\$D52)+(VLOOKUP(I\$34,\$G\$65;\$I\$69,3)*\$D57)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=JF(\$F\$10=6,f   | =(VLOOKUP(IS34,SGS65:SIS69,2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD48)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD49)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[  | =(VLOOKUP(IS34,SG\$65:SI569,2)*SH51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD48)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD58)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD58)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>D65*SD\$48,E65*SD\$48)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[   | =(VLOOKUP(IS34,SG\$65:SIS69_2)*SH51)+(VLOOKUP(IS34,SG\$65:SIS69.3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD48)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD49)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD50)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD51)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>D65*SD\$48,E65*SD\$48)<br>D66*SD\$48,E66*SD\$48)<br>D67*SD\$48,E66*SD\$48)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[  | =(VLOOKUP(IS34,SGS65:SIS69,2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD49)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD59)<br>DS5*SD548,E65*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD544)<br>D66*SD54,E66*SD544)<br>D66*SD54,E66*SD545)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[   | =(VLOOKUP(IS34,SGS65:SIS69_2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD48)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD49)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD59)<br>D65*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD544)<br>D70*SD554,E70*SD554)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[  | =(VLOOKUP(IS34,SGS65:SIS69_2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69.3)*SH55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD48)+(VLOOKUP(IS34,SGS65:SIS69.3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD49)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD59)<br>=(SS552)S48,E65*SD548)<br>D65*SD548,E66*SD548)<br>D66*SD548,E66*SD544)<br>D68*SD548,E66*SD544)<br>D70*SD54,E71*SD554)  |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[  | =(VLOOKUP(IS34,SGS65:SIS69,2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD48)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD49)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD59)<br>D65*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)<br>D66*SD548,E66*SD548)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[  | =(VLOOKUP(IS34,SGS65:SIS69_2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69.3)*SH55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD48)+(VLOOKUP(IS34,SGS65:SIS69.3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD49)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD59)<br>=(SS552)S48,E65*SD548)<br>D65*SD548,E66*SD548)<br>D66*SD548,E66*SD544)<br>D68*SD548,E66*SD544)<br>D70*SD54,E71*SD554)  |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[  | =(VLOOKUP(IS34,SGS65:SIS69,2)*SH51)+(VLOOKUP(IS34,SGS65:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD48)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD50)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD52)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SGS65:SIS69,2)*SD53)+(VLOOKUP(IS34,SGS65:SIS69,3)*SD59)<br>=(SS52)S48,E65*SD548)<br>D65*SD548,E66*SD548)<br>D66*SD548,E66*SD544)<br>D68*SD548,E66*SD544)<br>D70*SD54,E71*SD554)   |
| \$1\$69,3)*\$H55)<br>\$1\$69,3)*\$D54)<br>\$1\$69,3)*\$D55)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D56)<br>\$1\$69,3)*\$D57)<br>\$1\$69,3)*\$D58)                         | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,1<br>=IF(\$F\$10=6,1<br>=IF(\$F\$10=6,1<br>=IF(\$F\$10=6,0<br>=IF(\$F\$10=6,0<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)   | =(VLOOKUP(IS34,SG565:SIS69,2)*SH51)+(VLOOKUP(IS34,SG565:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD48)+(VLOOKUP(IS34,SG565:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD50)+(VLOOKUP(IS34,SG565:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD50)+(VLOOKUP(IS34,SG565:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD50)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG55;SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)+(VLOOKUP(IS34,SG565;SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)+(VLOOKUP(IS34,SG565;SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD54)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD54)   |
| \$1569.3) *5H55<br>\$1569.3) *5D54<br>\$1569.3] *5D55<br>\$1569.3] *5D56<br>\$1569.3] *5D56<br>\$1569.3] *5D57<br>\$1569.3] *5D59<br>\$1569.3] *5D59                    | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=F(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C   | =(VLOOKUP(IS34,SG565:SIS69,2)*SH51)+(VLOOKUP(IS34,SG565:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD48)+(VLOOKUP(IS34,SG565:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD50)+(VLOOKUP(IS34,SG565:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD50)+(VLOOKUP(IS34,SG565:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD52)+(VLOOKUP(IS34,SG565:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD52)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG565:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55)<br>=(SG550S48,E67*SD548)<br>=(SG550S48,E67*SD544)<br>=(SG550S48,E67*SD554)<br>=(SG565,SIS64,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG565,SIS64,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554)<br>=(SG550S48,E77*SD554   |
| SIS69,3)*SH55)<br>SIS69,3)*SD54<br>SIS69,3)*SD56<br>SIS69,3)*SD56<br>SIS69,3)*SD57)<br>SIS69,3)*SD59<br>SIS69,3)*SD59<br>SIS69,3)*SD59<br>SIS69,3)*SD59                 | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)=IF(  | =(VLOOKUP(IS34,SG\$65:SIS69,2)*SH51)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD48)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD50)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD50)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>D65*SD\$48,E65*SD\$48)<br>D65*SD\$48,E66*SD\$48)<br>D66*SD\$48,E66*SD\$48)<br>D66*SD\$48,E66*SD\$48)<br>D66*SD\$54,E70*SD\$54)<br>D70*SD\$54,E70*SD\$54)<br>D72*SD\$54,E72*SD\$54)<br>D72*SD\$54,E72*SD\$54)   |
| \$1569,3)*5H55j<br>\$1659,3)*5D55j<br>\$1569,3)*5D55j<br>\$1569,3)*5D56j<br>\$1569,3]*5D57j<br>\$1569,3]*5D57j<br>\$1569,3]*5D59j<br>\$1569,3]*5D59j<br>\$1569,3]*5D59j | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,1<br>=IF(\$F\$10=6,1<br>=IF(\$F\$10=6,1<br>=IF(\$F\$10=6,0<br>=IF(\$F\$10=6,0<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)<br>=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=IF(\$F\$10=6,0)=  | =(VLOOKUP(IS34,SG56:SIS69,2)*SH51)+(VLOOKUP(IS34,SG56:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD48)+(VLOOKUP(IS34,SG56:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD49)+(VLOOKUP(IS34,SG56:SIS69,3)*SD55)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD50)+(VLOOKUP(IS34,SG56:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD51)+(VLOOKUP(IS34,SG56:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG565:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56)<br>)50*SD548,E66*SD548)<br>)50*SD548,E66*SD548)<br>)50*SD548,E66*SD544)<br>)50*SD548,E70*SD554)<br>)70*SD554,E70*SD554)<br>)70*SD554,E70*SD554)<br>)72*SD554,E72*SD554)<br>)72*SD554,E72*SD554)  |
| SIS69.3) 'SH55)<br>SIS69.3) 'SD54)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD57)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)                    | =H55<br>=D54<br>=D55<br>=D56<br>=D57<br>=D58<br>=D59<br>=F(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)=IF(\$F\$10=6,C)<br>=IF(\$F\$10=6,C)=IF(\$F\$10=6,C)=IF(\$F\$10=6, | =(VLOOKUP(IS34,SG56:SIS69,2)*SH51)+(VLOOKUP(IS34,SG55:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD48)+(VLOOKUP(IS34,SG55:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD50)+(VLOOKUP(IS34,SG56:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD50)+(VLOOKUP(IS34,SG56:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD52)+(VLOOKUP(IS34,SG56:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD52)+(VLOOKUP(IS34,SG56:SIS69,3)*SD58)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG56:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55;SIS69,2)*SD53)+(VLOOKUP(IS34,SG56:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55;SIS69,2)*SD53)+(VLOOKUP(IS34,SG56;SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG55;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG55;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG55;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG5;SIS69,2)*SD53)<br>=(VLOOKUP(IS34,S   |
| SIS69.3) 'SH55)<br>SIS69.3) 'SD54)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD57)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)                    | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[]F   | =(VLOOKUP(IS34,SG\$65:SIS69,2)*SH51)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD48)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD50)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD50)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD52)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SIS69,3)*SD59)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG\$55:SIS69,2)*SD53)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD54)<br>=(VLOOKUP(IS34,SG\$55;SD            |
| SIS69.3) 'SH55)<br>SIS69.3) 'SD54)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD57)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)                    | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[]F   | =(VLOOKUP(IS34,SG\$65:SI569,2)*SH51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD43)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI\$69,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,SG\$65:SI\$69,2)*SD54)<br>=(VLOOKUP(IS34,S |
| SIS69.3) 'SH55)<br>SIS69.3) 'SD54)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD57)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)                    | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[]F   | =(VLOOKUP(IS34,SG\$65:SI569,2)*SH51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD43)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34                             |
| SIS69.3) 'SH55)<br>SIS69.3) 'SD54)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD57)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)                    | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[]F   | =(VLOOKUP(IS34,SG\$65:SI569,2)*SH51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD43)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34                             |
| SIS69.3) 'SH55)<br>SIS69.3) 'SD54)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD56)<br>SIS69.3) 'SD57)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)<br>SIS69.3) 'SD59)                    | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[]F   | =(VLOOKUP(IS34,SG\$65:SI569,2)*SH51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD43)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34                             |
| SI\$69.3)*SH55j<br>SI\$69.3)*SD53<br>SI\$69.3)*SD56j<br>SI\$69.3)*SD56j<br>SI\$69.3)*SD58j<br>SI\$69.3)*SD58j<br>SI\$69.3)*SD59j<br>SI\$69.3)*SD59j<br>                 | =H55<br>=D54<br>=D55<br>=D55<br>=D57<br>=D58<br>=D59<br>=D59<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>=IF(\$F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[<br>]F\$10=6,[]F   | =(VLOOKUP(IS34,SG\$65:SI569,2)*SH51)+(VLOOKUP(IS34,SG\$65:SI569,3)*SH55)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD43)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD56)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD50)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD57)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD52)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$66:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)+(VLOOKUP(IS34,SG\$65:SI569,3)*SD59)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$65:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34,SG\$69:SI569,2)*SD53)<br>=(VLOOKUP(IS34                             |

2/10/2009

## Cholla Ash Monofill Cholla Generating Station Arizona Public Service

Site Specific IDF Graph



P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Hydrology\Calculations\Rational Method\ADOT-IDF-Cholla-Ash-Monofill\_2-9-09 2/10/2009 8:29 AM

| Project Name:  | Cholla Power Pla  |  |                                   | Date:<br>Computed By:   | 02/06/09<br>MCW  |
|--|---|--|-----------------------------------|---|--|
| Subject:<br>Location:  | 25-Year Peak Dis<br>Joseph City, AZ   | charge Onsite  |                                   | Checked By:   |  |
| 25-yr, 24<br>25-yr,<br>Length of I   | - On-site Basin 4<br>hr Precipitation =<br>10 min Intensity =<br>Hydrologic Zone =<br>ongest Flowpath =<br>Upper Elevation=<br>Lower Elevation=<br>Longest Flowpath =<br>Kb = | 2.22 in<br>4.48 in/hr<br>6<br>819 feet<br>0.16 miles<br>5230.00 feet<br>5086.00 feet<br>928.58 ft/mi<br>0.08 | Q=CIA<br>Des                      | C <sub>D</sub> =<br>I=<br>Area =<br>Total Area =<br>sign Peak Flow =                                  | 0.60<br>4.48 in/hr<br>8.89 acres<br>8.89 acres<br>23.9 cfs |
| Construction of the Constr | -0.31 <b>-</b> 0.38<br>Calculated<br>r) Tc (min)<br>4.5<br>4.9<br>5.3<br>6.2  | OK*  | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentra<br>length of longest<br>watershed resista<br>slope of longest<br>average rainfall i | flowpath (miles)<br>ance coefficient<br>flowpath           |

| Project Name:<br>Subject:<br>Location: | Cholla Power Pla<br>25-Year Peak Dis<br>Joseph City, AZ  |   |                                   | Date:<br>Computed By:<br>Checked By:   | 02/06/09<br>MCW                 |
|--|--|---|-----------------------------------|--|---------------------------------|
| 25-yr, 2<br>25-yr<br>Length of         | I - On-site Basin 5<br>4-hr Precipitation =<br>, 10 min Intensity =<br>Hydrologic Zone =<br>Longest Flowpath =<br>Upper Elevation=<br>Lower Elevation=<br>Longest Flowpath =<br>Kb = | 2.22 in<br>4.48 in/hr<br>6<br>629 feet<br>0.12 miles<br>5230.00 feet<br>5103.00 feet<br>1065.40 ft/mi<br>0.08 | Q=CIA<br>De                       | Area = 13.72   | acres<br>acres                  |
|  | Calculated<br>nr) Tc (min)<br>5 3.8<br>8 4.1<br>9 4.5<br>0 5.2   |   | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentration (<br>length of longest flowpa<br>watershed resistance of<br>slope of longest flowpa<br>average rainfall intensit | ath (miles)<br>oefficient<br>th |

| Project Name:   | Cholla Power P   |                              |                             | Date:   | 02/06/09<br>MCW                 |
|---|--|------------------------------|-----------------------------|---|---------------------------------|
| Subject:<br>Location:   | 25-Year Peak Discharge Onsite<br>Joseph City, AZ                   |                              | Computed By:<br>Checked By: |   |                                 |
| Ash Fill Channe   | el - On-site Basin 6   |                              | Q=CIA                       |   | 1                               |
| 25-vr. 2  | 24-hr Precipitation =  | 2.22 in                      |                             | C <sub>D</sub> = 0.60   |                                 |
| •   | r, 10 min Intensity =  | 4.48 in/hr                   |                             |   |                                 |
|   | Hydrologic Zone =  | 6                            |                             |   | in/hr<br>acres                  |
| Length of   | f Longest Flowpath =   | 835 feet<br>0.16 miles       |                             | Total Area = 19.87  | acres                           |
|   | Upper Elevation=<br>Lower Elevation=                               | 5230.00 feet<br>5077.00 feet | Des                         | sign Peak Flow = 53.5   | cfs                             |
| Slope o   | f Longest Flowpath =<br>Kb =                                       | 967.47 ft/mi<br>0.08         |                             |   |                                 |
| 0.50 0.52   | S <sup>-0.31</sup> I <sup>-0.38</sup>                              |                              |                             |   |                                 |
| Tc=11.4L <sup>0.50</sup> K <sub>b</sub> <sup>0.52</sup>                   |  |                              |                             |   |                                 |
|   |  |                              | Tc =                        | time of concentration (h  |                                 |
| T <b>c=11.4L<sup>000</sup>K</b> b <sup>002</sup><br>Trials                |  |                              | L =                         | length of longest flowpa  | ath (miles)                     |
| Trials  | Calculated   |                              | L =<br>Kb =                 | length of longest flowpa<br>watershed resistance c                            | ath (miles)<br>oefficient       |
| Trials<br>Tc (min) l(in/  | Calculated<br>hr)Tc (min)  |                              | L =                         | length of longest flowpa  | ath (miles)<br>oefficient<br>th |
| Trials<br>Tc (min) I(in/<br>5 5.7   | Calculated<br>hr) Tc (min)<br>75 4.5                               | OK*                          | L =<br>Kb =<br>S =          | length of longest flowpa<br>watershed resistance c<br>slope of longest flowpa | ath (miles)<br>oefficient<br>th |
| Trials<br>Tc (min) l(in/  | Calculated<br>hr) Tc (min)<br>75 4.5<br>18 4.9                     | OK*                          | L =<br>Kb =<br>S =          | length of longest flowpa<br>watershed resistance c<br>slope of longest flowpa | ath (miles)<br>oefficient<br>th |
| Trials<br>Tc (min) I(in/<br>5 5.7<br>10 4.4<br>15 3.6<br>30 2,4           | Calculated<br>hr) Tc (min)<br>75 4.5<br>18 4.9<br>59 5.3<br>10 6.2 | OK*                          | L =<br>Kb =<br>S =          | length of longest flowpa<br>watershed resistance c<br>slope of longest flowpa | ath (miles)<br>oefficient<br>th |
| Trials<br>Tc (min) I(in/<br>5 5.7<br>10 4.4<br>15 3.6                     | Calculated<br>hr) Tc (min)<br>75 4.5<br>18 4.9<br>59 5.3<br>10 6.2 | OK*                          | L =<br>Kb =<br>S =          | length of longest flowpa<br>watershed resistance c<br>slope of longest flowpa | ath (miles)<br>oefficient<br>th |
| Trials<br>Tc (min) l(in/<br>5 5.7<br>10 4.4<br>15 3.6<br>30 2.4<br>60 1.4 | Calculated<br>hr) Tc (min)<br>75 4.5<br>18 4.9<br>59 5.3<br>10 6.2 |                              | L =<br>Kb =<br>S =          | length of longest flowpa<br>watershed resistance c<br>slope of longest flowpa | ath (miles)<br>oefficient<br>th |

| Project Name:                              | Cholla Power Pla  | nt- Ash Fill  |                                   | Date:  | 02/06/09   |
|--|---|---|-----------------------------------|--|--|
| Subject:<br>Location:                      | 25-Year Peak Dis<br>Joseph City, AZ   | charge Onsite   |                                   | Computed By:<br>Checked By:  | MCW  |
| 25-yr, 2<br>25-y<br>Length o               | el - On-site Basin 7<br>24-hr Precipitation =<br>r, 10 min Intensity =<br>Hydrologic Zone =<br>f Longest Flowpath =<br>Lower Elevation=<br>f Longest Flowpath =<br>Kb = | 2.22 in<br>4.48 in/hr<br>6<br>475 feet<br>0.09 miles<br>5227.00 feet<br>5115.00 feet<br>1246.02 ft/mi<br>0.08 | Q=CIA<br>Des                      | C <sub>D</sub> =<br> =<br>Area =<br>Total Area =   | 0.60<br>4.48 in/hr<br>4.67 acres<br>4.67 acres<br>12.6 cfs |
| 10 4.<br>15 3.0<br>30 2.<br>60 1.<br>Denot | 2 <b>S<sup>-0.31</sup>I<sup>-0.38</sup></b><br>Calculated<br>/hr) Tc (min)<br>75 3.1<br>48 3.4<br>39 3.7  | OK*   | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentr<br>length of longes<br>watershed resist<br>slope of longest<br>average rainfall | t flowpath (miles)<br>tance coefficient<br>flowpath        |

# **REFERENCES**

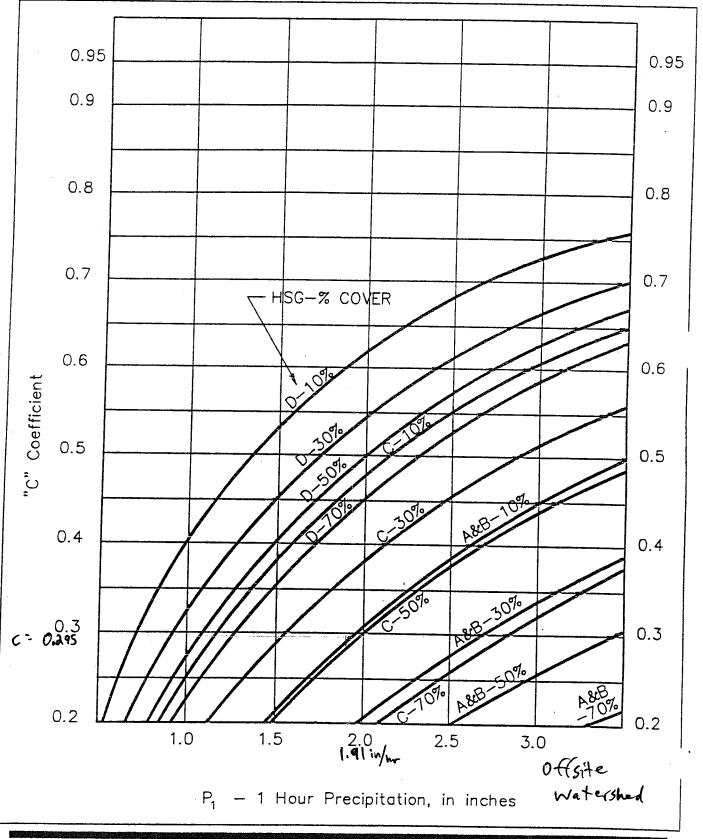
# **TABLE 2-1** RESISTANCE COEFFICIENT (K<sub>b</sub>) FOR USE WITH THE RATIONAL METHOD $T_c$ EQUATION

|  |                                | κ <sub>b</sub>           |      |
|--|--------------------------------|--------------------------|------|
| Description of Landform  | Defined<br>Drainage<br>Network | Overland Flow<br>Only    |      |
| Mountain, with forest and dense ground<br>cover<br>(overland slopes - 50% or greater)  | 0.15                           | 0.30                     |      |
| Mountain, with rough rock and boulder cover (overland slopes - 50% or greater)   | 0.12                           | 0.25                     |      |
| Foothills<br>(overland slopes - 10% to 50%)  | 0.10                           | 0.20                     |      |
| Alluvial fans, Pediments and Rangeland (overland slopes - 10% or less)   | 0.05                           | 0.10 €                   | - Kb |
| Irrigated Pasture <sup>a</sup>   |                                | 0.20                     |      |
| Tilled Agricultural Fields <sup>a</sup>  |                                | 0.08                     |      |
| URBAN<br>Residential, L is less than 1,000 ft <sup>b</sup><br>Residential, L is greater than 1,000 ft <sup>b</sup><br>Grass; parks, cemeteries, etc. <sup>a</sup><br>Bare ground; playgrounds, etc. <sup>a</sup><br>Paved; parking lots, etc. <sup>a</sup> | 0.04<br>0.025<br><br>          | <br>0.20<br>0.08<br>0.02 |      |

Notes:

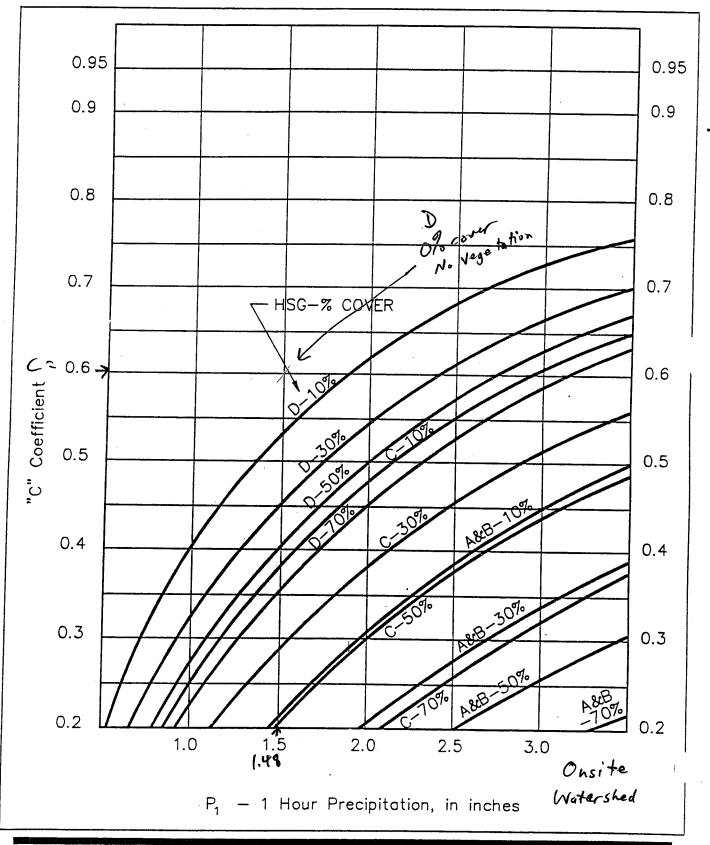
a - No defined drainage network.
b - L is length in the T<sub>c</sub> equation. Streets serve as drainagae network.

#### FIGURE 2-5 RATIONAL "C" COEFFICIENT UPLAND RANGELAND (GRASS & BRUSH)



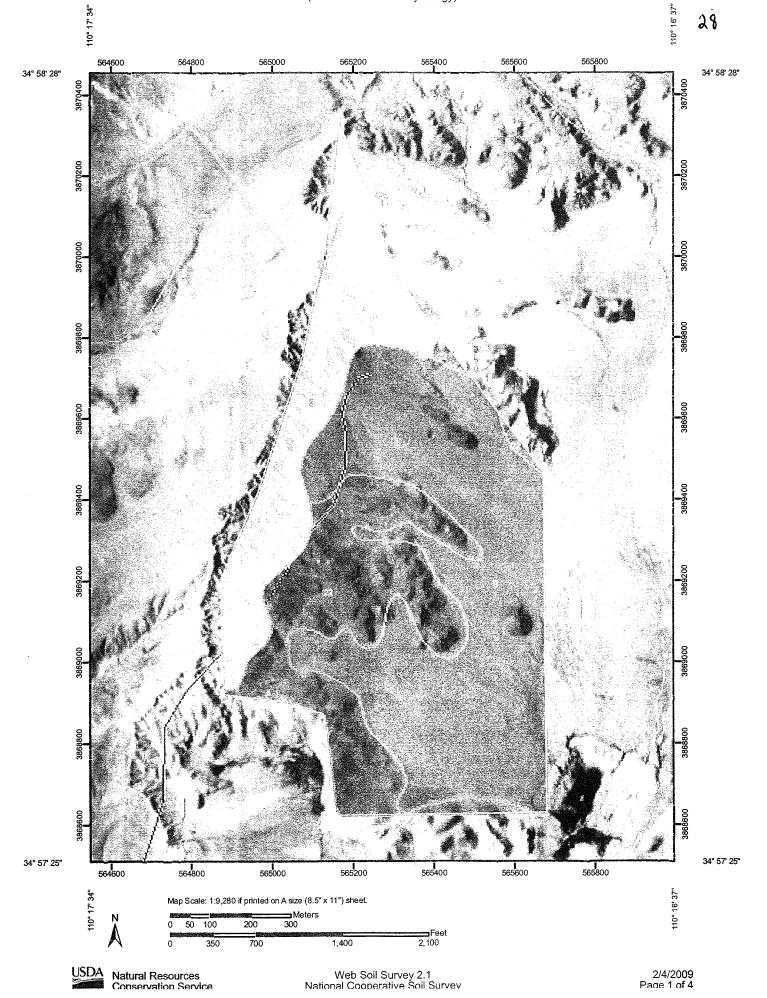
AS A FUNCTION OF RAINFALL DEPTH, HYDROLOGIC SOIL GROUP (HSG), AND % OF VEGETATION COVER

#### FIGURE 2-5 RATIONAL "C" COEFFICIENT UPLAND RANGELAND (GRASS & BRUSH)



AS A FUNCTION OF RAINFALL DEPTH, HYDROLOGIC SOIL GROUP (HSG), AND % OF VEGETATION COVER

**MARCH 1993** 



| OI)<br>f Interest (AOI) | Map Scale: 1:9,280 if printed on A size (8.5" × 11") sheet.<br>The soil surveys that comprise your AOI were mapped at 1:24,000                            |
|-------------------------|---|
| f Interest (AOI)        | The soil surveys that comprise your $\Delta\Omega$ were mapped at 1:24 $\Omega\Omega$   |
|                         | The soll surveys that complise your Act were mapped at 1.24,000   |
| ap Units                | Please rely on the bar scale on each map sheet for accurate map measurements.   |
|                         | Source of Map: Natural Resources Conservation Service<br>Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov<br>Coordinate System: UTM Zone 12N NAD83 |
|                         | This product is generated from the USDA-NRCS certified data as on the version date(s) listed below.   |
|                         | Soil Survey Area: Navajo County Area, Arizona, Central Part<br>Survey Area Data: Version 10, Sep 11, 2008   |
|                         | Date(s) aerial images were photographed: 6/21/1997  |
|                         | The orthophoto or other base map on which the soil lines were   |
| ed or not available     | compiled and digitized probably differs from the background<br>imagery displayed on these maps. As a result, some minor shiftin                           |
|                         | of map unit boundaries may be evident.  |
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# **Soil Properties and Qualities**

| Map unit symbol      | Map unit name  | Rating | Acres in AOI | Percent of AOI |
|----------------------|--|--------|--------------|----------------|
| 3                    | Badland-Torriorthents association, 1 to 30 percent slopes      |        | 43.8         | 21.4%          |
| 9                    | Burnswick sandy clay loam, 1 to 5 percent slopes               | В      | 106.0        | 51.7%          |
| 21                   | Grieta sandy loam, 3 to 10 percent slopes                      | В      | 0.2          | 0.1%           |
| 22                   | Gypsiorthids-Torriorthents association, 5 to 60 percent slopes | В      | 55.0         | 26.8%          |
| Totals for Area of I | nterest  | 205.0  | 100.0%       |                |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Pre-Development

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Assumed Post-Jevelopment

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## **Rating Options**

Aggregation Method: Dominant Condition Component Percent Cutoff: None Specified Tie-break Rule: Lower

# **OFF-SITE HYDROLOGY**

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Report\Draft Drainage Report.doc

| Project Name:  | Cholla Power Pla   | nt- Ash Fill  |                                   | Date:  | 02/03/09  |
|--|--|---|-----------------------------------|--|---|
| Subject:   | 100-Year Peak Di   | scharge   |                                   | Computed By:   | MCW   |
| Location:  | Joseph City, AZ  |   |                                   | Checked By:  |   |
| 100-yr, 2<br>100-yr<br>Length of   | I - Pre-development Ba<br>4-hr Precipitation =<br>, 10 min Intensity =<br>Hydrologic Zone =<br>Longest Flowpath =<br>Lopper Elevation=<br>Lower Elevation=<br>Kb = | sin Off-1<br>2.77 in<br>5.73 in/hr<br>6<br>2,963 feet<br>0.56 miles<br>5197.00 feet<br>5068.00 feet<br>229.85 ft/mi<br>0.10 | Q=CIA<br>Des                      | = 4.<br>Area = 39.<br>Total Area = 39.   | 30<br>60 in/hr<br>63 acres<br>63 acres<br>3.8 cfs |
| Tc=11.4L <sup>0.50</sup> K <sub>b</sub> <sup>0.52</sup> S<br>Trials<br>Tc (min) I(in/h<br>5 7.3-<br>15 4.7-<br>16 4.6(<br>30 3.1(<br>60 1.9) | Calculated<br>ar) Tc (min)<br>4 13.4<br>4 15.9<br>0 16.1<br>0 18.7   | OK  | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentratior<br>length of longest flov<br>watershed resistance<br>slope of longest flow<br>average rainfall inter | vpath (miles)<br>e coefficient<br>path            |

| Project Name:  | Cholla Power Pl  | ant- Ash Fill              |                                   | Date:  | 02/03/09                        |
|--|--|----------------------------|-----------------------------------|--|---------------------------------|
| Subject:<br>Location:  | 100-Year Peak D<br>Joseph City, AZ   | -                          |                                   | Computed By:<br>Checked By:  | MCW                             |
| 100-yr, 24<br>100-yr,<br>H<br>Length of L  | Pre-development Bather<br>-hr Precipitation =<br>10 min Intensity =<br>Hydrologic Zone =<br>ongest Flowpath =<br>Lower Elevation=<br>ongest Flowpath =<br>Kb = | 2.77 in<br>5.73 in/hr<br>6 | Q=CIA<br>Desi                     | Area = 49.27<br>Total Area = 49.27   | in/hr<br>acres<br>acres         |
| Tc=11.4L <sup>0.50</sup> K <sub>b</sub> <sup>0.52</sup> S <sup>-0</sup><br>Trials<br>Tc (min) I(in/hr)<br>5 7.34<br>15 4.74<br>18 4.30<br>30 3.10<br>60 1.91 | 0.31 <sub>I</sub> -0.38<br>Calculated  | OK                         | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentration (<br>length of longest flowpa<br>watershed resistance of<br>slope of longest flowpa<br>average rainfall intensit | ath (miles)<br>oefficient<br>th |

| Project Name:<br>Subject:<br>Location:  | Cholla Power P<br>100-Year Peak I<br>Joseph City, AZ                                 | Discharge  |                                   | Date:<br>Computed By:<br>Checked By:   | 02/03/09<br>MCW                             |
|---|--|--|-----------------------------------|--|---|
| 100-yr, 10<br>Hyd<br>Length of Lor<br>Ur<br>Lo  | Pre-development B<br>Precipitation =<br>min Intensity =<br>drologic Zone =           | 2.77 in<br>5.73 in/hr<br>6<br>4,497 feet<br>0.85 miles<br>5245.00 feet<br>5079.00 feet<br>194.89 ft/mi | Q=CIA<br>De                       | Area = 59.6<br>Total Area = 59.6   | 0<br>0 in/hr<br>5 acres<br>5 acres<br>9 cfs |
| Tc=11.4L <sup>0.50</sup> K <sub>b</sub> <sup>0.52</sup> S <sup>-0.31</sup><br>Trials<br>Tc (min) I(in/hr)<br>5 7.34<br>15 4.74<br>22 3.80<br>30 3.10<br>60 1.91 | Calculated<br>Tc (min)<br>17.4<br>20.6<br>22.4<br>24.2<br>29.1<br>formation that nee | OK<br>ds to be entered.  | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentration (<br>length of longest flowp<br>watershed resistance of<br>slope of longest flowpa<br>average rainfall intensi | ath (miles)<br>coefficient<br>ath           |

| Project Name:  | Cholla Power Pla  | nt- Ash Fill   |                                   | Date:  | 02/03/09                               |
|--|---|--|-----------------------------------|--|--|
| Subject:   | 100-Year Peak Di  | scharge  |                                   | Computed By:   | MCW                                    |
| Location:  | Joseph City, AZ   |  |                                   | Checked By:  |  |
| 100-yr, 2<br>100-yr  | - Post Development O<br>4-hr Precipitation =<br>, 10 min Intensity =<br>Hydrologic Zone =<br>Longest Flowpath = | ff-1<br>2.77 in<br>5.73 in/hr<br>6<br>1,357 feet<br>0.26 miles<br>5192.00 feet | Q=CIA                             | Area = 14.*  | 30<br>73 in/hr<br>10 acres<br>10 acres |
|  | Lower Elevation=<br>Longest Flowpath =<br>Kb =  | 5121.00 feet<br>276.26 ft/mi<br>0.10   | Desig                             | n Peak Flow =23  | <u>.8</u> cfs                          |
| Tc=11.4L <sup>0.50</sup> K <sub>b</sub> <sup>0.52</sup> S<br>Trials<br>Tc (min) I(in/r<br>5 7.3<br>9 6.0<br>10 5.7<br>15 4.7<br>30 3.1<br>60 1.9 | Calculated<br>nr) Tc (min)<br>4 8.6<br>0 9.3<br>3 9.4<br>4 10.1<br>0 11.9                                       | OK*  | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentration<br>length of longest flow<br>watershed resistance<br>slope of longest flowp<br>average rainfall intens | path (miles)<br>coefficient<br>ath     |
|  | es information that need<br>owed Tc = 10 minutes  | ls to be entered.  |                                   |  |  |

| Project Name:Cholla Power Plant- Ash FillSubject:100-Year Peak DischargeLocation:Joseph City, AZ  | Date: 02/03/0<br>Computed By: MCW<br>Checked By:   |
|---|--|
| Ash Fill Channel - Post Development Off-2<br>100-yr, 24-hr Precipitation = 2.77 in<br>100-yr, 10 min Intensity = 5.73 in/hr<br>Hydrologic Zone = 6<br>Length of Longest Flowpath = 2,076 feet<br>0.39 miles<br>Upper Elevation= 5210.00 feet<br>Lower Elevation= 5118.00 feet<br>Slope of Longest Flowpath = 233.99 ft/mi<br>Kb = 0.10  | Q=CIA<br>$C_{50B} = 0.30$<br>I = 5.00  in/hr<br>Area = 34.4 acres<br>Total Area = 34.4 acres<br>Design Peak Flow = 50.7 cfs  |
| Kb =       0.10         Tc=11.4L <sup>0.50</sup> K <sub>b</sub> <sup>0.52</sup> S <sup>-0.31</sup> I <sup>-0.38</sup> Trials       Calculated         Tc (min)       l(in/hr)       Tc (min)         5       7.34       11.2         13       5.00       13.0       OK         15       4.74       13.2         30       3.10       15.5         60       1.91       18.7         Denotes information that needs to be entered. | Tc = time of concentration (hrs)<br>L = length of longest flowpath (miles)<br>Kb = watershed resistance coefficient<br>S = slope of longest flowpath<br>I = average rainfall intensity (in/hr) |

| Project Name:  | Cholla Power Plan   | t- Ash Fill  |                                   | Date:   | 02/03/09  |
|--|---|--|-----------------------------------|---|---|
| Subject:   | 100-Year Peak Dise  | charge   |                                   | Computed By:  | MCW   |
| Location:  | Joseph City, AZ   |  |                                   | Checked By:   |   |
| 100-yr,<br>100- <u>-</u><br>Length of L  | - Post Development Off-<br>24-hr Precipitation =<br>yr, 10 min Intensity =<br>Hydrologic Zone =<br>-ongest Flowpath =<br>Lower Elevation=<br>Lower Elevation=<br>Lower Flowpath =<br>Kb = | 2.77 in<br>5.73 in/hr<br>6<br>3,505 feet<br>0.66 miles<br>5245.00 feet<br>5119.00 feet<br>189.81 ft/mi | Q=CIA<br>Des                      |   | 0.30<br>4.20 in/hr<br>49.19 acres<br>49.19 acres<br><b>60.9</b> cfs |
| <b>Γc=11.4L<sup>0.50</sup>K<sub>b</sub><sup>0.52</sup>S<sup>-</sup></b><br>Trials<br>Tc (min) I(in/h<br>5 7.34<br>15 4.74<br>19 4.20<br>30 3.10<br>60 1.91 | 0.31 <sub>I</sub> -0.38<br>Calculated<br>r) Tc (min)<br>15.5<br>18.3<br>19.2<br>21.5  | OK   | Tc =<br>L =<br>Kb =<br>S =<br>I = | time of concentrati<br>length of longest fl<br>watershed resistar<br>slope of longest flo<br>average rainfall int | owpath (miles)<br>nce coefficient<br>owpath                         |

.

### Hydrograph Data Based on Site Specific Watershed and Rainfall Data FORMULAS

|                            | А  | В   | С  | D                                       | E            | F                  | G                        | Н                     |       | J  |
|----------------------------|--|---|--|---|--------------|--------------------|--------------------------|-----------------------|-------|----|
| 1                          | Project Name:                            |   | Cholla Power Plant- Ash Fill   |   |              |                    | Date:                    |                       | 39847 |    |
| 2                          | Subject:                                 |   | 100-Year Peak Discharge  |   |              |                    | Computed By:             |                       | M     | CW |
| 3                          | Location:                                |   | Joseph City, AZ  |   |              |                    | Checked By:              |                       |       |    |
| 4                          |  |   |  |   |              |                    |                          |                       |       |    |
| 5                          | Ash Fill Chann                           | el - Pre-development Dr                   | ainage Area 1  |   |              | Q=CIA              |                          |                       |       |    |
| 6                          |  |   |  |   |              |                    | C <sub>50B</sub> =       | 0.295                 |       |    |
| 7                          | 100                                      | -yr, 6-hr Precipitation =                 |  | ='IDF Data'!H42                         | in           |                    | C =                      | 0                     |       |    |
| 8                          |  | 100-yr, 10 min Intensity                  |  | ='IDF Data'!H19                         | in/hr        |                    | C <sub>Composite</sub> = | =(H6*H10+H7*H11)/H12  | 2     |    |
| 9                          |  | Hydrologic Zone -                         |  | ='IDF Data'!F10                         |              |                    |                          | =B26                  | in/hr |    |
| 10                         |  | , 0                                       |  |   |              | 50B Area =         |                          | 59.65                 | acres |    |
| 11                         |  |   |  |   |              | Area =             |                          | 0                     | acres |    |
| 12                         | Leng                                     | th of Longest Flowpath =                  |  | 4497.4                                  | feet         | Total Area =       |                          | =H10+H11              | acres |    |
| 13                         | Marena a contracto atalia                | an a  | De la compañía de la compañía de la compañía de paísica de la compañía de la compañía de compañía de la compañí            | =D12/5280                               | miles        |                    |                          |                       |       |    |
| 14<br>15                   |  | Upper Elevation=<br>Lower Elevation=      | en Sambaredo en energia en este a compañía en este a ser este entre entre entre entre entre entre entre entre e            | 5245<br>5079                            | feet<br>feet | Design Peak Flow = |                          | =H8*H9*H12            | cfs   |    |
| 16                         | 900-00-00-00-00-00-00-00-00-00-00-00-00- | be of Longest Flowpath =                  |  |   | 0 T T T T    | Design reak now -  |                          |                       | =     |    |
| 16<br>17                   | 30                                       | e of Longest Flowpath -                   |  | = 0.1                                   | S INTRE      |                    |                          |                       |       |    |
| 18                         |  |   |  | ••••••••••••••••••••••••••••••••••••••• |              |                    |                          |                       |       |    |
| 19                         | Tc=11.4L <sup>0.50</sup> K               | 0.52 S <sup>-0.31</sup> F <sup>0.38</sup> |  |   |              |                    |                          |                       |       |    |
| 19<br>20<br>21             |  |   |  |   |              | Tc =               | time of concer           | ntration (hrs)        |       |    |
| 21                         | Trials                                   |   |  |   |              | L =                | length of longe          | est flowpath (miles)  |       |    |
| 22<br>23<br>24<br>25<br>26 |  |   | Calculated   |   |              | Kb =               |                          | istance coefficient   |       |    |
| 23                         | Tc (min)                                 | l(in/hr)                                  | Tc (min)   |   |              | S =                | slope of longe           | •                     |       |    |
| 24                         | 5  |   | =(11.4*\$D\$13^0.5*\$D\$17^0.52*\$D\$16^-0.31*B24^-0.38)*60  |   |              | 1 =                | average rainfa           | all intensity (in/hr) |       |    |
| 25                         | 15                                       | ='IDF Data'IH20                           | =(11.4*\$D\$13^0.5*\$D\$17^0.52*\$D\$16^-0.31*B25^-0.38)*60  | 014                                     |              |                    |                          |                       |       |    |
| 26                         | 22                                       | 3.8<br>3.1                                | =(11.4*\$D\$13^0.5*\$D\$17^0.52*\$D\$16^-0.31*B26^-0.38)*60<br>=(11.4*\$D\$13^0.5*\$D\$17^0.52*\$D\$16^-0.31*B27^-0.38)*60 | OK                                      |              |                    |                          |                       |       |    |
| $\frac{2}{28}$             | 30<br>60                                 | 그렇게 이 것 같아요. 이 가지 않았는 것 같아요.              | =(11.4*\$D\$13^0.5*\$D\$17^0.52*\$D\$16^-0.31*B28^-0.38)*60<br>=(11.4*\$D\$13^0.5*\$D\$17^0.52*\$D\$16^-0.31*B28^-0.38)*60 |   |              |                    |                          |                       |       |    |
| 29                         | 00                                       | 1.91                                      |  |   |              |                    |                          |                       |       |    |
| 30                         |  |   |  |   |              |                    |                          |                       |       |    |
| 31                         | 14.111.11114                             | Denotes information that                  | at needs to be entered.  |   |              |                    |                          |                       |       |    |
| 28<br>29<br>30<br>31<br>32 |  |   |  |   |              |                    |                          |                       |       |    |

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### **APPENDIX C**

## HYDRAULC CALCULATIONS

### **APPENDIX C**

### HYDRAULC CALCULATIONS

### **ON-SITE HYDRAULIC CALCULATIONS**

### **ON-SITE CHANNEL**

# NORMAL DEPTH CALCULATIONS

# Worksheet for DROP Onsite SOUTH channel(25 cfs-5:1)

**Project Description** 

| Manning Formula Normal Depth   |
|--|
|  |
| 0.035<br>0.20000 ft/ft<br>2.50 ft/ft (H:V)<br>2.50 ft/ft (H:V)   |
| 10.00 ft<br>25.00 ft³/s  |
|  |
| 0.29 ft<br>3.14 ft <sup>2</sup><br>11.58 ft<br>11.46 ft<br>0.55 ft<br>0.02311 ft/ft<br>7.96 ft/s<br>0.98 ft<br>1.28 ft<br>2.68<br>Supercritical<br>0.00 ft<br>0.00 ft<br>0.00 ft<br>0.00 ft<br>0.00 ft |
|  |
| 0.00 ft  |
| 0.00 ft<br>Infinity ft/s<br>Infinity ft/s<br>0.29 ft<br>0.55 ft<br>0.20000 ft/ft<br>0.02311 ft/ft  |
|  |

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### Worksheet for Onsite SOUTH channel (25 cfs - 1.6% slope)

| Project Description   |  |             |
|-----------------------|--|-------------|
| Friction Method       | Manning Formula  |             |
| Solve For             | Normal Depth   |             |
| Input Data            |  |             |
| Roughness Coefficient | 0.035  |             |
| Channel Slope         | 0.01600  | ft/ft       |
| Left Side Slope       | 2.50   | ft/ft (H∶V) |
| Right Side Slope      | 2.50   | ft/ft (H:V) |
| Bottom Width          | 10.00  | ft          |
| Discharge             | 25.00  | ft³/s       |
| Results               | andro andro<br>Santa andro<br>Santa andro andro andro andro<br>Santa andro |             |
| Normal Depth          | 0.61   | ft          |
| Flow Area             | 7.09   | ft²         |
| Wetted Perimeter      | 13.31  | ft          |
| Top Width             | 13.07  | ft          |
| Critical Depth        | 0.55   | ft          |
| Critical Slope        | 0.02311  | ft/ft       |
| Velocity              | 3.53   | ft/s        |
| Velocity Head         | 0.19   | ft          |
| Specific Energy       | 0.81   | ft          |
| Froude Number         | 0.84   |             |
| Flow Type             | Subcritical  |             |
| GVF Input Data        |  |             |
| Downstream Depth      | 0.00   | ft          |
| _ength                | 0.00   | ft          |
| Number Of Steps       | 0  |             |
| GVF Output Data       |  |             |
| Jpstream Depth        | 0.00   | ft          |
| Profile Description   |  |             |
| Profile Headloss      | 0.00   | ft          |
| Downstream Velocity   | Infinity   | ft/s        |
| Jpstream Velocity     | Infinity   | ft/s        |
| Iormal Depth          | 0.61   | ft .        |
| Critical Depth        | 0.55   | ft          |
| Channel Slope         | 0.01600  | ft/ft       |
| Critical Slope        | 0.02311  | ft/ft       |
|                       |  |             |

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### Worksheet for DROP STRUCTURE Onsite sec-1(95 cfs-5:1)

| Project Description   |                      |
|-----------------------|----------------------|
| Friction Method       | Manning Formula      |
| Solve For             | Normal Depth         |
| Input Data            |                      |
| Roughness Coefficient | 0.035                |
| Channel Slope         | 0.20000 ft/ft        |
| Left Side Slope       | 2.50 ft/ft (H:V)     |
| Right Side Slope      | 2.50 ft/ft (H:V)     |
| Bottom Width          | 10.00 ft             |
| Discharge             | 95.00 ft³/s          |
| Results               |                      |
| Normal Depth          | 0.64 ft              |
| Flow Area             | 7.43 ft <sup>2</sup> |
| Wetted Perimeter      | 13.45 ft             |
| Top Width             | 13.20 ft             |
| Critical Depth        | 1.26 ft              |
| Critical Slope        | 0.01845 ft/ft        |
| Velocity              | 12.79 ft/s           |
| Velocity Head         | 2.54 ft              |
| Specific Energy       | 3.18 ft              |
| Froude Number         | 3.01                 |
| -low Type             | Supercritical        |
| GVF Input Data        |                      |
| Downstream Depth      | 0.00 ft              |
| _ength                | 0.00 ft              |
| Number Of Steps       | 0                    |
| GVF Output Data       |                      |
| Jpstream Depth        | 0.00 ft              |
| Profile Description   |                      |
| Profile Headloss      | 0.00 ft              |
| ownstream Velocity    | Infinity ft/s        |
| Ipstream Velocity     | Infinity ft/s        |
| lormal Depth          | 0.64 ft              |
| Critical Depth        | 1.26 ft              |
| hannel Slope          | . 0.20000 ft/ft      |
| ritical Slope         | 0.01845 ft/ft        |
|                       |                      |

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#### Worksheet for Onsite channel sec-1(95 cfs - 0.885% slope) **Project Description** Friction Method Manning Formula Solve For Normal Depth Input Data **Roughness Coefficient** 0.035 **Channel Slope** 0.00885 ft/ft Left Side Slope 2.50 ft/ft (H:V) **Right Side Slope** 2.50 ft/ft (H:V) Bottom Width 10.00 ft Discharge 95.00 ft³/s Results Normal Depth 1.55 ft Flow Area 21.43 ft² Wetted Perimeter 18.32 ft Top Width 17.73 ft Critical Depth 1.26 ft Critical Slope 0.01845 ft/ft Velocity 4 4 3 ft/s Velocity Head 0.31 ft Specific Energy 1.85 ft Froude Number 0.71 Flow Type Subcritical **GVF** Input Data 요즘은 정희들은 물건 Downstream Depth 0.00 ft Length 0.00 ft Number Of Steps 0 GVF Output Data Upstream Depth 0.00 ft **Profile Description Profile Headloss** 0.00 ft Downstream Velocity Infinity ft/s Upstream Velocity Infinity ft/s Normal Depth 1.55 ft Critical Depth 1.26 ft Channel Slope 0.00885 ft/ft Critical Slope 0.01845 ft/ft

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# Worksheet for Onsite channel sec-2(95 cfs - 1.04% slope)

Project Description

| Friction Method       | Manning Formula |          |             |
|-----------------------|-----------------|----------|-------------|
| Solve For             | Normal Depth    |          |             |
| Input Data            |                 |          |             |
| Roughness Coefficient |                 | 0.035    |             |
| Channel Slope         |                 | 0.01040  | ft/ft       |
| Left Side Slope       |                 | 2.50     | ft/ft (H:V) |
| Right Side Slope      |                 | 2.50     | ft/ft (H:V) |
| Bottom Width          |                 | 10.00    | ft          |
| Discharge             |                 | 95.00    | ft³/s       |
| Results               |                 |          |             |
| Normal Depth          |                 | 1.48     | ft          |
| Flow Area             |                 | 20.25    | ft²         |
| Wetted Perimeter      |                 | 17.96    | ft          |
| Top Width             |                 | 17.39    | ft          |
| Critical Depth        |                 | 1.26     | ft          |
| Critical Slope        |                 | 0.01846  | ft/ft       |
| Velocity              |                 | 4.69     | ft/s        |
| Velocity Head         |                 | 0.34     | ft          |
| Specific Energy       |                 | 1.82     | ft          |
| Froude Number         |                 | 0.77     |             |
| Flow Type             | Subcritical     |          |             |
| GVF Input Data        |                 |          |             |
| Downstream Depth      |                 | 0.00     | ft          |
| Length                |                 | 0.00     | ft          |
| Number Of Steps       |                 | 0        |             |
| GVF Output Data       |                 |          |             |
| Upstream Depth        |                 | 0.00     | ft          |
| Profile Description   |                 |          |             |
| Profile Headloss      |                 | 0.00     | ft          |
| Downstream Velocity   |                 | Infinity | ft/s        |
| Upstream Velocity     |                 | Infinity | ft/s        |
| Normal Depth          |                 | 1.48     | ft          |
| Critical Depth        |                 | 1.26     | ft          |
| Channel Slope         |                 | 0.01040  | ft/ft       |
| Critical Slope        |                 | 0.01846  | ft/ft       |
|                       |                 | 1        |             |

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### Worksheet for Onsite channel sec-3(95 cfs - 0.5% slope)

Project Description

| Friction Method       | Manning Formula |             |  |
|-----------------------|-----------------|-------------|--|
| Solve For             | Normal Depth    |             |  |
| Input Data            |                 |             |  |
| Roughness Coefficient | 0.035           |             |  |
| Channe! Slope         | 0.00500         | ft/ft       |  |
| Left Side Slope       | 2.50            | ft/ft (H:V) |  |
| Right Side Slope      | 2.50            | ft/ft (H:V) |  |
| Bottom Width          | 10.00           | ft          |  |
| Discharge             | 95.00           | ft³/s       |  |
| Results               |                 |             | and a second |
| Normal Depth          | 1.80            | ft          |  |
| Flow Area             | 26.19           | ft²         |  |
| Wetted Perimeter      | 19.72           | ft          |  |
| Top Width             | 19.02           | ft          |  |
| Critical Depth        | 1.26            | ft          |  |
| Critical Slope        | 0.01845         | ft/ft       |  |
| Velocity              | 3.63            | ft/s        |  |
| Velocity Head         | 0.20            | ft          |  |
| Specific Energy       | 2.01            | ft          |  |
| Froude Number         | 0.55            |             |  |
| Flow Type             | Subcritical     |             |  |
| GVF Input Data        |                 |             |  |
| Downstream Depth      | 0.00            | ft          |  |
| Length                | 0.00            | ft          |  |
| Number Of Steps       | 0               |             |  |
| GVF Output Data       |                 |             | and the second standards   |
| Upstream Depth        | 0.00            | ft          |  |
| Profile Description   |                 |             |  |
| Profile Headloss      | 0.00            | ft          |  |
| Downstream Velocity   | Infinity        | ft/s        |  |
| Upstream Velocity     | Infinity        | ft/s        |  |
| Normal Depth          | 1.80            | ft          |  |
| Critical Depth        | 1.26            | ft          |  |
| Channel Slope         | 0.00500         | ft/ft       |  |
| Critical Slope        | 0.01845         | ft/ft       |  |

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### Worksheet for Onsite channel sec-4(95 cfs - 1.0% slope)

Project Description

| Friction Method                       | Manning Formula  |                 |
|---------------------------------------|--|-----------------|
| Solve For                             | Normal Depth   |                 |
| Input Data                            |  |                 |
| Roughness Coefficient                 | 0.035  |                 |
| Channel Slope                         | 0.01000  | ft/ft           |
| Left Side Slope                       | 2.50   | ft/ft (H:V)     |
| Right Side Slope                      | 2.50   | ft/ft (H:V)     |
| Bottom Width                          | 10.00  | ft              |
| Discharge                             | 95.00  | ft³/s           |
| Results                               | en en de la companya |                 |
| Normal Depth                          | 1.49   | ft              |
| Flow Area                             | 20.54  | ft <sup>2</sup> |
| Wetted Perimeter                      | 18.05  | ft              |
| Top Width                             | 17.47  | ft              |
| Critical Depth                        | 1.26   | ft              |
| Critical Slope                        | 0.01845  | ft/ft           |
| Velocity                              | 4.63   | ft/s            |
| Velocity Head                         | 0.33   | ft              |
| Specific Energy                       | 1.83   | ft              |
| Froude Number                         | 0.75   |                 |
| Flow Type                             | Subcritical  |                 |
| GVF Input Data                        |  |                 |
| Downstream Depth                      | 0.00   | ft              |
| Length                                | 0.00   | ft              |
| Number Of Steps                       | 0  |                 |
| GVF Output Data                       |  |                 |
| Upstream Depth<br>Profile Description | 0.00   | ft              |
| Profile Headloss                      | 0.00   | ft              |
| Downstream Velocity                   | Infinity   | ft/s            |
| Upstream Velocity                     | Infinity   | ft/s            |
| Normal Depth                          | 1.49   | ft              |
| Critical Depth                        | 1.26   | ft              |
| Channel Slope                         | 0.01000  | ft/ft           |
| Critical Slope                        | 0.01845  | ft/ft           |
|                                       |  |                 |

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### Worksheet for Onsite channel sec-5(40 cfs - 1.0% slope)

**Project Description** 

| Friction Method       | Manning Formula |                               |
|-----------------------|-----------------|-------------------------------|
| Solve For             | Normal Depth    |                               |
| Input Data            |                 |                               |
| Roughness Coefficient | 0.035           |                               |
| Channel Slope         | 0.01000         | ft/ft                         |
| Left Side Slope       | 2.50            | ft/ft (H:V)                   |
| Right Side Slope      | 2.50            | ft/ft (H:V)                   |
| Bottom Width          | 10.00           | ft                            |
| Discharge             | 40.00           | ft³/s                         |
| Results               |                 | gen de argener de la presente |
| Normal Depth          | 0.92            | ft                            |
| Flow Area             | 11.34           | ft²                           |
| Wetted Perimeter      | 14.96           | ft                            |
| Top Width             | 14.61           | ft                            |
| Critical Depth        | 0.74            | ft                            |
| Critical Slope        | 0.02127         | ft/ft                         |
| Velocity .            | 3.53            | ft/s                          |
| Velocity Head         | 0.19            | ft                            |
| Specific Energy       | 1.11            | ft                            |
| Froude Number         | 0.71            | · ••                          |
| Flow Type             | Subcritical     |                               |
| GVF Input Data        |                 |                               |
| Downstream Depth      | 0.00            | ft                            |
| Length                | 0.00            | ft                            |
| Number Of Steps       | 0               |                               |
| GVF Output Data       |                 |                               |
| Upstream Depth        | 0.00            | ft                            |
| Profile Description   |                 |                               |
| Profile Headloss      | 0.00            | ft                            |
| Downstream Velocity   | Infinity        | ft/s                          |
| Upstream Velocity     | Infinity        | ft/s                          |
| Normal Depth          | 0.92            | ft                            |
| Critical Depth        | 0.74            | ft                            |
| Channel Slope         | 0.01000         | ft/ft                         |
| Critical Slope        | 0.02127         | ft/ft                         |

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# Worksheet for Onsite channel sec-6(40 cfs - 1.0% slope)

### **Project Description**

| Friction Method       | Manning Formula |          |             |
|-----------------------|-----------------|----------|-------------|
| Solve For             | Normal Depth    |          |             |
| Input Data            |                 |          |             |
| Roughness Coefficient |                 | 0.035    |             |
| Channel Slope         | C               | 0.01000  | ft/ft       |
| Left Side Slope       |                 | 2.50     | ft/ft (H:V) |
| Right Side Slope      |                 | 2.50     | ft/ft (H:V) |
| Bottom Width          |                 | 10.00    | ft          |
| Discharge             |                 | 40.00    | ft³/s       |
| Results               |                 |          |             |
| Normal Depth          |                 | 0.92     | ft          |
| Flow Area             |                 | 11.34    | ft²         |
| Wetted Perimeter      |                 | 14.96    | ft          |
| Top Width             |                 | 14.61    | ft          |
| Critical Depth        |                 | 0.74     | ft          |
| Critical Slope        | . 0             | .02127   | ft/ft       |
| Velocity              |                 | 3.53     | ft/s        |
| Velocity Head         |                 | 0.19     | ft          |
| Specific Energy       |                 | 1.11     | ft          |
| Froude Number         |                 | 0.71     |             |
| Flow Type             | Subcritical     |          |             |
| GVF Input Data        |                 |          |             |
| Downstream Depth      |                 | 0.00     | ft          |
| Length                |                 | 0.00     | ft          |
| Number Of Steps       |                 | 0        |             |
| GVF Output Data       |                 |          |             |
| Upstream Depth        |                 | 0.00     | ft          |
| Profile Description   |                 |          |             |
| Profile Headloss      |                 | 0.00     | ft          |
| Downstream Velocity   |                 | Infinity | ft/s        |
| Upstream Velocity     | I               | Infinity | ft/s        |
| Normal Depth          |                 | 0.92     | ft          |
| Critical Depth        |                 | 0.74     | ft          |
| Channel Slope         | 0.4             | 01000    | ft/ft       |
| Critical Slope        | 0.0             | 02127    | ft/ft       |
|                       |                 |          |             |

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# Worksheet for DROP STRUCTURE Onsite Sec-7 (40 cfs-5:1)

| Project Description   |  |          |             |
|-----------------------|--|----------|-------------|
| Friction Method       | Manning Formula                          |          |             |
| Solve For             | Normal Depth                             |          |             |
| Input Data            |  |          |             |
| Roughness Coefficient |  | 0.035    |             |
| Channel Slope         |  | 0.20000  | ft/ft       |
| Left Side Slope       |  | 2.50     | ft/ft (H:V) |
| Right Side Slope      |  | 2.50     | ft/ft (H∶V) |
| Bottom Width          |  | 10.00    | ft          |
| Discharge             |  | 40.00    | ft³/s       |
| Results               |  |          |             |
| Normal Depth          |  | 0.39     | ft          |
| Flow Area             |  | 4.24     | ft²         |
| Wetted Perimeter      |  | 12.08    | ft          |
| Top Width             |  | 11.93    | ft          |
| Critical Depth        |  | 0.74     | ft          |
| Critical Slope        |  | 0.02127  | ft/ft       |
| Velocity              |  | 9.44     | ft/s        |
| Velocity Head         |  | 1.39     | ft          |
| Specific Energy       |  | 1.77     | ft          |
| Froude Number         |  | 2.79     |             |
| Flow Type             | Supercritical                            |          |             |
| GVF Input Data        | an a |          |             |
| Downstream Depth      |  | 0.00     | ft          |
| Length                |  | 0.00     | ft          |
| Number Of Steps       |  | . 0      |             |
| GVF Output Data       |  |          |             |
| Upstream Depth        |  | 0.00     | ft          |
| Profile Description   |  |          |             |
| Profile Headloss      |  | 0.00     | ft          |
| Downstream Velocity   |  | Infinity | ft/s        |
| Upstream Velocity     |  | Infinity | ft/s        |
| Normal Depth          |  | 0.39     | ft          |
| Critical Depth        |  | 0.74     | ft          |
| Channel Slope         |  | 0.20000  | ft/ft       |
| Critical Slope        |  | 0.02127  | ft/ft       |
|                       |  |          |             |

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# Worksheet for Onsite channel sec-7(40 cfs - 1.0% slope)

Project Description

| Friction Method<br>Solve For             | Manning Formula      |         |
|--|----------------------|---------|
| Input Data                               |                      |         |
| Roughness Coefficient<br>Channel Slope   | 0.035<br>0.01000     |         |
| Left Side Slope<br>Right Side Slope      | 2.50<br>2.50         |         |
| Bottom Width                             | 10.00                | ) ft    |
| Discharge                                | 40.00                | ) ft³/s |
| Results                                  |                      |         |
| Normal Depth<br>Flow Area                | 0.92<br>11.34        |         |
| Wetted Perimeter                         | 14.96                |         |
| Top Width                                | 14.61                |         |
| Critical Depth<br>Critical Slope         | 0.74<br>0.02127      |         |
| Velocity                                 | 3.53                 |         |
| Velocity Head<br>Specific Energy         | 0.19<br>1.11         |         |
| Froude Number                            | 0.71                 |         |
| Flow Type                                | Subcritical          |         |
| GVF Input Data                           |                      |         |
| Downstream Depth                         | 0.00                 |         |
| Length<br>Number Of Steps                | 0.00                 |         |
| GVF Output Data                          | · ·                  |         |
| Upstream Depth                           | 0.00                 | · • •   |
| Profile Description                      | 0.00                 |         |
| Profile Headloss                         | 0.00                 |         |
| Downstream Velocity<br>Upstream Velocity | Infinity<br>Infinity |         |
| Normal Depth                             | 0.92                 | •       |
| Critical Depth                           | 0.74                 |         |
| Channel Slope<br>Critical Slope          | 0.01000<br>0.02127   |         |
|  | 5.52127              |         |

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# Worksheet for Onsite channel sec-8(40 cfs - 0.5% slope)

| Project Description                            |                 |               |       |  |
|--|-----------------|---------------|-------|--|
| Friction Method                                | Manning Formula |               |       |  |
| Solve For                                      | Normal Depth    |               |       |  |
| Input Data                                     |                 |               |       |  |
|  |                 |               |       |  |
| Roughness Coefficient                          |                 | 0.035         |       |  |
| Channel Slope<br>Left Side Slope               |                 | 0.00500       |       |  |
| Right Side Slope                               |                 | 2.50          |       |  |
| Bottom Width                                   |                 | 2.50<br>10.00 |       |  |
| Discharge                                      |                 |               | ft³/s |  |
| -<br>An an |                 |               |       |  |
| Results  |                 |               |       |  |
| Normal Depth                                   |                 | 1.12          | ft    |  |
| Flow Area                                      |                 | 14.35         | ft²   |  |
| Wetted Perimeter                               |                 | 16.04         | ft    |  |
| Top Width                                      |                 | 15.60         | ft    |  |
| Critical Depth                                 |                 | 0.74          | ft    |  |
| Critical Slope                                 |                 | 0.02127       | ft/ft |  |
| Velocity                                       |                 | 2.79          | ft/s  |  |
| Velocity Head                                  |                 | 0.12          | ft    |  |
| Specific Energy                                |                 | 1.24          | ft    |  |
| Froude Number                                  |                 | 0.51          |       |  |
| Flow Type                                      | Subcritical     |               |       |  |
| GVF Input Data                                 |                 | . 2           |       |  |
| Downstream Depth                               |                 | 0.00          | ft    |  |
| Length   |                 | 0.00          | ft    |  |
| Number Of Steps                                |                 | 0             |       |  |
| GVF Output Data                                |                 |               |       |  |
| Upstream Depth                                 |                 | 0.00          | ft    |  |
| Profile Description                            |                 |               |       |  |
| Profile Headloss                               |                 | 0.00          | ft    |  |
| Downstream Velocity                            |                 | Infinity      | ft/s  |  |
| Upstream Velocity                              |                 | Infinity      | ft/s  |  |
| Normal Depth                                   |                 | 1.12          | ft    |  |
| Critical Depth                                 |                 | 0.74          | ft    |  |
| Channel Slope                                  |                 | 0.00500       | ft/ft |  |
| Critical Slope                                 |                 | 0.02127       | ft/ft |  |
|  |                 |               |       |  |

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27 Siemons Company Drive Suite 200 W Watertown, CT 06795 USA +1-203-755-1666

# Worksheet for Onsite channel sec-9(40 cfs - 0.5% slope)

**Project Description** 

| Friction Method       | Manning Formula |                    |
|-----------------------|-----------------|--------------------|
| Solve For             | Normal Depth    |                    |
| Input Data            |                 |                    |
| Roughness Coefficient | 0.03            | 5                  |
| Channel Slope         | 0.0050          | 0 ft/ft            |
| Left Side Slope       | 2.5             | 0 ft/ft (H:V)      |
| Right Side Slope      | 2.5             | 0 ft/ft (H:V)      |
| Bottom Width          | 10.0            | 0 ft               |
| Discharge             | 40.0            | 0 ft³/s            |
| Results               |                 |                    |
| Normal Depth          | 1.13            | 2 ft               |
| Flow Area             | 14.3            | 5 ft²              |
| Wetted Perimeter      | 16.04           | 4 ft               |
| Top Width             | 15.60           | ) ft               |
| Critical Depth        | 0.74            | t ft               |
| Critical Slope        | 0.02127         | <sup>7</sup> ft/ft |
| Velocity              | 2.79            | ) ft/s             |
| Velocity Head         | 0.12            | 2 ft               |
| Specific Energy       | 1.24            | ⊦ ft               |
| Froude Number         | 0.51            |                    |
| Flow Type             | Subcritical     |                    |
| GVF Input Data        |                 |                    |
| Downstream Depth      | 0.00            | ft ft              |
| Length                | 0.00            | ft                 |
| Number Of Steps       | C               |                    |
| GVF Output Data       |                 |                    |
| Upstream Depth        | 0.00            | ft                 |
| Profile Description   |                 |                    |
| Profile Headloss      | 0.00            | ft                 |
| Downstream Velocity   | Infinity        |                    |
| Upstream Velocity     | Infinity        |                    |
| Normal Depth          | 1.12            |                    |
| Critical Depth        | 0.74            |                    |
| Channel Slope         | 0.00500         | ft/ft              |
| Critical Slope        | 0.02127         | ft/ft              |
|                       |                 |                    |

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### **ON-SITE CHANNEL**

### **RIP-RAP SIZING CALCULATIONS**

### Cholla Ash Monofill Riprap Comparison Onsite Channels Drop Structures

|                                       | Ch             | olla Ast  | n Monofi |      |        | nel Riprap | Rock Size (fee  | et)  |      |                              |                            |
|---------------------------------------|----------------|-----------|----------|------|--------|------------|-----------------|------|------|------------------------------|----------------------------|
|                                       |                |           | ,        | Metł | nod    | 1          |                 |      |      |                              |                            |
| Onsite Channel                        | USACE<br>(D30) | ASCE      | USBR     | USGS | ISBASH | HEC-11     | Maricopa<br>Cty | Min  | Max  | Chosen<br>Rock Size<br>(D50) | Layer<br>Thickness<br>(ft) |
| Section 1 (bank)                      | 0.09           | 0.14      | 0.26     | 0.38 | 0.25   | 0.05       | 0.17            | 0.05 | 0.38 | 0.33                         | 1.00                       |
| Section 1 (bottom)                    | 0.09           | 0.13      | 0.26     | 0.38 | 0.25   | 0.04       |                 | 0.04 | 0.38 | 0.33                         | 1.00                       |
| Section 2 (bank)                      | 0.11           | 0.16      | 0.29     | 0.43 | 0.28   | 0.06       | 0.17            | 0.06 | 0.43 | 0.33                         | 1.00                       |
| Section 2 (bottom)                    | 0.11           | 0.14      | 0.29     | 0.43 | 0.28   | 0.05       |                 | 0.05 | 0.43 | 0.33                         | 1.00                       |
| Section 3 (bank)                      | 0.05           | 0.09      | 0.17     | 0.23 | 0.17   | 0.03       | 0.08            | 0.03 | 0.23 | 0.33                         | 1.00                       |
| Section 3 (bottom)                    | 0.05           | 0.09      | 0.17     | 0.23 | 0.17   | 0.02       |                 | 0.02 | 0.23 | 0.33                         | 1.00                       |
| Section 4 (bank)                      | 0.10           | 0.15      | 0.29     | 0.42 | 0.27   | 0.06       | 0.17            | 0.06 | 0.42 | 0.33                         | 1.00                       |
| Section 4 (bottom)                    | 0.10           | 0.14      | 0.29     | 0.42 | 0.27   | 0.04       |                 | 0.04 | 0.42 | 0.33                         | 1.00                       |
| Section 5 (bank)                      | 0.06           | 0.09      | 0.16     | 0.22 | 0.16   | 0.03       | 0.08            | 0.03 | 0.22 | 0.33                         | 1.00                       |
| Section 5 (bottom)                    | 0.06           | 0.08      | 0.16     | 0.22 | 0.16   | 0.02       |                 | 0.02 | 0.22 | 0.33                         | 1.00                       |
| Section 6 (bank)                      | 0.06           | 0.09      | 0.16     | 0.22 | 0.16   | 0.03       | 0.08            | 0.03 | 0.22 | 0.33                         | 1.00                       |
| Section 6 (bottom)                    | 0.06           | 0.08      | 0.16     | 0.22 | 0.16   | 0.02       |                 | 0.02 | 0.22 | 0.33                         | 1.00                       |
| Section 7 (bank)                      | 0.06           | 0.09      | 0.16     | 0.22 | 0.16   | 0.03       | 0.08            | 0.03 | 0.22 | 0.33                         | 1.00                       |
| Section 7 (bottom)                    | 0.06           | 0.08      | 0.16     | 0.22 | 0.16   | 0.02       |                 | 0.02 | 0.22 | 0.33                         | 1.00                       |
| Section 8 (bank)                      | 0.03           | 0.05      | 0.10     | 0.12 | 0.10   | 0.01       | 0.08            | 0.01 | 0.12 | 0.33                         | 1.00                       |
| Section 8 (bottom)                    | 0.03           | 0.05      | 0.10     | 0.12 | 0.10   | 0.01       |                 | 0.01 | 0.12 | 0.33                         | 1.00                       |
| Section 9 (bank)                      | 0.03           | 0.05      | 0.10     | 0.12 | 0.10   | 0.01       | 0.08            | 0.01 | 0.12 | 0.33                         | 1.00                       |
| Section 9 (bottom)                    | 0.03           | 0.05      | 0.10     | 0.12 | 0.10   | 0.01       |                 | 0.01 | 0.12 | 0.33                         | 1.00                       |
| Drop Struc On-sec 1-basin (bnk)       | 1.61           | 1.16      | 2.33     | 5.02 | 2.09   | 1.23       | 3.50            | 1.16 | 5.02 | 1.00*                        | 2.00                       |
| Drop Struc On-sec 1-basin (btm)       | 1.61           | 1.07      | 2.33     | 5.02 | 2.09   | 0.92       |                 | 0.92 | 5.02 | 1.00*                        | 2.00                       |
| Drop Struc On-sec 7- 5:1(bnk)         | 0.85           | 0.63      | 1.24     | 2.39 | 1.14   | 0.50       | 1.83            | 0.50 | 2.39 | 1.00*                        | 2.00                       |
| Drop Struc On-sec 7- 5:1(btm)         | 0.85           | 0.58      | 1.24     | 2.39 | 1.14   | 0.37       |                 | 0.37 | 2.39 | 1.00*                        | 2.00                       |
| SOUTH Channel                         |                |           |          |      |        |            |                 |      |      |                              |                            |
| Section 1 (bank)                      | 0.07           | 0.09      | 0.16     | 0.22 | 0.16   | 0.03       | 0.08            | 0.03 | 0.22 | 0.33                         | 1.00                       |
| Section 1 (bottom)                    | 0.07           | 0.08      | 0.16     | 0.22 | 0.16   | 0.00       | 0.00            | 0.03 | 0.22 | 0.33                         | 1.00                       |
| Drop Struc On-SOUTH-basin (bnk)       | 0.60           | 0.45      | 0.88     | 1.58 | 0.81   | 0.34       | 1.33            | 0.34 | 1.58 | 1.00*                        | . 2.00                     |
| Drop Struc On-SOUTH-basin (btm)       | 0.60           | 0.42      | 0.88     | 1.58 | 0.81   | 0.26       | 1.00            | 0.34 | 1.58 | 1.00*                        | 2.00                       |
| *NOTE: All drop structures and basins | s will consi   | st of arc | uted rip | ran  |        |            |                 |      |      |                              |                            |

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Riprap Sizing\RDS runs\_comparison

By:\_\_\_\_\_ Checked:\_\_\_\_\_

### Cholla Ash Monofill Riprap Calculation

| 1Calculation of Riprap Size for Channel Lining<br>Calculations are based on Drainage Design Manual for Maricopa County (Manual)3Calculations are based on Drainage Design Manual for Maricopa County (Manual)4Channel Name:<br>Design Flood Freque<br>Location/Station:<br>$32+50$ to $33+00$ 788Relevant Equations10 $d_{s_0} = \frac{0.001 V_s^A}{d_{ms}^A K_1^A}$ 11 $d_{s_0} = \frac{0.001 V_s^A}{d_{ms}^A K_1^A}$ 12 $d_{s_0} = \frac{0.001 V_s^A}{d_{ms}^A K_1^A}$ 13 $d_{s_0} = \frac{0.001 V_s^A}{d_{ms}^A K_1^A}$ 14 $d_{s_0} = \frac{0.001 V_s^A}{d_{ms}^A K_1^A}$ 15 $K_1 = \left[1 - \frac{\sin^2 \theta}{\sin^2 k}\right]^{n^2}$ 16 $d_{s_0} = - \text{Median diameter of the riprap materials, ft}$ 17 $V_a = - Average velocity in the main channel, ft's20d_{sog} = - \text{Median diameter of flow in the main channel, ft's21V_a = - Average velocity in the main channel, ft's22d_{mg} = - \text{Average velocity in the main channel, ft's23M_{sog} = - Riprap material's angle or repose, degree24\theta = $   |    | A             | В                        | С  | D         | E   | F     | G            | Н                                     | 1         |       | J            | К  |
|---|----|---------------|--------------------------|--|-----------|---|-------|--------------|---------------------------------------|-----------|-------|--------------|----|
| 2       Calculations are based on Drainage Design Manual for Maricopa County (Manual)         3       Channel Name:       Cholla Ash Onsite Drop Structure SOUTH channel         5       Design Flood Freque       100 -yr         6       Location/Station:       32+50 to 33+00         7       8         8       Relevant Equations         10       1         11 $d_{so} = \frac{0.001 V_s^3}{d_{ms}^3 K_1^{1.5}}$ 12 $d_{so} = \frac{0.001 V_s^3}{d_{ms}^3 K_1^{1.5}}$ 14 $K_1 = \begin{bmatrix} 1 - \frac{\sin^2 \theta}{\sin^2 \phi} \end{bmatrix}^{1.5}$ 15       Where.         20 $d_{so} = Median diameter of the riprap materials. ft         21       V_s = Average velocity in the main channel, ft/s         22       d_{so} = Average depth of flow in the main channel, ft/s         23       K_1 = Bank angle correction factor         24       \theta = Bank angle of repose, degree         25       \phi = \frac{7.96}{10.29} ft/s         28       Based on output from FlowMaster and based on the Manual)         31       V_s = \frac{7.96}{10.29} ft/s         33       \theta = \frac{21.80}{2.93} degree       2.5.1 (H:V)         34       \theta = \frac{21.80}{40.99} = \frac{1.25 ft}{1.00} degree         35       L_s = \frac{0.82}{1.00} (inch) = 16 inche sis stable. $  | 1  | Calculat      | ion of Ri                | prap Size f  | or Cha    | annel Lin   | ing   |              | · · · · · · · · · · · · · · · · · · · |           |       | L            |    |
| $\begin{array}{c cccc} 3 \\ \hline 4 \\ \hline 1 \\ \hline 3 \\ 3 \\$   | 2  | Calculatio    | ons are bas              | ed on Draina   | age Des   | ign Manua   | l for | Maricopa     | County (M                             | anual)    |       |              |    |
| $\begin{array}{c c} \hline \\ \hline $  | 3  |               |                          |  |           |   |       | ·            |                                       | ,         |       |              |    |
| 5Design Flood Freque100 -yr10Location/Station:32+50 to 33+007888101111 $d_{su} = 0.001 V_s^*$ 13 $d_{su} = \frac{0.001 V_s^*}{d_{us}^* K_1^{1.5}}$ 14 $d_{su} = \frac{0.001 V_s^*}{d_{us}^* K_1^{1.5}}$ 15 $f_{su} = \frac{1}{2} \int_{us}^{us} K_1^{1.5}$ 16 $K_1 = \left[1 - \frac{\sin^2 \theta}{\sin^2 \phi}\right]^{us}$ 19Where,20 $d_{so} = Median diameter of the riprap materials, ft21V_a = Average velocity in the main channel, ft/s22d_{sug} = Average depth of flow in the main channel, ft23K_1 = Bank angle correction factor24\theta = Bank angle or rection factor25\phi = Riprap material's angle of repose, degree26(Based on output from FlowMaster and based on the Manual)30V_a = \frac{7.96}{0.29} ft/s33\theta = 221.8034\theta = 221.8035\theta = 221.8036\theta = -221.8037M_a = 0.8238\theta_{s0} = 1.25 ft39d_{s0} = 1.25 ft40d_{s0} (inch) = 16 inch $  |    | Channel N     | lame:                    | Cholla Ash   | Onsite    | Drop Struc  | ture  | SOUTHick     | nannel                                |           |       |              |    |
| $\begin{array}{c} \hline 7\\ 8\\ 9\\ \hline 8\\ \hline 8\\ \hline 8\\ \hline 8\\ \hline 8\\ \hline 8\\ \hline $   | h  | -             |                          | e 100 -  | yr        |   |       |              |                                       |           |       |              |    |
| BRelevant Equations101112 $d_{so} = \frac{0.001V_a^3}{d_{so}^4 K_1^{1/5}}$ 13 $f_{so} = \frac{0.001V_a^3}{d_{so}^4 K_1^{1/5}}$ 14 $f_{so} = \frac{1}{d_{so}^4 K_1^{1/5}}$ 15 $K_1 = \left[1 - \frac{\sin^2 \theta}{\sin^2 \phi}\right]^{1/5}$ 18 $Where,$ 19 $d_{so} = Median diameter of the riprap materials, ft19V_a = Average velocity in the main channel, ft/s21V_a = Average depth of flow in the main channel, ft22d_{sog} = Average depth of flow in the main channel, ft23Hence,24\theta = Bank angle correction factor25\theta = Riprap material's angle of repose, degree26Parameters27Input Parameters28(Based on output from FlowMaster and based on the Manual)31V_a = \frac{7.96}{1.6} ft/s32\theta = \frac{21.80}{21.80} degree [2.5:1 (H:V)]\theta = \frac{21.80}{21.40} degree From Figure 6.14 of the Manual for rounded riprap - attached.33Hence,34K_1 = 0.8235d_{s0} = 1.25 ft36d_{s0} = 1.25 ft37d_{s0} = 1.25 ft38d_{s0} = 1.25 ft39d_{s0} = 1.25 ft40d_{s0} = 1.6 inch41d_{s0} = 1.6 inch$  |    | Location/     | Station:                 | 32+50 to 33  | +00       |   |       |              |                                       |           |       |              |    |
| 9Relevant Equations101112131415161718191920212223242526272819292021222324252627281929203132333434353636373849394140414141   |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $\begin{array}{c} 10\\ 11\\ 12\\ 13\\ 14\\ 15\\ 16\\ 17\\ 18\\ 18\\ 18\\ 18\\ 18\\ 18\\ 19\\ 18\\ 19\\ 19\\ 19\\ 19\\ 19\\ 19\\ 19\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10\\ 10$   |    | Polovanti     | Equationa                |  |           |   |       |              |                                       |           |       |              |    |
| $\begin{aligned} \frac{11}{12} \\ \frac{11}{13} \\ \frac{11}{14} \\ \frac{11}{12} \\ \frac{11}{13} \\ \frac{11}{15} \\ $  |    | Itelevant i   | Lyuations                |  |           |   |       |              |                                       |           |       |              |    |
| $ \begin{array}{c} \frac{12}{13}\\ \frac{14}{15}\\ \frac{14}{15}\\ \frac{14}{15}\\ \frac{14}{15}\\ \frac{14}{15}\\ \frac{16}{17}\\ \frac{16}{10}\\ 1$   |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $ \begin{array}{c} \frac{13}{14} \\ \frac{15}{16} \\ \frac{1}{16} \\ \frac$   |    |               |                          | 0011/3   |           |   |       |              |                                       |           |       |              |    |
| $\frac{15}{16}$ $\frac{17}{18}$ Where,<br>$\frac{1}{17}$ $\frac{1}{18}$ Where,<br>$\frac{1}{12}$ $\frac{1}{17}$ $\frac{1}{18}$ Where,<br>$\frac{1}{12}$ $\frac{1}{12}$ $\frac{1}{$  |    |               | $d_{50} = -$             | .0017  |           |   |       |              |                                       |           |       |              |    |
| $\frac{15}{16}$ $\frac{17}{18}$ Where,<br>$\frac{1}{17}$ $\frac{1}{18}$ Where,<br>$\frac{1}{12}$ $\frac{1}{17}$ $\frac{1}{18}$ Where,<br>$\frac{1}{12}$ $\frac{1}{12}$ $\frac{1}{$  |    |               | d                        | $\begin{bmatrix} a_{12} \\ a_{22} \end{bmatrix} K_1^{1.5}$ |           |   |       |              |                                       |           |       |              |    |
| $ \frac{17}{18} $ Where, $ \begin{array}{c} \mathcal{K}_{1} = \left[1 - \frac{\sin^{-2}\theta}{\sin^{2}\phi}\right] $ Where, $ \begin{array}{c} \mathcal{K}_{1} = \left[1 - \frac{\sin^{-2}\theta}{\sin^{2}\phi}\right] $ $ \begin{array}{c} \mathcal{K}_{2} = \left[1 - \frac{\sin^{-2}\theta}{\sin^{2}\phi}\right] $ $ \begin{array}{c} \mathcal{K}_{2} = \left[1 - \frac{\sin^{-2}\theta}{\sin^{2}\phi}\right] $ $ \begin{array}{c} \mathcal{K}_{3} = \left[1 - \frac{\sin^{-2}\theta}{\sin^{2}\phi}\right] $ $ \begin{array}{c} \mathcal{K}_{4} = \left[1 - \frac{\sin^{-2}\theta}{\sin^{-2}\phi}\right] $ $ \begin{array}{c} \mathcal{K}_{4} = \left[1 - \frac{\sin^{-2}\theta$ |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $\frac{18}{19}$ Where,<br>$\frac{11}{12} \left[ \frac{1}{3} \sin^2 \phi \right]$ Where,<br>$\frac{1}{20}$ $\frac{1}{20}$ $\frac{1}$   |    |               | Г                        | $\sin^2 \theta$  |           |   |       |              |                                       |           |       |              |    |
| Where,<br>$d_{50} = Median diameter of the riprap materials, ft V_a = Average velocity in the main channel, ft/sd_{avg} = Average depth of flow in the main channel, ft d_{avg} = Average depth of flow in the main channel, ft d_{avg} = Average depth of flow in the main channel, ft d_{avg} = Bank angle correction factord = Bank angle correction factor d = Bank angle with the horizontal, degree\phi = Riprap material's angle of repose, degreed = Riprap material's angle of repose, degreed = Riprap material's angle of the Manual)V_a = \frac{7.96}{0.29} ft/sd_{avg} = \frac{7.96}{0.29} ft/sd_{avg} = \frac{7.96}{0.29} ft degree [2.5:1 (H:V)]\phi = \frac{21.80}{41.0} degree [2.5:1 (H:V)]\phi = \frac{41.0}{41.0} degree From Figure 6.14 of the Manual for rounded riprap - attached.K_1 = 0.82d_{50} = 1.25 ftd_{50} (inch) = 16 inch $   |    |               | $K_{+} = 1$              | $-\frac{\sin^2 \theta}{\sin^2 \theta}$                     |           |   |       |              |                                       |           |       |              |    |
| 20 $d_{50}$ =Median diameter of the riprap materials. ft21 $V_a$ =Average velocity in the main channel, ft/s22 $d_{avg}$ =Average depth of flow in the main channel, ft23 $K_1$ =Bank angle correction factor24 $\theta$ =Bank angle with the horizontal, degree25 $\phi$ =Riprap material's angle of repose, degree26Input Parameters27Input Parameters28Input Parameters29(Based on output from FlowMaster and based on the Manual)30 $V_a$ = $7.96$ ft/s31 $V_a$ = $7.96$ ft/s32 $d_{avg}$ = $0.29$ ft33 $D_{50}$ = $16$ inch34 $\theta$ = $21.80$ degree35 $\phi$ = $1.25$ ft36 $K_1$ = $0.82$ 39 $d_{50}$ = $1.25$ ft40 $d_{50}$ (inch) =16 inch4142 $41$  | _  | Where         | L                        | $\sin \varphi$   |           |   |       |              |                                       |           |       |              |    |
| 21 $V_a$ =Average velocity in the main channel, ft/s22 $d_{avg}$ =Average depth of flow in the main channel, ft23K <sub>1</sub> =Bank angle correction factor24 $\theta$ =Bank angle with the horizontal, degree26 $\phi$ =Riprap material's angle of repose, degree27Input Parameters29(Based on output from FlowMaster and based on the Manual)30 $V_a$ = $7.96$ 31 $V_a$ = $7.96$ 32 $d_{avg}$ = $0.29$ 33 $D_{50}$ = $16$ 34 $\theta$ = $21.80$ $\phi$ = $21.80$ $degree$ From Figure 6.14 of the Manual for rounded riprap - attached.36 $K_1$ = $0.82$ 39 $d_{50}$ = $1.25$ ft40 $d_{50}$ (inch) =16 inch41 $42$  |    | where,        | d <sub>ee</sub> =        | Modion diam  | otor of   | ****  |       | della fi     |                                       |           |       |              |    |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$  |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| 23 $K_1 =$ Bank angle correction factor24 $\theta =$ Bank angle with the horizontal, degree25 $\phi =$ Riprap material's angle of repose, degree27Input Parameters28Input Parameters29(Based on output from FlowMaster and based on the Manual)31 $V_a =$ 32 $d_{avg} =$ 33 $D_{50} =$ 34 $\theta =$ 21.80degree35 $\phi =$ 41.0degree38 $K_1 =$ $0.82$ 39 $d_{50} =$ 40 $d_{50}$ (inch) =4142  |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $\begin{array}{cccc} 24\\ 25\\ 26\\ 27\\ 26\\ 27\\ 28\\ 1nput Parameters\\ 29\\ (Based on output from FlowMaster and based on the Manual)\\ \hline & V_a = & \hline 7.96\\ 32\\ 32\\ 32\\ 32\\ 33\\ 32\\ 34\\ 34\\ 6 = & \hline 21.80\\ 36\\ 36\\ 36\\ 37\\ 1 \\ 40 \\ 41\\ 42\\ \end{array}$   |    |               | 0                        |  |           |   | un ci | nannei, it   |                                       |           |       |              |    |
| $\begin{array}{cccc} \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & \text{Riprap material's angle of repose, degree} \\ \hline \phi &= & Riprap mate$   |    |               |                          |  |           |   | d     |              |                                       |           |       |              |    |
| $26$<br>$27$ Input Parameters $29$<br>$30$ (Based on output from FlowMaster and based on the Manual) $31$<br>$32$<br>$33$<br>$33$<br>$34$<br>$4^{\circ}$ = $7.96$<br>$16$<br>$16$<br>$16$<br>$16$ $34$<br>$35$<br>$36$ $q =$<br>$41.0$ $41$<br>$42$ $0.29$<br>$1.80$ $41$<br>$41$ $41$<br>$42$ $41$ $41$<br>$41$ $41$ $41$<br>$41$  |    |               | -                        | Riprap mater   | rial's an | ale of repos  | re d  | earee        |                                       |           |       |              |    |
| $28$ Input Parameters $29$ (Based on output from FlowMaster and based on the Manual) $30$ $V_a =$ $31$ $V_a =$ $32$ $d_{avg} =$ $32$ $d_{avg} =$ $33$ $D_{50} =$ $34$ $\theta =$ $21.80$ degree $25$ $\phi =$ $41.0$ degree $7.96$ ft/s $34$ $\theta =$ $21.80$ degree $25.1$ (H:V)] $35$ $\phi =$ $41.0$ degree $7.96$ ft $36$ $K_1 =$ $37$ Hence, $38$ $K_1 =$ $450 =$ $1.25$ ft $40$ $d_{50}$ (inch) = $16$ inch <d50 16="" =="" inches="" is="" stable.<="" td=""></d50>  | 26 |               | r                        | 11   |           | gie en oper   | , u   | ogree        |                                       |           |       |              |    |
| Based on output from FlowMaster and based on the Manual)<br>$V_{a} = 7.96 \text{ ft/s}$ $d_{avg} = 0.29 \text{ ft}$ $32  d_{avg} = 0.29 \text{ ft}$ $33  D_{50} = 16 \text{ inch} \text{ Assume a } D_{50} \text{ and then calculate if it is stable.}$ $\frac{34}{35}  \phi = 21.80 \text{ degree} [2.5:1 (\text{H:V})]$ $\phi = 41.0 \text{ degree} \text{ From Figure 6.14 of the Manual for rounded riprap - attached.}$ $K_{1} = 0.82$ $\frac{39}{40}  d_{50} = 1.25 \text{ ft}$ $d_{50} (\text{inch}) = 16 \text{ inch}  $  | 27 |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$   |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $31$<br>$32$ $V_a =$ 7.96<br>$ft/s$ ft/s $32$<br>$33$ $d_{avg} =$ 0.29<br>$0.29$ ft $33$<br>$34$<br>$35$<br>$36$ $\rho =$ 21.80<br>$41.0$ degree $q =$ 21.80<br>$41.0$ degree[2.5:1 (H:V)]<br>  |    | (Based on     | output from              | FlowMaster   | and bas   | sed on the N  | /anu  | ial)         |                                       |           |       |              |    |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$   |    |               | V <sub>e</sub> =         | 7 96 ft  | /c        |   |       |              |                                       |           |       |              |    |
| 33<br>34<br>34<br>35<br>36 $D_{50} =$ 16<br>16<br>inchAssume a $D_{50}$ and then calculate if it is stable.<br>$\theta =$ 21.80<br>21.80<br>degreedegree[2.5:1 (H:V)]<br>From Figure 6.14 of the Manual for rounded riprap - attached.36<br>37<br>38 $K_1 =$ 0.82<br>$d_{50} =$ 1.25 ft<br>16 inchD50 = 16 inches is stable.  |    |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$   |    |               |                          |  |           | Assuma  |       | and than     | loulote # 1                           | in n+-1 ' |       |              |    |
| $ \phi = 41.0 \text{ degree} From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ \phi = 41.0 \text{ degree} From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $ $ From Figure 6.14 of the Manual for rounded riprap - attached. } $   |    |               |                          |  |           |   |       | anu inen ca  | iculate if it                         | is stabl  | e.    |              |    |
| 36       37       Hence,         37       Hence,         38 $K_1 =$ 0.82         39 $d_{50} =$ 1.25 ft         40 $d_{50}$ (inch) =       16 inch         41       42   |    |               |                          |  | 0         |   | / J   | 14 of the M  | anual for r                           | hunded    | rinra | n ottaal     | .  |
| 38 $K_1 =$ 0.82         39 $d_{50} =$ 1.25 ft         40 $d_{50}$ (inch) =       16 inch         41       42  | 36 |               | Ψ                        |  | egree     | romrigu   | 60.   |              | anuariorio                            | Junded    | npra  | ip - attache | a. |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$  | 37 | Hence,        |                          |  |           |   |       |              |                                       |           |       |              |    |
| $d_{50}$ (inch) = 16 inch <d50 16="" =="" inches="" is="" stable.<br=""><math>d_{11}</math> (inch) = 16 inch <d50 16="" =="" inches="" is="" stable.<="" td=""><td>38</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></d50></d50>  | 38 |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| 41 42   | 39 |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| 42  | 40 |               | d <sub>50</sub> (inch) = | 16 ir  | nch       | <d50 =<="" td=""><td>16</td><td>inches is st</td><td>able.</td><td></td><td></td><td></td><td></td></d50> | 16    | inches is st | able.                                 |           |       |              |    |
|   | _  |               |                          |  |           |   |       |              |                                       |           |       |              |    |
| $(1 \leq 1)$ Deretors proposed deging given $d = (1 \geq 1)$  |    | <b>T</b> 1. ( |                          |  |           |   |       |              |                                       |           |       |              |    |
| Therefore, proposed design riprap size $(d_{50}) = 16$ inch   | 43 | Iherefo       | re, propose              | ed design rip  | rap siz   | e (d <sub>50</sub> ) =  | 16    | inch         |                                       |           |       |              |    |

Page \_\_\_\_\_ Date:

Ву:\_\_\_\_ Checked:

|          | A          | В                        | С                                    | D           | E   | F                    | G         | Н                                     | <u> </u>     | J             | К  |
|----------|------------|--------------------------|--------------------------------------|-------------|---|----------------------|-----------|---------------------------------------|--------------|---------------|----|
| 1        | Calculat   | ion of Ri                | prap Size                            | for Ch      |   |                      |           | 1                                     | l!           |               |    |
| 2        | Calculatio | ons are bas              | ed on Drair                          | nage Des    | sign Manu   | al for M             | aricopa   | County (M                             | anual)       |               |    |
| 3        |            |                          |                                      |             | •   |                      | •         | · · · · · · · · · · · · · · · · · · · |              |               |    |
| 4        | Channel N  |                          | Cholla Ast                           | ONSITI      | E SOUTH   | Channe               | 1         |                                       |              |               |    |
| 5        |            | ood Freque               |                                      | •           |   |                      |           | ÷.                                    |              |               |    |
| 6        | Location/  | Station:                 | 35+00 to 3                           | 8+50        |   |                      |           |                                       |              |               |    |
| 8        |            |                          |                                      |             |   |                      |           |                                       |              |               |    |
| 9        | Relevant I | Equations                |                                      |             |   |                      |           |                                       |              |               |    |
| 10       |            |                          |                                      |             |   |                      |           |                                       |              |               |    |
| 11       |            |                          |                                      |             |   |                      |           |                                       |              |               |    |
| 12       |            | 0                        | $001V^{3}$                           |             |   |                      |           |                                       |              |               |    |
| 13       |            | $d_{50} = \frac{0}{d}$   | 10.5 × 1.5                           |             |   |                      |           |                                       |              |               |    |
| 14<br>15 |            |                          | avg K                                |             |   |                      |           |                                       |              |               |    |
| 16       |            |                          | 70                                   | 5           |   |                      |           |                                       |              |               |    |
| 17       |            | K - 1                    | $-\frac{\sin^2\theta}{\cos^2\theta}$ |             |   |                      |           |                                       |              |               |    |
| 18       |            |                          | $\sin^2 \phi$                        |             |   |                      |           |                                       |              |               |    |
| 19       | Where,     |                          | <u> </u>                             |             |   |                      |           |                                       |              |               |    |
| 20       |            | d <sub>50</sub> =        | Median dia                           | meter of    | the riprap  | material             | s, ft     |                                       |              |               |    |
| 21       |            | V <sub>a</sub> =         | Average ve                           | locity in   | the main c  | hannel,              | ft/s      |                                       |              |               |    |
| 22       |            | d <sub>avg</sub> =       | Average de                           | epth of flo | w in the n  | nain chai            | nnel, ft  |                                       |              |               |    |
| 23       |            | K <sub>1</sub> =         | Bank angle                           |             |   |                      |           |                                       |              |               |    |
| 24       |            | θ =                      | Bank angle                           | with the    | horizonta   | , degree             | 1         |                                       |              |               |    |
| 25       | а<br>т     | $\phi =$                 | Riprap mat                           | erial's ar  | gle of rep  | ose, deg             | ree       |                                       |              |               |    |
| 26<br>27 |            |                          |                                      |             |   |                      |           |                                       |              |               |    |
|          | Input Para | motore                   |                                      |             |   |                      |           |                                       |              |               |    |
|          |            |                          | FlowMaste                            | r and had   | ed on the   | Manual               | <b>\</b>  |                                       |              |               |    |
| 30       | ·          |                          |                                      |             |   | Manual               | )         |                                       |              |               |    |
| 31       |            | ∨ <sub>a</sub> =         | 3.53                                 | ft/s        |   |                      |           |                                       |              |               |    |
| 32       |            | d <sub>avg</sub> =       | 0.61                                 | ft          |   |                      |           |                                       |              |               |    |
| 33       |            | D <sub>50</sub> =        | 1                                    | inch        | Assume  | a D <sub>50</sub> an | d then ca | alculate if it                        | is stable.   |               |    |
| 34       |            | θ =                      |                                      | degree      | [2.5:1 (H   |                      |           |                                       |              |               |    |
| 35       |            | $\phi$ =                 | 41.0                                 | degree      | From Fig  | ure 6.14             | of the N  | lanual for ro                         | ounded ripra | ap - attached | l. |
| 36       | 1.1        |                          |                                      |             |   |                      |           |                                       |              |               |    |
|          | Hence,     | K -                      |                                      |             |   |                      |           |                                       |              | ~             |    |
| 38       |            | K <sub>1</sub> =         | 0.82                                 | ~           |   |                      |           |                                       |              |               |    |
| 39       |            | d <sub>50</sub> =        | 0.08                                 |             |   |                      |           |                                       |              |               |    |
| 40       |            | d <sub>50</sub> (inch) = | 1                                    | inch        | <d50< th=""><th>= 1 inc</th><th>hes is st</th><th>table.</th><th></th><th></th><th></th></d50<> | = 1 inc              | hes is st | table.                                |              |               |    |
| 41       |            |                          |                                      |             |   |                      |           |                                       |              |               |    |
| 42       | Therefo    | re propos                | ed design ri                         | nran ei-    | o (d. ) =   |                      | . 1.      |                                       |              |               |    |
| L        | merelu     | re, propose              | eu design ri                         | prap siz    | e (a <sub>50</sub> ) =  | 1 inc                | :n        |                                       |              |               |    |

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|          | A B C D E F G H I J K  |
|----------|--|
| 1        | Calculation of Riprap Size for Channel Lining                                      |
| 2        | Calculations are based on Drainage Design Manual for Maricopa County (Manual)      |
| 3        |  |
| 4        | Channel Name: Cholla Ash Onsite Drop Structure channel section 1                   |
| 5        | Design Flood Freque 100 -yr  |
| 6        | _ocation/Station: 32+50 to 33+00   |
| 7        |  |
| 8        |  |
| 9        | Relevant Equations   |
| 10       |  |
| 11       |  |
| 13       | $d = \frac{0.001 V_a^3}{2}$  |
| 14       | $d_{50} = \frac{0.001 V_a^3}{d_{avy}^{0.5} K_{1.5}^{1.5}}$                         |
| 15       |  |
| 16       | $\int_{V} \int_{V} \sin^2 \theta \int_{V}^{0.5}$                                   |
| 17       | $ \Lambda_1 =  1 - \frac{1}{2}$  |
| 18       | $\int \int \sin^2 \phi$  |
|          | Where,   |
| 20       | $d_{50}$ = Median diameter of the riprap materials, ft                             |
| 21       | $V_a$ = Average velocity in the main channel, ft/s                                 |
| 22       | d <sub>avg</sub> = Average depth of flow in the main channel, ft                   |
| 23       | K <sub>1</sub> = Bank angle correction factor                                      |
| 24       | $\theta$ = Bank angle with the horizontal, degree                                  |
| 25       | $\phi$ = Riprap material's angle of repose, degree                                 |
| 26<br>27 |  |
|          | nput Parameters  |
|          | Based on output from FlowMaster and based on the Manual)                           |
| 30       |  |
| 31       | $V_a = 12.79 \text{ ft/s}$   |
| 32       | $d_{avg} = 0.64$ ft  |
| 33       | $D_{50} = 42$ inch Assume a $D_{50}$ and then calculate if it is stable.           |
| 34       | $\theta = 21.80$ degree [2.5:1 (H:V)]  |
| 35       | $\phi$ = 41.0 degree From Figure 6.14 of the Manual for rounded riprap - attached. |
| 36       |  |
|          | tence,   |
| 38       | K <sub>1</sub> = 0.82  |
| 39       | $d_{50} = 3.49 \text{ ft}$   |
| 40       | $d_{50}$ (inch) = 42 inch <d50 42="" =="" inches="" is="" stable.<="" td=""></d50> |
| 41       |  |
| 42       |  |
| 43       | Therefore, proposed design riprap size $(d_{50}) = 42$ inch                        |

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|          | A           | В                        | С  | D          | E   | F                   | G           | Н            |               | J              |    |
|----------|-------------|--------------------------|--|------------|---|---------------------|-------------|--------------|---------------|----------------|----|
| 1        | Calculat    | ion of Ri                | prap Size                                | for Ch     |   |                     |             |              |               | J              | K  |
| 2        | Calculatio  | ns are bas               | ed on Drair                              | age De     | sign Man  | ual for             | Maricon     | a County     | (Manual)      |                |    |
| 3        |             |                          |  | J- J       | - gir man   | 441 101             | mancop      | a county     | (Manual)      |                |    |
| 4        | Channel N   | lame:                    | Cholla Asł                               |            | E Channe  | l sacti             | ion 1       |              |               |                |    |
| 5        | Design Flo  | od Freque                | e 100                                    |            | - onumic  | 1 3000              |             |              |               |                |    |
| 6        | Location/S  | Station:                 | 35+00 to 3                               | -          |   |                     |             |              |               |                |    |
| 7        |             |                          |  |            |   |                     |             |              |               |                |    |
| 8<br>9   | Dolovert F  | •                        |  |            |   |                     |             |              |               |                |    |
|          | Relevant E  | quations                 |  |            |   |                     |             |              |               |                |    |
| 10<br>11 |             |                          |  |            |   |                     |             |              |               |                |    |
| 12       |             |                          | 201113                                   |            |   |                     |             |              |               |                |    |
| 13       |             | $d_{50} = \frac{0}{d}$   | $\frac{.001V_a}{a}$                      |            |   |                     |             |              |               |                |    |
| 14       |             | d                        | $\frac{1}{a_{yg}} \frac{a}{K_{1}^{1.5}}$ |            |   |                     |             |              |               |                |    |
| 15       |             |                          |  |            |   |                     |             |              |               |                |    |
| 16       |             | ſ                        | $\sin^2 \theta$                          | 7          |   |                     |             |              |               |                |    |
| 17       |             | $K_1 = 1$                |  |            |   |                     |             |              |               |                |    |
| 18       |             | L                        | $\sin^2 \phi$                            |            |   |                     |             |              |               |                |    |
|          | Where,      | d -                      | NA. 12 12                                | -          |   |                     |             |              |               |                |    |
| 20       |             | d <sub>50</sub> =        | Median diar                              |            |   |                     |             |              |               |                |    |
| 21       |             | ∨ <sub>a</sub> =         | Average ve                               |            |   |                     |             |              |               |                |    |
| 22       |             | d <sub>avg</sub> =       | Average de                               |            |   | nain ch             | nannel, ft  |              |               |                |    |
| 23       |             | K <sub>1</sub> =         | Bank angle                               |            |   |                     |             |              |               |                | [  |
| 24<br>25 |             | $\theta =$               | Bank angle                               | with the   | horizonta   | l, degr             | ee          |              |               |                |    |
| 25       |             | φ =                      | Riprap mate                              | erial's an | gle of rep  | ose, de             | egree       |              |               |                |    |
| 27       |             |                          |  |            |   |                     |             |              |               |                |    |
|          | Input Para  | meters                   |  |            |   |                     |             |              |               |                |    |
| 29       | (Based on a | output from              | FlowMaster                               | and bas    | sed on the  | Manu                | al)         |              |               |                |    |
| 30       |             |                          |  |            |   |                     | ,           |              |               |                |    |
| 31       |             | V <sub>a</sub> =         | 4.43 1                                   | ft/s       |   |                     |             |              |               |                |    |
| 32       |             | d <sub>avg</sub> =       | 1.55 f                                   | ft         |   |                     |             |              |               |                |    |
| 33       |             | D <sub>50</sub> =        | 2 i                                      | nch        | Assume  | a D <sub>50</sub> a | and then a  | calculate if | it is stable. |                |    |
| 34       |             | θ =                      | 21.80                                    |            | [2.5:1 (H   |                     |             |              |               |                |    |
| 35       |             | $\phi = [$               | 41.0                                     | degree     | From Fig  | ure 6.1             | 14 of the I | Manual for   | rounded rip   | rap - attached | d. |
| 36<br>37 | Honoc       |                          |  |            |   |                     |             |              | -1-           | ,              |    |
|          | Hence,      | K                        | 0.00                                     |            |   |                     |             |              |               |                |    |
| 38       |             | K1 =                     | 0.82                                     |            |   |                     |             |              |               |                |    |
| 39       |             | d <sub>50</sub> =        | 0.09 f                                   | -          |   |                     |             |              |               |                |    |
| 40       |             | d <sub>50</sub> (inch) = | 2 ii                                     | nch        | <d50< td=""><td>= 2 i</td><td>nches is s</td><td>stable.</td><td></td><td></td><td></td></d50<> | = 2 i               | nches is s  | stable.      |               |                |    |
| 41       |             |                          |  |            |   |                     |             |              |               |                |    |
| 43       | Therefor    | a proposo                | d design rip                             |            | . (al. )  |                     |             | 7            |               |                |    |
|          | mereror     | e, propose               | u uesign fip                             | siap size  | $= (a_{50}) =$  | 2 ii                | nch         | <u> </u>     |               |                |    |

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|          | A B C D E F G H I J K   |
|----------|---|
| 1        | Calculation of Riprap Size for Channel Lining   |
| 2        | Calculations are based on Drainage Design Manual for Maricopa County (Manual)   |
| 3        |   |
| 4        | Channel Name: Cholla Ash ONSITE Channel section 2   |
| 5        | Design Flood Freque 100 -yr   |
|          | Location/Station: 35+00 to 38+50  |
| 7        |   |
| 8        | Relevant Equations  |
| 10       | Relevant Equations  |
| 11       |   |
| 12       | 0.0011/3  |
| 13       | $d_{50} = \frac{0.001 V_a^3}{d_{avg}^{0.5} K_1^{1.5}}$  |
| 14       | $\int d_{avg}^{a,s} K_1^{a,s} + \int d_{avg}^{a,s} K_1^{a,s} + $ |
| 15       |   |
| 16<br>17 | $\left[ \int_{\mathcal{U}} \sin^2 \theta \right]^{0.5}$   |
| 18       | $K_1 = \left  1 - \frac{\sin^2 \phi}{\sin^2 \phi} \right $  |
|          | Where,  |
| 20       | $d_{50}$ = Median diameter of the riprap materials, ft  |
| 21       | $V_a$ = Average velocity in the main channel, ft/s  |
| 22       | d <sub>avg</sub> = Average depth of flow in the main channel, ft  |
| 23       | $K_1 =$ Bank angle correction factor  |
| 24       | $\theta$ = Bank angle with the horizontal, degree   |
| 25       | $\phi$ = Riprap material's angle of repose, degree  |
| 26       |   |
| 27       | Input Parameters  |
|          | (Based on output from FlowMaster and based on the Manual)   |
| 30       |   |
| 31       | $V_a = 4.69$ ft/s   |
| 32       | $d_{avg} = 1.48$ ft   |
| 33       | $D_{50} = 2$ inch Assume a $D_{50}$ and then calculate if it is stable.   |
| 34       | $\theta$ = 21.80 degree [2.5:1 (H:V)]   |
| 35       | $\phi = 41.0$ degree From Figure 6.14 of the Manual for rounded riprap - attached.  |
| 36       |   |
|          | Hence,<br>K1 = 0.82   |
| 38       |   |
| 39       |   |
| 40       | $d_{50}$ (inch) = 2 inch <d50 2="" =="" inches="" is="" stable.<="" th=""></d50>  |
| 41       |   |
| 43       | Therefore, proposed design riprap size $(d_{50}) = 2$ inch  |
| <u> </u> | 2 Inch  |

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|          | A B C D E   | F G                          | Н                |             | J        | К  |
|----------|---|------------------------------|------------------|-------------|----------|----|
| 1        | Calculation of Riprap Size for Channel Li                   |                              | 1                |             |          |    |
| 2        |   | ial for Maricona             | County/M-        | leural)     |          |    |
| 3        |   | arior maricopa               | County (Ma       | anuarj      |          |    |
| 4        |   | l contina 2                  |                  |             |          |    |
| 5        |   | i section 5                  |                  |             |          |    |
| 6        |   |                              |                  |             |          |    |
| 7        |   |                              |                  |             |          |    |
| 8        |   |                              |                  |             |          |    |
| 9        | Relevant Equations  |                              |                  |             |          |    |
| 10       |   |                              |                  |             |          |    |
| 11       |   |                              |                  |             |          |    |
| 12       | $(0.001 V_a^3)$   |                              |                  |             |          |    |
| 13       |   |                              |                  |             |          |    |
| 14       | + avg - 1   |                              |                  |             |          |    |
| 16       |   |                              |                  |             |          |    |
| 17       |   |                              |                  |             |          |    |
| 18       |   |                              |                  |             |          |    |
| 19       | Where,  |                              |                  |             |          |    |
| 20       | d <sub>50</sub> = Median diameter of the riprap             | materials, ft                |                  |             |          |    |
| 21       |   |                              |                  |             |          |    |
| 22       |   |                              |                  |             |          |    |
| 23       |   |                              |                  |             |          |    |
| 24       | $\theta = Bank angle with the horizontal$                   | l. dearee                    |                  |             |          |    |
| 25       | $\phi = Riprap material's angle of rep$                     |                              |                  |             |          |    |
| 26       | 5   | Ū                            |                  |             |          |    |
| 27       |   |                              |                  |             |          |    |
|          | Input Parameters  |                              |                  |             |          |    |
| 29<br>30 |   | Manual)                      |                  |             |          |    |
| 31       |   |                              |                  |             |          |    |
| 32       |   |                              |                  |             |          |    |
|          |   | • D. • • ! !!                |                  |             |          |    |
| 33       |   | a D <sub>50</sub> and then c | alculate if it i | s stable.   |          |    |
| 35       |   |                              | Ionual for       |             |          | a  |
| 36       |   | ure 6.14 of the M            | anual for ro     | unded ripra | attached | J. |
|          |   |                              |                  |             |          |    |
| 38       | K <sub>1</sub> = 0.82                                       |                              |                  |             |          |    |
| 39       | $d_{50} = 0.05 \text{ ft}$                                  |                              |                  |             |          |    |
| 40       |   | = 1 inches is s              | table            |             |          |    |
| 41       |   | 1 110103 13 5                |                  |             |          |    |
| 42       |   |                              |                  |             |          |    |
| 43       | Therefore, proposed design riprap size (d <sub>50</sub> ) = | 1 inch                       |                  |             |          |    |
| ·        |   |                              | L                |             |          |    |

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|----------|--|
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|          | А          | В                        | С  | D                     | E   | F        | G           | H              | 1           | J            | K  |
|----------|------------|--------------------------|--|-----------------------|---|----------|-------------|----------------|-------------|--------------|----|
| 1        | Calculati  | on of Rip                | orap Size  | for Cha               | nnel Lin  | ina      |             | h              |             | -            |    |
| 2        |            |                          | ed on Drair  |                       |   |          | Maricopa    | County (Ma     | anual)      |              |    |
| 3        |            |                          |  | Ū                     | •   |          |             | ,              | ,           |              |    |
| 4        | Channel N  | ame:                     | Cholla Asł   |                       | Channel   | secti    | ion 4       |                |             |              |    |
| 5        | Design Flo | od Freque                |  |                       |   |          |             |                |             |              |    |
| 6        | Location/S | station:                 | 35+00 to 3   | 8+50                  |   |          |             |                |             |              |    |
| 7        |            |                          |  |                       |   |          |             |                |             |              |    |
| 8        | D - 1      |                          |  |                       |   |          |             |                |             |              |    |
|          | Relevant E | quations                 |  |                       |   |          |             |                |             |              |    |
| 10       |            |                          |  |                       |   |          |             |                |             |              |    |
| 11<br>12 |            |                          |  |                       |   |          |             |                |             |              |    |
| 13       |            | $d_{m} = \frac{0}{2}$    | $.001V_{a}^{+}$                                      |                       |   |          |             |                |             |              |    |
| 14       |            | $d_{50} = \frac{0}{d}$   | $\begin{bmatrix} 0.5 \\ avg \end{bmatrix} K_1^{1.5}$ |                       |   |          |             |                |             |              |    |
| 15       |            | L                        |  |                       |   |          |             |                |             |              |    |
| 16       |            | Г                        | $\sin^2 \Theta^{-1}$                                 | 5                     |   |          |             |                |             |              |    |
| 17       |            | $K_{1} = 1$              | $-\frac{\sin^2\theta}{1-2}$                          |                       |   |          |             |                |             |              |    |
| 18       | 10/1-      | L                        | $\sin^{+}\phi$                                       |                       |   |          |             |                |             |              |    |
|          | Where,     | d –                      | N 4 1'   |                       |   |          |             |                |             |              |    |
| 20       |            | d <sub>50</sub> =        | Median dia   |                       |   |          |             |                |             |              |    |
| 21       |            | V <sub>a</sub> =         | Average ve   |                       |   |          |             |                |             |              |    |
| 22       |            | d <sub>avg</sub> =       | Average de   |                       |   | ain cl   | nannel, ft  |                |             |              |    |
| 23       |            | K <sub>1</sub> =         | Bank angle   |                       |   |          |             |                |             |              |    |
| 24       |            | θ =                      | Bank angle   |                       |   |          |             |                |             |              |    |
| 25<br>26 |            | φ =                      | Riprap mat   | erial's an            | gle of repo   | se, d    | egree       |                |             |              |    |
| 27       |            |                          |  |                       |   |          |             |                |             |              |    |
| 28       | Input Para | meters                   |  |                       |   |          |             |                |             |              |    |
|          |            |                          | I FlowMaste  | r and bas             | ed on the l   | Manu     | ual)        |                |             |              |    |
| 30       |            |                          |  |                       |   |          | -           |                |             |              |    |
| 31       |            | V <sub>a</sub> =         | 4.63   | ft/s                  |   |          |             |                |             |              |    |
| 32       |            | d <sub>avg</sub> =       | 1.49   | ft                    |   |          |             |                |             |              |    |
| 33       |            | D <sub>50</sub> =        | 2  | inch                  | Assume a  | $D_{50}$ | and then ca | alculate if it | is stable.  |              |    |
| 34       |            | θ =                      |  | degree                | [2.5:1 (H:\   |          |             |                |             |              |    |
| 35       |            | $\phi$ =                 | 41.0   | degree                | From Figu   | ire 6.   | 14 of the M | lanual for ro  | ounded ripr | ap - attache | d. |
| 36       | Hence,     |                          |  |                       |   |          |             |                |             |              |    |
|          |            | K1 =                     | 0.82   |                       |   |          |             |                |             |              |    |
| 38       |            | $d_{50} =$               |  | £1.                   |   |          |             |                |             |              |    |
| 39       |            |                          | 0.11   |                       | 0.55  | -        |             |                |             |              |    |
| 40       |            | d <sub>50</sub> (inch) = | 2  | inch                  | <d50 =<="" td=""><td>: 2</td><td>inches is s</td><td>table.</td><td></td><td></td><td></td></d50> | : 2      | inches is s | table.         |             |              |    |
| 41       |            |                          |  |                       |   |          |             |                |             |              |    |
| 43       | Therefor   | e propos                 | ed design r  | inran ei <del>a</del> | a(d) =  |          | inch        | 1              |             |              |    |
|          |            | s, proposi               | sa design f  | ipi ap sizi           | = (u <sub>50</sub> ) -  | 12       | inch        | L              |             |              |    |

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|          | A          | В                        | С   | D          | E  | F               | G            | Н              | 1            | J            | K  |
|----------|------------|--------------------------|---|------------|--|-----------------|--------------|----------------|--------------|--------------|----|
| 1        | Calculati  | on of Rip                | orap Size                                     | for Cha    | nnel Lin   | ina             |              |                |              | I            |    |
| 2        |            |                          | ed on Drain                                   |            |  |                 | Maricopa     | County (Ma     | anual)       |              |    |
| 3        |            |                          |   | -          | -  |                 | ·            |                |              |              |    |
| 4        | Channel Na | ame:                     | Cholla Ash                                    |            | Channel s  | sect            | ion 5        |                |              |              |    |
| 5        | Design Flo | od Freque                | 100   | -yr        |  |                 |              |                |              |              |    |
| 6        | Location/S | tation:                  | 35+00 to 3                                    | 8+50       |  |                 |              |                |              |              |    |
| 7        |            |                          |   |            |  |                 |              |                |              |              |    |
| 89       | Relevant E | quations                 |   |            |  |                 |              |                |              | •            |    |
| 10       |            | quations                 |   |            |  |                 |              |                |              |              |    |
| 11       |            |                          |   |            |  |                 |              |                |              |              |    |
| 12       |            |                          | 001123  |            |  |                 |              |                |              |              |    |
| 13       |            | $d_{50} = \frac{0}{d}$   | .001V //                                      |            |  |                 |              |                |              |              |    |
| 14       |            | d d                      | $\frac{d}{d} \frac{K_1}{K_1}$                 |            |  |                 |              |                |              |              |    |
| 15       |            |                          |   | ~          |  |                 |              |                |              |              |    |
| 16       |            | [                        | $\sin^2 \theta$                               | 5          |  |                 |              |                |              |              |    |
| 17<br>18 |            | $ K_1  =  1 $            | $-\frac{\sin^2\theta}{\sin^2\phi}\Big]^{0.5}$ |            |  |                 |              |                |              |              |    |
| 19       | Where,     | L                        | SIL Y   |            |  |                 |              |                |              |              |    |
| 20       |            | d <sub>50</sub> =        | Median dia                                    | meter of   | the riprap n   | nate            | rials, ft    |                |              |              |    |
| 21       |            | V <sub>a</sub> =         | Average ve                                    |            |  |                 |              |                |              |              |    |
| 22       |            | d <sub>avg</sub> =       | Average de                                    |            |  |                 |              |                |              |              |    |
| 23       |            | K1 =                     | Bank angle                                    | correctio  | on factor  |                 |              |                |              |              |    |
| 24       |            | θ =                      | Bank angle                                    | with the   | horizontal,  | degi            | ree          |                |              |              |    |
| 25       |            | φ =                      | Riprap mat                                    | erial's an | gle of repos   | se, d           | legree       |                |              |              |    |
| 26       |            |                          |   |            |  |                 |              |                |              |              |    |
| 27<br>28 | Input Para | matara                   |   |            |  |                 |              |                |              |              |    |
| 20       |            |                          | FlowMaste                                     | r and has  | ed on the N  | Mani            | (ادر         |                |              |              |    |
| 30       |            | pat non                  | iommusic                                      |            |  | viaill          | aan          |                |              |              |    |
| 31       |            | V <sub>a</sub> =         | 3.53  | ft/s       |  |                 |              |                |              |              |    |
| 32       |            | d <sub>avg</sub> =       | 0.92  | ft         |  |                 |              |                |              |              |    |
| 33       |            | D <sub>50</sub> =        | 1   | inch       | Assume a   | D <sub>50</sub> | and then ca  | alculate if it | is stable.   |              |    |
| 34       |            | θ =                      | 21.80   | degree     | [2.5:1 (H:\  |                 |              |                |              |              |    |
| 35       |            | $\phi =$                 | 41.0  | degree     | From Figu  | re 6            | .14 of the N | lanual for ro  | ounded ripra | ap - attache | d. |
| 36       | Llana      |                          |   |            |  |                 |              |                |              |              |    |
|          | Hence,     | K -                      | 0.00  |            |  |                 |              |                |              |              |    |
| 38       |            | K1 =                     | 0.82  | <i>t</i> . |  |                 |              |                |              |              |    |
| 39       |            | d <sub>50</sub> =        | 0.06  |            |  |                 |              |                |              |              |    |
| 40       |            | d <sub>50</sub> (inch) = | 1   | inch       | <d50 =<="" th=""><th>: 1</th><th>inches is sl</th><th>table.</th><th></th><th></th><th></th></d50> | : 1             | inches is sl | table.         |              |              |    |
| 41<br>42 |            |                          |   |            |  |                 |              |                |              |              |    |
| 42       | Therefor   | e propos                 | ed design ri                                  | inran eiz  | o (d.) -   | 4               | inch         | I              |              |              |    |
| 43       | inereloi   | e, proposi               | eu uesign ri                                  | iprap siz  | $e_{(a_{50})} =$   | 11              | inch         | L              |              |              |    |

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|    | A B C D E F G H I J K  |
|----|--|
| 1  | Calculation of Riprap Size for Channel Lining  |
| 2  | Calculations are based on Drainage Design Manual for Maricopa County (Manual)                                |
| 3  |  |
| 4  | Channel Name: Cholla Ash ONSITE Channel section 6  |
| 5  | Design Flood Freque 100 -yr  |
| 6  | Location/Station: 35+00 to 38+50   |
| 7  |  |
| 8  |  |
|    | Relevant Equations   |
| 10 |  |
| 12 |  |
| 13 | $d_{in} = \frac{0.001 V_a}{1000}$  |
| 14 | $d_{50} = \frac{0.001 V_a^3}{d_{acs}^{0.5} K_1^{1.5}}$   |
| 15 |  |
| 16 | $\begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}^{0.5}$  |
| 17 | $ \Lambda_1 =  I - \dots \rangle$  |
| 18 | $\sin^2 \phi$  |
| 20 | Where. $d_{50} = Median diameter of the riprap materials. ft$  |
| 21 | $d_{50}$ = Median diameter of the riprap materials, ft<br>$V_a$ = Average velocity in the main channel, ft/s |
| 22 | $d_{avg} = Average depth of flow in the main channel, ft$  |
| 23 | $K_1 =$ Bank angle correction factor   |
| 24 | $\theta$ = Bank angle with the horizontal, degree  |
| 25 | $\phi$ = Riprap material's angle of repose, degree   |
| 26 |  |
| 27 |  |
|    | Input Parameters   |
| 30 | Based on output from FlowMaster and based on the Manual)   |
| 31 | $V_a = 3.53$ ft/s  |
| 32 | $d_{avg} = 0.92$ ft  |
| 33 | $D_{50} = 1$ inch Assume a $D_{50}$ and then calculate if it is stable.                                      |
| 34 | $\theta = 21.80$ degree [2.5:1 (H:V)]  |
| 35 | $\phi$ = 41.0 degree From Figure 6.14 of the Manual for rounded riprap - attached.                           |
| 36 |  |
|    | Hence,   |
| 38 | $K_1 = 0.82$   |
| 39 | $d_{50} = 0.06 \text{ ft}$   |
| 40 | $d_{50}$ (inch) = 1 inch <d50 1="" =="" inches="" is="" stable.<="" th=""></d50>                             |
| 41 |  |
| 42 |  |
| 43 | Therefore, proposed design riprap size (d <sub>50</sub> ) = 1 inch   |

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### Cholla Ash Monofill Riprap Calculation

|          | A B                                   | СТ   | D       | E   | F      | G            | Н               |             | J            | К  |
|----------|---------------------------------------|--|---------|---|--------|--------------|-----------------|-------------|--------------|----|
| 1        | Calculation of                        | Riprap Size fo   |         |   | ing    | <u> </u>     |                 |             | J            | Γ. |
| 2        | Calculations are                      | based on Draina  | ae Des  | ian Manua   | al for | Maricona     | County /M       | (احبيم      |              |    |
| 3        | 1                                     |  | 5       | -gri mana   |        | maneopa      | oounty (ma      | inual)      |              |    |
| 4        | Channel Name:                         | Cholla Ash (   |         | Dron Str  | ictur  | s saction .  | 7               |             |              |    |
| 5        | Design Flood Fre                      | eque 100 - y   |         | . Drop our  | acture | section      |                 |             |              |    |
| 6        | Location/Station                      |  |         |   |        |              |                 |             |              |    |
| 7        | ]                                     |  |         |   |        |              |                 |             |              |    |
| 8        |                                       |  |         |   |        |              |                 |             |              |    |
| 9        | Relevant Equation                     | ns   |         |   |        |              |                 |             |              |    |
| 10       |                                       |  |         |   |        |              |                 |             |              |    |
| 11       | ا                                     |  |         |   |        |              |                 |             |              |    |
| 12<br>13 |                                       | $-\frac{0.001V_a^3}{2}$                                |         |   |        |              |                 |             |              |    |
| 14       | <sup>cr</sup> 50                      | $=\frac{0.001V_a^3}{d_{avg}^{0.5}K_1^{1.5}}$           |         |   |        |              |                 |             |              |    |
| 15       | <u>ا</u> ا                            |  |         |   |        |              |                 |             |              |    |
| 16       |                                       | $\left[ \sin^2 \theta \right]^{0.5}$                   |         |   |        |              |                 |             |              |    |
| 17       | $K_1$ :                               | $= \left  1 - \frac{\sin \theta}{\cos \theta} \right $ |         |   |        |              |                 |             |              |    |
| 18       |                                       | $\begin{bmatrix} \sin^-\phi \end{bmatrix}$             |         |   |        |              |                 |             |              |    |
|          | Where,                                |  |         |   |        |              |                 |             |              |    |
| 20       | d <sub>50</sub> =<br>V <sub>a</sub> = | Median diam  |         |   |        |              |                 |             |              |    |
| 21       |                                       | Average velo   |         |   |        |              |                 |             |              |    |
| 22       | d <sub>avg</sub> =                    | Average dept   |         |   | ain ch | annel, ft    |                 |             |              |    |
| 23<br>24 | K <sub>1</sub> =<br>θ =               | Bank angle o   |         |   |        |              |                 |             |              |    |
| 25       | φ =                                   | Bank angle w   | in the  | horizontal,   | degre  | e            |                 |             |              |    |
| 26       | φ-                                    | Riprap materi  | ais an  | gie or repo   | se, ae | gree         |                 |             |              |    |
| 27       |                                       |  |         |   |        |              |                 |             |              |    |
|          | Input Parameters                      |  |         |   |        |              |                 |             |              |    |
| 29       | (Based on output I                    | rom FlowMaster a                                       | ind bas | ed on the I   | Manua  | al)          |                 |             |              |    |
| 30       |                                       |  |         |   |        |              |                 |             |              |    |
| 31       | ∨ <sub>a</sub> =                      | 9.44 ft/   | S       |   |        |              |                 |             |              |    |
| 32       | d <sub>avg</sub> =                    | 0.39 ft  |         |   | _      |              |                 |             |              |    |
| 33       | D <sub>50</sub> =                     | 22 in  |         |   |        | nd then ca   | lculate if it i | s stable.   |              |    |
| 34<br>35 | $\theta = \phi = 0$                   | 21.80 de   |         | [2.5:1 (H:\   |        |              |                 |             |              |    |
| 36       | φ =                                   | 41.0 de  | gree    | From Figu   | re 6.1 | 4 of the M   | anual for ro    | unded ripra | p - attached | i. |
|          | Hence,                                |  |         |   |        |              |                 |             |              |    |
| 38       | K <sub>1</sub> =                      | 0.82   |         |   |        |              |                 |             |              |    |
| 39       | d <sub>50</sub> =                     | 1.80 ft  |         |   |        |              |                 |             |              |    |
| 40       | d <sub>50</sub> (inc                  | h)= 22 ind   | ch      | <d50 =<="" td=""><td>22 ir</td><td>nches is sta</td><td>able.</td><td></td><td></td><td></td></d50> | 22 ir  | nches is sta | able.           |             |              |    |
| 41       |                                       |  |         |   |        |              |                 |             |              |    |
| 42       | <b>T</b> 1 (                          |  |         |   |        |              |                 |             |              |    |
| 43       | Therefore, prop                       | oosed design ripr                                      | ap size | e (d <sub>50</sub> ) =  | 22 ir  | nch          |                 |             |              |    |
|          |                                       |  |         |   |        |              |                 |             |              |    |

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|    | A          | В                        | С  | D         | E  | F      | G            | Н             |              | J                                     | к  |
|----|------------|--------------------------|--|-----------|--|--------|--------------|---------------|--------------|---------------------------------------|----|
| 1  | Calculat   | ion of Rin               | orap Size  | for Cha   |  |        | <u> </u>     |               | <u> </u>     |                                       |    |
| 2  |            |                          | ed on Drain  |           |  |        | Maricona     | County (N     | (anual)      |                                       |    |
| 3  |            |                          |  | age 200   | .gir mana  |        | mancopa      | oounty (n     | anuarj       |                                       |    |
| 4  | Channel N  | ame                      | Cholla Ash   |           | Channel  | Foot   | ion 7        |               |              |                                       |    |
|    | Design Flo |                          |  |           | . Channel  | 3001   |              |               |              |                                       |    |
| 6  | Location/S |                          | 35+00 to 3   |           |  |        |              |               |              |                                       |    |
| 7  |            |                          |  |           |  |        |              |               |              |                                       |    |
| 8  |            |                          |  |           |  |        |              |               |              |                                       |    |
|    | Relevant E | quations                 |  |           |  |        |              |               |              |                                       |    |
| 10 |            |                          |  |           |  |        |              |               |              |                                       |    |
| 11 |            |                          | ····· , ]  |           |  |        |              |               |              |                                       |    |
| 13 |            | $d_{1} = \frac{0}{2}$    | .001V  |           |  |        |              |               |              |                                       |    |
| 14 |            | $d_{50} = \frac{0}{d}$   | $\begin{bmatrix} 0.5 \\ avg \end{bmatrix} K_1^{1.5}$ |           |  |        |              |               |              |                                       |    |
| 15 |            |                          |  |           |  |        |              |               |              |                                       |    |
| 16 |            | Г                        |  | 7         |  |        |              |               |              |                                       |    |
| 17 |            | $K_{1} = 1$              | $-\frac{\sin^2\theta}{\cos^2\theta}$                 |           |  |        |              |               |              |                                       |    |
| 18 |            |                          | $\sin^2 \phi$  |           |  |        |              |               |              |                                       |    |
|    | Where,     | d –                      | NA   |           |  |        |              |               |              |                                       |    |
| 20 |            | d <sub>50</sub> =        | Median dia   |           |  |        |              |               |              |                                       |    |
| 21 |            | ∨ <sub>a</sub> =         | Average ve   |           |  |        |              |               |              |                                       |    |
| 22 |            | d <sub>avg</sub> =       | Average de   |           |  | ain c  | hannel, ft   |               |              |                                       |    |
| 23 |            | K <sub>1</sub> =         | Bank angle   |           |  |        |              |               |              |                                       |    |
| 25 |            | $\Theta = \phi =$        | Bank angle   |           |  |        |              |               |              |                                       |    |
| 26 |            | $\psi$ -                 | Riprap mate  | enais an  | gie of repo  | ise, u | legree       |               |              |                                       |    |
| 27 |            |                          |  |           |  |        |              |               |              |                                       |    |
|    | Input Para |                          |  |           |  |        |              |               |              |                                       |    |
|    | (Based on  | output from              | FlowMaster   | r and bas | sed on the   | Manu   | ual)         |               |              |                                       |    |
| 30 |            |                          | ı  |           |  |        |              |               |              |                                       |    |
| 31 |            | ∨ <sub>a</sub> =         | 3.53   |           |  |        |              |               |              |                                       |    |
| 32 |            | d <sub>avg</sub> =       | 0.92   |           |  |        |              |               |              |                                       |    |
| 33 |            | D <sub>50</sub> =        |  | inch      |  |        | and then c   | alculate if i | t is stable. |                                       |    |
| 34 |            | $\theta =$               |  | degree    | [2.5:1 (H:   |        |              |               |              |                                       |    |
| 35 |            | $\phi =$                 | 41.0   | degree    | ⊢rom Fig   | ure 6  | .14 of the I | Aanual for    | rounded ripr | ap - attache                          | d. |
|    | Hence,     |                          |  |           |  |        |              |               |              |                                       |    |
| 38 |            | K1 =                     | 0.82   |           |  |        |              |               |              |                                       |    |
| 39 |            | d <sub>50</sub> =        | 0.06   | ft        |  |        |              |               |              |                                       |    |
| 40 |            | d <sub>50</sub> (inch) = |  | inch      | <d50< td=""><td>= 1</td><td>inches is s</td><td>table</td><td></td><td></td><td></td></d50<> | = 1    | inches is s  | table         |              |                                       |    |
| 41 |            | 50 (                     |  |           | 000  |        |              |               |              |                                       |    |
| 42 |            |                          |  |           |  |        |              |               |              |                                       |    |
| 43 | Therefo    | re, propose              | ed design ri   | prap siz  | e (d <sub>50</sub> ) =   | 1      | inch         | ]             |              |                                       |    |
|    |            |                          |  |           |  |        |              |               |              | · · · · · · · · · · · · · · · · · · · |    |

Page \_\_\_\_\_. Date:\_\_\_\_\_

.

| <u> </u> | A   | В                        | С  | D           | E  | IFT                 | G           | н              | I           | J            | K  |
|----------|---|--------------------------|--|-------------|--|---------------------|-------------|----------------|-------------|--------------|----|
| 1        | 1   |                          | orap Size  | -           |  |                     |             | I              | L '         | I            |    |
| 2        |   |                          |  |             |  |                     | Maricopa    | County (Ma     | anual)      |              |    |
| 3        | Calculations are based on Drainage Design Manual for Maricopa County (Manual) |                          |  |             |  |                     |             |                |             |              |    |
| 4        | Channel Name: Cholla Ash ONSITE Channel section 8                             |                          |  |             |  |                     |             |                |             |              |    |
| 5        | Design Flo  | ood Freque               |  |             |  |                     |             |                |             |              |    |
| 6        | Location/Station: 35+00 to 38+50  |                          |  |             |  |                     |             |                |             |              |    |
| 7        | -   |                          |  |             |  |                     |             |                |             |              |    |
| 8        | Delevent  |                          |  |             |  |                     |             |                |             |              |    |
|          | Relevant E  | quations                 |  |             |  |                     |             |                |             |              |    |
| 10       | -   |                          |  |             |  |                     |             |                |             |              |    |
| 12       | •   |                          | 0011/3   |             |  |                     |             |                |             |              |    |
| 13       | 1   | $d_{50} = \frac{0}{d}$   | .001V //   |             |  |                     |             |                |             |              |    |
| 14       |   | ct ct                    | $\begin{bmatrix} m_{avg} \\ avg \end{bmatrix} K_{1}^{max}$ |             |  |                     |             |                |             |              |    |
| 15       |   |                          |  |             |  |                     |             |                |             |              |    |
| 16       | •   | Ι., Γ.                   | $-\frac{\sin^2\theta}{\sin^2\phi}\bigg]^0$                 | .5          |  |                     |             |                |             |              |    |
| 18       | -   | $K_1 = 1$                | $-\frac{1}{\sin^2 \phi}$                                   |             |  |                     |             |                |             |              |    |
|          | Where,  | L                        |  |             |  |                     |             |                |             |              |    |
| 20       | 1   | d <sub>50</sub> =        | Median dia   | meter of    | the riprap   | materi              | als, ft     |                |             |              |    |
| 21       |   | $\vee_a =$               | Average ve   | elocity in  | the main c   | hannel              | , ft/s      |                |             |              |    |
| 22       |   | d <sub>avg</sub> =       | Average d  | epth of flo | w in the n   | nain ch             | annel, ft   |                |             |              |    |
| 23       |   | K1 =                     | Bank angle   | e correctio | on factor  |                     |             |                |             |              |    |
| 24       | ]   | θ =                      | Bank angle   | e with the  | horizonta  | l, degre            | ee          |                |             |              |    |
| 25       |   | $\phi$ =                 | Riprap ma  | terial's an | gle of rep   | ose, de             | egree       |                |             |              |    |
| 26<br>27 |   |                          |  |             |  |                     |             |                |             |              |    |
| 28       | Input Para  | meters                   |  |             |  |                     |             |                |             |              |    |
| 29       | (Based on   | output from              | n FlowMaste  | er and bas  | sed on the   | Manu                | al)         |                |             |              |    |
| 30       |   |                          |  | •           |  |                     |             |                |             |              |    |
| 31       |   | V <sub>a</sub> =         | 2.79   | ft/s        |  |                     |             |                |             |              |    |
| 32       |   | d <sub>avg</sub> =       | 1.12   | ft          |  |                     |             |                |             |              |    |
| 33       |   | D <sub>50</sub> =        |  | linch       | Assume   | a D <sub>50</sub> a | and then c  | alculate if it | is stable.  |              |    |
| 34       | 4   | θ =                      |  | degree      | [2.5:1 (H  |                     |             |                |             |              |    |
| 35       | -   | $\phi =$                 | 41.0   | degree      | From Fig   | jure 6.1            | 14 of the N | Manual for ro  | ounded ripr | ap - attache | d. |
| 36       | Hence,  |                          |  |             |  |                     |             |                |             |              |    |
| 38       |   | K <sub>1</sub> =         | 0.82   |             |  |                     |             |                |             |              |    |
| 39       | 1   | d <sub>50</sub> =        | 0.02   |             |  |                     |             |                |             |              |    |
| 40       | 1   | d <sub>50</sub> (inch) = |  | inch        | <d50< th=""><th>= 1;</th><th>nches is s</th><th>tahle</th><th></th><th></th><th></th></d50<> | = 1;                | nches is s  | tahle          |             |              |    |
| 40       | 1   | ~50 (mon) -              | '  | 11011       | 000  | - 11                | 101103 15 5 |                |             |              |    |
| 42       |   |                          |  |             |  |                     |             |                |             |              |    |
| 43       | Therefo   | re, propos               | ed design ı  | riprap siz  | :e (d <sub>50</sub> ) =  | 1 i                 | nch         | 1              |             |              |    |
|          |   |                          |  |             |  |                     |             |                |             |              |    |

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|----------|--|
| Checked: |  |

|          | A   | В                        | С  | D            | E  | F                 | G           | Н              | I           | J            | К   |
|----------|---|--------------------------|--|--------------|--|-------------------|-------------|----------------|-------------|--------------|-----|
| 1        | Calculat  | ion of Rip               | orap Size                                  | for Cha      | nnel Li  | nina              |             | <b>.</b>       |             |              | L   |
| 2        |   |                          |  |              |  |                   | Maricopa    | County (Ma     | anual)      |              |     |
| 3        |   |                          |  | -            | -  |                   | •           |                | ,           |              |     |
| 4        | Channel Name: Cholla Ash ONSITE Channel section 9 |                          |  |              |  |                   |             |                |             |              |     |
| 5        |   | ood Freque               | e 100                                      | -yr          |  |                   |             |                |             |              |     |
| 6        | Location/S  | Station:                 | 35+00 to 3                                 | 8+50         |  |                   |             |                |             |              |     |
| 7        |   |                          |  |              |  |                   |             |                |             |              |     |
| 9        | Relevant I  | Equations                |  |              |  |                   |             |                |             |              |     |
| 10       |   | quationo                 |  |              |  |                   |             |                |             |              |     |
| 11       |   |                          |  |              |  |                   |             |                |             |              |     |
| 12       |   | 0                        | $001V^{3}$                                 |              |  |                   |             |                |             |              |     |
| 13       |   | $d_{50} = \frac{0}{d}$   | 105 K 15                                   |              |  |                   |             |                |             |              |     |
| 14       |   | (1                       | $a_{xg}\Lambda_{+}$                        |              |  |                   |             |                |             |              |     |
| 15<br>16 |   |                          |  | -            |  |                   |             |                |             |              |     |
| 17       |   | $\nu = 1$                | $\sin^2 \theta$                            | .)           |  |                   |             |                |             |              |     |
| 18       |   | $ \Lambda_1 =  1 $       | $-\frac{\sin^2\theta}{\sin^2\phi}\bigg]^0$ |              |  |                   |             |                |             |              |     |
|          | Where,  | L                        |  |              |  |                   |             |                |             |              |     |
| 20       |   | d <sub>50</sub> =        | Median dia                                 | meter of     | the riprap   | mater             | ials, ft    |                |             |              |     |
| 21       |   | V <sub>a</sub> =         | Average ve                                 | elocity in t | he main c  | hanne             | el, ft/s    |                |             |              |     |
| 22       |   | d <sub>avg</sub> =       | Average de                                 | epth of flo  | w in the n   | nain c            | nannel, ft  |                |             |              |     |
| 23       |   | K <sub>1</sub> =         | Bank angle                                 | e correctio  | on factor  |                   |             |                |             |              |     |
| 24       |   | θ =                      | Bank angle                                 | e with the   | horizonta  | l, degi           | ee          |                |             |              |     |
| 25       |   | $\phi =$                 | Riprap mat                                 | terial's an  | gle of rep   | ose, d            | egree       |                |             |              |     |
| 26<br>27 | {   |                          |  |              |  |                   |             |                |             |              |     |
| 28       | Input Para  | ameters                  |  |              |  |                   |             |                |             |              |     |
| 29       |   |                          | n FlowMaste                                | er and bas   | sed on the   | Manu              | al)         |                |             |              |     |
| 30       |   |                          |  |              |  |                   | ,           |                |             |              |     |
| 31       |   | V <sub>a</sub> =         | 2.79                                       | ft/s         |  |                   |             |                |             |              |     |
| 32       |   | d <sub>avg</sub> =       | 1.12                                       | ft           |  |                   |             |                |             |              |     |
| 33       |   | D <sub>50</sub> =        |  | linch        | Assume   | a D <sub>50</sub> | and then c  | alculate if it | is stable.  |              |     |
| 34       |   | $\theta$ =               |  | degree       | [2.5:1 (H  |                   |             |                |             |              |     |
| 35       |   | $\phi =$                 | 41.0                                       | degree       | From Fig   | jure 6            | 14 of the N | Manual for ro  | ounded ripr | ap - attache | ed. |
| 37       | Hence,  |                          |  |              |  |                   |             |                |             |              |     |
| 38       | rionee,   | K <sub>1</sub> =         | 0.82                                       |              |  |                   |             |                |             |              |     |
| 39       |   | d <sub>50</sub> =        | 0.03                                       | ft           |  |                   |             |                |             |              |     |
| 40       |   | d <sub>50</sub> (inch) = |  | inch         | <d50< th=""><th>= 1</th><th>inches is s</th><th>table</th><th></th><th></th><th></th></d50<> | = 1               | inches is s | table          |             |              |     |
| 41       |   | 50 ()                    | I  |              | 200  | . 1               |             |                |             |              |     |
| 42       |   |                          |  |              |  | _                 |             |                |             |              |     |
| 43       | Therefo   | re, propos               | ed design r                                | iprap siz    | e (d <sub>50</sub> ) =   | 1                 | inch        | ]              |             |              |     |
|          |   |                          |  |              |  |                   |             |                |             |              |     |

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|                | A                     | В  | С                                      | D                   |  |              | <u>.</u>   |           |
|----------------|-----------------------|--|--|---------------------|--|--------------|--|-----------|
| 1              | Calculation of Rip    | prap Size for Char                       | nel Lining                             | LU                  | E  | F            | G  | H         |
| 2              | Calculations are base | ed on Drainage Desig                     | n Manual for Maricon                   | a County (Manua     | IN   |              |  |           |
| 3              |                       | <b>J</b>                                 | in manadi tor maricop                  | a county (manua     | 1)   |              |  |           |
| 4              | Channel Name:         |  | Cholla Ash Offsite Cl                  | honnol o stiru d    |  |              |  |           |
|                | Design Flood Freque   | ncv:                                     | 100                                    |                     |  |              |  |           |
| 6              | Location/Station:     | ,  | 1+50 to 7+50                           | -yr                 |  |              |  |           |
| 7              |                       |  |  |                     |  |              |  |           |
| 8              |                       |  |  |                     |  |              |  |           |
|                | Relevant Equations    |  |  |                     |  |              |  |           |
| 10             |                       |  |  |                     |  |              |  |           |
| 11             |                       |  |  |                     |  |              |  |           |
| 12             |                       | 0.001                                    | $V^{3}$                                |                     |  |              |  |           |
| 13             |                       | $d_{50} = \frac{0.001}{d_{avg}^{0.5} K}$ | <u>a</u><br>r 1.5                      |                     |  |              |  |           |
| 14<br>15<br>16 |                       |  | <u>`1</u>                              |                     |  |              |  |           |
| 15             |                       | ·····                                    |  |                     |  |              |  |           |
| 17             |                       | , sin                                    | $n^2 \theta$                           |                     |  |              |  |           |
| 18             |                       |  | $\overline{n^2 \phi}$                  |                     |  |              |  |           |
| 19             | Where,                |  | ·                                      |                     |  |              |  |           |
| 20             |                       | d <sub>50</sub> =                        | Median diameter of the                 | e ripran materials  | ft   |              |  |           |
| 21             |                       |  | Average velocity in the                |                     |  |              |  |           |
| 22             | 1                     |  | Average depth of flow                  |                     |  |              |  |           |
| 23<br>24<br>25 |                       |  | Bank angle correction                  |                     |  |              |  |           |
| 24             |                       |  | Bank angle with the ho                 |                     |  |              |  |           |
| 25             |                       | $\phi =$                                 | Riprap material's angle                | e of repose, deared | 9  |              |  |           |
| 26             |                       |  | -                                      |                     |  |              |  |           |
| 27             | Input Parameters      |  |  |                     |  |              |  |           |
| 20             | (Based on output from | Elow Montor and have                     |  |                     |  |              |  |           |
| 30             |                       | nowinaster and based                     | on the Manual)                         |                     |  |              |  |           |
| 31             | Ň                     | √ <sub>a</sub> = [                       | 7.96                                   | ft/s                |  |              |  |           |
| 32             | (                     |  |  | ft                  |  |              |  |           |
| 33             |                       |  |  | inch                | Assume a D and th                                      |              | - <b>F</b> - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - |           |
| 34             |                       |  |  | degree              | Assume a D <sub>50</sub> and the                       | en calculate | if it is stable.                                 |           |
| 35             |                       |  |  | degree              | [2.5:1 (H:V)]  | ha Manual f  | an and the first                                 |           |
| 36             |                       | · L                                      | ······································ | 009100              | From Figure 6.14 of t                                  |              | or rounded riprap -                              | attached. |
|                | Hence,                |  |  |                     |  |              |  |           |
| 38             | ł                     | ζ <sub>1</sub> =                         | =(1-((SIN(RADIANS(C                    | 34)))^2/(SIN(RAD)   | ANS(C35)))^2))^0 5                                     |              |  |           |
| 39             | c                     | 1 <sub>50</sub> =                        | =0.001*C31^3/(C32^0.                   | 5*C38^1 5)          | ft   |              |  |           |
| 40             | c                     |  | =CEILING(C39*12,1) i                   |                     | <d50 =<="" td=""><td>-000</td><td></td><td></td></d50> | -000         |  |           |
| 41             |                       |  |  |                     |  | =C33 inch    | ies is stable.                                   |           |
| 42             |                       |  |  |                     |  |              |  |           |
| 43             | Therefore, proposed   | d design riprap size (                   | d <sub>50</sub> ) =                    |                     |  | =C33 inch    |  |           |
| _              |                       |  |  |                     |  | 1-033 men    | 1  |           |

Onsite SOUTH Channel-DROP Date: 02/12/2009 Time: 17:05 \*\*\*\*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* RΥ \* \* WEST Consultants, Inc. \* \* \* \* Version 3.0 March, 2005 \* \* \* \*  $\frac{1}{2}$ \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* WEB:WWW.WESTCONSULTANTS.COM \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite SOUTH Channel DROP

USACE Method

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 7.96 ft/s N/A N/A 165. lbs/cu ft 1.00 0.29 ft 2.50 1.1 Channel Bank Angular

Average

### Output Results:

Computed D300.60 ftComputed Local Depth Averaged Velocity7.96 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 1.250  | ft |
| Selected Minimum |       | 0.61   | ft |
| Selected Minimum | D90   | 0.88   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 67.                      | 169.           |
| W50                       | 34.                      | 50.            |
|                           | Page 1                   |                |

W15

| ASCE  | Method                           |  |
|---|----------------------------------|--|
| Input Parameters:   |                                  |  |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement     | 165.<br>Ch                       | 7.96 ft/s<br>2.50<br>lbs/cu ft<br>annel Bank |
| Output Results:   |                                  |  |
| Computed D50  |                                  | 0.45 ft                                      |
| *** Using Gradations from CO  | E ETL 1110-2-120 ***             |  |
| Specific Weight165.0 lbs/Layer Thickness0.7Selected Minimum D300.1Selected Minimum D900.1 | cu ft<br>50 ft<br>37 ft<br>53 ft |  |
| Percent Lighter by Weight   | Stone Weigh<br>Minimum           | t, lbs<br>Maximum                            |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                  | 36.<br>11.<br>5.                             |
| USBR 1  | Method                           |  |
| Input Parameters:   |                                  |  |
| Average Channel Velocity  |                                  | 7.96 ft/s                                    |
| Output Results:   |                                  |  |
| Computed D50  |                                  | 0.88 ft                                      |
| *** Using Gradations from CO  | E ETL 1110-2-120 ***             |  |
| Selected Minimum D30 0.7  | cu ft<br>20 ft<br>73 ft<br>26 ft |  |
| Poncont Lighton by Weight   | Stone Weigh                      |  |
| Percent Lighter by Weight<br>w100   | Minimum<br>117.                  | Maximum                                      |
| w100<br>w50<br>w15  | 58.<br>18.                       | 292.<br>86.<br>43.                           |

Onsite SOUTH Channel-DROP USGS Method \_\_ Input Parameters: 7.96 ft/s Average Channel Velocity Output Results: \_\_\_\_\_ 1.58 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 2.750 ft 1.34 ft Layer Thickness Selected Minimum D30 1.94 ft Selected Minimum D90 Stone Weight, 1bs Maximum Percent Lighter by Weight Minimum 1797. w100 719. 532. W50 359. 266. 112. W15 \_\_\_\_\_ Isbash Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity Unit Weight of Stone 7.96 ft/s 165. lbs/cu ft High Turbulence Level Output Results: \_\_\_\_\_\_ 0.81 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 1.500 ft 0.73 ft Layer Thickness Selected Minimum D30 1.06 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 292. 117. w100 W50 58. 86. 43. W15 18. \_\_\_\_ Cal B & SP Method \_\_\_\_\_

Average Channel Velocity Velocity Affecting Bank Unit Weight of Stone Cotangent of Side slope Flow Type

-\_\_\_\_\_

7.96 ft/s 10.61 ft/s 165. lbs/cu ft 2.50 Impinging

#### Output Results:

Computed W

40.71 lbs

\*\* CalTrans A Gradation \*\*

#### (1) Outside Layer:

| Gradation Class<br>Layer Thickness   | 1/2 Ton<br>3.40 ft     |
|--------------------------------------|------------------------|
| Percent Larger than                  | Rock Size (Ton)        |
| 0 - 5<br>50 - 100<br>95 - 100        | $1.00 \\ 0.50 \\ 0.25$ |
| (2) Inner Layer:                     |                        |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft        |
| (3) Backing:                         |                        |
| Backing Class No.<br>Layer Thickness | 1<br>1.8 ft            |
| (4) Fabric:                          |                        |
| Fabric Type                          | В                      |
| Total Thickness (1)+(2)+(3)+(4):     | 5.2 ft                 |

\_\_\_\_ HEC-11 Method \_\_\_\_\_

# Input Parameters:

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose

| Riprap Placement<br>Safety Factor  | Onsite SOUTH Cha       | nnel-DROP<br>Channel Bank<br>1.1 |
|------------------------------------|------------------------|----------------------------------|
| Output Results:                    |                        |                                  |
| Computed D50                       |                        | 0.34 ft                          |
| **                                 | FHWA Gradation**       |                                  |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft      |                                  |
| Percent Smaller by Size            | Rock Size, ft          | Rock Weight, lbs                 |
| D100<br>D50<br>D10                 | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5.                |

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Project: Cholla Ash Onsite Description: Onsite SOUTH Channel DROP\_BTM

\_ USACE Method \_\_ Input Parameters: \_\_\_\_\_ Velocity Type Average Channel Shape Trapezoidal Channel Type Straight Bend Angle (deg) N/A Average Channel Velocity 7.96 ft/s Bottom width N/A Bend Radius N/A Top Width N/A Unit Weight of Stone 165. lbs/cu ft Riprap Layer Thickness 1.00 Local Flow Depth 0.29 ft Cotangent of Side Slope N/A Safety Factor 1.1 Riprap Placement Channel Bottom Rock Type Angular Output Results: \_\_\_\_\_

Computed D300.60 ftComputed Local Depth Averaged Velocity7.96 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 1.250  | ft |
| Selected Minimum | D30   | 0.61   | ft |
| Selected Minimum | D90   | 0.88   | ft |

| Percent Lighter by Weight  | Minimum  |   |
|--|--|---|
| w100<br>w50  | 67.<br>34.   | 169.<br>50.   |
| W15  | 11.  | 25.   |
| ASCE   | Method   |   |
| Input Parameters:  |  | ,   |
| Local Velocity   |  | 7.96 ft/s   |
| Cotangent of Side slope<br>Unit Weight of Stone  | 16   | N/A<br>55. lbs/cu ft                                |
| Riprap Placement   |  | annel Bottom  |
| Output Results:  |  |   |
| Computed D50   |  | 0.42 ft   |
| *** Using Gradations from CC   | DE ETL 1110-2-120 *  | * *   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.   | '50 ft<br>37 ft  |   |
| Specific Weight 165.0 lbs/<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.  | '50 ft<br>37 ft  |   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.  | '50 ft<br>37 ft  |   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight   | 250 ft<br>37 ft<br>53 ft<br>Stone Wei<br>Minimum<br>15.          | Maximum<br>36.                                      |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight   | 250 ft<br>37 ft<br>53 ft<br>Stone Wei<br>Minimum                 | Maximum   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15   | 250 ft<br>37 ft<br>53 ft<br>Minimum<br>15.<br>7.                 | Maximum<br>36.<br>11.                               |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15   | 250 ft<br>37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximum<br>36.<br>11.                               |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:  | 250 ft<br>37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximum<br>36.<br>11.                               |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br>Average Channel Velocity                        | 250 ft<br>37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximum<br>36.<br>11.<br>5.                         |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br>Average Channel Velocity<br>Dutput Results:     | 250 ft<br>37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximum<br>36.<br>11.<br>5.                         |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br><br>Average Channel Velocity<br>Output Results: | 250 ft<br>37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.<br>Method | Maximum<br>36.<br>11.<br>5.<br>7.96 ft/s<br>0.88 ft |

Selected Minimum D300.73 ftSelected Minimum D901.06 ft

| Percent Lighter by Weight  | Stone W<br>Minimum      | eight, lbs<br>Maximum               |
|--|-------------------------|-------------------------------------|
| W100<br>W50<br>W15   | 117.<br>58.<br>18.      | 292.<br>86.<br>43.                  |
| USGS   | Method                  |                                     |
| Input Parameters:  |                         |                                     |
| Average Channel Velocity   | •                       | 7.96 ft/s                           |
| Output Results:  |                         |                                     |
| Computed D50   |                         | 1.58 ft                             |
| *** Using Gradations from CC   | DE ETL 1110-2-120       | * * *                               |
| Specific Weight165.0lbs/Layer Thickness2.7Selected Minimum D301.Selected Minimum D901. | 50 ft<br>34 ft<br>94 ft | aight lbg                           |
| Percent Lighter by Weight  | Minimum                 | eight, lbs<br>Maximum               |
| W100<br>W50<br>W15   | 719.<br>359.<br>112.    | 1797.<br>532.<br>266.               |
| Isbash   | Method                  |                                     |
| Input Parameters:  |                         |                                     |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                   | 1                       | 7.96 ft/s<br>165. lbs/cu ft<br>High |
| Output Results:  |                         |                                     |
| Computed D50   |                         | 0.81 ft                             |
| *** Using Gradations from CO   | E ETL 1110-2-120        | * * *                               |

| Specific W | leight  | 165.0 | lbs/cu | ft |
|------------|---------|-------|--------|----|
| Layer Thic | kness   |       | 1.500  | ft |
| Selected M | linimum | D30   | 0.73   | ft |
| Selected M | linimum | D90   | 1.06   | ft |

| Percent Lighter by Weight   | Stone Weigł<br>Minimum |   |
|---|------------------------|---|
| W100<br>W50<br>W15  | 117.<br>58.<br>18.     | 292.<br>86.<br>43.  |
| Cal B & SP  | Method                 |   |
| Input Parameters:   |                        |   |
| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type | 165.                   | 7.96 ft/s<br>10.61 ft/s<br>1bs/cu ft<br>2.50<br>Impinging |
| Output Results:   |                        |   |
| Computed W  |                        | 40.71 lbs   |

\*\* CalTrans A Gradation \*\*

(1) Outside Layer:

| Gradation Class | 1/2 Ton |
|-----------------|---------|
| Layer Thickness | 3.40 ft |

Percent Larger than Rock Size (Ton)

| 0 - 5    | 1.00 |
|----------|------|
| 50 - 100 | 0.50 |
| 95 - 100 | 0.25 |

(2) Inner Layer:

| Gradation Class | None    |
|-----------------|---------|
| Layer Thickness | 0.00 ft |
| bayer mickness  | 0.00    |

(3) Backing:

Backing Class No.

1

.

Layer Thickness 1.8 ft (4) Fabric: Fabric Type В Total Thickness (1) + (2) + (3) + (4): 5.2 ft \_\_\_\_HEC-11 Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 7.96 ft/s 3.00 ft Average Flow Depth Unit Weight of Stone 165. lbs/cu ft Cotangent of Side Slope N/A Material Angle of Repose deg. Riprap Placement Channel Bottom Safety Factor 1.1 Output Results: \_\_\_\_\_ Computed D50 0.26 ft \*\* FHWA Gradation\*\* Facing Gradation Class Layer Thickness 1.90 Ēt Percent Smaller by Size Rock Size, ft Rock Weight, lbs

| D100 | 1.30 | 200. |
|------|------|------|
| D50  | 0.95 | 75.  |
| D10  | 0.40 | 5.   |

Onsite SOUTH Channel Date: 02/12/2009 Time: 17:03 \*\*\*\*\*\* \* 20 RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \*  $\dot{\mathbf{x}}$ \* \* Version 3.0 March, 2005 \* \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. ÷ \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite SOUTH Channel

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 3.53 ft/s N/A N/A 165. lbs/cu ft 1.00 0.61 ft 2.50 1.1 Channel Bank Angular

Average

Output Results:

Computed D300.07 ftComputed Local Depth Averaged Velocity3.53 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| W50                       | 7.                       | 11.            |
|                           | Page 1                   |                |

| w15  | 2.  | 5.  |
|--|---|---|
| <i>A</i>   | ASCE Method                                 |   |
| Input Parameters:  |   |   |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement    | 165. ]                                      | 3.53 ft/s<br>2.50<br>bs/cu ft<br>nel Bank |
| Output Results:  |   |   |
| Computed D50   |   | 0.09 ft                                   |
| *** Using Gradations fro   | om COE ETL 1110-2-120 ***                   |   |
| Specific Weight 165.0<br>Layer Thickness<br>Selected Minimum D30<br>Selected Minimum D90 | lbs/cu ft<br>0.750 ft<br>0.37 ft<br>0.53 ft |   |
| Percent Lighter by Weight  | Stone Weight,<br>Minimum                    | lbs<br>Maximum                            |
| w100<br>w50<br>w15   | 15.<br>7.<br>2.                             | 36.<br>11.<br>5.                          |
| L  | ISBR Method                                 |   |
| Input Parameters:  |   |   |
| Average Channel Velocity   | 3   | .53 ft/s                                  |
| Output Results:  |   |   |
| Computed D50   |   | 0.16 ft                                   |
| *** Using Gradations fro   | m COE ETL 1110-2-120 ***                    |   |
| Specific Weight 165.0<br>Layer Thickness<br>Selected Minimum D30<br>Selected Minimum D90 | lbs/cu ft<br>0.750 ft<br>0.37 ft<br>0.53 ft |   |
| Percent Lighter by Weight  | Stone Weight,<br>Minimum                    | lbs<br>Maximum                            |

| Percent Lighter by weight | MITTINUM | Maximum |
|---------------------------|----------|---------|
| w100                      | 15.      | 36.     |
| W50                       | 7.       | 11.     |
| w15                       | 2.       | 5.      |

|   | Onsite SOUTH Chann<br>Method         |                                    |
|---|--------------------------------------|------------------------------------|
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity  |                                      | 3.53 ft/s                          |
| Output Results:   |                                      |                                    |
| Computed D50  |                                      | 0.22 ft                            |
| *** Using Gradations from C   | DE ETL 1110-2-120                    | * * *                              |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.1<br>Selected Minimum D30 0<br>Selected Minimum D90 0   | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                    |
| Percent Lighter by Weight   | Stone We<br>Minimum                  | ight, lbs<br>Maximum               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
| Isbasł  | n Method                             |                                    |
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                                    | 10                                   | 3.53 ft/s<br>65. lbs/cu ft<br>High |
| Output Results:   |                                      |                                    |
| Computed D50  |                                      | 0.16 ft                            |
| *** Using Gradations from CC  | DE ETL 1110-2-120                    | * * *                              |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                    |
| Percent Lighter by Weight   | Stone We <sup>.</sup><br>Minimum     | ight, lbs<br>Maximum               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
| Cale &  | SP Method                            |                                    |

|   | channer   |
|---|---|
| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type                     | 3.53 ft/s<br>4.71 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
| Output Results:   |   |
| Computed W  | 0.31 lbs  |
| ** CalTrans A Gradation   | * *   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | $1.00 \\ 0.50 \\ 0.25$  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Page 4 | 3.53 ft/s<br>3.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

| Percent Smaller by Size            | Rock Size, ft     | Rock Weight, lbs               |
|------------------------------------|-------------------|--------------------------------|
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft |                                |
| **                                 | FHWA Gradation**  |                                |
| Computed D50                       |                   | 0.03 ft                        |
| Output Results:                    |                   |                                |
| Riprap Placement<br>Safety Factor  | Onsite SOUTH (    | Channel<br>Channel Bank<br>1.1 |

| D100 | 1.30 | 200. |
|------|------|------|
| D50  | 0.95 | 75.  |
| D10  | 0.40 | 5.   |

Onsite SOUTH Channel\_btm Date: 02/12/2009 Time: 17:03 \*\*\*\*\*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* \* WEST Consultants, Inc. \* \* \*  $\dot{\mathbf{v}}$  $\dot{x}$ \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite SOUTH Channel\_btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 3.53 ft/s N/A N/A 165. lbs/cu ft 1.00 0.61 ft N/A 1.1 Channel Bottom Angular

Output Results:

| Local Velocity/Avg. Velocity<br>Side Slope Correction Factor<br>Correction for Layer Thickness | 0.07 ft<br>3.53 ft/s<br>1.00<br>1.06<br>1.00 |
|--|--|
| Correction for Layer Thickness<br>Correction for Secondary Currents                            | $1.00 \\ 1.00$                               |

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

3.53 ft/s N/A 165. lbs/cu ft Channel Bottom

# Output Results:

Computed D50

0.08 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight    | Stone Weig<br>Minimum                | ht, lbs<br>Maximum |
|------------------------------|--------------------------------------|--------------------|
| w100<br>w50<br>w15           | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.   |
| USBR                         | Method                               |                    |
| Input Parameters:            |                                      |                    |
| Average Channel Velocity     |                                      | 3.53 ft/s          |
| Output Results:              |                                      |                    |
| Computed D50                 |                                      | 0.16 ft            |
| *** Using Gradations from CC | DE ETL 1110-2-120 **                 | *                  |
|                              | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                    |
| Percent Lighter by Weight    | Stone Weig<br>Minimum                | ht, lbs<br>Maximum |
| w100                         | 15.                                  | 36.                |

| ) | 15. | 36. |
|---|-----|-----|
| ) | 7.  | 11. |
| 5 | 2.  | 5.  |
|   | 2.  |     |

|   | Onsite SOUTH Channel_<br>SS Method       |                                   |
|---|--|-----------------------------------|
| Input Parameters:   |  |                                   |
| Average Channel Velocity  |  | 3.53 ft/s                         |
| Output Results:   |  |                                   |
| Computed D50  |  | 0.22 ft                           |
| *** Using Gradations from   | COE ETL 1110-2-120 *                     | **                                |
| Specific Weight 165.0 lb<br>Layer Thickness 0<br>Selected Minimum D30<br>Selected Minimum D90 | 0.750 ft<br>0.37 ft                      |                                   |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                     | ght, lbs<br>Maximum               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                          | 36.<br>11.<br>5.                  |
| Isba  | sh Method                                |                                   |
| Input Parameters:   |  |                                   |
| Average Channel Velocity<br>Unit Weight of Stone<br>Furbulence Level                          | 16                                       | 3.53 ft/s<br>5. lbs/cu ft<br>High |
| Dutput Results:   |  |                                   |
| Computed D50  |  | 0.16 ft                           |
| *** Using Gradations from (   | COE ETL 1110-2-120 *                     | * *                               |
| Selected Minimum D30 (  | s/cu ft<br>.750 ft<br>0.37 ft<br>0.53 ft |                                   |
|   | Stone Wei                                | ght, lbs                          |
| Percent Lighter by Weight   | Minimum                                  | Maximum                           |

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type           | 3.53 ft/s<br>4.71 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 0.31 lbs  |
| ** CalTrans A Gradation **  |   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1.8 ft  |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose | 3.53 ft/s<br>3.00 ft<br>165. lbs/cu ft<br>N/A<br>deg.         |

| Riprap Placement<br>Safety Factor  | Onsite SOUTH Cha       | annel_btm<br>Channel Bottom<br>1.1 |
|------------------------------------|------------------------|------------------------------------|
| Output Results:                    |                        |                                    |
| Computed D50                       |                        | 0.02 ft                            |
| **                                 | FHWA Gradation**       |                                    |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft      |                                    |
| Percent Smaller by Size            | Rock Size, ft          | Rock Weight, lbs                   |
| D100<br>D50<br>D10                 | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5.                  |

ONSITE Channel DROP Sec-1 Date: 02/12/2009 Time: 15:41 \* 4 RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* ☆  $\frac{1}{2}$ \* March, 2005 \* Version 3.0 \* \* \*  $\star$ 20 \* COPYRIGHT (c) 2005 \* WEST CONSULTANTS, INC. ÷ \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-1 DROP

USACE Method \_\_\_\_\_

Average Trapezoidal Straight N/A 12.79 ft/s N/A 165. lbs/cu ft 1.00 0.64 ft 2.50 1.1 Channel Bank Angular

Output Results:

Rock Type

Computed D301.61 ftComputed Local Depth Averaged Velocity12.79 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 3.500 ft  |
| Selected Minimum | D30   | 1.70 ft   |
| Selected Minimum | D90   | 2.47 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 1482.<br>741.            | 3704.<br>1096. |
|                           | Page 1                   |                |

548.

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters: \_\_\_\_\_\_

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

12.79 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results: \_\_\_\_

Computed D50

W15

1.16 ft

818.

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 2.000  |    |
| Selected Minimum | D30   | 0.97   | ft |
| Selected Minimum | D90   | 1.41   | ft |

| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum       |
|---|--------------------------|----------------------|
| W100<br>W50<br>W15  | 276.<br>138.<br>43.      | 691.<br>205.<br>102. |
| USE   | BR Method                |                      |
| Input Parameters:   |                          |                      |
| Average Channel Velocity  | 12                       | 2.79 ft/s            |
| Output Results:   |                          |                      |
| Computed D50  |                          | 2.33 ft              |
| *** Using Gradations from   | COE ETL 1110-2-120 ***   |                      |
| Specific Weight 165.0 lk<br>Layer Thickness 4<br>Selected Minimum D30<br>Selected Minimum D90 | 4.000 ft<br>1.95 ft      |                      |
| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum       |
| w100<br>w50   | 2212.<br>1106.           | 5529.<br>1637.       |

W15

346.

ONSITE Channel DROP Sec-1 USGS Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity

12.79 ft/s

Output Results:

Computed D50

5.02 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Warning: The required stone size is greater than the largest USACE stone gradation.

\_\_\_\_\_ Isbash Method \_\_\_\_\_ Input Parameters: -----12.79 ft/s Average Channel Velocity Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: 2.09 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness4.000 ftSelected Minimum D301.95 ftSelected Minimum D902.82 ft Layer Thickness 4.000 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 2212. 5529. w50 1106. 1637. W15 346. 818. \_\_\_\_\_ HEC-11 Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose Riprap Placement

.

Page 3

Safety Factor

Output Results:

Computed D50

1.23 ft

1.1

\*\* FHWA Gradation\*\*

Gradation Class Light Layer Thickness 2.60 ft

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.80          | 500.             |
| D50                     | 1.30          | 200.             |
| D10                     | 0.40          | 5.               |

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ONSITE Channel DROP Sec-1\_btm Date: 02/12/2009 Time: 15:42 \*\*\*\*\*\* \* \* RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY  $\dot{\mathbf{x}}$ WEST Consultants, Inc. \* ÷ \* \* 2. \* Version 3.0 March, 2005 \*  $^{*}$ \* \* \* \* COPYRIGHT (c) 2005 \* \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-1 DROP bottom

USACE Method \_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 12.79 ft/s N/A N/A 165. lbs/cu ft 1.00 0.64 ft N/A 1.1 Channel Bottom Angular

Average

Output Results:

| Computed D30<br>Computed Local Depth Averaged Velocity<br>Local Velocity/Avg. Velocity<br>Side Slope Correction Factor<br>Correction for Layer Thickness | 1.61 ft<br>12.79 ft/s<br>1.00<br>1.06<br>1.00 |
|--|---|
| Correction for Layer Thickness   | 1.00  |
| Correction for Secondary Currents  | 1.00  |

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 3.500 ft  |
| Selected Minimum | D30   | 1.70 ft   |
| Selected Minimum | D90   | 2.47 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 1482.<br>741.            | 3704.<br>1096. |
|                           | Page 1                   |                |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 12.79 ft/s N/A 165. lbs/cu ft Channel Bottom

### Output Results:

Computed D50

1.07 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu |    |
|------------------|-------|--------|----|
| Layer Thickness  |       | 2.000  | ft |
| Selected Minimum | D30   | 0.97   | ft |
| Selected Minimum | D90   | 1.41   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum       |
|---------------------------|--------------------------|----------------------|
| W100<br>W50<br>W15        | 276.<br>138.<br>43.      | 691.<br>205.<br>102. |
|                           | USBR Method              |                      |
| Input Parameters:         |                          |                      |

| Average | Channe] | Velocity |
|---------|---------|----------|

Output Results:

Computed D50

2.33 ft

12.79 ft/s

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 4.000  | ft |
| Selected Minimum | D30   | 1.95   | ft |
| Selected Minimum | D90   | 2.82   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 2212.                    | 5529.          |
| w50                       | 1106.                    | 1637.          |
| W15                       | 346.                     | 818.           |

W15

ONSITE Channel DROP Sec-1\_btm USGS Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity

Output Results:

Computed D50

5.02 ft

12.79 ft/s

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Warning: The required stone size is greater than the largest USACE stone gradation.

Input Parameters: Average Channel Velocity 12.79 ft/s

Unit weight of Stone Turbulence Level 12.79 ft/s 165. lbs/cu ft High

Output Results:

Computed D50

2.09 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 4.000  | ft |
| Selected Minimum | D30   | 1.95   | ft |
| Selected Minimum | D90   | 2.82   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 2212.                    | 5529.          |
| w50                       | 1106.                    | 1637.          |
| w15                       | 346.                     | 818.           |

\_\_\_\_\_ HEC-11 Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose Riprap Placement 12.79 ft/s 4.00 ft 165. lbs/cu ft N/A deg. Channel Bottom

Page 3

Safety Factor

Output Results:

Computed D50

0.92 ft

\*\* FHWA Gradation\*\*

Gradation Class Facing Layer Thickness 1.90 ft

| Percent            | Smaller by Size | Rock Size, ft          | Rock Weight, lbs  |
|--------------------|-----------------|------------------------|-------------------|
| D100<br>D50<br>D10 |                 | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5. |

ONSITE Channel Sec-1 Date: 02/12/2009 Time: 15:43 \*\*\*\*\*\*\*\*\* \* 1 RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. ÷ \* \* \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC.  $\frac{1}{2}$ PH: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-1

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.43 ft/s N/A 165. lbs/cu ft 1.00 1.55 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.09 ftComputed Local Depth Averaged Velocity4.43 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

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\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 4.43 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results:

Computed D50

0.14 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weigh<br>Minimum   | t, lbs<br>Maximum |
|---------------------------|--------------------------|-------------------|
| w100<br>w50<br>w15        | 15.<br>7.<br>2.          | 36.<br>11.<br>5.  |
| U                         | SBR Method               |                   |
| Input Parameters:         |                          |                   |
| Average Channel Velocity  |                          | 4.43 ft/s         |
| Output Results:           |                          |                   |
| Computed D50              |                          | 0.26 ft           |
| *** Using Gradations fro  | m COE ETL 1110-2-120 *** |                   |
| Specific Weight 165.0     | lbs/cu ft                |                   |

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
| W15                       | 2.                       | 5.             |

|   | DNSITE Channel Sec<br>Method         |                                    |
|---|--------------------------------------|------------------------------------|
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity  |                                      | 4.43 ft/s                          |
| Output Results:   |                                      |                                    |
| Computed D50  |                                      | 0.38 ft                            |
| *** Using Gradations from CC  | DE ETL 1110-2-120                    | * * *                              |
| Specific Weight 165.0 lbs/<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                    |
| Percent Lighter by Weight   | Stone We<br>Minimum                  | ight, lbs<br>Maximum               |
| v100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
| Isbash  | Method                               |                                    |
| nput Parameters:  |                                      |                                    |
| verage Channel Velocity<br>nit Weight of Stone<br>urbulence Level                                       | 1                                    | 4.43 ft/s<br>65. lbs/cu ft<br>High |
| output Results:   |                                      |                                    |
| omputed D50   |                                      | 0.25 ft                            |
| *** Using Gradations from CC  | DE ETL 1110-2-120                    | * * *                              |
| pecific Weight 165.0 lbs/<br>ayer Thickness 0.7<br>elected Minimum D30 0.<br>elected Minimum D90 0.     | /cu ft<br>/50 ft<br>37 ft<br>53 ft   |                                    |
| Percent Lighter by Weight   | Stone We <sup>.</sup><br>Minimum     | ight, lbs<br>Maximum               |
| /100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
|   |                                      |                                    |

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| ft/s<br>00 ft<br>2.50<br>deg.<br>Bank<br>1.1 |
|--|
|  |

Output Results:

\_\_\_\_\_

Computed D50

0.05 ft

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 ft |

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.30          | 200.             |
| D50                     | 0.95          | 75.              |
| D10                     | 0.40          | 5.               |

ONSITE Channel Sec-1\_btm Date: 02/12/2009 Time: 15:44 -2-RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* Version 3.0 March, 2005 \* \* \* \* 4 \* COPYRIGHT (c) 2005 \* WEST CONSULTANTS, INC. \* PH: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-1 bottom

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.43 ft/s N/A 165. lbs/cu ft 1.00 1.55 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.09 ftComputed Local Depth Averaged Velocity4.43 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight<br>Minimum | , lbs<br>Maximum |
|---------------------------|-------------------------|------------------|
| w100<br>w50               | 15.<br>7.               | 36.<br>11.       |
|                           | Page 1                  |                  |

W15

| ASCE  | Method                               |  |
|---|--------------------------------------|--|
| Input Parameters:   |                                      |  |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement               |                                      | 4.43 ft/s<br>N/A<br>165. lbs/cu ft<br>Channel Bottom |
| Output Results:   |                                      |  |
| Computed D50  |                                      | 0.13 ft  |
| *** Using Gradations from C   | OE ETL 1110-2-12                     | 20 ***   |
| Specific Weight 165.0 lbs<br>Layer Thickness 0.<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |  |
| Percent Lighter by Weight   | Stone<br>Minimum                     | Weight, lbs<br>Maximum                               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                     |
| USBR  | Method                               |  |
| Input Parameters:   |                                      |  |
| Average Channel Velocity  |                                      | 4.43 ft/s  |
| Output Results:   |                                      |  |
| Computed D50  |                                      | 0.26 ft  |
| *** Using Gradations from C   | OE ETL 1110-2-12                     | 20 ***   |
| Selected Minimum D30 0  | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |  |
| Percent Lighter by Weight   | Stone<br>Minimum                     | Weight, lbs<br>Maximum                               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                     |

ONSITE Channel Sec-1\_btm USGS Method \_ Input Parameters: 4.43 ft/s Average Channel Velocity Output Results: 0.38 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 15. 7. 36. w100 11. W50 2. 5. W15 Isbash Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.43 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: 0.25 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft 0.750 ft 0.37 ft Specific Weight Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. 7. 2. W50 11. W15 5. \_\_\_\_\_ HEC-11 Method \_\_\_

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose Riprap Placement Safety Factor

4.43 ft/s 4.00 ft 165. lbs/cu ft N/A deg. Channel Bottom 1.1

Output Results:

-----

Computed D50

0.04 ft

\*\* FHWA Gradation\*\*

Gradation Class Layer Thickness

.

Facing 1.90 ft

| Percent Smaller by Size | Rock Size, ft          | Rock Weight, lbs  |
|-------------------------|------------------------|-------------------|
| D100<br>D50<br>D10      | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5. |

Date: 02/12/2009 Time: 15:50 \* \* RIPRAP DESIGN SYSTEM (RDS) \* ΒY \* \* \* WEST Consultants, Inc. \* \* \*  $\dot{\mathbf{x}}$ \* Version 3.0 \* March, 2005 4 \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-2

USACE Method \_\_\_\_\_

ONSITE Channel Sec-2

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 4.69 ft/s N/A N/A 165. lbs/cu ft 1.00 1.48 ft 2.50 1.1 Channel Bank Angular

Average

Output Results:

Computed D300.11 ftComputed Local Depth Averaged Velocity4.69 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weig<br>Minimum | ht, lbs<br>Maximum |
|---------------------------|-----------------------|--------------------|
| w100<br>w50               | 15.                   | 36.                |
| w50                       | Page 1                | 11.                |

\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

4.69 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results:

Computed D50

0.16 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Specific Weight165.0lbs/cu ftLayer Thickness0.750ftSelected Minimum D300.37ftSelected Minimum D900.53ft

| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum   |
|---|--------------------------|------------------|
| w100<br>w50<br>w15  | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |
| USBR Method   |                          |                  |
| Input Parameters:   |                          |                  |
| Average Channel Velocity  | 4                        | .69 ft/s         |
| Output Results:   |                          |                  |
| Computed D50  |                          | 0.29 ft          |
| *** Using Gradations from COE ETL 1110-2-120 ***  |                          |                  |
| Specific Weight165.0 lbs/cu ftLayer Thickness0.750 ftSelected Minimum D300.37 ftSelected Minimum D900.53 ft |                          |                  |
| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum   |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |

|   | ONSITE Channel Sec<br>Method         |                                    |
|---|--------------------------------------|------------------------------------|
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity  |                                      | 4.69 ft/s                          |
| Output Results:   |                                      |                                    |
| Computed D50  |                                      | 0.43 ft                            |
| *** Using Gradations from Co  | DE ETL 1110-2-120 ;                  | * * *                              |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.7<br>Selected Minimum D30 0<br>Selected Minimum D90 0   | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                    |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ight, lbs<br>Maximum               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
| Isbash  | n Method                             |                                    |
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                                    | 16                                   | 4.69 ft/s<br>55. lbs/cu ft<br>High |
| Output Results:   | ,                                    |                                    |
| Computed D50  |                                      | 0.28 ft                            |
| *** Using Gradations from CC  | )E ETL 1110-2-120 *                  | * *                                |
| Specific Weight 165.0 lbs/<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | cu ft<br>50 ft<br>37 ft<br>53 ft     |                                    |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ght, lbs<br>Maximum                |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
|   |                                      |                                    |
|   |                                      |                                    |

4.69 ft/s 4.00 ft 165. lbs/cu ft 2.50 41.00 deg. Channel Bank 1.1

Output Results:

-----

Computed D50

0.06 ft

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 Ťt |
|                 |         |

| Percent Smaller by Size | Rock Size, ft   | Rock Weight, lbs  |
|-------------------------|---|-------------------|
| D100<br>D50<br>D10      | $   \begin{array}{r}     1.30 \\     0.95 \\     0.40   \end{array} $ | 200.<br>75.<br>5. |

ONSITE Channel Sec-2\_btm Date: 02/12/2009 Time: 15:50 \* \* RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY ÷ \* WEST Consultants, Inc. \* \* \* \* \* \* Version 3.0 March, 2005 \* \* \*  $_{\star}$ \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-2\_btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.69 ft/s N/A N/A 165. lbs/cu ft 1.00 1.48 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.11 ftComputed Local Depth Averaged Velocity4.69 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1:06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Stone Weigh<br>Minimum | it, lbs<br>Maximum |
|------------------------|--------------------|
| 15.                    | 36.                |
| /.<br>Page 1           | 11.                |
|                        |                    |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

4.69 ft/s N/A 165. lbs/cu ft Channel Bottom

# Output Results:

#### Computed D50

#### 0.14 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight   | Stone Weight<br>Minimum              | , lbs<br>Maximum |
|-----------------------------|--------------------------------------|------------------|
| w100<br>w50<br>w15          | 15.<br>7.<br>2.                      | 36.<br>11.<br>5. |
| USBR                        | Method                               |                  |
| Input Parameters:           |                                      |                  |
| Average Channel Velocity    |                                      | 4.69 ft/s        |
| Output Results:             |                                      |                  |
| Computed D50                |                                      | 0.29 ft          |
| *** Using Gradations from C | OE ETL 1110-2-120 ***                |                  |
| Selected Minimum D30 0      | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                  |
| Percent Lighter by Weight   | Stone Weight<br>Minimum              | , lbs<br>Maximum |
| w100<br>w50<br>w15          | 15.<br>7.<br>2.                      | 36.<br>11.<br>5. |

W15

ONSITE Channel Sec-2\_btm USGS Method \_ Input Parameters: Average Channel Velocity 4.69 ft/s Output Results: ----Computed D50 0.43 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft 0.37 ft Selected Minimum D30 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 2. 11. W15 5. \_\_\_\_ Isbash Method \_\_\_\_ Input Parameters: Average Channel Velocity 4.69 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: Computed D50 0.28 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 11. W15 2. 5. \_\_\_\_\_ HEC-11 Method \_\_\_\_\_

4.69 ft/s 4.00 ft 165. lbs/cu ft N/A deg. Channel Bottom 1.1

Output Results:

Computed D50

0.05 ft

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 ft |
|                 |         |

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.30          | 200.             |
| D50                     | 0.95          | 75.              |
| D10                     | 0.40          | 5.               |

ONSITE Channel Sec-3 Date: 02/12/2009 Time: 15:51 \*\*\*\*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) 4 \* \* ΒY \* WEST Consultants, Inc. \* \*  $^{\star}$ \* \* Version 3.0 March, 2005 \* \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC.  $-\frac{1}{2}$ \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-3

USACE Method \_\_\_\_\_

Average Trapezoidal Straight N/A 3.63 ft/s N/A 165. lbs/cu ft 1.00 1.80 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.05 ftComputed Local Depth Averaged Velocity3.63 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| W100                      | 15.                      | 36.            |
| w50                       | 1.                       | 11.            |
|                           | Page 1                   |                |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters: 

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

3.63 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results: -----

Computed D50

0.09 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight   | Stone Weight,<br>Minimum           | lbs<br>Maximum   |
|---|------------------------------------|------------------|
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                    | 36.<br>11.<br>5. |
| USBR  | Method                             |                  |
| Input Parameters:   |                                    |                  |
| Average Channel Velocity  | 3                                  | 6.63 ft/s        |
| Output Results:   |                                    |                  |
| Computed D50  |                                    | 0.17 ft          |
| *** Using Gradations from CC  | DE ETL 1110-2-120 ***              |                  |
| Specific Weight 165.0 lbs/<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | 'cu ft<br>'50 ft<br>37 ft<br>53 ft |                  |
| Percent Lighter by Weight   | Stone Weight,<br>Minimum           | lbs<br>Maximum   |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                    | 36.<br>11.<br>5. |

|   | ISITE Channel Se<br>1ethod   |                                     |
|---|------------------------------|-------------------------------------|
| Input Parameters:   |                              |                                     |
| Average Channel Velocity  |                              | 3.63 ft/s                           |
| Output Results:   |                              |                                     |
| Computed D50  |                              | 0.23 ft                             |
| *** Using Gradations from COE   | ETL 1110-2-120               | * * *                               |
| Specific Weight165.0 lbs/cLayer Thickness0.75Selected Minimum D300.3Selected Minimum D900.5                   | u ft<br>O ft<br>7 ft<br>3 ft |                                     |
| Percent Lighter by Weight   | Stone W<br>Minimum           | eight, lbs<br>Maximum               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.              | 36.<br>11.<br>5.                    |
| Isbash  | Method                       |                                     |
| Input Parameters:   |                              |                                     |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level  |                              | 3.63 ft/s<br>165. lbs/cu ft<br>High |
| Output Results:   |                              |                                     |
| Computed D50  |                              | 0.17 ft                             |
| *** Using Gradations from COE   | ETL 1110-2-120               | * * *                               |
| Specific Weight 165.0 lbs/co<br>Layer Thickness 0.750<br>Selected Minimum D30 0.3<br>Selected Minimum D90 0.5 | u ft<br>0 ft<br>7 ft<br>3 ft |                                     |
| Percent Lighter by Weight   | Stone W<br>Minimum           | eight, lbs<br>Maximum               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.              | 36.<br>11.<br>5.                    |
| HEC-11 M  | Method                       |                                     |

3.63 ft/s 4.00 ft 165. lbs/cu ft 2.50 41.00 deg. Channel Bank 1.1

Output Results:

\_\_\_\_\_

Computed D50

0.03 ft

e

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 ft |
|                 |         |

| Percent Smaller by Size | Rock Size, ft          | Rock Weight, lbs  |
|-------------------------|------------------------|-------------------|
| D100<br>D50<br>D10      | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5. |

ONSITE Channel Sec-3\_btm Date: 02/12/2009 Time: 15:52 \*\*\* \* 4. RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* Version 3.0 March, 2005 \* \* \* \* \* \* COPYRIGHT (c) 2005 ÷ \* WEST CONSULTANTS, INC. 4 \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* 

Project: Cholla Ash Onsite Description: Onsite Channel SEC-3\_btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 3.63 ft/s N/A N/A 165. lbs/cu ft 1.00 1.80 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.05 ftComputed Local Depth Averaged Velocity3.63 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |  |
|------------------|-------|-----------|--|
| Layer Thickness  |       | 0.750 ft  |  |
| Selected Minimum |       | 0.37 ft   |  |
| Selected Minimum | D90   | 0.53 ft   |  |

| Percent Lighter by Weight | Stone Weight<br>Minimum | , lbs<br>Maximum |
|---------------------------|-------------------------|------------------|
| w100<br>w50               | 15.<br>7.               | 36.<br>11.       |
|                           | Page 1                  |                  |

\_\_\_\_\_ ASCE Method \_\_\_\_\_ Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

3.63 ft/s N/A 165. lbs/cu ft Channel Bottom

# Output Results:

Computed D50

w100

W50

W15

0.09 ft

36.

11.

5.

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight  | Stone Weight<br>Minimum | , lbs<br>Maximum |
|--|-------------------------|------------------|
| w100<br>w50<br>w15   | 15.<br>7.<br>2.         | 36.<br>11.<br>5. |
| USBR Met   |                         |                  |
| Input Parameters:  |                         |                  |
| Average Channel Velocity   |                         | 3.63 ft/s        |
| Output Results:  |                         |                  |
| Computed D50   |                         | 0.17 ft          |
| *** Using Gradations from COE E  | TL 1110-2-120 ***       |                  |
| Specific Weight165.0lbs/cuLayer Thickness0.750Selected Minimum D300.37Selected Minimum D900.53 | ft<br>ft<br>ft<br>ft    |                  |
| Percent Lighter by Weight  | Stone Weight<br>Minimum | , lbs<br>Maximum |

15. 7. 2.

W15

ONSITE Channel Sec-3\_btm USGS Method Input Parameters: \_\_\_\_\_ 3.63 ft/s Average Channel Velocity Output Results: \_\_\_\_\_ 0.23 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight Layer Thickness 0.750 ft 0.37 ft Selected Minimum D30 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. w100 15. 7. W50 11. 2. W15 5. Isbash Method \_\_\_ Input Parameters: -----Average Channel Velocity 3.63 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: \_\_\_\_\_ Computed D50 0.17 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 0.750 ft Layer Thickness Selected Minimum D30 0.37 ft 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. 7. 2. 11. w50 5. W15 HEC-11 Method \_\_

Input Parameters:

3.63 ft/s 4.00 ft 165. lbs/cu ft N/A deg. Channel Bottom 1.1

Output Results:

Computed D50

0.02 ft

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 ft |
|                 |         |

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.30          | 200.             |
| D50                     | 0.95          | 75.              |
| D10                     | 0.40          | 5.               |

ONSITE Channel Sec-4 Date: 02/12/2009 Time: 16:30 \*\*\* ..... 4. RIPRAP DESIGN SYSTEM (RDS)  $\star$ \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 \* ي. \* WEST CONSULTANTS, INC. PH: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-4

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.63 ft/s N/A N/A 165. lbs/cu ft 1.00 1.49 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.10 ftComputed Local Depth Averaged Velocity4.63 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

W15

| ASC   | E Method                                 |  |
|---|--|--|
| Input Parameters:   |  |  |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement             | 165.<br>Ch                               | 4.63 ft/s<br>2.50<br>lbs/cu ft<br>annel Bank |
| Output Results:   |  |  |
| Computed D50  |  | 0.15 ft                                      |
| *** Using Gradations from o   | COE ETL 1110-2-120 ***                   |  |
| Specific Weight 165.0 lb<br>Layer Thickness 0<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | s/cu ft<br>.750 ft<br>0.37 ft<br>0.53 ft |  |
| Percent Lighter by Weight   | Stone Weigh<br>Minimum                   | t, 1bs<br>Maximum                            |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                          | 36.<br>11.<br>5.                             |
| USBF  | R Method                                 |  |
| Input Parameters:   |  |  |
| Average Channel Velocity  |  | 4.63 ft/s                                    |
| Output Results:   |  |  |
| Computed D50  |  | 0.29 ft                                      |
| *** Using Gradations from C   | COE ETL 1110-2-120 ***                   |  |
| Selected Minimum D30 (  | 5/cu ft<br>750 ft<br>).37 ft<br>).53 ft  |  |
| Percent Lighter by Weight   | Stone Weight<br>Minimum                  | , lbs<br>Maximum                             |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                          | 36.<br>11.<br>5.                             |

ONSITE Channel Sec-4 USGS Method \_ Input Parameters: 4.63 ft/s Average Channel Velocity Output Results: 0.42 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 15. 7. 36. w100 11. W50 2. 5. W15 Isbash Method \_\_\_ Input Parameters: . \_\_\_\_\_**\_\_\_\_** Average Channel Velocity 4.63 ft/s 165. lbs/cu ft Unit Weight of Stone High Turbulence Level Output Results: 0.27 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. w100 15. 7. W50 11. 2. 5. W15 \_\_\_\_\_ HEC-11 Method \_\_\_

4.63 ft/s 4.00 ft 165. lbs/cu ft 2.50 41.00 deg. Channel Bank 1.1

Output Results:

-----

Computed D50

0.06 ft

\*\* FHWA Gradation\*\*

| Gradation Class |  |
|-----------------|--|
| Layer Thickness |  |

| Percent Smaller by Size | Rock Size, ft   | Rock Weight, lbs  |
|-------------------------|---|-------------------|
| D100<br>D50<br>D10      | $     \begin{array}{r}       1.30 \\       0.95 \\       0.40     \end{array} $ | 200.<br>75.<br>5. |

Facing 1.90 ft

ONSITE Channel Sec-4\_btm Date: 02/12/2009 Time: 16:31 \* RIPRAP DESIGN SYSTEM (RDS) 10 \* \* ΒY \* WEST Consultants, Inc. \*  $^{\star}$ \* \* \* \* Version 3.0 March, 2005 \* \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SUITE 340 +AX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-4\_btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.63 ft/s N/A N/A 165. lbs/cu ft 1.00 1.49 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.10 ftComputed Local Depth Averaged Velocity4.63 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 4.63 ft/s N/A 165. lbs/cu ft Channel Bottom

## Output Results:

#### Computed D50

0.14 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ght, lbs<br>Maximum |
|---|--------------------------------------|---------------------|
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.    |
| USBR  | Method                               |                     |
| Input Parameters:   |                                      |                     |
| Average Channel Velocity  |                                      | 4.63 ft/s           |
| Output Results:   |                                      |                     |
| Computed D50  |                                      | 0.29 ft             |
| *** Using Gradations from CO  | DE ETL 1110-2-120 *                  | **                  |
| Specific Weight165.0 lbs,Layer Thickness0.3Selected Minimum D300Selected Minimum D900 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                     |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ght, lbs<br>Maximum |
| w100  | 15.                                  | 36.                 |

| w100 | 15. | 36. |
|------|-----|-----|
| w50  | 7.  | 11. |
| w15  | 2.  | 5.  |

ONSITE Channel Sec-4\_btm USGS Method \_ Input Parameters: -----4.63 ft/s Average Channel Velocity Output Results: 0.42 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 36. 15. 7. w50 11. 2. W15 5. Isbash Method \_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.63 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ Computed D50 0.27 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 11. 2. 5. W15 \_\_\_\_ HEC-11 Method \_\_\_

Input Parameters:

4.63 ft/s 4.00 ft 165. lbs/cu ft N/A deg. Channel Bottom 1.1

Output Results:

------

Computed D50

0.04 ft

\*\* FHWA Gradation\*\*

| Gradat  | ion   | Clack  |   |
|---------|-------|--------|---|
| Glauat  | IOII  | Class  | • |
| Layer T | rhic  | lunare |   |
| Layer   | IIIIC | .KHESS | ) |

### Facing 1.90 ft

| Percent Smaller by Size | Rock Size, ft        | Rock Weight, lbs |
|-------------------------|----------------------|------------------|
| D100<br>D50<br>D10      | 1.30<br>0.95<br>0.40 | 200.<br>75.      |

ONSITE Channel Sec-5-6-7 Date: 02/12/2009 Time: 16:32 \* RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* \* Version 3.0 March, 2005 \* 2 ÷ ÷ \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-5-6-7

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 3.53 ft/s N/A N/A 165. lbs/cu ft 1.00 0.92 ft 2.50 1.1 Channel Bank Angular

Average

Output Results:

Computed D300.06 ftComputed Local Depth Averaged Velocity3.53 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  |    |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

W15

| ASCE  | Method                               |   |
|---|--------------------------------------|---|
| Input Parameters:   |                                      |   |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement                 | 16                                   | 3.53 ft/s<br>2.50<br>5. lbs/cu ft<br>Channel Bank |
| Output Results:   |                                      |   |
| Computed D50  |                                      | 0.09 ft   |
| *** Using Gradations from Co  | DE ETL 1110-2-120 **                 | * *   |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.3<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |   |
| Percent Lighter by Weight   | Stone Weig<br>Minimum                | ght, lbs<br>Maximum                               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                  |
| USBR  | Method                               |   |
| Input Parameters:   |                                      |   |
| Average Channel Velocity  |                                      | 3.53 ft/s   |
| Output Results:   |                                      |   |
| Computed D50  |                                      | 0.16 ft   |
| *** Using Gradations from CC  | DE ETL 1110-2-120 **                 | * *   |
| Selected Minimum D30 0.   | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |   |
| Percent Lighter by Weight   | Stone Weig<br>Minimum                | ht, lbs<br>Maximum                                |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                  |

ONSITE Channel Sec-5-6-7 USGS Method \_ Input Parameters: Average Channel Velocity 3.53 ft/s Output Results: 0.22 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 0.750 ft Layer Thickness 0.37 ft Selected Minimum D30 0.53 ft Selected Minimum D90 Stone Weight, 1bs Minimum Percent Lighter by Weight Maximum 36. 15. w100 7. 11. W50 W15 2. 5. Isbash Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 3.53 ft/s 165. lbs/cu ft Unit Weight of Stone Turbulence Level High Output Results: Computed D50 0.16 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 15. 36. w100 7. 11. w50 2. 5. W15 \_\_\_\_\_ HEC-11 Method \_\_\_

3.53 ft/s 4.00 ft 165. lbs/cu ft 2.50 41.00 deg. Channel Bank 1.1

Output Results:

-----

Computed D50

0.03 ft

\*\* FHWA Gradation\*\*

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.30          | 200.             |
| D50                     | 0.95          | 75.              |
| D10                     | 0.40          | 5.               |

ONSITE Channel Sec-5-6-7\_btm Date: 02/12/2009 Time: 16:32 э., RIPRAP DESIGN SYSTEM (RDS) \* ΒY \* \* \* WEST Consultants, Inc. \* \* \* \* Version 3.0 March, 2005 \*  $\dot{x}$ \* \*\* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-5-6-7\_btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 3.53 ft/s N/A 165. lbs/cu ft 1.00 0.92 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.06 ftComputed Local Depth Averaged Velocity3.53 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

W15

W15

ASCE Method \_\_\_\_\_ **Input Parameters:** Local Velocity Cotangent of Side slope 3.53 ft/s N/A Unit Weight of Stone Riprap Placement 165. lbs/cu ft Channel Bottom 6 Output Results: \_\_\_\_\_ Computed D50 0.08 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 11. W15 2. 5. \_\_\_\_\_ USBR Method \_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 3.53 ft/s Output Results: \_\_\_\_\_ Computed D50 0.16 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. 7. 2. W50 11.

5.

ONSITE Channel Sec-5-6-7\_btm USGS Method \_\_\_\_\_

Input Parameters: 3.53 ft/s Average Channel Velocity Output Results: 0.22 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 15. 36. w100 7. 11. w50 2. w15 5. Isbash Method \_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 3.53 ft/s 165. lbs/cu ft Unit Weight of Stone High Turbulence Level Output Results: 0.16 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. w100 15. 7. 11. W50 2. 5. W15 \_\_\_\_\_ HEC-11 Method \_\_\_\_

3.53 ft/s 4.00 ft 165. lbs/cu ft N/A deg. Channel Bottom 1.1

Output Results: \_\_\_\_

------

Computed D50

D10

0.02 ft

75. 5.

\*\* FHWA Gradation\*\*

0.40

| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft |                  |
|------------------------------------|-------------------|------------------|
| Percent Smaller by Size            | Rock Size, ft     | Rock Weight, lbs |
| D100<br>D50                        | 1.30<br>0.95      | 200.<br>75.      |

ONSITE Channel DROP Sec-7 Date: 02/12/2009 Time: 16:41 \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* Version 3.0 March, 2005 \* 2 \* \* ÷ \* COPYRIGHT (c) 2005 \* WEST CONSULTANTS, INC. ÷ PH: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*

Project: Cholla Ash Onsite Description: Onsite Channel DROP SEC-7

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 9.44 ft/s N/A 165. lbs/cu ft 1.00 0.39 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.85 ftComputed Local Depth Averaged Velocity9.44 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 2.000 ft  |
| Selected Minimum |       | 0.97 ft   |
| Selected Minimum | D90   | 1.41 ft   |

| Percent Lighter by Weight | Stone Weight<br>Minimum | , lbs<br>Maximum |
|---------------------------|-------------------------|------------------|
| w100<br>w50               | 276.<br>138.            | 691.<br>205.     |
|                           | Page 1                  |                  |

W15

.

.

102.

| ASCE  | Method                               |   |
|---|--------------------------------------|---|
| Input Parameters:   |                                      |   |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement               |                                      | 9.44 ft/s<br>2.50<br>165. lbs/cu ft<br>Channel Bank |
| Output Results:   |                                      |   |
| Computed D50  |                                      | 0.63 ft   |
| *** Using Gradations from C   | OE ETL 1110-2-120                    | ***   |
| Specific Weight 165.0 lbs<br>Layer Thickness 1.<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>250 ft<br>.61 ft<br>.88 ft |   |
| Percent Lighter by Weight   | Stone W<br>Minimum                   | eight, lbs<br>Maximum                               |
| W100<br>W50<br>W15  | 67.<br>34.<br>11.                    | 169.<br>50.<br>25.                                  |
| USBR  | Method                               |   |
| Input Parameters:   |                                      |   |
| Average Channel Velocity  |                                      | 9.44 ft/s   |
| Output Results:   |                                      |   |
| Computed D50  |                                      | 1.24 ft   |
| *** Using Gradations from Co  | DE ETL 1110-2-120                    | * * *   |
| Selected Minimum D30 1  | /cu ft<br>250 ft<br>.10 ft<br>.59 ft |   |
| Percent Lighter by Weight   | Stone W<br>Minimum                   | eight, lbs<br>Maximum                               |
| W100<br>W50<br>W15  | 394.<br>197.<br>62.                  | 984.<br>291.<br>146.                                |

ONSITE Channel DROP Sec-7 USGS Method \_ Input Parameters: \_\_\_\_\_\_ Average Channel Velocity 9.44 ft/s Output Results: -----Computed D50 2.39 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight Layer Thickness 165.0 lbs/cu ft 4.500 ft 2.19 ft 3.17 ft Selected Minimum D30 Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 7873. 3149. 1575. 2330. 492. 1165. \_\_\_\_\_ Isbash Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity Unit Weight of Stone 9.44 ft/s 165. lbs/cu ft Turbulence Level High Output Results: \_\_\_\_\_ Computed D50 1.14 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* specific weight 165 0 lbs/cu ft

| opeen re nergne  | T01.0 |          |
|------------------|-------|----------|
| Layer Thickness  |       | 2.000 ft |
| Selected Minimum | D30   | 0.97 ft  |
| Selected Minimum | D90   | 1.41 ft  |
|                  |       |          |
|                  |       |          |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 276.                     | 691.           |
| w50                       | 138.                     | 205.           |
| w15                       | 43.                      | 102.           |

\_\_\_\_\_ HEC-11 Method \_\_\_\_\_

Input Parameters:

w100

W50

W15

9.44 ft/s 4.00 ft 165. lbs/cu ft 2.50 41.00 deg. Channel Bank 1.1

Output Results:

-----

Computed D50

0.50 ft

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 ft |
|                 |         |

| Percent Smaller by Size | Rock Size, ft   | Rock Weight, lbs  |
|-------------------------|---|-------------------|
| D100<br>D50<br>D10      | $     \begin{array}{r}       1.30 \\       0.95 \\       0.40     \end{array} $ | 200.<br>75.<br>5. |

ONSITE Channel DROP Sec-7\_btm Date: 02/12/2009 Time: 16:41 \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* \* WEST Consultants, Inc. × -!-\*  $\mathcal{L}_{\mathcal{F}}$ March, 2005 \* \* Version 3.0 \* \* \* \* \* COPYRIGHT (c) 2005 \* \* \* WEST CONSULTANTS, INC. PH: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*

Project: Cholla Ash Onsite Description: Onsite Channel DROP SEC-7\_btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Straight N/A 9.44 ft/s N/A N/A 165. lbs/cu ft 1.00 0.39 ft N/A 1.1 Channel Bottom Angular

Average Trapezoidal

Output Results:

Computed D300.85 ftComputed Local Depth Averaged Velocity9.44 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 2.000  |    |
| Selected Minimum | D30   | 0.97   | ft |
| Selected Minimum | D90   | 1.41   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 276.                     | 691.<br>205.   |
| WSO                       | Page 1                   | 203.           |

\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters: 

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

9.44 ft/s N/A 165. lbs/cu ft Channel Bottom

Output Results: -----

Computed D50

W15

0.58 ft

146.

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Specific Weight165.0lbs/cu ftLayer Thickness1.000 ftSelected Minimum D300.49 ftSelected Minimum D900.70 ft

| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum    |
|---|--------------------------|-------------------|
| W100<br>W50<br>W15  | 35.<br>17.<br>5.         | 86.<br>26.<br>13. |
| USBF  | R Method                 |                   |
| Input Parameters:   |                          |                   |
| Average Channel Velocity  | 9                        | .44 ft/s          |
| Output Results:   |                          |                   |
| Computed D50  |                          | 1.24 ft           |
| *** Using Gradations from C   | COE ETL 1110-2-120 ***   |                   |
| Specific Weight 165.0 lbs<br>Layer Thickness 2.<br>Selected Minimum D30 1<br>Selected Minimum D90 1 | .250 ft<br>L.10 ft       |                   |
| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum    |
| w100<br>w50   | 394.<br>197.             | 984.<br>291.      |

62.

W15

ONSITE Channel DROP Sec-7\_btm USGS Method \_\_\_ Input Parameters: Average Channel Velocity 9.44 ft/s Output Results: -----2.39 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 4.500 ft Layer Thickness Selected Minimum D30 2.19 ft 3.17 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 7873. W100 3149. 1575. 2330. W50 w15 492. 1165. \_\_\_\_\_ Isbash Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Average Channel Velocity 9.44 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: \_\_\_\_\_ Computed D50 1.14 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 2.000 ft Layer Thickness Selected Minimum D30 0.97 ft 1.41 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 276. 691. W50 138. 205. . 102. W15 43. \_\_\_\_\_ HEC-11 Method \_\_\_\_\_

| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Riprap Placement<br>Safety Factor |                   | 9.44 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>N/A<br>deg.<br>Channel Bottom<br>1.1 |
|--|-------------------|--|
| Output Results:  |                   |  |
| Computed D50   |                   | 0.37 ft  |
| **   | FHWA Gradation**  |  |
| Gradation Class<br>Layer Thickness   | Facing<br>1.90 ft |  |

\_\_\_\_\_

| Percent Smaller by Size | Rock Size, ft          | Rock Weight, lbs  |
|-------------------------|------------------------|-------------------|
| D100<br>D50<br>D10      | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5. |

ONSITE Channel Sec-8-9 Date: 02/12/2009 Time: 16:42 \* \* RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* -2-\* \* Version 3.0 March, 2005 \* \* -2-\* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Onsite Description: Onsite Channel SEC-8-9

USACE Method \_\_\_\_\_

Average Trapezoidal

Straight

165. lbs/cu ft

Channel Bank

N/A 2.79 ft/s

N/A

N/A

N/A

1.00

1.1

1.12 ft 2.50

Angular

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

## Output Results:

Computed D300.03 ftComputed Local Depth Averaged Velocity2.79 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters: \_\_\_\_\_

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

2.79 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results: 

Computed D50

0.05 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Specific Weight165.0lbs/cu ftLayer Thickness0.750ftSelected Minimum D300.37ftSelected Minimum D900.53ft

| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum                           |
|---|--------------------------|--|
| w100<br>w50<br>w15  | 15.<br>7.<br>2.          | 36.<br>11.<br>5.                         |
| USBR Me   | thod                     | <u>.                                </u> |
| Input Parameters:   |                          |  |
| Average Channel Velocity  | 2                        | .79 ft/s                                 |
| Output Results:   |                          |  |
| Computed D50  |                          | 0.10 ft                                  |
| *** Using Gradations from COE   | ETL 1110-2-120 ***       |  |
| Specific Weight 165.0 lbs/cu<br>Layer Thickness 0.750<br>Selected Minimum D30 0.37<br>Selected Minimum D90 0.53 | ft                       |  |
| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum                           |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.          | 36.<br>11.<br>5.                         |

W15

| ONSITE Channel Sec-8-9<br>USGS Method   |                                      |                                    |
|---|--------------------------------------|------------------------------------|
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity  |                                      | 2.79 ft/s                          |
| Output Results:   |                                      |                                    |
| Computed D50  |                                      | 0.12 ft                            |
| *** Using Gradations from CC  | DE ETL 1110-2-120 *                  | ***                                |
| Specific Weight 165.0 lbs/<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                    |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ight, lbs<br>Maximum               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
| Isbash  | n Method                             |                                    |
| Input Parameters:   |                                      |                                    |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                                    | 16                                   | 2.79 ft/s<br>55. lbs/cu ft<br>High |
| Output Results:   |                                      |                                    |
| Computed D50  |                                      | 0.10 ft                            |
| *** Using Gradations from CC  | DE ETL 1110-2-120 *                  | ***                                |
| Selected Minimum D30 0.   | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                    |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ight, lbs<br>Maximum               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                   |
| HEC-12  | 1 Method                             |                                    |
|   |                                      |                                    |

| Average Channel Velocity | 2.79 ft/s      |
|--------------------------|----------------|
| Average Flow Depth       | 4.00 ft        |
| Unit Weight of Stone     | 165. lbs/cu ft |
| Cotangent of Side Slope  | 2.50           |
| Material Angle of Repose | 41.00 deg.     |
| Riprap Placement         | Channel Bank   |
| Safety Factor            | 1.1            |
| Output Results:          |                |

Computed D50

\_\_\_\_\_

0.01 ft

\*\* FHWA Gradation\*\*

| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft   |                   |
|------------------------------------|---|-------------------|
| Percent Smaller by Size            | Rock Size, ft   | Rock Weight, lbs  |
| D100<br>D50<br>D10                 | $     \begin{array}{r}       1.30 \\       0.95 \\       0.40     \end{array} $ | 200.<br>75.<br>5. |

Date: 02/12/2009 Time: 16:43 RIPRAP DESIGN SYSTEM (RDS) \* BY WEST Consultants, Inc. March, 2005 \* \* Version 3.0 \* COPYRIGHT (c) 2005 \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* 

Project: Cholla Ash Onsite Description: Onsite Channel SEC-8-9\_btm

\_ USACE Method \_\_\_\_\_

Input Parameters: \_\_\_\_\_ Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 2.79 ft/s N/A N/A 165. lbs/cu ft 1.00 1.12 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.03 ftComputed Local Depth Averaged Velocity2.79 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | n D30 | 0.37   | ft |
| Selected Minimum | n D90 | 0.53   | ft |

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| Percent Lighter by Weight  |  |   |
|--|--|---|
| W100<br>W50  | 15.<br>7.  | 36.<br>11.  |
| W15  | 2.   | 5.  |
|  |  |   |
| ASCE   | Method   |   |
| T  |  |   |
| Input Parameters:  |  |   |
| Local Velocity   |  | 2.79 ft/s   |
| Cotangent of Side slope<br>Unit Weight of Stone  | 1.6  | N/A<br>5. lbs/cu ft                                 |
| Riprap Placement   |  | annel Bottom  |
|  |  |   |
| Output Results:  |  |   |
| Computed D50   |  | 0.05 ft   |
|  |  |   |
| *** Using Gradations from CO   | DE ETL 1110-2-120 *  | * *   |
| Specific Weight 165.0 lbs/   | cu ft  |   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.   | 50 ft  |   |
| Selected Minimum D30 0.<br>Selected Minimum D90 0.   | 37 ft<br>53 ft   |   |
|  | 55 10  |   |
|  |  |   |
|  | Stone Wei  |   |
| Percent Lighter by Weight  |  | ght, lbs<br>Maximum                                 |
| W100   | Minimum<br>15.   | Maximum 36.   |
|  | Minimum  | Maximum   |
| W100<br>W50<br>W15   | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.                         |
| W100<br>W50<br>W15   | Minimum<br>15.<br>7.                                       | Maximum<br>36.<br>11.<br>5.                         |
| W15  | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.                         |
| W100<br>W50<br>W15<br>USBR<br>Input Parameters:  | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.                         |
| W100<br>W50<br>W15<br>USBR<br>Input Parameters:  | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.                         |
| W100<br>W50<br>W15<br>Input Parameters:<br>Average Channel Velocity  | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.                         |
| W100<br>W50<br>W15<br>Input Parameters:<br>Average Channel Velocity  | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.                         |
| W100<br>W50<br>W15<br>USBR   | Minimum<br>15.<br>7.<br>2.                                 | Maximum<br>36.<br>11.<br>5.<br>2.79 ft/s            |
| W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br>Average Channel Velocity<br>Output Results:<br>Computed D50                                       | Minimum<br>15.<br>7.<br>2.<br>Method                       | Maximum<br>36.<br>11.<br>5.<br>2.79 ft/s<br>0.10 ft |
| W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br>Average Channel Velocity<br>Dutput Results:   | Minimum<br>15.<br>7.<br>2.<br>Method                       | Maximum<br>36.<br>11.<br>5.<br>2.79 ft/s<br>0.10 ft |
| <pre>/100 W50 W15USBR nput Parameters:verage Channel Velocity utput Results:omputed D50 *** Using Gradations from CO pecific Weight 165.0 lbs/</pre> | Minimum<br>15.<br>7.<br>2.<br>Method<br>E ETL 1110-2-120 * | Maximum<br>36.<br>11.<br>5.<br>2.79 ft/s<br>0.10 ft |

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Selected Minimum D300.37 ftSelected Minimum D900.53 ft

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| Percent Lighter by Weight  | Stone We<br>Minimum | ight, lbs<br>Maximum               |
|--|---------------------|------------------------------------|
| W100<br>W50<br>W15   | 15.<br>7.<br>2.     | 36.<br>11.<br>5.                   |
| USGS   | Method              |                                    |
| Input Parameters:  |                     |                                    |
| Average Channel Velocity   |                     | 2.79 ft/s                          |
| Output Results:  |                     |                                    |
| Computed D50   |                     | 0.12 ft                            |
| *** Using Gradations from CC   | )E ETL 1110-2-120   | * * *                              |
| Specific Weight165.0lbs/Layer Thickness0.7Selected Minimum D300.7Selected Minimum D900.7 | 750 ft              |                                    |
| Percent Lighter by Weight  | Stone We<br>Minimum | ight, lbs<br>Maximum               |
| W100<br>W50<br>W15   | 15.<br>7.<br>2.     | 36.<br>11.<br>5.                   |
| Isbash   | n Method            |                                    |
| Input Parameters:  |                     |                                    |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                     | 1                   | 2.79 ft/s<br>65. lbs/cu ft<br>High |
| Output Results:  |                     |                                    |
| Computed D50   |                     | 0.10 ft                            |
|  |                     |                                    |

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\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Specific Weight165.0lbs/cu ftLayer Thickness0.750 ftSelected Minimum D300.37 ftSelected Minimum D900.53 ft

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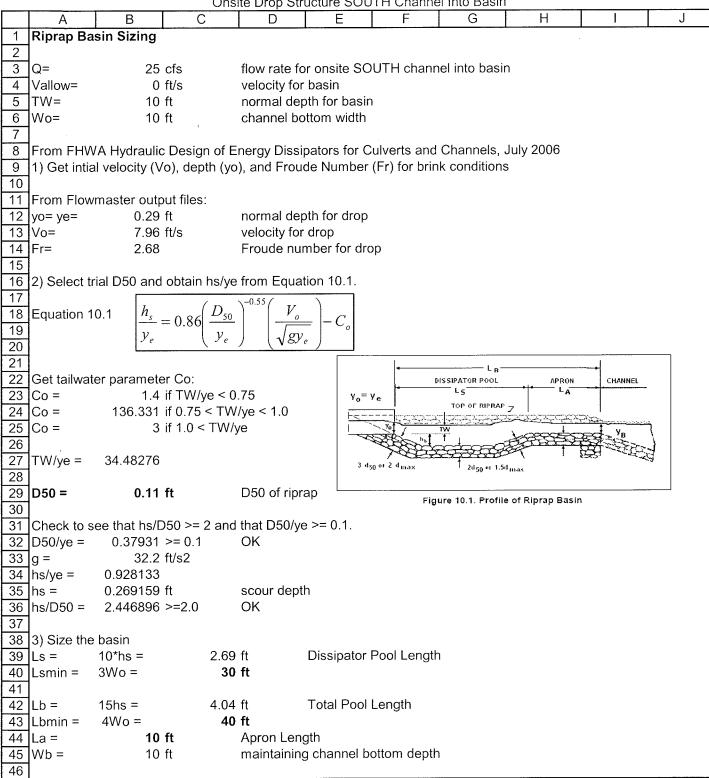
| Percent Lighter by Weight  |                      | Weight,   | lbs<br>Maximum   |
|--|----------------------|-----------|--|
| W100<br>W50<br>W15   | 15.<br>7.<br>2.      |           | 36.<br>11.<br>5.   |
| Н  | EC-11 Method         | 1         |  |
| Input Parameters:  |                      |           |  |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Riprap Placement<br>Safety Factor |                      | 165. lb   | 79 ft/s<br>4.00 ft<br>os/cu ft<br>N/A<br>deg.<br>. Bottom<br>1.1 |
| Output Results:  |                      |           |  |
| Computed D50   |                      |           | 0.01 ft  |
| ** ]   | FHWA Gradation**     |           |  |
| Gradation Class<br>Layer Thickness   | Facing<br>1.90 ft    |           |  |
| Percent Smaller by Size  | Rock Size, ft F      | lock Weig | ht, lbs  |
| D100<br>D50<br>D10   | 1.30<br>0.95<br>0.40 |           | 200.<br>75.<br>5.  |

## **ON-SITE CHANNEL**

## **DROP STRUCTURE CALCULATIONS**

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Report\Draft Drainage Report.doc

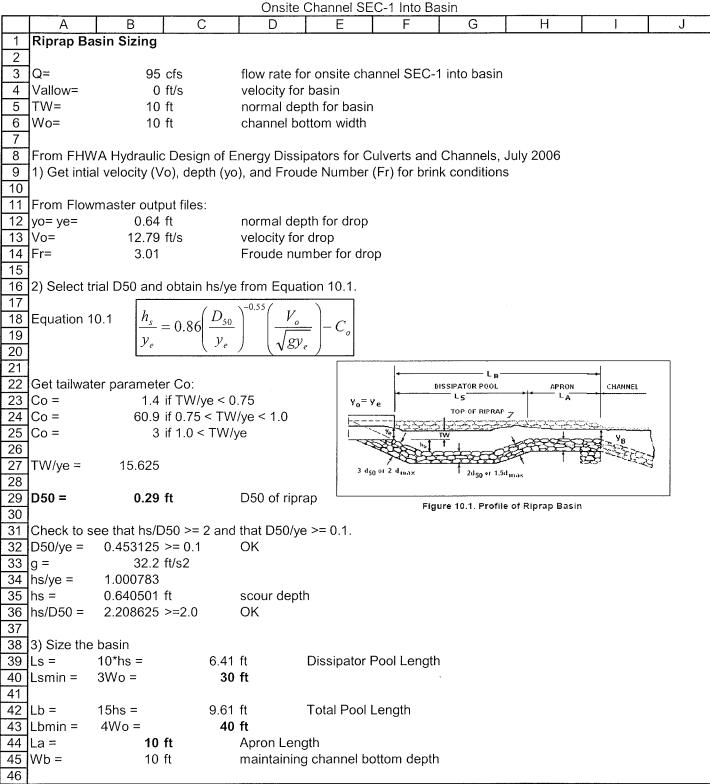
#### Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Onsite Drop Structure SOUTH Channel Into Basin



#### Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Disite Drop Structure SOUTH Channel Into Basir

|    |                     |   | Ons   | ite Drop St                | tructure SC                    | OUTH C    | Channe         | el Into Basir         | ו  |                        |                     |
|----|---------------------|---|---|----------------------------|--------------------------------|-----------|----------------|-----------------------|--|------------------------|---------------------|
|    | A                   | В   | С   | D                          | E                              |           | F              | G                     | Н  |                        | J                   |
| 47 | Hydraulic           | Jump  | · · · · · · · ·                                       |                            |                                |           |                |                       |  | -                      |                     |
| 48 | From Drai           | nage Desigr                                 | n Manual for  | Maricopa (                 | County, Hyd                    | draulics  | s: Hydr        | aulic Struct          | ures, 2003   |                        |                     |
| 49 | Y1 =                | 0.29  | ft  | upstream                   | normal de                      | pth for ( | drop           |                       |  |                        |                     |
| 50 | Ydn =               | 10  | ft  | downstre                   | eam norma                      | al depti  | h basi         | n                     |  |                        |                     |
| 51 | Q =                 | 25  | cfs   |                            | gh the drop                    |           |                |                       |  |                        |                     |
| 52 | g =                 | 32.2  | ft/s2   |                            | 0 1                            |           |                |                       |  |                        |                     |
|    | A1 =                | 3.14  |   | area of flo                | w through                      | the dro   | a              |                       |  |                        |                     |
|    | A2 =                | 10.43                                       |   |                            | w in next s                    |           | 17             |                       |  |                        |                     |
|    | z =                 | 2.5   |   | sideslope                  |                                | ٦         |                |                       |  |                        |                     |
|    | b =                 | 10  |   | •                          | dth of char                    | nel       |                | <ol> <li>A</li> </ol> | 2 V.   | <u>)</u> в             | 2 <u>_</u>          |
| 57 | 5                   | 10  |   | bottonn wi                 | attroi onai                    |           | V1             | 553                   |  |                        |                     |
|    | 2) Calculat         | e seguant h                                 | eight of jum  | n                          |                                |           | ¢/             | XC                    | $\overline{V_2}$ $\overline{V_2}$ $\phi(\overline{Z})$ |                        | 2                   |
| 59 | Equation 7          |   |   | 5.                         |                                |           | У <sub>1</sub> | ′ ⊧L                  | <b>+</b> Î   | _                      |                     |
| 60 |                     | 1 1   | Γ.  | <u> </u>                   |                                |           | V <sub>1</sub> |                       | Ŷ <u></u> Ţ V₁   | ф (                    | ₽                   |
| 61 |                     | $Y_{2} = \frac{1}{2}$                       | $Y_{1} \left  \left( 1 + 8F_{r1}^{2} \right) \right $ | $)^{2} - 1   $             |                                |           |                | KC55                  | <u>2</u>   | X022-                  | - ¥2                |
| 62 |                     | - 2   |   | í _                        |                                |           | У1             |                       | $\rightarrow$ TW $y_1$                                 | T                      | $W \rightarrow V_2$ |
|    | Y2 =                | 0.96  | f+  | OK                         | height of                      | iumn      |                | ¢/                    | · V2   | <u>•</u>               | -2                  |
| 64 | 12 -                | 0.90  | ιι  | UN                         | neight of                      | յսութ     |                | с                     |  | D                      |                     |
|    | 2) Another          | abaali an a                                 | equant heigh  | tofiumo                    |                                |           |                | Figure 6.10. Hydrau   | lic Jump Types Slopin                                  | g Channeis (Bradley, 1 | 961;                |
| 66 | Use Fig. 7-         |   | equant neigh  | it of jump.                |                                |           |                |                       |  |                        |                     |
| 67 | USE FIG. 7          |   | V=  | 7.06                       | 6 ft/s                         |           |                |                       |  |                        |                     |
|    | Fr1 =               |   | top width =   | 11.46                      |                                |           |                |                       |  |                        |                     |
| 69 | ГГ I —  -           |   | •   |                            |                                | – flo     |                | , top width           |  |                        |                     |
| 70 |                     |   | ym =<br>Fr1 =   | 0.27<br>2.68               |                                | - 110     | w area         | a / top width         | 1  |                        |                     |
| 70 | L                   |   |   | 2.00                       | 0                              |           |                |                       |  |                        |                     |
| 72 | J = Y2 / Y1         |   |   | t - b/(                    |                                |           |                |                       |  |                        |                     |
| 73 | J = TZ / T I<br>J = |   |   | t = b/(zy1)                | 13.7                           | 0         |                |                       |  |                        |                     |
| 73 | J –<br>Y2 =         | 3.1<br><b>0.899</b>                         | £4  | t =                        |                                |           |                |                       |  |                        |                     |
| 74 | 12                  | 0.099                                       | 11  | use larger                 | height of                      | Jump      |                |                       |  |                        |                     |
|    | 1) Coloulat         | o donth at h                                | eginning loc  | ation of ium               | <b>a</b> n                     |           |                |                       |  |                        |                     |
|    | Equation 7          |   |   | ation of juit              | ιp.                            | _         |                |                       |  |                        |                     |
| 78 |                     | $ZY^3$                                      | $ZY_1^2 = O$  | $ZY_2^3$                   | $bY_2^2 = O$                   |           |                |                       |  |                        |                     |
| 70 |                     | $\left  \frac{-1}{2} + \frac{1}{2} \right $ | $\frac{1}{2} + \frac{z}{z}$                           | $=\frac{2}{2}+\frac{1}{2}$ | $\frac{1}{3} + \frac{2}{gA_2}$ | -         |                |                       |  |                        |                     |
| 80 |                     | 3   | $2 gA_1$  | 3                          | $S gA_2$                       | ?         |                |                       |  |                        |                     |
|    |                     | 0 272                                       | Pog -   | 0 275                      | 5 /Diuglig                     |           | forV           | 2 until hoth          | sidos oquel  |                        |                     |
|    | Leq =               | 0.373                                       |   |                            |                                |           |                |                       | sides equal)   |                        |                     |
| 82 | Yb =                | 0.29  | H   | OK                         | depth at j                     |           | cation         |                       |  |                        |                     |
|    |                     | a langth of:                                |   |                            |                                |           |                |                       |  |                        |                     |
|    |                     | e length of j                               | ump.  |                            |                                |           |                |                       |  |                        |                     |
|    | Use Fig. 7-         |   |   |                            |                                |           |                |                       |  |                        |                     |
|    | Lj / y1 =           | 33  | £1  |                            |                                |           |                |                       |  |                        |                     |
|    | Lj =                | 9.57  | π   | = jump ler                 | igth                           |           |                |                       |  |                        |                     |
| 88 | The                 |   |   | ~~                         | . <i>EL</i>                    |           |                |                       |  |                        |                     |
| 89 | Ineretore           |   | th of jump =  |                            | ) ft                           |           |                |                       |  |                        |                     |
| 90 |                     |   | h of apron =  |                            | ) ft                           |           |                |                       |  |                        |                     |
| 91 |                     | I otal Leng                                 | th of basin =   | 40                         | ) ft                           |           |                |                       |  |                        |                     |

## Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump



#### Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Onsite Channel SEC 1 Into Basin

|    |             |  |   | Onsite                           | Channel SE                              | EC-1 Ir   | nto Ba           | isin               |  |                       |                      |
|----|-------------|--|---|----------------------------------|---|-----------|------------------|--------------------|--|-----------------------|----------------------|
|    | A           | В  | С   | D                                | E                                       | F         | F                | G                  | Н  |                       | J                    |
| 47 | Hydraulic   | Jump   |   |                                  |   |           |                  |                    |  | -                     |                      |
| 48 | From Drai   | nage Desigr  | n Manual for                                  | Maricopa C                       | ounty, Hydr                             | aulics    | : Hydr           | aulic Struc        | tures, 2003                                  |                       |                      |
|    | Y1 =        | 0.64   |   |                                  | normal dept                             |           |                  |                    |  |                       |                      |
| 50 | Ydn =       | 10   | ft  |                                  | am normal                               |           |                  | n                  |  |                       |                      |
| 51 | Q =         |  | cfs   | flow throug                      |   | •         |                  |                    |  |                       |                      |
|    | g =         | 32.2   |   |                                  | ,                                       |           |                  |                    |  |                       |                      |
|    | A1 =        | 7.43   |   | area of flow                     | w through th                            | ne dror   | n                |                    |  |                       |                      |
|    | A2 =        | 10.43  |   |                                  | w in next se                            |           | ٢                |                    |  |                       |                      |
| 55 |             | 2.5  |   | sideslope l                      |   | саон<br>г |                  |                    |  |                       |                      |
| 56 |             | 10   |   |                                  | Ith of chann                            |           |                  | (1) A              | (2)  | ① <sup>B</sup>        | 2 <u> </u>           |
| 57 | <b>D</b> –  | 10   |   | bottom wid                       |   |           | V1               | 5                  |  | 1                     | $\frac{1}{\sqrt{2}}$ |
|    | 2) Coloulat | to soquant b                                       | eight of jum                                  | 2                                |   |           | ¢/               | XELL               | $- \overline{V_2} \overset{y_2}{+} \phi (?)$ |                       |                      |
|    | Equation 7  |  |   | J.                               |   |           | У <sub>1</sub> ′ | , ⊨L               | +l   |                       |                      |
| 60 |             | .2   | Γ,  | $\overline{1}$                   |   |           | V1               | <b>()</b>          | <sup>2</sup> ∓ V1                            | ( <b>1</b> )          |                      |
| 61 |             | $Y_{2} = -\frac{1}{2}$                             | $Y_1 \left( 1 + 8F_{r1}^2 \right)$            | $)^{\overline{2}} - 1$           |   |           |                  | (3)                |  | 4050-                 | <u> </u>             |
| 62 |             | 2  |   | ´                                |   |           | У <sub>1</sub> ́ |                    | Tw <sup>y</sup> 1                            |                       | $w \overline{v_2}$   |
|    | V0 -        | 0.40   | £1  |                                  | المعتملة معاني                          |           |                  | ¢/                 | V2   | <u>•/</u>             | v2                   |
| 1  | Y2 =        | 2.42   | IL  | OK                               | height of ju                            | imb [     |                  | c                  |  | D                     | ×.                   |
| 64 |             |  |   |                                  |   |           |                  | Figure 6.10. Hydra | ulic Jump Types Slopir                       | ng Channels (Bradley. | 1961:                |
|    |             |  | equant heigh                                  | it of jump.                      |   |           |                  |                    |  |                       |                      |
|    | Use Fig. 7  |  |   | 40.70                            | <u>.</u>                                |           |                  |                    |  |                       |                      |
| 67 | -           | <b>*</b> *   | V=  | 12.79                            |   |           |                  |                    |  |                       |                      |
|    | Fr1 =       |  | top width =                                   | 13.20                            |   |           |                  |                    |  |                       |                      |
| 69 |             | $\sqrt{gy_m}$                                      | ym =  | 0.56                             | ft                                      | = flov    | w area           | a / top widt       | h  |                       |                      |
| 70 | L           | <b>v</b> <u>s</u> , <u>m</u>                       | Fr1 =   | 3.00                             |   |           |                  |                    |  |                       |                      |
| 71 |             |  |   |                                  |   |           |                  |                    |  |                       |                      |
|    | J = Y2 / Y1 |  |   | t = b/(zy1)                      |   |           |                  |                    |  |                       |                      |
| 73 | J =         | 3.5  | <i>c.</i>                                     | t = .                            | 6.25                                    |           |                  |                    |  |                       |                      |
|    | Y2 =        | 2.24   | ft  | use larger                       | height of ju                            | ımp       |                  |                    |  |                       |                      |
| 75 |             |  |   |                                  |   |           |                  |                    |  |                       |                      |
|    |             |  | eginning loc                                  | ation of jum                     | p.                                      |           |                  |                    |  |                       |                      |
|    | Equation 7  | $.3$ $7v^3$  | $7Y^2$ O                                      | 7V <sup>3</sup> h                | $V^2$                                   |           |                  |                    |  |                       |                      |
| 78 |             | $\left \frac{\mathcal{L}I}{\mathcal{L}I}\right $ + | $\frac{z_{I_1}}{z_{I_1}} + \frac{y}{z_{I_2}}$ | $=\frac{L_{1_2}}{2}+\frac{D}{2}$ | $\frac{I_2}{2} + \frac{\mathcal{V}}{2}$ |           |                  |                    |  |                       |                      |
| 79 |             | 3  | $2 gA_{I}$                                    | 3                                | 3 $gA_2$                                |           |                  |                    |  |                       |                      |
| 80 |             | L  |   |                                  |   |           | <u> </u>         |                    |  |                       |                      |
|    | Leq =       | 1.128  |   |                                  |   |           |                  | 2 until both       | n sides equal                                | )                     |                      |
|    | Yb =        | 0.48   | ft  | OK                               | depth at jur                            | mp loc    | cation           |                    |  |                       |                      |
| 83 |             |  |   |                                  |   |           |                  |                    |  |                       |                      |
|    |             | e length of j                                      | ump.  |                                  |   |           |                  |                    |  |                       |                      |
|    | Use Fig. 7- |  |   |                                  |   |           |                  |                    |  |                       |                      |
| 86 | Lj / y1 =   | 55   |   |                                  |   |           |                  |                    |  |                       |                      |
| 87 | Lj =        | 35.2   | ft  | = jump leng                      | gth                                     |           |                  |                    |  |                       |                      |
| 88 |             |  |   |                                  |   |           |                  |                    |  |                       |                      |
| 89 | Therefore   | e: Min. Leng                                       | th of jump =                                  | 36                               | ft                                      |           |                  | <i>r</i> .         |  |                       |                      |
| 90 |             | Min. Lengt   | h of apron =                                  | 10                               | ft                                      |           |                  |                    |  |                       |                      |
| 91 |             | Total Leng   | th of basin =                                 | 46                               | ft                                      |           |                  |                    |  |                       |                      |
|    |             |  |   |                                  |   |           |                  |                    | . <u>.</u>                                   |                       |                      |

#### Cholla Ash Monofill Riprap Sizing and Hydraulic Jump Onsite Channel SEC-7 Drop Structure

| Image: Control of the second state of the second  |         | A           | B                 | С                        | D                     | E                         |            | F                         | G                          | Н               | 1              | J          |
|---|---------|-------------|-------------------|--------------------------|-----------------------|---------------------------|------------|---------------------------|----------------------------|-----------------|----------------|------------|
| $ \begin{array}{c} \hline 2 \\ \hline 3 \\ \hline 2 \\ \hline 4 \\ \hline 4 \\ \hline 2 \\ \hline 4 \\ \hline 8 \\ \hline 7 \\ \hline 8 \\ \hline 7 \\ 7 \\$  | 1       |             | L                 | - <b>L</b>               |                       | ·                         | ł          |                           | -                          |                 | •              | I          |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2       |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| Image: Provide the set of t   |         | 0=          | 40                | cfs                      | flow rate for         | or onsite                 | channe     | al SEC-J                  | 7 just befor               | e brink of dro  | מכ             |            |
|   |         | -           |                   |                          |                       |                           |            |                           |                            |                 | - 4            |            |
| 6Wore10 ftchannel bottom width7From FHWA Hydraulic Dasign of Energy Dissipators for Culverts and Channels, July 200691) Get initial velocity (Ve), depth (yo), and Froude Number (Fr) for brink conditions11From Flowmaster output files:12yor yee0.39 ftnormal depth for drop13Vor9.44 ftyvelocity for drop14Free2.79Froude number for drop152) Solect trial D50 and obtain hs/ye from Equation 10.1.17 $\frac{h_x}{y} = 0.86 \left(\frac{D_{20}}{y_x}\right)^{453} \left(\frac{V_x}{\sqrt{gy_x}}\right) - C_x$ 22Get tailwater parameter Co:23Co =7.835897 if 0.75 < TW/ye < 1.026Co =7.835897 if 0.75 < TW/ye < 1.027TW/ye =2.35897428D50 =0.16 ft29D50 =0.16 ft20D50 vig =0.410256 >= 0.120D50/ye =0.23752 ft21Co =2.234898 >= 2.023p =0.35752 ft24Lip mine 3Wo =30 ft39Size the basin3939Size the basin3939Size the basin3910 ftApron Length41La =10 ft42Lup mine 4Wo =40 ft43Luping Figure 10.344La =40ft4142La =10 ft43Luping Figure 10.344452.192581 ft4647   | _       |             |                   |                          | -                     |                           |            |                           |                            | dron            |                |            |
| $ \begin{array}{c} \hline \hline$  |         | 4           |                   |                          |                       |                           |            |                           | 20 0, publ                 | arop            |                |            |
| $\frac{1}{8} = From FHWA Hydraulic Design of Energy Dissipators for Culvers and Channels, July 2006 1) Get intial velocity (Vo), depth (yo), and Froude Number (Fr) for brink conditions 1) From Flowmaster output files: 12 yo=ye= 0.39 ff normal depth for drop 13 Vo= 9.44 ft/s velocity for drop 14 Fr= 2.79 Froude number for drop 15 16 (2) Select trial D50 and obtain hs/ye from Equation 10.1. 17 18 Equation 10.1 \frac{h_x}{p_x} = 0.86 \left(\frac{D_{30}}{y_x}\right)^{-0.35} \left(\frac{V_x}{\sqrt{gv_x}}\right) - C_02122 Get tailwater parameter Co:23 Co = 1.4 if TW/ye < 0.7524 Co = 7.833897 if 0.75 × TW/ye < 1.025 Co = 3 if 1.0 × TW/ye < 1.026 Co = 7.833897 if 0.75 × TW/ye < 1.027 TW/ye = 2.3589742829 D50 = 0.16 ft D50 of niprap193030 Check to see that hs/500 > 2 and that D50/ye > = 0.1.32 g = 32.2 ft/s233 hs/ye = 0.91671735 hs = 0.36752 ft scour depth36 hs/D50 = 2.234498 >=2.0 OK3739 JSize the basin39 LS = 10°hs = 5.36 ft Total Pool Length414142 Lb = 16hs = 5.36 ft Total Pool Length43 Lbmin = 4Wo = 40 ft44 La = 10 ft Apron Length45 Computer quivalent circular diameter, De, for brink area5758 Rock size for riprap after energy dissipators Equation 10.654 Scize for riprap after energy dissipators Equation 10.654 Scize for riprap after energy dissipators Equation 10.655 Rock size for riprap after energy dissipators Equation 10.654 Scize for riprap after energy dissipators Equation 10.654 Scize for riprap after energy dissipators Equation 10.655 Rock size for riprap after energy dissipators Equation 10.654 Scize for riprap after energy dissipators Equation 10.655 Rock size for riprap after energy dissipators Equation 10.655 Rock size for riprap after energy dissipators Equation 10.656 LDe L (h) VIVo (Fig.57 Act 3 sector for 3 sector for 3 sector for 3 sector for 5 se$   |         | 1           | 10                |                          | onumer be             |                           |            |                           |                            |                 |                |            |
| $ \begin{array}{ c c c } \hline \hline$  |         | From FHM    | /A Hydrauli       | c Design of F            | nerav Dissi           | inators fo                | r Culve    | erts and                  | Channels                   | July 2006       |                |            |
| Image: constraint of the state of the   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$  |         |             |                   |                          | ), and i iou          |                           |            |                           | K COndition.               | 5               |                |            |
| $ \begin{array}{c} 12 \\ 12 \\ 12 \\ 13 \\ 13 \\ 14 \\ 15 \\ 15 \\ 15 \\ 15 \\ 15 \\ 15 \\ 15$  |         | From Flow   | master out        | nut files:               |                       |                           |            |                           |                            |                 |                |            |
| 13Voc9.44 fVsvelocity for drop14Fr=2.79Froude number for drop152) Select trial D50 and obtain hs/ye from Equation 10.1.17Equation 10.1 $\left[\frac{h_s}{y_s} = 0.86 \left(\frac{D_{s0}}{y_s}\right)^{-9.55} \left(\frac{V_o}{\sqrt{gV_s}}\right) - C_o\right]$ 21Get tailwater parameter Co:22Co =1.4 if TW/ye < 0.75  |         |             |                   |                          | normal der            | ath for dr                | 20         |                           |                            |                 |                |            |
| Image: style sty  |         |             |                   |                          |                       |                           | οp         |                           |                            |                 |                |            |
| $\frac{15}{16} \\ 2) Select trial D50 and obtain hs/ye from Equation 10.1. \frac{h}{y_{r}} = 0.86 \left(\frac{D_{30}}{y_{r}}\right)^{-3.5} \left(\frac{V_{o}}{\sqrt{gy_{r}}}\right) - C_{o} \frac{19}{20} \\ 22 \\ Cot = 1.4 \text{ if } W/ye < 0.75 \\ 23 \\ Co = 1.4 \text{ if } W/ye < 0.75 \\ 24 \\ Co = 7.835897 \text{ if } 0.75 < W/ye < 1.0 \\ 26 \\ 27 \\ TW/ye = 2.358974 \\ 28 \\ 26 \\ 27 \\ TW/ye = 2.358974 \\ 28 \\ 29 \\ 50 = 0.16 \text{ ft} D50 \text{ of riprap}  \frac{v_{s} - v_{s} -$   |         |             |                   |                          |                       |                           | dron       |                           |                            |                 |                |            |
| Interval       Select trial D50 and obtain hs/ye from Equation 10.1.         Image: Imag   |         |             | 2.70              |                          | i ioudo na            |                           | arop       |                           |                            |                 |                |            |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $  |         | 2) Select t | rial D50 and      | l obtain hs/ve           | from Equa             | tion 10.1                 |            |                           |                            |                 |                |            |
| Image: Figure 10.1 $\frac{h_{x}}{y_{x}} = 0.86 \left( \frac{D_{30}}{y_{x}} \right)^{m} \left( \frac{V_{o}}{\sqrt{gy_{x}}} \right)^{-C_{o}}$ Image: Figure 10.1 $\frac{h_{x}}{y_{x}} = 0.86 \left( \frac{D_{30}}{y_{x}} \right)^{m} \left( \frac{V_{o}}{\sqrt{gy_{x}}} \right)^{-C_{o}}$ Image: Figure 10.1 $\frac{h_{x}}{10.75} < TW/ye < 0.75$ Image: Figure 10.1 $\frac{h_{x}}{10.75} < TW/ye < 1.0$ Image: Figure 10.1 $\frac{h_{x}}{10.97} < \frac{h_{x}}{10.97} < \frac{h_{x}}$ |         | 2) 00/000   |                   |                          |                       |                           | •          |                           |                            |                 |                |            |
| $\frac{19}{20} \qquad \qquad$  | <b></b> | Equation 1  | $0.1$ $h_{\rm h}$ | $(D_{50})$               | $^{-0.55}(V_{\odot})$ |                           |            |                           |                            |                 |                |            |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $  |         |             |                   | $= 0.86 - \frac{30}{10}$ |                       | $= \left  -C_{o} \right $ |            |                           |                            |                 |                |            |
| 21       Get tailwater parameter Co:       Image: 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1   |         |             | Ye                | ( ye                     | ) $\sqrt{3y}$         | e )                       |            |                           |                            |                 |                |            |
| <sup>22</sup> Co = 1.4 if TW/ye < 0.75 <sup>23</sup> Co = .7.835897 if 0.75 < TW/ye < 1.0 <sup>25</sup> Co = 3 if 1.0 < TW/ye <sup>26</sup> Co = 3 if 1.0 < TW/ye <sup>26</sup> Co = 3 if 1.0 < TW/ye <sup>27</sup> TW/ye = 2.358974 <sup>28</sup> TW/ye = 2.3588 <sup>28</sup> TW/ye = 30 ft <sup>28</sup> TW/ye = 10 ft <sup>28</sup> TW/ye = 0.74 <sup>28</sup> TW/ye = 0.3588 <sup>29</sup> Compute equivalent circular diameter, De, for brink area <sup>20</sup> A = 0.3588 <sup>29</sup> Compute equivalent circular diameter, De, for brink area <sup>29</sup> TW/ye = 2.64 specific gravity of rock <sup>29</sup> TW/ye = 0.68 <sup>29</sup> Z/y/ye = 2.64 specific gravity of rock <sup>29</sup> Z/ye = 15 <sup>29</sup> Z/ye = 15 <sup>29</sup> Z/ye = 15 <sup>29</sup> Z/ye   |         |             |                   |                          |                       |                           |            | 1                         |                            |                 |                |            |
| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$  |         | Get tailwat | er paramet        | er Co <sup>.</sup>       |                       |                           |            | •                         |                            | APPON           | CHANNEL        |            |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $  |         |             | •                 |                          | 75                    | v                         | -= v -     |                           |                            |                 |                |            |
| 25       Co =       3 if 1.0 < TW/ye         26       W/ye =       2.358974         27       TW/ye =       2.358974         28       D50 =       0.16 ft       D50 of riprap         3 uge 1 2 mass       1 ange 1 10 mass       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         32       D50/ye =       0.410256 >= 0.1       OK         33       g =       3.2.2 ft/s2       Scourd epth         34       hs/ye =       0.916717       Scourd epth         35       hs =       0.35752 ft       scourd epth         40       Lsmin =       3Wo =       30 ft       Lissipator Pool Length         41       La =       10 ft       Apron Length       Apron Length         44       La =       10 ft       Apron Length         45       Wb =       10 ft       Apron Length         46       A =       0.3588       Dec       O.68         52       Scource for downstream riprap due to TW/ye >0.74       Dec       D_{30} = \frac{0.692}{S-1} (\frac{V^2}{2g})   |         |             |                   |                          |                       |                           | 0 72       |                           | TOP OF RIPRAP              | 7               |                |            |
| 28       TW/ye = 2.358974       Image: 1.3 max         28       D50 = 0.16 ft       D50 of riprap       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         32       D50/ye = 0.410256 >= 0.1 OK       OK         33       g = 32.2 ft/s2       sh/s/pe = 0.916717         34       hs/pe = 0.916717       scourd epth         35       hs/D50 = 2.234498 >= 2.0 OK       OK         37       33       3) Size the basin       3.58 ft       Dissipator Pool Length         41       Ls = 10° hs = 3.58 ft       Total Pool Length       4.44         42       Lbmin = 4Wo = 40 ft       4.44       4.44       Lom ft       A pron Length         45       Wb = 10 ft       maintaining channel bottom depth       4.7       4) Assess need for downstream riprap due to TW/ye >0.74       4.8         49       Compute equivalent circular diameter, De, for brink area $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 5.5         55       L/De       L (ft)       10.3, VI (ft/s)       D50 (ft) $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 5.6         56 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>, ye</td> <td>66555</td> <td>W</td> <td></td> <td></td> <td>ñ l</td>   |         |             |                   |                          |                       |                           | , ye       | 66555                     | W                          |                 |                | ñ l        |
| 27       TW/ye = 2.358974       1 solver 1   |         |             | 0                 |                          | •                     | -                         | - Carlos   | Son -                     | Ť.                         | <u>485555</u>   |                |            |
| 28       D50 =       0.16 ft       D50 of riprap       Figure 10.1. Profile of Riprap Basin         30       31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       D50/ye = 0.410256 >= 0.1       OK         32       D50/ye =       0.410256 >= 0.1       OK       Siger 1.24 max         33       g =       32.2 ft/s2       Siger 1.24 max       Figure 10.1. Profile of Riprap Basin         33       g =       0.410256 >= 0.1       OK       OK         34       hs/ye =       0.916717       Siger 1.24 max       Siger 1.24 max         35       hs =       0.35752 ft       scour depth       Siger 1.24 max         36       a.32 2.24 ks2       OK       Siger 1.24 max       Siger 1.24 max         37       38       3) Size the basin       Siger 1.24 max       Siger 1.24 max       Siger 1.24 max         40       Lsmin =       300 ft       Total Pool Length       Siger 1.24 max       Siger 1.24 max         41       La =       10 ft       Apron Length       Ager 1.24 max       Ager 1.24 max         41       La =       10 ft       maintaining channel bottom depth       Ager 1.24 max       Ager 1.24 max         41       La =       0.68       Siger 2.64 specific gravity of rock       Ager   |         | TW/ve =     | 2 358974          |                          |                       |                           | 7          | Partie                    | 272 CC                     |                 |                | 7:17       |
| 23       D50 =       0.16 ft       D50 of riprap       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       OK         33       g =       32.2 ft/s2         34       hs/ye =       0.916717         35       hs =       0.35752 ft         36       3) Size the basin         38       3) Size the basin         39       Ls =       10*hs =         38       3) Size the basin         39       Ls =       10*hs =         44       Lb =       15hs =         536       ft       Total Pool Length         44       La =       10 ft         47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3         49       Compute equivalent circular diameter, De, for brink area         51       De =       0.68         52       S       2.64 specific gravity of rock         55       10       0.43 3.776         56       L/De       L (ft)       10.31         57       14.79513       10       0  |         |             | 100001            |                          |                       |                           | 3 150 01 2 | 4 max                     | 1 2d <sub>50</sub> er 1.5d | mas             |                |            |
| 30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.         32       D50/ye = 0.410256 >= 0.1 OK         33       g = 32.2 ft/s2         34       hs/ye = 0.916717         35       hs = 0.35752 ft       scour depth         36       hs/D50 = 2.234498 >= 2.0 OK         37       38       3) Size the basin         39       Ls = 10°hs = 3.58 ft       Dissipator Pool Length         40       Lsmin = 3Wo = 30 ft         41       41         42       Lb = 15hs = 5.36 ft       Total Pool Length         43       tbmin = 4Wo = 40 ft         44       La = 10 ft       Apron Length         45       Wb = 10 ft       maintaining channel bottom depth         46       A = 0.3588       Ompute equivalent circular diameter, De, for brink area         51       De = 0.68       De = 0.68         52       S       S = 2.64 specific gravity of rock         53       Rock size for riprap after energy dissipators Equation 10.6       D <sub>30</sub> = $\frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       VI/Vo (Fig. 10.3) VI (ft/s)       D50 (ft)         56       L/De       L (ft)       0.4 3.776<   |         | D50 =       | 0.16              | ft                       | D50 of ripr           | ap 📖                      |            |                           |                            |                 |                |            |
| 31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.         32       D50/ye = 0.410256 >= 0.1 OK         33       g = 32.2 ft/s2         34       hs/ye = 0.916717         35       hs = 0.35752 ft scour depth         36       hs/D50 = 2.234498 >= 2.0 OK         37       38         39       Ls = 10*hs = 3.58 ft Dissipator Pool Length         40       Lsmin = 3Wo = 30 ft         41       Lb = 15hs = 5.36 ft Total Pool Length         42       Lb = 15hs = 5.36 ft Total Pool Length         43       Lbmin = 4Wo = 40 ft         44       La = 10 ft Apron Length         45       Wb = 10 ft maintaining channel bottom depth         46       47         47       Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3         Compute equivalent circular diameter, De, for brink area         52       S = 2.64 specific gravity of rock         53       Rock size for riprap after energy dissipators Equation 10.6         54       S = 2.64 specific gravity of rock         55       -         56       L/De       L (ft)       10.3) VI (ft/s)       D50 (ft)         57       14.79513       0.4 3.776       0.09       0.09<   |         |             |                   |                          |                       | e.b                       |            | Figu                      | ire 10.1. Profile          | of Riprap Basin | 1              |            |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$  |         | Check to s  | ee that hs/[      | )<br>50 >= 2 and         | that D50/v            | e >= 0.1.                 |            |                           |                            |                 |                |            |
| $\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$  |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 34       hs/ye =       0.916717         35       hs =       0.35752 ft       scour depth         36       hs/D50 =       2.234498 >=2.0       OK         37       38       3) Size the basin  |         | -           |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 35       hs =       0.35752 ft       scour depth         36       hs/D50 =       2.234498 >=2.0       OK         37       38       3) Size the basin       39       Ls =       10*hs =       3.58 ft       Dissipator Pool Length         40       Lsmin =       3Wo =       30 ft       441       441       441       441       442       Lb =       15hs =       5.36 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       Apron Length       444       La =       10 ft       Apron Length         44       La =       10 ft       Apron Length       444       444       La =       10 ft       Apron Length         44       La =       10 ft       Apron Length       447       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3 $A = \frac{\pi D_c^2}{4} = y_o W_o$ $A = \frac{\pi D_c^2}{4} = y_o W_o$ 50       A =       0.3588 $D_{50} = \frac{0.692}{5} \left( \frac{V^2}{2g} \right)$ $D_{50} = \frac{0.592}{5} \left( \frac{V^2}{2g} \right)$ $D_{50} = \frac{0.592}{5} \left( \frac{V^2}{2g} \right)$ $D_{50} = \frac{0.592}{5} \left( \frac{V^2}{2g} \right)$ $A = \frac{0.3588}{5} = \frac{0.4}{5} = \frac{0.3776}{5} = \frac{0.098}{5}$  |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 36       hs/D50 =       2.234498 >= 2.0       OK         37       3) Size the basin       33       3) Size the basin         38       1) Size the basin       30       ft         40       Lsmin =       3Wo =       30 ft         41       42       Lb =       15hs =       5.36 ft       Total Pool Length         42       Lb =       15hs =       5.36 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       4       Assess need for downstream riprap due to TW/ye >0.74       Using Figure 10.3         49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50       A =       0.3588 $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 53       Rock size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 56       L/De       L (ft)       10.3 VI (ft/s)       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4 <td></td> <td></td> <td></td> <td>ft</td> <td>scour dept</td> <td>h</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>  |         |             |                   | ft                       | scour dept            | h                         |            |                           |                            |                 |                |            |
| $37$ 38       3) Size the basin         39       Ls =       10*hs =       3.58 ft       Dissipator Pool Length         40       Lsmin =       3Wo =       30 ft         41       42       Lb =       15hs =       5.36 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       44         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74       48         Using Figure 10.3       49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50       A =       0.3588       51       De =       0.68         52       53       Rock size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 56       L/De       L (ft)       VI/Vo (Fig.       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4       3.776       0.09       9         59       25.15172       17       0.38       3.5872   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 38       3) Size the basin         39       Ls =       10*hs =       3.58 ft       Dissipator Pool Length         40       Lsmin =       3Wo =       30 ft         41       10       11       11       11         42       Lb =       15hs =       5.36 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       11         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74       44         48       Using Figure 10.3       Image: Compute equivalent circular diameter, De, for brink area       Image: Compute equivalent circular diameter, De, for brink area       Image: Compute equivalent circular diameter, De, for brink area       Image: Compute equivalent circular display to rock       Image: Compute equivalent circular display to rock       Image: Compute equivalent energy dissipators Equation 10.6       Image: Compute equivale   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 39Ls =10*hs =3.58 ftDissipator Pool Length40Lsmin =3Wo =30 ft41414242Lb =15hs =5.36 ftTotal Pool Length43Lbmin =4Wo =40 ft44La =10 ftApron Length45Wb =10 ftmaintaining channel bottom depth46474) Assess need for downstream riprap due to TW/ye >0.7448Using Figure 10.3Compute equivalent circular diameter, De, for brink area50A =0.358851De =0.685253Rock size for riprap after energy dissipators Equation 10.654S =2.64 specific gravity of rock5514.79513100.425822.19269150.45925.15172170.385925.15172170.385925.15172170.385043.7760.095925.15172170.385950100.425950100.485950170.385950170.385950170.385050170.3851500.43.77652170.383.587253100.4254501755171756185714 <td></td> <td>3) Size the</td> <td>basin</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>   |         | 3) Size the | basin             |                          |                       |                           |            |                           |                            |                 |                |            |
| 40       Lsmin = 3Wo =       30 ft         41       42       Lb =       15hs =       5.36 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       Apron Length         43       La =       10 ft       Apron Length         44       La =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74 $A = \frac{\pi D_e^2}{4} = y_o W_o$ 49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50       A =       0.3588 $De =$ 0.68         51       De =       0.68 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 53       Rock size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4       3.776       0.09       9       9       25.15172       17       0.38       3.5872       0.08       Riprap placement required for 17 ft from brink.   |         |             |                   | 3.58                     | ft                    | Dissipate                 | or Poo     | l Lenath                  | 1                          |                 |                |            |
| 4142Lb =15hs =5.36 ftTotal Pool Length43Lbmin =4Wo =40 ft44La =10 ftApron Length45Wb =10 ftmaintaining channel bottom depth46474) Assess need for downstream riprap due to TW/ye >0.7448Using Figure 10.3 $A = 0.3588$ 49Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50A =0.358851De =0.6852S $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56L/DeL (ft)10.3)5714.79513100.425822.19269150.45925.15172170.3851De and the figure figu  |         |             | 3Wo =             |                          |                       |                           |            | 0                         |                            |                 |                |            |
| 42<br>43<br>Lb =15hs =5.36 ftTotal Pool Length43<br>44<br>44<br>45Lbmin =4Wo =40 ft44<br>45<br>46<br>46<br>47<br>49La =10 ftApron Length46<br>47<br>49Wb =10 ftmaintaining channel bottom depth48<br>49<br>50<br>51<br>51<br>52Compute equivalent circular diameter, De, for brink area<br>A = $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50<br>52<br>53<br>56De =0.68<br>0.6852<br>55De =0.68<br>0.6853<br>56<br>56L/De<br>L (ft)VI/Vo (Fig.<br>10.3)D50 (ft)<br>3.776D50 (ft)<br>0.0959<br>59<br>59100.43.7760.09<br>0.08Riprap placement required for 17 ft from brink.   |         |             | -                 |                          |                       |                           |            |                           |                            |                 |                |            |
| 43<br>44<br>44<br>45Lbmin = 4Wo =40 ft<br>Apron Length44<br>45<br>46<br>47<br>40La =10 ft<br>maintaining channel bottom depth46<br>47<br>41<br>41<br>42<br>42Assess need for downstream riprap due to TW/ye >0.74<br>48<br>49<br>49<br>49<br>   |         | Lb =        | 15hs =            | 5.36                     | ft                    | Total Po                  | ol Len     | qth                       |                            |                 |                |            |
| 44<br>45<br>46<br>46<br>47<br>47<br>49La =10 ftApron Length<br>maintaining channel bottom depth46<br>47<br>49<br>494) Assess need for downstream riprap due to TW/ye >0.74<br>Using Figure 10.3<br>Compute equivalent circular diameter, De, for brink area<br>50<br>A = $A = 0.3588$ 51<br>52<br>53<br>54<br>55De =0.6852<br>53<br>54S =2.64 specific gravity of rock56<br>56L/De<br>57L (ft)10.3)<br>1056<br>57L/De<br>14.79513VI (ft/s)<br>10D50 (ft)57<br>59<br>5925.15172170.383.587260<br>5925.15172170.383.58720.08Riprap placement required for 17 ft from brink.   |         |             |                   |                          |                       |                           |            | -                         |                            |                 |                |            |
| 45<br>46<br>47<br>4) Assess need for downstream riprap due to TW/ye >0.74         48<br>49<br>49<br>Compute equivalent circular diameter, De, for brink area<br>50<br>A = 0.3588         51<br>52<br>53<br>53<br>54<br>55         53<br>54<br>55         54<br>55         56       L/De         L/De       L (ft)         10.3       VI (ft/s)         56       L/De         L/De       L (ft)         10       0.42         39       0.50 (ft)         57       14.79513         10       0.42         30       0.4         30       3.5872         0.08   |         |             |                   |                          |                       | gth                       |            |                           |                            |                 |                |            |
| 46<br>47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3         49       Compute equivalent circular diameter, De, for brink area         50       A =         51       De =         52       0.68         53       Rock size for riprap after energy dissipators Equation 10.6         54       S =         55       VI/Vo (Fig.         56       L/De         57       14.79513         58       22.19269         58       22.19269         59       25.15172         59       25.15172         59       0.48         59       25.15172         59       0.88         59       0.15         50       0.4         51       0.4         52       0.08         53       0.10         54       0.10         55       0.4         56       L/De         57       14.79513         58       0.4         59       25.15172         50       0.4         50       0.10         50       0.10    <   |         |             |                   |                          |                       | 0                         | l bottor   | m depth                   |                            |                 |                |            |
| 47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3         49       Compute equivalent circular diameter, De, for brink area         50       A =       0.3588         51       De =       0.68         52       S         53       Rock size for riprap after energy dissipators Equation 10.6         54       S =       2.64 specific gravity of rock         55       VI/Vo (Fig.         56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4       3.776       0.09         59       25.15172       17       0.38       3.5872       0.08       Riprap placement required for 17 ft from brink.  |         |             |                   |                          |                       | ,                         |            |                           |                            |                 |                |            |
| 48       Using Figure 10.3         49       Compute equivalent circular diameter, De, for brink area         50       A =       0.3588         51       De =       0.68         52       S       Compute equivalent circular diameter, De, for brink area         53       Rock size for riprap after energy dissipators Equation 10.6 $M = \frac{\pi D_e^2}{4} = y_o W_o$ 53       Rock size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 54       S =       2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4       3.776       0.09       Riprap placement required for 17 ft from brink.  |         | 4) Assess   | need for do       | wnstream ribi            | ap due to             | TW/ye >C                  | .74        |                           |                            |                 |                |            |
| 49       Compute equivalent circular diameter, De, for brink area $A = \frac{nD_e}{4} = y_o W_o$ 50       A = 0.3588         51       De = 0.68         52       S         53       Rock size for riprap after energy dissipators Equation 10.6         54       S = 2.64 specific gravity of rock         55 $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 56       L/De         L/De       L (ft)         10       0.42         3.776       0.09         59       25.15172         17       0.38         3.5872       0.08   |         |             |                   |                          |                       |                           |            | -n <sup>2</sup>           |                            |                 |                |            |
| 50       A =       0.3588       4         51       De =       0.68         52       Book size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 53       Rock size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4       3.776       0.09         59       25.15172       17       0.38       3.5872       0.08       Riprap placement required for 17 ft from brink.  |         |             |                   | ircular diamet           | er, De. for           | brink area                | al∕        | $1 = \frac{\pi D_e^2}{2}$ | -=vW                       |                 |                |            |
| 51       De =       0.68         52       Rock size for riprap after energy dissipators Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 53       S =       2.64 specific gravity of rock         55 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       14.79513       10       0.42       3.9648       0.10         58       22.19269       15       0.4       3.776       0.09       Riprap placement required for 17 ft from brink.   |         |             |                   |                          | ,,                    |                           |            | 4                         | 0.00                       |                 |                |            |
| 52<br>53<br>54Rock size for riprap after energy dissipators Equation 10.6<br>2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56L/DeL (ft)10.3)VI (ft/s)D50 (ft)5714.79513100.423.96480.105822.19269150.43.7760.095925.15172170.383.58720.08Riprap placement required for 17 ft from brink.   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 53       Rock size for riprap after energy dissipators Equation 10.6         54       S =       2.64 specific gravity of rock         55       VI/Vo (Fig.         56       L/De       L (ft)         57       14.79513       10       0.42         58       22.19269       15       0.4       3.776         59       25.15172       17       0.38       3.5872       0.08  |         |             |                   |                          |                       |                           | г          |                           |                            |                 |                |            |
| $54$ S =       2.64 specific gravity of rock $D_{50} = \frac{1}{S-1} \left(\frac{1}{2g}\right)$ $56$ L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft) $57$ 14.79513       10       0.42       3.9648       0.10 $58$ 22.19269       15       0.4       3.776       0.09 $59$ 25.15172       17       0.38 <b>3.5872 0.08</b> Riprap placement required for 17 ft from brink.  |         | Rock size f | or riprap af      | ter energy dis           | sipators Ed           | juation 1                 | 0.6        | р (                       | $0.692 (V^2)$              |                 |                |            |
| 55       3 - 1 (2g)         56       L/De       L (ft)         57       14.79513       10       0.42         58       22.19269       15       0.4         59       25.15172       17       0.38         3.9648       0.09       0.09         59       25.15172       17   |         |             |                   |                          |                       | •                         |            | $D_{50} = -$              | $\frac{1}{S-1}$            |                 |                |            |
| 56         L/De         L (ft)         10.3)         VI (ft/s)         D50 (ft)           57         14.79513         10         0.42         3.9648         0.10           58         22.19269         15         0.4         3.776         0.09           59         25.15172         17         0.38         3.5872         0.08         Riprap placement required for 17 ft from brink.   |         |             |                   | . 3                      |                       |                           |            |                           | 5 - 1 ( 2g                 | <u> </u>        |                |            |
| 56         L/De         L (ft)         10.3)         VI (ft/s)         D50 (ft)           57         14.79513         10         0.42         3.9648         0.10           58         22.19269         15         0.4         3.776         0.09           59         25.15172         17         0.38         3.5872         0.08         Riprap placement required for 17 ft from brink.   |         |             |                   | VI/Vo (Fia.              |                       |                           |            |                           |                            |                 |                |            |
| 57         14.79513         10         0.42         3.9648         0.10           58         22.19269         15         0.4         3.776         0.09           59         25.15172         17         0.38         3.5872         0.08         Riprap placement required for 17 ft from brink.   | 56      | L/De        | L (ft)            |                          | VI (ft/s)             | D50 (                     | ft)        |                           |                            |                 |                |            |
| 58         22.19269         15         0.4         3.776         0.09           59         25.15172         17         0.38         3.5872         0.08         Riprap placement required for 17 ft from brink.   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
| 59         25.15172         17         0.38         3.5872         0.08         Riprap placement required for 17 ft from brink.   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |
|   |         |             |                   |                          |                       |                           |            | Rip                       | ap placem                  | ent reauired    | l for 17 ft fi | rom brink. |
|   |         |             |                   |                          |                       |                           |            |                           |                            |                 |                |            |

#### Cholla Ash Monofill Riprap Sizing and Hydraulic Jump Onsite Channel SEC-7 Drop Structure

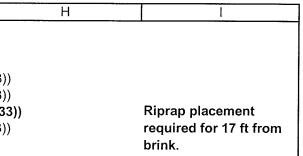
|     |              |                            |   |                              | nannel SEC-   |                 | ucture        |                                   |  |                                      |
|-----|--------------|----------------------------|---|------------------------------|---|-----------------|---------------|-----------------------------------|--|--------------------------------------|
|     | A            | В                          | С   | D                            | E   | F               | G             | Н                                 |  | J                                    |
| 61  | Hydraulic    | Jump                       |   |                              |   |                 |               | •                                 |  | •                                    |
| 62  | From Drair   | nage Desigr                | n Manual for  | Maricopa (                   | County, Hydr  | aulics: Hyd     | raulic Struc  | ctures, 2003                      |  |                                      |
| 63  | Y1 =         | 0.39                       | ft  | upstream                     | normal dept   | h for drop      |               |                                   |  |                                      |
| 64  | Ydn =        | 0.92                       | ft  |                              | am normal   |                 |               |                                   |  |                                      |
| 65  | Q =          | 40                         | cfs   |                              | gh the drop   | •               |               |                                   |  |                                      |
| 66  | g =          | 32.2                       | ft/s2   |                              | •   |                 |               |                                   |  |                                      |
|     | A1 =         | 4.24                       |   | area of flo                  | w through th  | ne drop         |               |                                   |  |                                      |
| 68  | A2 =         | 11.34                      |   |                              | w in next se  |                 |               |                                   |  |                                      |
| 69  | z =          | 2.5                        | ft  | sideslope                    | H:1   | [               | •             |                                   | Ď  |                                      |
| 70  | b =          | 10                         | ft  | bottom wi                    | dth of chann  | el v.           | Ф <b>^</b>    | @ v1 v                            |  | 2                                    |
| 71  |              |                            |   |                              |   | 1               | 155           |                                   |  | $\overline{V_2}$ TW $\overline{V_2}$ |
| 72  | 2) Calculat  | e sequant h                | eight of jum  | p.                           |   | <u>•</u>        | X             | $\sim \sqrt{2}$ $+$ $\frac{1}{2}$ | 12 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - | ·····                                |
|     | Equation 7   |                            |   |                              |   | 1               | I FL-         | (î)                               | (T) (                                    | 5                                    |
| 74  | -            |                            | V (1.002  |                              |   | V1              | ~             | TT VI                             | ľ  | Í T                                  |
| 75  |              | $I_{2}^{r} = -\frac{1}{2}$ | $Y_{1}$ $(1 + 8F_{r1}^{2})$   | ) 1                          |   | y.,             |               | >                                 |  |                                      |
| 76  |              | 2                          | L   |                              |   | . 1             |               | $\nabla_2$ TW 1                   |  | $\overline{V_2}$                     |
|     | Y2 =         | 1.36                       | ft  | OK                           | height of ju  | mp              | ¥             | t                                 |  | .                                    |
| 78  |              |                            |   |                              |   |                 |               | ulic Jump Types Sloping           | Channels (Bradley,                       | 1961:                                |
| 79  | 3) Another   | check on se                | equant heigh  | nt of jump.                  |   |                 | ,             |                                   | ,-                                       | ,                                    |
|     | Use Fig. 7-  |                            |   |                              |   |                 |               |                                   |  |                                      |
| 81  | F            |                            | V=  | 9.43                         | ft/s  |                 |               |                                   |  |                                      |
| 82  | Fr1 =        | V                          | top width =   | 11.93                        | ft  |                 |               |                                   |  |                                      |
| 83  | -            | Jov                        | ym =  | 0.36                         | i ft  | = flow are      | a / top widtl | h                                 |  |                                      |
| 84  | Ľ            | $\sqrt{S} f_m$             | Fr1 =   | 2.79                         | l   |                 |               |                                   |  |                                      |
| 85  |              |                            |   |                              |   |                 |               |                                   |  |                                      |
|     | J = Y2 / Y1  |                            |   | t = b/(zy1)                  |   |                 |               |                                   |  |                                      |
|     | J =          | 3.4                        |   | t =                          | 10.26   |                 |               |                                   |  |                                      |
|     | Y2 =         | 1.326                      | ft  | use larger                   | of Y2 for ma  | ax height of    | jump          |                                   |  |                                      |
| 89  |              |                            |   |                              |   |                 |               |                                   |  |                                      |
|     |              |                            | eginning loc  | ation of jun                 | np.   |                 |               |                                   |  |                                      |
|     | Equation 7   | $^{.3}$ $\boxed{7}$        | $7^3 TY^2$  | 0 77                         | $hY^2$  | 0               |               |                                   |  |                                      |
| 92  |              |                            | $\frac{Y_{1}^{3}}{2} + \frac{ZY_{1}^{2}}{2} + \frac{ZY_{1}^{2}}{2}$ | $\frac{Q}{d} = \frac{21}{2}$ | $\frac{y_{b}^{3}}{b} + \frac{bY_{b}^{2}}{3} + \frac{bY_{b}}{3}$ | <u><u> </u></u> |               |                                   |  |                                      |
| 93  |              | 3                          | 2   | $gA_1 = 3$                   | 3   | $gA_b$          |               |                                   |  |                                      |
| 94  | 1            | 0 500                      | D   | 0.500                        | (D)   |                 |               |                                   |  |                                      |
|     | Leq =        | 0.533                      |   |                              |   |                 |               | sides equal)                      |  |                                      |
|     | Yb =         | 0.34                       | п   | OK                           | depth at be   | ginning jun     | np location   |                                   |  |                                      |
| 97  | 1) Coloulat  | o longth of t              |   |                              |   |                 |               |                                   |  |                                      |
|     |              | e length of j              | ump.  |                              |   |                 |               |                                   |  |                                      |
|     | Use Fig. 7-  |                            |   |                              |   |                 |               |                                   |  |                                      |
| 100 | Lj / y1 =    | 41<br>15 00 -              | ft  | - jump los                   | ath   |                 |               |                                   |  |                                      |
| 101 | <b>с</b> ј — | 15.99                      | 11  | = jump len                   | gui   |                 |               |                                   |  |                                      |
| 102 | Thoroford    | Min Long                   | th of jump =  | 20                           | ft  |                 |               |                                   |  |                                      |
| 103 | neleiüle     |                            | h of apron =  |                              | ft  |                 |               |                                   |  |                                      |
| 104 |              |                            | h of basin =  |                              | ft  |                 |               |                                   |  |                                      |
| 105 |              |                            | lired riprap=   |                              |   | (from brink     | of drop)      |                                   |  |                                      |
|     |              | ngur or requ               | area npiap≞   | 17                           |   |                 |               |                                   |  |                                      |

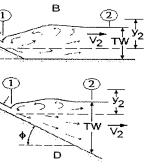
|          |  |  | Riprap S         | Cholla Ash N<br>Sloping Drop S<br>Sizing and Hydrai | Structure                               | ulas   |  |                |     |   |
|----------|--|--|------------------|---|---|--|--|----------------|-----|---|
|          | A                                      | В  | C                |   | E                                       | F  | G                                      | Н              | 1   |   |
| 1        | <b>Riprap Basin Sizing</b>             |  |                  |   |   | •  | V                                      | II             | • • |   |
| 2        |  |  |                  |   |   |  |  |                |     |   |
|          | Q=                                     | 80   | cfs              | flow rate for s                                     | ection 6 just be                        | fore brink of drop   |  |                |     |   |
|          | Vallow=                                | 4.39   | ft/s             |   | ection 5, past dro                      |  |  |                |     |   |
|          | TW=                                    | 1.36   | ft               |   |   |  |  |                |     |   |
| 6        | Wo=                                    | 10   | ft               | channel botto                                       | for section 5, pa                       | asturop  |  |                |     |   |
| 7        | VV0-                                   | 10   | 11               | channel bollo                                       | n w                                     |  |  |                |     |   |
|          | From EUN/A Undrouti                    | c Design of Energy Dissipators for Culverts and Channels,  | h.h. 0000        |   |   |  |  |                |     |   |
| 9        | 1) Cot inticl volgaity ()              | (a) depth (va), and Erouda Number (Er) for briely and Channels,  | July 2006        |   |   |  |  |                |     |   |
| 10       | () Get initial velocity ()             | /o), depth (yo), and Froude Number (Fr) for brink condition  | IS               |   |   |  |  |                |     |   |
|          | From Flowmanter and                    |  |                  |   |   |  |  |                |     |   |
|          | From Flowmaster out                    |  | ~                |   | _                                       |  |  |                |     |   |
|          | yo= ye=                                | 0.58   | ft               | normal depth  |   |  |  |                |     |   |
|          | Vo=                                    | 12.05  | ft/s             | velocity for dro                                    |   |  |  |                |     |   |
| 14       | Fr=                                    | 2.96   |                  | Froude numbe  | er for drop                             |  |  |                |     |   |
| 15       |  |  |                  |   |   |  |  |                |     |   |
|          | <ol><li>Select trial D50 and</li></ol> | l obtain hs/ye from Equation 10.1.   |                  | F   |   |  |  |                |     |   |
| 17       | _                                      | $()^{-0.55}$   |                  |   |   |  |  |                |     |   |
|          | Equation 10.1 $h_s$                    | $= 0.86 \left(\frac{D_{50}}{N}\right)^{-0.55} \left(\frac{V_o}{\sqrt{N}}\right) - C_o$   |                  |   |   | DISSIPATOR POOL  | APRON                                  | CHANNEL        |     |   |
| 19       | $y_e$                                  | $\left(\begin{array}{c} y_e \end{array}\right)  \left(\begin{array}{c} \sqrt{gy_e} \end{array}\right)  \left(\begin{array}{c} 0 \\ 0 \end{array}\right)$ |                  |   | y <sub>o</sub> =y <sub>e</sub>          | LS   | LA                                     |                |     |   |
| 20       |  |  |                  |   | F                                       | TOP OF RIPRAP  |  |                |     |   |
| 21       |  |  |                  |   | Ye Ye                                   | TAN THE REAL PROPERTY OF THE P | <u> </u>                               |                |     |   |
| 22       | Get tailwater parameter                | er Co:   |                  |   | - ARCO-                                 |  | 10000000000000000000000000000000000000 | V <sub>B</sub> |     |   |
|          | Co =                                   | 1.4  | if TW/ye < 0     | .75   |   |  | ST TET                                 | STREET.        |     |   |
|          | Co =                                   | =4*B5/B12-1.6  | if 0.75 < TW     | //ye < 1.0  | 3 d <sub>50</sub> or 2 d <sub>max</sub> | t 2d 50 or 1.5   | d <sub>max</sub>                       | 4              |     |   |
| 25       | Co =                                   | 3  | if 1.0 < TW/     |   |   |  |  |                |     |   |
| 26       |  |  |                  | ,   | -                                       | Figure 10.1. Profile   | e of Ripran Basin                      |                |     |   |
| 27       | TW/ye =                                | =B5/B12  |                  |   |   | i igure to ti ti tota  | e of Ripidp Basin                      |                |     |   |
| 28       |  |  |                  |   |   |  |  |                |     |   |
| 29       | D50 =                                  | 0.25   | ft               | D50 of riprap                                       |   |  |  |                |     |   |
| 30       |  |  |                  |   |   |  |  |                |     |   |
| 31       | Check to see that hs/E                 | 050 >= 2 and that D50/ye >= 0.1.   |                  |   |   |  |  |                |     |   |
| 32       | D50/ye =                               | =B29/B12   | >= 0.1           | OK  |   |  |  |                |     |   |
| 33       | g =                                    | 32.2   | ft/s2            |   |   |  |  |                |     |   |
| 34       | g =<br>hs/ye =                         | =0.86*((B32)^(-0.55))*(B14)-B25  |                  |   |   |  |  |                |     |   |
| 35       | hs =                                   | =B34*B12   | ft               | scour depth   |   |  |  |                |     |   |
| 36       | hs/D50 =                               | =B35/B29   | >=2.0            | OK  |   |  |  |                |     | 1 |
| 37       |  |  |                  |   |   |  |  |                |     |   |
|          | 3) Size the basin                      |  |                  |   |   |  |  |                |     |   |
| 39       |  | 10*hs =  | =10*B35          | ft  | Dissipator F                            | Pool Length  |  |                |     |   |
|          | Lsmin =                                | 3Wo =  | =3*B6            | ft  | Dissipator 1                            | con Longun   |  |                |     |   |
| 41       |  |  |                  |   |   |  |  |                |     |   |
| 42       | Lb =                                   | 15hs =   | =15*B35          | ft  | Total Pool L                            | enath  |  |                |     |   |
|          | Lbmin =                                | 4Wo =  | =10 B33<br>=4*B6 | ft  |   | longun   |  |                |     |   |
| 44       |  | =C43-C40   | -4 80<br>ft      | Apron Length  |   |  |  |                |     |   |
|          |  | 10   | ft               |   | annal hattam                            | anth   |  |                |     |   |
| 46       |  |  | 11               | maintaining ch                                      | annel bottom de                         | shui   |  |                |     |   |
|          | 1) Assess need for do                  | wnstream riprap due to TW/ye >0.74 (for Drop Structures  | in channel       | ah <i>u</i> )                                       |   |  |  |                |     |   |
|          | Using Figure 10.3                      |  |                  | пу)   |   |  |  |                |     |   |
|          |  | rcular diameter, De, for brink area $A = \frac{\pi D_e^2}{4}$  |                  |   |   |  |  |                |     |   |
|          |  | =B5*B12 $A = \frac{A}{4}$  | $Y = Y_o W_o$    |   |   |  |  |                |     |   |
| 50<br>51 | ¬ −<br>⊃o −                            | B0 B12 4   |                  |   |   |  |  |                |     |   |
|          | Je –                                   | =(B50*4/PI())^0.5  |                  |   |   |  |  |                |     |   |
| 52       | Dook olas fas danas f                  |  |                  |   |   | 0 600 ( 77)  | 2                                      |                |     |   |
| 53       | Rock size for riprap af                |  |                  |   | $D_{50}$                                | $= \frac{0.692}{V^2}$  | _                                      |                |     |   |
| 54<br>55 | 5 =                                    | =165/62.4  | spe              | cific gravity of roo                                | ck 50                                   | -S-1 2g  | z                                      |                |     |   |
| 55       |  |  |                  |   | L                                       |  | <u></u>                                |                |     |   |

· •

## Cholla Ash Monofill Sloping Drop Structure

|                                 |                                |  |                         | Riprap Sizi   | ing and Hydraulic  | Jump Fo   | ormulas                   |                        |                           |               |
|---------------------------------|--------------------------------|--|-------------------------|---|--------------------|-----------|---------------------------|------------------------|---------------------------|---------------|
|                                 | A                              | В  |                         | С   | D                  | Ē         | F                         |                        | G                         |               |
| 56                              | L/[                            | De   | L (ft)                  | VI/Vo (Fig.<br>10.3)  | VI (ft/s)          | D50 (ft)  | )                         |                        |                           |               |
|                                 | =B57/\$B\$51                   | 10   |                         | .42   | =C57*\$B\$13       |           | ,<br>2/(\$B\$54-1))*((D57 | '^2)/(2*'Drop Off      | -basin'I\$B\$3            | 3))           |
|                                 | =B58/\$B\$51                   | 15   | 0                       | and the second se | =C58*\$B\$13       |           | 2/(\$B\$54-1))*((D58      |                        |                           |               |
|                                 | =B59/\$B\$51                   | 17   |                         |   | =C59*\$B\$13       |           | 2/(\$B\$54-1))*((D59      |                        |                           |               |
|                                 | =B60/\$B\$51                   | 20   | 0.                      |   | =C60*\$B\$13       |           | 2/(\$B\$54-1))*((D60      |                        |                           |               |
| 61                              |                                |  |                         |   |                    | ] (       |                           | _).().op on            | 2001110200                | -//           |
| 62<br>63                        |                                | ign Manual for Maricopa County, Hydraulics   | s: Hydraulic Structures | s, 2003   |                    |           |                           |                        |                           |               |
|                                 | Y1 =                           | 0.58   | ft                      |   | upstream normal    | •         | •                         |                        |                           |               |
|                                 | Ydn =                          | 1.36   | ft                      |   | downstream nor     |           | oth section 5             |                        |                           |               |
|                                 | Q =                            | 80   | cf                      |   | flow through the c | ł         |                           |                        |                           |               |
| 67                              |                                | 32.2   |                         | /s2   |                    |           |                           |                        |                           |               |
|                                 | A1 =                           | 6.64   | ft2                     |   | area of flow throu |           |                           |                        |                           |               |
|                                 | A2 =                           | 10.43  | ft2                     |   | area of flow in ne | xt sectio | n                         |                        |                           |               |
| 70                              |                                | 2.5  | ft                      |   | sideslope H:1      |           |                           | A                      |                           |               |
| 71                              | b =                            | 10   | ft                      |   | bottom width of cl | hannel    | Va                        | 1                      | ② <sub>V1</sub>           | $v_{1}^{(1)}$ |
| 72                              |                                |  |                         |   |                    |           | 1 miles                   | 1553                   |                           | Y             |
|                                 | 2) Calculate sequan            | t height of jump.  |                         |   |                    |           | • <u>/</u>                |                        | $V_2 + \frac{1}{2} \phi/$ | <u> </u>      |
| 74                              | Equation 7.2                   |  |                         |   |                    |           | y <sub>1</sub> '          | ⊨L                     |                           | -             |
| 75<br>76<br>77                  |                                | $Y_{2} = \frac{1}{2}Y_{1} \left[ \left( 1 + 8F_{r1}^{2} \right)^{\frac{1}{2}} - 1 \right]$ |                         |   |                    |           | Y1                        |                        |                           | C             |
| 76                              |                                |  |                         |   |                    |           |                           | (5)                    | ¥2 >                      | $\leq$        |
| 11                              | No                             |  |                         |   | 014                |           | У <sub>1</sub>            | 12-2-                  | <u> </u>                  | 1             |
| 78<br>79                        | Y2 =                           | =0.5*B64*(((1+8*(D85^2))^0.5)-1)   | ft                      |   | OK                 | height    |                           | ¢                      | $\overline{V_2}$          |               |
|                                 | 3) Another check on            | sequant height of jump.  |                         |   |                    |           |                           |                        |                           |               |
|                                 | Use Fig. 7-8                   |  |                         |   |                    |           |                           | Figure 6.10. Hydraulic | Jump Types Slop           | ing C         |
| 82                              |                                |  | V:                      |   | =B66/B68           | ft/s      |                           |                        |                           |               |
|                                 | $Fr1 = \frac{\nu}{\sqrt{1-1}}$ |  | to                      |   | 12.9               | ft        |                           |                        |                           |               |
| 84                              | $\sqrt{gy_m}$                  |  |                         | •   | =B68/D83           |           | = flow area / top w       | ridth                  |                           |               |
| 84<br>85                        | L                              |  |                         |   | =D82/SQRT(B67*     |           | •                         |                        |                           |               |
| 86                              |                                |  |                         |   | `                  | ,         |                           |                        |                           |               |
|                                 | J = Y2 / Y1                    |  |                         | :   | t = b/(zy1)        |           |                           |                        |                           |               |
| 88                              |                                | 3.5  |                         |   |                    | =B71/(E   | 370*B64)                  |                        |                           |               |
|                                 | Y2 = ,                         | =B88*B64   | ft                      |   | use larger         | height o  | of jump                   |                        |                           |               |
| 90                              |                                |  |                         |   |                    |           |                           |                        |                           |               |
| 91                              |                                | t beginning location of jump.  |                         |   |                    |           |                           |                        |                           |               |
| 92                              | Equation 7.3                   | $X_1^3 ZY_1^2 Q ZY_2^3 bY_2^2$   |                         |   |                    |           |                           |                        |                           |               |
| 93                              |                                | ╧᠊᠊┽╺┉┉╧╸┽╺┉┈╴═╶┈┈╴┿╶┈┈╴┿  | $\underline{Q}$         |   |                    |           | •                         |                        |                           |               |
| 93<br>94<br>95                  |                                | $3  2  gA_1  3  3$   | $gA_2$                  |   |                    |           |                           |                        |                           |               |
| 95                              |                                | -/070*/06442\/2\+/070*/06442\/2\+/070*   |                         |   |                    | D74+D0-   |                           |                        |                           | / <b>-</b> /  |
| 96                              | Leq =                          | =(B70*(B64^3)/3)+(B70*(B64^2)/2)+(B66  |                         |   |                    |           | 7^2/3)+(B66/(B67*         | 869))                  |                           | (Plu          |
| 97<br>98                        | Yb =                           | 0.44   | ft                      | (   | ОК                 | depth at  | t jump location           |                        |                           | unt           |
|                                 | 4) Calculate length c          | fiump  |                         |   |                    |           |                           |                        |                           |               |
|                                 | Use Fig. 7-9                   | ո յսութ.   |                         |   |                    |           |                           |                        |                           |               |
|                                 | Lj / y1 =                      | 55   |                         |   |                    |           |                           |                        |                           |               |
| 102                             | - j / y                        | =B101*B64  | ft                      | -   | - iump longth      |           |                           |                        |                           |               |
| 102<br>103<br>104<br>105<br>106 | _j —                           |  | 11                      | -   | = jump length      |           |                           |                        |                           |               |
| 103                             |                                |  | Therefore: Min Long     | th of jump - 1  | 20                 | £4        |                           |                        |                           |               |
| 104                             |                                |  | Therefore: Min. Lengt   |   |                    | ft<br>#   |                           |                        |                           |               |
| 100                             |                                |  |                         | n of apron = *  |                    | ft<br>4   |                           |                        |                           |               |
| 100                             |                                |  | i otal Lengti           | n or basin = =  | =D105+D104         | ft        |                           |                        |                           |               |





g Channels (Bradley, 1961)

(Plug in values for Y2 until both sides equal)

2/13/2009

# **ON-SITE STORAGE VOLUME CALCULATION**

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## Cholla Ash Monofill On-Site Basin Calculation

|       | Storage | Storage |             |         | Total   |
|-------|---------|---------|-------------|---------|---------|
|       | Area    | Area    | Volume *(1) | Volume  | Volume  |
| Depth | (sq ft) | (ac)    | (cu ft)     | (ac-ft) | (ac ft) |
| 0     | 18,225  | 0.42    | 0           | 0       | 0       |
| 9     | 35,721  | 0.82    | 238,383     | 5.473   | 5.5     |
| 12    | 45,369  | 1.04    | 121,347     | 2.786   | 8.3     |

Notes: The volume was calculated using the conic equation (V =  $h/3 \times (a1 + a2 + (a1 \times a2)^{(1/2)})$ 

## **OFF-SITE HYDRAULIC CALCULATIONS**

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## **OFF-SITE CHANNEL**

## NORMAL DEPTH CALCULATIONS

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| Project Description          |                                 |                           | •           |  |
|------------------------------|---------------------------------|---------------------------|-------------|--|
| Friction Method<br>Solve For | Manning Formula<br>Normal Depth |                           |             |  |
| Input Data                   |                                 |                           |             |  |
| Roughness Coefficient        |                                 | 0.035                     |             |  |
| Channel Slope                |                                 | 0.20000                   | ft/ft       |  |
| Left Side Slope              |                                 | 2.50                      | ft/ft (H∶V) |  |
| Right Side Slope             |                                 | 2.50                      | ft/ft (H∶V) |  |
| Bottom Width                 |                                 | 10.00                     | ft          |  |
| Discharge                    |                                 | 25.00                     | ft³/s       |  |
| Results                      |                                 | fikt i slav<br>Fri fikt   |             |  |
| Normal Depth                 |                                 | 0.29                      | ft          |  |
| Flow Area                    |                                 | 3.14                      | ft²         |  |
| Wetted Perimeter             |                                 | 11.58                     | ft          |  |
| Top Width                    |                                 | 11.46                     | ft          |  |
| Critical Depth               |                                 | 0.55                      | ft          |  |
| Critical Slope               | (                               | 0.02311                   | ft/ft       |  |
| Velocity                     |                                 | 7.96                      | ft/s        |  |
| Velocity Head                |                                 | 0.98                      | ft          |  |
| Specific Energy              |                                 | 1.28                      | ft          |  |
| Froude Number                |                                 | 2.68                      |             |  |
| Flow Type                    | Supercritical                   |                           |             |  |
| GVF Input Data               |                                 | 95 L S                    |             |  |
| Downstream Depth             |                                 | 0.00                      | ft          |  |
| Length                       |                                 | 0.00                      | ft          |  |
| Number Of Steps              |                                 | 0                         |             |  |
| GVF Output Data              |                                 | n an tha an<br>Tha Albana |             |  |
| Upstream Depth               |                                 | 0.00                      | ft          |  |
| Profile Description          |                                 |                           |             |  |
| Profile Headloss             |                                 | 0.00                      | ft          |  |
| Downstream Velocity          |                                 | Infinity                  | ft/s        |  |
| Jpstream Velocity            |                                 | Infinity                  | ft/s        |  |
| Normal Depth                 |                                 | 0.29                      | ft          |  |
| Critical Depth               |                                 | 0.55                      | ft          |  |
| Channel Slope                | 0                               | .20000                    | ft/ft       |  |
| Critical Slope               | 0                               | .02311                    | ft/ft       |  |

Worksheet for DROP Channel Section 1 (25 cfs-5:1)

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# Worksheet for Channel Section 1 (30 cfs - 0.885% Slope)

| Project Description                    |                                 |                  |  |
|--|---------------------------------|------------------|--|
| Friction Method<br>Solve For           | Manning Formula<br>Normal Depth |                  |  |
| Input Data                             |                                 |                  |  |
| Roughness Coefficient<br>Channel Slope |                                 | 0.035<br>0.00885 | ft/ft                                    |
| Left Side Slope                        |                                 | 2.50             | ft/ft (H:V)                              |
| Right Side Slope                       |                                 | 2.50             | ft/ft (H:V)                              |
| Bottom Width                           |                                 | 10.00            | ft                                       |
| Discharge                              |                                 | 25.00            | ft³/s                                    |
| Results                                |                                 |                  |  |
| Normal Depth                           |                                 | 0.73             | ft                                       |
| Flow Area                              |                                 | 8.62             | ft²                                      |
| Wetted Perimeter                       |                                 | 13.93            | ft                                       |
| Top Width                              |                                 | 13.65            | ft                                       |
| Critical Depth                         |                                 | 0.55             | ft                                       |
| Critical Slope                         |                                 | 0.02311          | ft/ft                                    |
| Velocity                               |                                 | 2.90             | ft/s                                     |
| Velocity Head                          |                                 | 0.13             | ft                                       |
| Specific Energy                        |                                 | 0.86             | ft                                       |
| Froude Number                          |                                 | 0.64             |  |
| Flow Type                              | Subcritical                     |                  |  |
| GVF Input Data                         |                                 |                  |  |
| Downstream Depth                       |                                 | 0.00             | ft                                       |
| Length                                 |                                 | 0.00             | ft                                       |
| Number Of Steps                        |                                 | 0                |  |
| GVF Output Data                        |                                 |                  | n - Carl<br>Maria - Carl<br>Maria - Carl |
| Upstream Depth<br>Profile Description  |                                 | 0.00             | ft                                       |
| Profile Headloss                       |                                 | 0.00             | ft                                       |
| Downstream Velocity                    |                                 | Infinity         | ft/s                                     |
| Upstream Velocity                      |                                 | Infinity         | ft/s                                     |
| Normal Depth                           |                                 | 0.73             | ft                                       |
| Critical Depth                         |                                 | 0.55             | ft                                       |
| Channel Slope                          |                                 | 0.00885          | ft/ft                                    |
| Critical Slope                         |                                 | 0.02311          | ft/ft                                    |
|  |                                 | • •              |  |

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## Worksheet for Channel Section 2 (80 cfs - 0.104% Slope)

ft/ft ft/ft (H:V) ft/ft (H:V) ft ft ft<sup>3</sup>/s

ft ft² ft ft ft ft/ft ft/s ft

ft ft

ft

ft ft/s ft/s ft ft ft ft/ft ft/ft

**Project Description** 

|                              | A.A                             |          |  |
|------------------------------|---------------------------------|----------|--|
| Friction Method<br>Solve For | Manning Formula<br>Normal Depth |          |  |
| 301VE F01                    | Nomai Depti                     |          |  |
| Input Data                   |                                 |          |  |
| Roughness Coefficient        |                                 | 0.035    |  |
| Channel Slope                |                                 | 0.01040  |  |
| Left Side Slope              |                                 | 2.50     |  |
| Right Side Slope             |                                 | 2.50     |  |
| Bottom Width                 |                                 | 10.00    |  |
| Discharge                    |                                 | 80.00    |  |
| Results                      |                                 |          |  |
| Normal Depth                 |                                 | 1.35     |  |
| Flow Area                    |                                 | 17.97    |  |
| Wetted Perimeter             |                                 | 17.24    |  |
| Top Width                    |                                 | 16.73    |  |
| Critical Depth               |                                 | 1.14     |  |
| Critical Slope               |                                 | 0.01896  |  |
| Velocity                     |                                 | 4.45     |  |
| Velocity Head                |                                 | 0.31     |  |
| Specific Energy              |                                 | 1.65     |  |
| Froude Number                | Curle aniti and                 | 0.76     |  |
| Flow Type                    | Subcritical                     |          |  |
| GVF Input Data               |                                 |          |  |
| Downstream Depth             |                                 | 0.00     |  |
| Length                       |                                 | 0.00     |  |
| Number Of Steps              |                                 | 0        |  |
| GVF Output Data              |                                 |          |  |
| Upstream Depth               |                                 | 0.00     |  |
| Profile Description          |                                 |          |  |
| Profile Headloss             |                                 | 0.00     |  |
| Downstream Velocity          |                                 | Infinity |  |
| Upstream Velocity            |                                 | Infinity |  |
| Normal Depth                 |                                 | 1.35     |  |
| Critical Depth               |                                 | 1.14     |  |
| Channel Slope                | (                               | 0.01040  |  |
| Critical Slope               | (                               | 0.01896  |  |
|                              |                                 |          |  |

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### Worksheet for Channel Section 3 (140 cfs - 0.5% Slope)

**Project Description** Friction Method Manning Formula Solve For Normal Depth Input Data **Roughness Coefficient** 0.035 Channel Slope 0.00500 ft/ft Left Side Slope 2.50 ft/ft (H:V) **Right Side Slope** 2.50 ft/ft (H:V) Bottom Width 10.00 ft Discharge 140.00 ft³/s Results Normal Depth 2.22 ft Flow Area 34.50 ft² Wetted Perimeter 21.95 ft Top Width 21.10 ft Critical Depth 1.59 ft Critical Slope 0.01739 ft/ft Velocity 4.06 ft/s Velocity Head 0.26 ft Specific Energy 2.48 ft Froude Number 0.56 Flow Type Subcritical **GVF** Input Data Downstream Depth 0.00 ft Length 0.00 ft Number Of Steps 0 **GVF** Output Data Upstream Depth 0.00 ft **Profile Description Profile Headloss** 0.00 ft Downstream Velocity Infinity ft/s Upstream Velocity Infinity ft/s Normal Depth 2.22 ft Critical Depth 1.59 ft Channel Slope 0.00500 ft/ft Critical Slope 0.01739 ft/ft

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## Worksheet for Channel Section 4 (140 cfs - 1.0% Slope)

**Project Description** 

| Manning Formula |   |
|-----------------|---|
| Normal Depth    |   |
|                 |   |
| 0.03            | 5   |
| 0.0100          | 0 ft/ft   |
| 2.5             | 0 ft/ft (H:V)   |
| 2.5             | 0 ft/ft (H:V)   |
| 10.0            | 0 ft  |
| 150.0           | 0 ft³/s   |
|                 |   |
| 1.9             | 1 ft  |
| 28.3            | 2 ft²   |
| 20.3            | 1 ft  |
| 19.5            | 7 ft  |
| 1.6             | 5 ft  |
| 0.0172          | 1 ft/ft   |
| 5.3             | 0 ft/s  |
| 0.4             | 4 ft  |
| 2.3             | 5 ft  |
| 0.7             | 8   |
| Subcritical     |   |
|                 |   |
| 0.0             | D ft  |
| 0.0             | D ft  |
|                 | )   |
|                 |   |
| 0.00            | ) ft  |
|                 |   |
| 0.00            | ) ft  |
|                 |   |
|                 |   |
|                 |   |
|                 |   |
|                 |   |
| 0.01721         | ft/ft   |
|                 | Normal Depth<br>0.03<br>0.0100<br>2.5<br>2.5<br>10.0<br>150.0<br>1.9<br>28.3<br>20.3<br>1.9<br>28.3<br>20.3<br>19.5<br>1.6<br>0.0172<br>5.3<br>0.4<br>2.3<br>0.7<br>Subcritical<br>0.00<br>0.00<br>0.00 |

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# Worksheet for Channel Section 5 (80 cfs - 1.0% Slope)

Project Description

| Friction Method            | Manning Formula |                |          |
|----------------------------|-----------------|----------------|----------|
| Solve For                  | Normal Depth    |                |          |
| Input Data                 |                 |                |          |
| ,<br>Roughness Coefficient |                 | 0.000          |          |
| Channel Slope              |                 | 0.035          |          |
| Left Side Slope            |                 | 0.01000        |          |
| Right Side Slope           |                 | 2.50           | . ,      |
| Bottom Width               |                 | 2.50           | · /      |
| Discharge                  |                 | 10.00<br>80.00 |          |
| Results                    |                 |                |          |
| Normal Depth               |                 | 1.20           | 4        |
| Flow Area                  |                 | 1.36<br>18.22  |          |
| Wetted Perimeter           |                 | 18.22          |          |
| Top Width                  |                 | 16.80          | ft<br>ft |
| Critical Depth             |                 | 1.14           | ft       |
| Critical Slope             |                 | 0.01896        | ft/ft    |
| Velocity                   |                 | 4.39           | ft/s     |
| Velocity Head              |                 | 0.30           | ft       |
| Specific Energy            |                 | 1.66           | ft       |
| Froude Number              |                 | 0.74           |          |
| Flow Type                  | Subcritical     |                |          |
| GVF Input Data             |                 |                |          |
| Downstream Depth           |                 | 0.00           | ft       |
| Length                     |                 | 0.00           | ft       |
| Number Of Steps            |                 | 0              |          |
| GVF Output Data            |                 |                |          |
| Upstream Depth             |                 | 0.00           | ft       |
| Profile Description        |                 |                |          |
| Profile Headloss           |                 | 0.00           | ft       |
| Downstream Velocity        |                 | Infinity       | ft/s     |
| Upstream Velocity          |                 | Infinity       | ft/s     |
| Normal Depth               |                 | 1.36           | ft       |
| Critical Depth             |                 | 1.14           | ft       |
| Channel Slope              |                 | 0.01000        | ft/ft    |
| Critical Slope             |                 | 0.01896        | ft/ft    |
|                            |                 |                |          |

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# Worksheet for DROP STRUCTURE Channel Sec-6 (80 cfs-5:1)

### **Project Description**

| Friction Method       | Manning Formula |            |  |
|-----------------------|-----------------|------------|--|
| Solve For             | Normal Depth    |            |  |
| Input Data            |                 |            |  |
| Roughness Coefficient | 0.035           |            |  |
| Channel Slope         | 0.20000         |            |  |
| Left Side Slope       | 2.50            |            |  |
| Right Side Slope      | 2.50            |            |  |
| Bottom Width          | 10.00           |            |  |
| Discharge             | 80.00           |            |  |
| Results               |                 |            |  |
| Normal Depth          | 0.50            |            |  |
| Flow Area             | 0.58            | ft         |  |
| Wetted Perimeter      | 6.64<br>13.12   | ft²        |  |
| Top Width             |                 |            |  |
| Critical Depth        | 12.90           | ft         |  |
| Critical Slope        | 1.14<br>0.01896 | ft         |  |
| Velocity              | 12.05           | ft/ft      |  |
| Velocity Head         | 2.26            | ft/s<br>ft |  |
| Specific Energy       | 2.20            | ft         |  |
| Froude Number         | 2.96            | it.        |  |
| Flow Type             | Supercritical   |            |  |
|                       | ouperonneur     |            |  |
| GVF Input Data        |                 |            |  |
| Downstream Depth      | 0.00            | ft         |  |
| Length                | 0.00            | ft         |  |
| Number Of Steps       | 0               |            |  |
| GVF Output Data       |                 |            |  |
| Upstream Depth        | 0.00            | ft         |  |
| Profile Description   |                 |            |  |
| Profile Headloss      | 0.00            | ft         |  |
| Downstream Velocity   | Infinity        | ft/s       |  |
| Upstream Velocity     | Infinity        | ft/s       |  |
| Normal Depth          | 0.58            | ft         |  |
| Critical Depth        | 1.14            | ft .       |  |
| Channel Slope         | 0.20000         | ft/ft      |  |
| Critical Slope        | 0.01896         | ft/ft      |  |
|                       |                 |            |  |

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# Worksheet for Channel Section 6 (80 cfs - 1.0% Slope)

Project Description

| Friction Method<br>Solve For | Manning Formula<br>Normal Depth |          |             |
|------------------------------|---------------------------------|----------|-------------|
| Input Data                   |                                 |          |             |
| Roughness Coefficient        |                                 | 0.035    |             |
| Channel Slope                |                                 | 0.01000  | ft/ft       |
| Left Side Slope              |                                 | 2.50     | ft/ft (H:V) |
| Right Side Slope             |                                 | 2.50     | ft/ft (H:V) |
| Bottom Width                 |                                 | 10.00    | ft          |
| Discharge                    |                                 | 80.00    | ft³/s       |
| Results                      |                                 |          |             |
| Normal Depth                 |                                 | 1.36     | ft          |
| Flow Area                    |                                 | 18.22    | ft²         |
| Wetted Perimeter             |                                 | 17.32    | ft          |
| Top Width                    |                                 | 16.80    | ft          |
| Critical Depth               |                                 | 1.14     | ft          |
| Critical Slope               |                                 | 0.01896  | ft/ft       |
| Velocity                     |                                 | 4.39     | ft/s        |
| Velocity Head                |                                 | 0.30     | ft          |
| Specific Energy              |                                 | 1.66     | ft          |
| Froude Number                |                                 | 0.74     |             |
| Flow Type                    | Subcritical                     |          |             |
| GVF Input Data               |                                 |          |             |
| Downstream Depth             |                                 | 0.00     | ft          |
| Length                       |                                 | 0.00     | ft          |
| Number Of Steps              |                                 | 0        |             |
| GVF Output Data              |                                 |          |             |
| Upstream Depth               |                                 | 0.00     | ft          |
| Profile Description          |                                 |          |             |
| Profile Headloss             |                                 | 0.00     | ft          |
| Downstream Velocity          |                                 | Infinity | ft/s        |
| Upstream Velocity            |                                 | Infinity | ft/s        |
| Normal Depth                 |                                 | 1.36     | ft          |
| Critical Depth               |                                 | 1.14     | ft          |
| Channel Slope                |                                 | 0.01000  | ft/ft       |
| Critical Slope               |                                 | 0.01896  | ft/ft       |
|                              |                                 |          |             |

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# Worksheet for Channel Section 7 (25 cfs - 0.5% Slope)

### **Project Description**

| Friction Method<br>Solve For           | Manning Formula<br>Normal Depth |          |       |
|--|---------------------------------|----------|-------|
| Input Data                             |                                 |          |       |
| Roughness Coefficient<br>Channel Slope |                                 | 0.039    |       |
| Left Side Slope                        |                                 | 2.50     |       |
| Right Side Slope                       |                                 | 2.50     |       |
| Bottom Width                           |                                 | 10.00    |       |
| Discharge                              |                                 | 25.00    | ft³/s |
| Results                                |                                 |          |       |
| Normal Depth                           |                                 | 0.86     | ft    |
| Flow Area                              |                                 | 10.43    | ft²   |
| Wetted Perimeter                       |                                 | 14.62    | ft    |
| Top Width                              |                                 | 14.29    | ft    |
| Critical Depth                         |                                 | 0.55     | ft    |
| Critical Slope                         |                                 | 0.02311  | ft/ft |
| Velocity                               |                                 | 2.40     | ft/s  |
| Velocity Head                          |                                 | 0.09     | ft    |
| Specific Energy                        |                                 | 0.95     | ft    |
| Froude Number                          |                                 | 0.49     |       |
| Flow Type                              | Subcritical                     |          |       |
| GVF Input Data                         |                                 |          |       |
| Downstream Depth                       |                                 | 0.00     | ft    |
| Length                                 |                                 | 0.00     | ft    |
| Number Of Steps                        |                                 | 0        |       |
| GVF Output Data                        |                                 |          |       |
| Upstream Depth<br>Profile Description  |                                 | 0.00     | ft    |
| Profile Headloss                       |                                 | 0.00     | ft    |
| Downstream Velocity                    |                                 | Infinity | ft/s  |
| Upstream Velocity                      |                                 | Infinity | ft/s  |
| Normal Depth                           |                                 | 0.86     | ft    |
| Critical Depth                         |                                 | 0.55     | ft    |
| Channel Slope                          |                                 | 0.00500  | ft/ft |
| Critical Slope                         |                                 | 0.02311  | ft/ft |
|  |                                 |          |       |

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## **OFF-SITE CHANNEL**

## **RIP-RAP SÍZING CALCULATIONS**

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### Cholla Ash Monofill Riprap Size Comparison Offsite Channel Drop Structures

| Method                       |                |      |      |      |        |        |                 |      |      |                              |                            |
|------------------------------|----------------|------|------|------|--------|--------|-----------------|------|------|------------------------------|----------------------------|
| Offsite Channel              | USACE<br>(D30) | ASCE | USBR | USGS | ISBASH | HEC-11 | Maricopa<br>Cty | Min  | Мах  | Chosen<br>Rock Size<br>(D50) | Layer<br>Thickness<br>(ft) |
| Section 1 (bank)             | 0.04           | 0.06 | 0.11 | 0.13 | 0.11   | 0.02   | 0.04            | 0.02 | 0.13 | 0.33                         | 1.00                       |
| Section 1 (bottom)           | 0.04           | 0.06 | 0.11 | 0.13 | 0.11   | 0.02   |                 | 0.02 | 0.13 | 0.33                         | 1.00                       |
| Section 2 (bank)             | 0.10           | 0.14 | 0.26 | 0.38 | 0.25   | 0.05   | 0.10            | 0.05 | 0.38 | 0.33                         | 1.00                       |
| Section 2 (bottom)           | 0.10           | 0.14 | 0.26 | 0.38 | 0.25   | 0.05   |                 | 0.05 | 0.38 | 0.33                         | 1.00                       |
| Section 3 (bank)             | 0.06           | 0.10 | 0.20 | 0.27 | 0.19   | 0.03   | 0.06            | 0.03 | 0.27 | 0.33                         | 1.00                       |
| Section 3 (bottom)           | 0.06           | 0.10 | 0.20 | 0.27 | 0.19   | 0.03   |                 | 0.03 | 0.27 | 0.33                         | 1.00                       |
| Section 4 (bank)             | 0.14           | 0.20 | 0.38 | 0.59 | 0.36   | 0.09   | 0.14            | 0.09 | 0.59 | 0.50                         | 1.00                       |
| Section 4 (bottom)           | 0.14           | 0.20 | 0.38 | 0.59 | 0.36   | 0.09   |                 | 0.09 | 0.59 | 0.50                         | 1.00                       |
| Section 5 (bank)             | 0.09           | 0.14 | 0.26 | 0.37 | 0.25   | 0.05   | 0.10            | 0.05 | 0.37 | 0.33                         | 1.00                       |
| Section 5 (bottom)           | 0.09           | 0.04 | 0.26 | 0.37 | 0.25   | 0.05   |                 | 0.04 | 0.37 | 0.33                         | 1.00                       |
| Section 6 (bank)             | 0.09           | 0.14 | 0.26 | 0.37 | 0.25   | 0.05   | 0.10            | 0.05 | 0.37 | 0.33                         | 1.00                       |
| Section 6 (bottom)           | 0.09           | 0.04 | 0.26 | 0.37 | 0.25   | 0.05   |                 | 0.04 | 0.37 | 0.33                         | 1.00                       |
| Section 7 (bank)             | 0.02           | 0.04 | 0.07 | 0.08 | 0.07   | 0.01   | 0.02            | 0.01 | 0.08 | 0.33                         | 1.00                       |
| Section 7 (bottom)           | 0.02           | 0.04 | 0.07 | 0.08 | 0.07   | 0.01   |                 | 0.01 | 0.08 | 0.33                         | 1.00                       |
| Drop Struc Sec-6-5:1 (bnk)   | 1.42           | 1.03 | 2.06 | 4.34 | 1.86   | 1.03   | 3.07            | 1.03 | 4.34 | 1.00*                        | 2.00                       |
| Drop Struc Sec-6-5:1 (btm)   | 1.42           | 0.95 | 2.06 | 4.34 | 1.86   | 0.77   |                 | 0.77 | 4.34 | 1.00*                        | 2.00                       |
| Drop Struc Sec-1-basin (bnk) | 0.60           | 0.45 | 0.88 | 1.58 | 0.81   | 0.30   | 1.33            | 0.30 | 1.58 | 1.00*                        | 2.00                       |
| Drop Struc Sec-1-basin (btm) | 0.60           | 0.42 | 0.88 | 1.58 | 0.81   | 0.22   |                 | 0.22 | 1.58 | 1.00*                        | 2.00                       |

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#### Cholla Ash Monofill Riprap Calculation

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|          | A B C D E F G H I J K  |
|----------|--|
| 1        | Calculation of Riprap Size for Channel Lining                                      |
| 2        | Calculations are based on Drainage Design Manual for Maricopa County (Manual)      |
| 3        | and a second of Drainage Deergh Manaal for Maneopa County (Manual)                 |
| 4        | Channel Name: Cholla Ash Offsite Channel section 1 Drop Structure                  |
| 5        | Design Flood Freque 100 -yr  |
| 6        | Location/Station: 1+50 to 7+50   |
| 7        |  |
| 8        |  |
| 9        | Relevant Equations   |
| 10       |  |
| 11       |  |
| 12<br>13 | $\int_{a} = 0.001 V_a^3$   |
| 14       | $d_{50} = \frac{0.001 V_a^3}{d_{avg}^{0.5} K_1^{1.5}}$                             |
| 15       |  |
| 16       | Γ  |
| 17       | $K_1 = \left[1 - \frac{\sin^2 \theta}{\sin^2 \theta}\right]^{0.5}$                 |
| 18       | $\sin^2 \phi$  |
| 19       | Where,   |
| 20       | $d_{50}$ = Median diameter of the riprap materials, ft                             |
| 21       | V <sub>a</sub> = Average velocity in the main channel, ft/s                        |
| 22       | d <sub>avg</sub> = Average depth of flow in the main channel, ft                   |
| 23       | K <sub>1</sub> = Bank angle correction factor                                      |
| 24       | $\theta$ = Bank angle with the horizontal, degree                                  |
| 25       | $\phi$ = Riprap material's angle of repose, degree                                 |
| 26       |  |
| 27       |  |
| 28<br>29 |  |
| 30       | (Based on output from FlowMaster and based on the Manual)                          |
| 31       | $V_a = 7.96$ ft/s  |
| 32       | d <sub>avg</sub> = 0.29 ft   |
| 33       | $D_{50} = 16$ inch Assume a $D_{50}$ and then calculate if it is stable.           |
| 34       | $\theta = 21.80$ degree [2.5:1 (H:V)]  |
| 35       | $\phi = 41.0$ degree From Figure 6.14 of the Manual for rounded riprap - attached. |
| 36       |  |
|          | Hence.   |
| 38       | $K_1 = 0.82$   |
| 39       | $d_{50} = 1.25 \text{ ft}$   |
| 40       | $d_{50}$ (inch) = 16 inch <d50 16="" =="" inches="" is="" stable.<="" td=""></d50> |
| 41       |  |
| 42       |  |
| 43       | Therefore, proposed design riprap size $(d_{50}) = 16$ inch                        |

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Cholla Ash Monofill Riprap Calculation

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|          | A          | В                                     | С                              | D           | E  | F         | G           | н              |              | J             | к  |
|----------|------------|---------------------------------------|--------------------------------|-------------|--|-----------|-------------|----------------|--------------|---------------|----|
| 1        | Calculat   | ion of Ri                             | orap Size                      | for Cha     | annel Li   | inina     | I           |                |              | · •           |    |
| 2        | Calculatio | ns are bas                            | ed on Drain                    | age Des     | ian Man  | ual for   | Maricona    | County (N      | lanual)      |               |    |
| 3        |            |                                       |                                | 0           | 5  |           |             | oounty (n      | landary      |               |    |
| 4        | Channel M  | lame:                                 | Cholla Ash                     | Offsite     | Channel  | sactio    | on 1        |                |              |               |    |
| 5        |            | ood Freque                            | 100                            |             | Guanner  | 36011     |             |                |              |               |    |
| 6        |            | Station: 1+                           |                                | ,           |  |           |             |                |              |               |    |
| 7        |            |                                       |                                |             |  |           |             |                |              |               |    |
| 8        | l          |                                       |                                |             |  |           |             |                |              |               |    |
| 9        | Relevant I | quations                              |                                |             |  |           |             |                |              |               |    |
| 10       | -          |                                       |                                |             |  |           |             |                |              |               |    |
| 11       |            |                                       |                                |             |  |           |             |                |              |               |    |
| 12       | 4          | - 0.                                  | $.001 V_a^3$                   |             |  |           |             |                |              |               |    |
| 14       | 1          | $d_{50} = \frac{0}{d}$                | $^{0.5}K_{1.5}^{1.5}$          |             |  |           |             |                |              |               |    |
| 15       | 1          |                                       |                                |             |  |           |             |                |              |               |    |
| 16       |            | Г                                     |                                | ]           |  |           |             |                |              |               |    |
| 17       |            | $K_1 = 1$                             | $\frac{\sin^2 \theta}{\theta}$ |             |  |           |             |                |              |               |    |
| 18       |            |                                       | $\sin^2 \phi$                  |             |  |           |             |                |              |               |    |
| 19       | Where,     |                                       |                                | J           |  |           |             |                |              |               |    |
| 20       |            | d <sub>50</sub> =                     | Median diar                    | meter of    | the riprap   | mater     | rials, ft   |                |              |               |    |
| 21       |            | V <sub>a</sub> =                      | Average ve                     | locity in t | he main d  | channe    | el, ft/s    |                |              |               |    |
| 22       |            | d <sub>avg</sub> =                    | Average de                     |             |  |           |             |                |              |               |    |
| 23       |            | K <sub>1</sub> =                      | Bank angle                     |             |  |           |             |                |              |               |    |
| 24       |            | θ =                                   | Bank angle                     |             |  | ıl, degr  | ee          |                |              |               |    |
| 25       |            | $\phi =$                              | Riprap mate                    |             |  |           |             |                |              |               |    |
| 26       |            |                                       |                                |             |  |           |             |                |              |               |    |
| 27<br>28 |            |                                       |                                |             |  |           |             |                |              |               |    |
| 28       | Input Para |                                       |                                |             |  |           |             |                |              |               |    |
| 30       | Loasen (II | output from                           | FlowMaster                     | and bas     | ed on the  | e Manu    | ial)        |                |              |               |    |
| 31       |            | V <sub>a</sub> =                      | 2.90                           | ft/s        |  |           |             |                |              |               |    |
| 32       |            | d <sub>avg</sub> =                    | 0.73                           |             |  |           |             |                |              |               |    |
| 33       |            | 0 <sub>avg</sub><br>D <sub>50</sub> = |                                | nch         | Accumo   |           | and there - | alouiate 161   | 11-1-1       |               |    |
| 34       |            | $\theta =$                            | 21.80                          |             |  |           | ano inen c  | alculate if it | is stable.   |               | .  |
| 35       |            | $\phi =$                              |                                | degree      | [2.5:1 (H  |           | 14 of the M | lanual for r   | ounded ripra | n ottook      |    |
| 36       |            | r 1                                   |                                |             | - ionri lį   | , ar e 0. |             | anual IOF f    | ounded ripra | ah - arracheo | ı. |
| 37       | Hence,     |                                       |                                |             |  |           |             |                |              |               |    |
| 38       |            | K1 =                                  | 0.82                           |             |  |           |             |                |              |               |    |
| 39       |            | d <sub>50</sub> =                     | 0.04 f                         | ťt          |  |           |             |                |              |               |    |
| 40       |            | d <sub>50</sub> (inch) =              | 1 i                            | nch         | <d50< td=""><td>= 6</td><td>inches is s</td><td>table</td><td></td><td></td><td></td></d50<> | = 6       | inches is s | table          |              |               |    |
| 41       |            |                                       |                                |             | 200  | 5         |             |                |              |               |    |
| 42       |            |                                       |                                |             |  |           |             |                |              |               |    |
| 43       | Therefo    | re, propose                           | d design ri                    | orap size   | e (d <sub>50</sub> ) =   | 6         | inch        |                |              |               |    |

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Cholla Ash Monofill<sup>2</sup> Riprap Calculation

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|          | A                 | В                        | С                            | D         | E  | F      | G           | Н                |             | J            | К |
|----------|-------------------|--------------------------|------------------------------|-----------|--|--------|-------------|------------------|-------------|--------------|---|
| 1        | Calculat          | ion of Ri                | orap Size                    | for Ch    |  |        |             | L                | '           | 5            |   |
| 2        | Calculatio        | ns are bas               | ed on Drair                  | age Des   | ion Manu   | al for | Maricona    | County (Ma       |             |              |   |
| 3        | Ī                 |                          |                              | <b>J</b>  |  |        | manoopu     | oounty (me       | indaty      |              |   |
| 4        | Channel N         | lame:                    | Cholla Ast                   | Offsite   | Channel s  | ectio  | n 2         |                  |             |              |   |
| 5        | Design Flo        | od Freque                | 100                          |           | onannere   | cono   |             |                  |             |              |   |
| 6        | Location/S        |                          | 8+00 to 11                   | -         |  |        |             |                  |             |              |   |
| 7        |                   |                          |                              |           |  |        |             |                  |             |              |   |
| 8        |                   |                          |                              |           |  |        |             |                  |             |              |   |
| 9        | <u>Relevant E</u> | quations                 |                              |           |  |        |             |                  |             |              |   |
| 10       |                   |                          |                              |           |  |        |             |                  |             |              |   |
| 12       |                   |                          |                              |           |  |        |             |                  |             |              |   |
| 13       |                   | $d_{1} = \frac{0}{2}$    | .0011/3                      |           |  |        |             |                  |             |              |   |
| 14       |                   | $d_{50} = \frac{0}{d}$   | $\frac{0.5}{avg}K_{1}^{1.5}$ |           |  |        |             |                  |             |              |   |
| 15       |                   |                          |                              |           |  |        |             |                  |             |              |   |
| 16       |                   | ſ                        |                              | 5         |  |        |             |                  |             |              |   |
| 17       |                   | $K_1 = 1$                | $-\frac{\sin^2\theta}{1-2}$  |           |  |        |             |                  |             |              |   |
| 18       | 14/1              |                          | $\sin^{\circ}\phi$           |           |  |        |             |                  |             |              |   |
| 19<br>20 | Where,            | d <sub>50</sub> =        | Median dia                   | meter of  | the riprop   | notor  | iolo ft     |                  |             |              |   |
| 20       |                   | $V_a =$                  | Average ve                   |           |  |        |             |                  |             |              |   |
| 22       |                   | d <sub>avg</sub> =       | Average de                   |           |  |        |             |                  |             |              |   |
| 23       |                   | K <sub>1</sub> =         | Bank angle                   |           |  |        | annei, it   |                  |             |              |   |
| 24       |                   | θ =                      | Bank angle                   |           |  | door   | 00          |                  |             |              |   |
| 25       |                   | φ =                      | Riprap mate                  |           |  |        |             |                  |             |              |   |
| 26       |                   | 1                        |                              |           | 5 pe   | 00, a. | 9.00        |                  |             |              |   |
| 27       |                   |                          |                              |           |  |        |             |                  |             |              |   |
|          | Input Para        |                          | -                            |           |  |        |             |                  |             |              |   |
| 29<br>30 | (based on (       | output from              | FlowMaster                   | r and bas | ed on the  | Manu   | al)         |                  |             |              |   |
| 31       |                   | V <sub>a</sub> =         | 4.45                         | ft/s      |  |        |             |                  |             |              |   |
| 32       |                   | d <sub>avg</sub> =       | 1.35                         |           |  |        |             |                  |             |              |   |
| 33       |                   | D <sub>50</sub> =        |                              | inch      | Assume a   | Den P  | and then ca | alculate if it i | s stable    |              |   |
| 34       |                   | $\theta =$               |                              | degree    | [2.5:1 (H:)  |        |             |                  |             |              |   |
| 35       |                   | φ =                      | 41.0                         | degree    |  |        | 14 of the N | lanual for ro    | unded ripra | n - attacher | 4 |
| 36       |                   |                          |                              |           | -  |        |             |                  |             |              |   |
|          | Hence,            |                          |                              |           |  |        |             |                  |             |              |   |
| 38       |                   | K <sub>1</sub> =         | 0.82                         |           |  |        |             |                  |             |              |   |
| 39       |                   | d <sub>50</sub> =        | 0.10                         |           |  |        |             |                  |             |              |   |
| 40       |                   | d <sub>50</sub> (inch) = | 2 1                          | inch      | <d50 =<="" th=""><th>= 6 i</th><th>nches is st</th><th>able.</th><th></th><th></th><th></th></d50> | = 6 i  | nches is st | able.            |             |              |   |
| 41       |                   |                          |                              |           |  |        |             |                  |             |              |   |
| 42<br>43 | Thorofor          |                          | • ما ما م ما ا               |           |  |        |             |                  |             |              |   |
| 43       | ineretor          | e, propose               | d design ri                  | prap siz  | e (d <sub>50</sub> ) =   | 6 i    | nch         |                  |             |              |   |

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|          | A          | В                        | СТ                             | D           | E  | F      | G            | Н              |             | J           | К        |
|----------|------------|--------------------------|--------------------------------|-------------|--|--------|--------------|----------------|-------------|-------------|----------|
| 1        | Calculat   | on of Ri                 | orap Size                      |             |  |        |              |                | L           | 5           | <u> </u> |
| 2        |            |                          | ed on Drain                    |             |  |        | Maricona     | County (M      | (leura      |             |          |
| 3        | 1          |                          |                                |             | ign mana   |        | maneopa      | oounty (ma     | anuarj      |             |          |
| 4        | Channel N  | ame:                     | Cholla Ash                     |             | Channel e  | octio  | n 3          |                |             |             |          |
| 5        | Design Flo |                          |                                |             | onamera  | ectio  | 11.5         |                |             |             |          |
| 6        | Location/S |                          | 11+50 to 1                     | -           |  |        |              |                |             |             |          |
| 7        | ]          |                          |                                |             |  |        |              |                |             |             |          |
| 8        |            |                          |                                |             |  |        |              |                |             |             |          |
| 9        | Relevant E | quations                 |                                |             |  |        |              |                |             |             |          |
| 10       |            |                          |                                |             |  |        |              |                |             |             |          |
| 11       |            |                          |                                |             |  |        |              |                |             |             |          |
| 12<br>13 |            | 0                        | $.001 V_a^3$                   |             |  |        |              |                |             |             |          |
| 14       |            | $d_{50} = \frac{0}{d}$   | $^{0.5}K^{1.5}$                |             |  |        |              |                |             |             |          |
| 15       |            | L                        | avg                            |             |  |        |              |                |             |             |          |
| 16       |            | Г"                       |                                | 7           |  |        |              |                |             |             |          |
| 17       | ]          | $K_1 = 1$                | $-\frac{\sin^2\theta}{\theta}$ |             |  |        |              |                |             |             |          |
| 18       |            |                          | $\sin^2 \phi$                  |             |  |        |              |                |             |             |          |
|          | Where,     | L                        |                                | -1          |  |        |              |                |             |             |          |
| 20       | 4          | d <sub>50</sub> =        | Median dia                     |             |  |        |              |                |             |             |          |
| 21       | •          | ∨ <sub>a</sub> =         | Average ve                     | locity in t | he main ch   | nanne  | el, ft/s     |                |             |             |          |
| 22       |            | d <sub>avg</sub> =       | Average de                     | pth of flo  | w in the m   | ain cł | nannel, ft   |                |             |             |          |
| 23       |            | K1 =                     | Bank angle                     | correctio   | on factor  |        |              |                |             |             |          |
| 24       |            | θ =                      | Bank angle                     | with the    | horizontal,  | degr   | ee           |                |             |             |          |
| 25       |            | $\phi$ =                 | Riprap mate                    | erial's an  | gle of repo  | se, d  | egree        |                |             |             |          |
| 26       |            |                          |                                |             |  |        |              |                |             |             |          |
|          | Input Para | metore                   |                                |             |  |        |              |                |             |             |          |
| 29       | (Based on  | output from              | FlowMaster                     | r and has   | ed on the  | Мари   |              |                |             |             |          |
| 30       |            |                          |                                |             |  | vianu  | (a)          |                |             |             |          |
| 31       |            | V <sub>a</sub> =         | 3.85                           | ft/s        |  |        |              |                |             |             |          |
| 32       |            | d <sub>avg</sub> =       | 1.85                           |             |  |        |              |                |             |             |          |
| 33       |            | D <sub>50</sub> =        |                                | inch        | Assume a   |        | and then ca  | alculate if it | is stable   |             |          |
| 34       |            | $\theta =$               |                                | degree      | [2.5:1 (H:)  |        |              |                |             |             |          |
| 35       |            | φ =                      |                                | degree      |  |        | 14 of the N  | lanual for ro  | unded ripra | n - attache | 4        |
| 36       |            |                          |                                | -           |  |        |              |                |             | .1          |          |
|          | Hence,     |                          |                                |             |  |        |              |                |             |             |          |
| 38       |            | K <sub>1</sub> =         | 0.82                           |             |  |        |              |                |             |             |          |
| 39       |            | d <sub>50</sub> =        | 0.06                           | ft          |  |        |              |                |             |             |          |
| 40       |            | d <sub>50</sub> (inch) = | 1 i                            | inch        | <d50 =<="" th=""><th>= 6 i</th><th>inches is st</th><th>table.</th><th></th><th></th><th></th></d50> | = 6 i  | inches is st | table.         |             |             |          |
| 41       |            |                          |                                |             |  |        |              |                |             |             |          |
| 42       |            |                          |                                |             |  | _      |              |                |             |             |          |
| 43       |            | e, propose               | ed design ri                   | prap siz    | e (d <sub>50</sub> ) =   | 6      | inch         |                |             |             |          |
|          |            |                          |                                |             |  |        |              |                |             |             |          |

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|          | A                       | В                        | С                                    | D          | E   | <b>T</b> FT       | G           | <u> </u> | T          | 1        | J            |      |   |
|----------|-------------------------|--------------------------|--------------------------------------|------------|---|-------------------|-------------|----------|------------|----------|--------------|------|---|
| 1        | Calcula                 | tion of Ri               | prap Size                            |            |   |                   |             | L        | I          | I        |              |      | ĸ |
| 2        | Calculati               | ons are bas              | sed on Drain                         | age Des    | ian Manuz   | al for            | Maricona    | Count    | v (Ma      | nual)    |              |      |   |
| 3        | ]                       |                          |                                      | J          | <u>.</u>  |                   |             | Jount    | y (ma      | nuarj    |              |      |   |
| 4        | Channel                 | Name:                    | Cholla Ash                           | Offsite    | Channel s   | ectio             | n 4         |          |            |          |              |      |   |
| 5        | Design F                | lood Frequ               | e 100                                |            |   | 001101            |             |          |            |          |              |      |   |
| 6        | Location                |                          | 13+75 to 2                           |            |   |                   |             |          |            |          |              |      |   |
| 7        |                         |                          |                                      |            |   |                   |             |          |            |          |              |      |   |
| 8        | Balavant                | <b>F</b>                 |                                      |            |   |                   |             |          |            |          |              |      |   |
|          | Relevant                | Equations                |                                      |            |   |                   |             |          |            |          |              |      |   |
| 10       |                         |                          |                                      |            |   |                   |             |          |            |          |              |      |   |
| 12       |                         |                          | 0011/3                               |            |   |                   |             |          |            |          |              |      |   |
| 13       |                         | $d_{50} = \frac{0}{a}$   | 1.001V                               |            |   |                   |             |          |            |          |              |      |   |
| 14       | ]                       | , C                      | $l_{mg}^{0.5}K_1^{1.5}$              |            |   |                   |             |          |            |          |              |      |   |
| 15       |                         | ·····                    |                                      | _          |   |                   |             |          |            |          |              |      |   |
| 16       |                         | ſ                        | $-\frac{\sin^2\theta}{\cos^2\theta}$ |            |   |                   |             |          |            |          |              |      |   |
| 17       |                         | $K_{\perp} = 1$          | $-\frac{\sin^2 \phi}{\sin^2 \phi}$   |            |   |                   |             |          |            |          |              |      |   |
| 18       | Where,                  |                          | $\sin \varphi$                       |            |   |                   |             |          |            |          |              |      |   |
| 20       | where,                  | d <sub>50</sub> =        | Median diar                          | meter of   | the rinran r  | natari            | ale ft      |          |            |          |              |      |   |
| 21       |                         | $V_a =$                  | Average ve                           |            |   |                   |             |          |            |          |              |      |   |
| 22       |                         | d <sub>avg</sub> =       | Average de                           |            |   |                   |             |          |            |          |              |      |   |
| 23       |                         | K1 =                     | Bank angle                           |            |   |                   |             |          |            |          |              |      |   |
| 24       |                         | θ =                      | Bank angle                           |            |   | deare             | e           |          |            |          |              |      |   |
| 25       |                         | $\phi$ =                 | Riprap mate                          | erial's an | gle of repo   | se, de            | gree        |          |            |          |              |      |   |
| 26       |                         |                          |                                      |            |   |                   |             |          |            |          |              |      |   |
| 27<br>28 | Innut Day               |                          |                                      |            |   |                   |             |          |            |          |              |      |   |
|          | Input Para<br>(Based on |                          | FloutAcotor                          |            |   |                   |             |          |            |          |              |      |   |
| 30       | 120360 011              | output non               | n FlowMaster                         | ano pas    | eu on the l   | vianua            | ai)         |          |            |          |              |      |   |
| 31       |                         | V <sub>a</sub> =         | 5.30                                 | ft/s       |   |                   |             |          |            |          |              |      |   |
| 32       |                         | d <sub>avg</sub> =       | 1.91                                 |            |   |                   |             |          |            |          |              |      |   |
| 33       |                         | D <sub>50</sub> =        | 6 i                                  | nch        | Assume a  | D <sub>50</sub> a | nd then ca  | alculate | e if it is | stable   |              |      |   |
| 34       |                         | θ =                      | 21.80                                |            | [2.5:1 (H:\   |                   |             |          |            | 20010.   |              |      |   |
| 35       |                         | $\phi =$                 |                                      |            |   |                   | 4 of the M  | lanual f | for rou    | nded rin | rap - attacl | ned. |   |
| 36       | 11                      |                          |                                      |            | ,   |                   |             |          |            |          | ,            |      |   |
|          | Hence,                  | 12                       |                                      |            |   |                   |             |          |            |          |              |      |   |
| 38       |                         | K <sub>1</sub> =         | 0.82                                 |            |   |                   |             |          |            |          |              |      |   |
| 39       |                         | d <sub>50</sub> =        | 0.14 f                               |            |   |                   |             |          |            |          |              |      |   |
| 40       |                         | d <sub>50</sub> (inch) = | 2 i                                  | nch        | <d50 =<="" th=""><th>6 ir</th><th>iches is st</th><th>able.</th><th></th><th></th><th></th><th></th><th></th></d50> | 6 ir              | iches is st | able.    |            |          |              |      |   |
| 41 42    |                         |                          |                                      |            |   |                   |             |          |            |          |              |      |   |
| 42       | Thorofo                 |                          | od dogtan. t                         | ·          |   | <b></b>           |             |          |            |          |              |      |   |
| 43       | Inereto                 | re, propose              | ed design rij                        | orap size  | e (d <sub>50</sub> ) =  | 6 ir              | nch         |          |            |          |              |      |   |

Page \_\_\_\_ Date:

## Cholla Ash Monofill Riprap Calculation

By:\_\_\_\_\_ Checked:\_\_\_\_\_

|          | A B C D E F G H I J K  |
|----------|--|
| 1        | Calculation of Riprap Size for Channel Lining  |
| 2        | Calculations are based on Drainage Design Manual for Maricopa County (Manual)                    |
| 3        |  |
| 4        | Channel Name: Cholla Ash Offsite Channel section 5   |
|          | Design Flood Freque 100 -yr  |
|          | Location/Station: 23+50 to 32+50   |
| 7        |  |
| 8        | Delevent Envirt  |
|          | Relevant Equations   |
| 10<br>11 |  |
| 12       |  |
| 13       | $d_{in} = \frac{0.001 V_a}{a}$   |
| 14       | $d_{50} = \frac{0.001 V_a^3}{d_{org}^{0.5} K_1^{1.5}}$   |
| 15       |  |
| 16       | $\begin{bmatrix} \kappa & - \begin{bmatrix} 1 & \sin^2 \theta \end{bmatrix}^{0.5} \end{bmatrix}$ |
| 17       | $ \Lambda_1  =  1 - \frac{1}{2} - \frac{1}{2} $  |
| 18       | $\left[ \sin^2 \phi \right]$   |
|          | Where,   |
| 20       | d <sub>50</sub> = Median diameter of the riprap materials, ft                                    |
| 21       | V <sub>a</sub> = Average velocity in the main channel, ft/s                                      |
| 22       | d <sub>avg</sub> = Average depth of flow in the main channel, ft                                 |
| 23       | K <sub>1</sub> = Bank angle correction factor  |
| 24<br>25 | $\theta$ = Bank angle with the horizontal, degree  |
| 26       | $\phi$ = Riprap material's angle of repose, degree   |
| 27       |  |
|          | Input Parameters   |
|          | (Based on output from FlowMaster and based on the Manual)  |
| 30       |  |
| 31       | $V_a = 4.39$ ft/s  |
| 32       | $d_{avg} = 1.36$ ft  |
| 33       | $D_{50} = 6$ inch Assume a $D_{50}$ and then calculate if it is stable.                          |
| 34       | $\theta = 21.80$ degree [2.5:1 (H:V)]  |
| 35       | $\phi = 41.0$ degree From Figure 6.14 of the Manual for rounded riprap - attached.               |
| 36       | Hanaa  |
|          | Hence,   |
| 38       | $K_1 = 0.82$   |
| 39       | $d_{50} = 0.10 \text{ ft}$   |
| 40       | $d_{50}$ (inch) = 2 inch <d50 6="" =="" inches="" is="" stable.<="" th=""></d50>                 |
| 41       |  |
| 42       | Therefore, proposed deging righter airs (d.) =   |
| 43       | Therefore, proposed design riprap size (d <sub>50</sub> ) =   6 inch                             |

Page \_\_\_\_\_ Date:

## Cholla Ash Monofill Riprap Calculation

By:\_\_\_\_\_ Checked:\_\_\_\_\_

|          | A B C D E F G H I J K  |
|----------|--|
| 1        | Calculation of Riprap Size for Channel Lining                                      |
| 2        | Calculations are based on Drainage Design Manual for Maricopa County (Manual)      |
| 3        |  |
| 4        | Channel Name: Cholla Ash Offsite Channel section 6                                 |
| 5        | Design Flood Freque 100 -yr  |
| 6        | Location/Station: 33+00 to 35+00   |
| 7        |  |
| 8        |  |
|          | Relevant Equations   |
| 10       |  |
| 11<br>12 |  |
| 13       | $d = \frac{0.001 V_a^3}{a}$  |
| 14       | $d_{50} = \frac{0.001 V_a^3}{d_{aig}^{0.5} K_1^{1.5}}$                             |
| 15       |  |
| 16       | $ [ \kappa - \left[ 1 + \sin^2 \theta \right]^{0.5} ] $                            |
| 17       | $ K_1  = \left 1 - \frac{\sin \theta}{2}\right $                                   |
| 18       | $\begin{bmatrix} \sin^2 \phi \end{bmatrix}$  |
|          | Where,   |
| 20       | $d_{50}$ = Median diameter of the riprap materials, ft                             |
| 21       | $V_a$ = Average velocity in the main channel, ft/s                                 |
| 22       | d <sub>avg</sub> = Average depth of flow in the main channel, ft                   |
| 23       | $K_1 =$ Bank angle correction factor   |
| 24<br>25 | $\theta$ = Bank angle with the horizontal, degree                                  |
| 25       | $\phi$ = Riprap material's angle of repose, degree                                 |
| 27       |  |
|          | Input Parameters   |
| 29       | (Based on output from FlowMaster and based on the Manual)                          |
| 30       |  |
| 31       | $V_a = 4.39$ ft/s  |
| 32       | $d_{avg} = 1.36$ ft  |
| 33       | $D_{50} = 6$ inch Assume a $D_{50}$ and then calculate if it is stable.            |
| 34       | $\theta$ = 21.80 degree [2.5:1 (H:V)]  |
| 35       | $\phi$ = 41.0 degree From Figure 6.14 of the Manual for rounded riprap - attached. |
| 36<br>37 |  |
|          | Hence,<br>$K_1 = 0.82$   |
| 38       |  |
| 39       | $d_{50} = 0.10 \text{ ft}$   |
| 40       | $d_{50}$ (inch) = 2 inch <d50 6="" =="" inches="" is="" stable.<="" th=""></d50>   |
| 41       |  |
| 43       | Therefore proposed design single (1)   |
|          | Therefore, proposed design riprap size $(d_{50}) = 6$ inch                         |

Cholla Ash Monofill Riprap Calculation

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By:\_\_\_\_\_ Checked:\_\_\_\_\_

|          | A B C D E F G H I J K  |
|----------|--|
| 1        | Calculation of Riprap Size for Channel Lining  |
| 2        | Calculations are based on Drainage Design Manual for Maricopa County (Manual)                |
| 3        |  |
| 4        | Channel Name: Cholla Ash Offsite Drop Structure section 6                                    |
|          | Design Flood Freque 100 -yr  |
|          | Location/Station: 32+50 to 33+00   |
| 7        |  |
|          | Relevant Equations   |
| 10       |  |
| 11       |  |
| 12       | $0.001V^{3}$   |
| 13       | $d_{50} = \frac{0.001 V_a^3}{d_{arg}^{0.5} K_1^{1.5}}$                                       |
| 14       | $\mathcal{A}_{avg} \mathbf{X}_{1}$   |
| 15<br>16 |  |
| 17       | $\left  \mathcal{K}_{1} = \left[ 1 - \frac{\sin^{2} \theta}{\sqrt{2}} \right]^{0.5} \right $ |
| 18       | $\left  \Lambda_{1} = \left  1 - \frac{1}{\sin^{2} \phi} \right $                            |
| 19       | Where,   |
| 20       | d <sub>50</sub> = Median diameter of the riprap materials, ft                                |
| 21       | V <sub>a</sub> = Average velocity in the main channel, ft/s                                  |
| 22       | d <sub>avg</sub> = Average depth of flow in the main channel, ft                             |
| 23       | K <sub>1</sub> = Bank angle correction factor  |
| 24       | $\theta$ = Bank angle with the horizontal, degree  |
| 25       | $\phi$ = Riprap material's angle of repose, degree   |
| 26<br>27 |  |
|          | Input Parameters   |
| 29       | (Based on output from FlowMaster and based on the Manual)                                    |
| 30       |  |
| 31       | $V_a = 12.05 \text{ ft/s}$   |
| 32       | $d_{avg} = 0.58$ ft  |
| 33       | $D_{50} = 37$ inch Assume a $D_{50}$ and then calculate if it is stable.                     |
| 34       | $\theta = 21.80$ degree [2.5:1 (H:V)]  |
| 35<br>36 | $\phi$ = 41.0 degree From Figure 6.14 of the Manual for rounded riprap - attached.           |
|          | Hence,   |
| 38       | $K_1 = 0.82$   |
| 39       | $d_{50} = 3.07 \text{ ft}$   |
| 40       | $d_{50}$ (inch) = 37 inch <d50 37="" =="" inches="" is="" stable.<="" td=""></d50>           |
| 41       |  |
| 42       |  |
| 43       | Therefore, proposed design riprap size $(d_{50}) = 37$ inch                                  |
|          |  |

.

| ····     | A          | В                        | С  | D          | E   | F         | G           | Н                | ······     | J            | К  |
|----------|------------|--------------------------|--|------------|---|-----------|-------------|------------------|------------|--------------|----|
| 1        | Calculat   | ion of Ri                | orap Size  | for Ch     |   | ining     | <u> </u>    | L                |            | L            |    |
| 2        | Calculatio | ns are bas               | ed on Drair  | nage Des   | sign Man  | ual for I | Maricopa    | County (Ma       | anual)     |              |    |
| 3        |            |                          |  | 5          | 5   |           |             |                  |            |              |    |
| 4        | Channel N  | lame:                    | Cholla Asl   | n Offsite  | Channel   | section   | ו 7         |                  |            |              |    |
| 5        | Design Flo | od Freque                |  |            |   |           |             |                  |            |              |    |
| 6        | Location/S | Station:                 | 35+00 to 3   | 8+50       |   |           |             |                  |            |              |    |
| 7        |            |                          |  |            |   |           |             |                  |            |              |    |
| 8<br>9   | Dolouget D |                          |  |            |   |           |             |                  |            |              |    |
|          | Relevant E | quations                 |  |            |   |           |             |                  |            |              |    |
| 10       |            |                          |  |            |   |           |             |                  |            |              |    |
| 12       |            | 0                        | 0011/3   |            |   |           |             |                  |            |              |    |
| 13       |            | $d_{50} = \frac{0}{a}$   | $\frac{10.5}{K^{1.5}}$   |            |   |           |             |                  |            |              |    |
| 14       |            | , " a                    | $\begin{bmatrix} a_{0,0} \\ a_{0,0} \end{bmatrix} K_1^{(1,0)}$ |            |   |           |             |                  |            |              |    |
| 15       |            |                          |  |            |   |           |             |                  |            |              |    |
| 16       |            |                          | $\sin^2 \theta$  | 5          |   |           |             |                  |            |              |    |
| 17<br>18 |            | $K_1 = 1$                | $-\frac{\sin^2 \phi}{\sin^2 \phi}$                             |            |   |           |             |                  |            |              |    |
|          | Where,     | L                        |  |            |   |           |             |                  |            |              |    |
| 20       |            | d <sub>50</sub> =        | Median dia   | imeter of  | the ripra   | o materia | als ft      |                  |            |              |    |
| 21       |            | V <sub>a</sub> =         | Average ve   |            |   |           |             |                  |            |              |    |
| 22       |            | d <sub>avg</sub> =       | Average de   |            |   |           |             |                  |            |              |    |
| 23       |            | K1 =                     | Bank angle   |            |   |           | annoi, n    |                  |            |              |    |
| 24       |            | θ =                      | Bank angle   |            |   | al deore  | e           |                  |            |              |    |
| 25       |            | φ =                      | Riprap mat   |            |   |           |             |                  |            |              |    |
| 26       |            | ,                        |  |            | 0   |           | 5           |                  |            |              |    |
| 27       |            |                          |  |            |   |           |             |                  |            |              |    |
|          | Input Para |                          |  |            |   |           |             |                  |            |              |    |
| 29<br>30 | (Based on  | output from              | I FlowMaste  | er and bas | sed on th   | e Manua   | al)         |                  |            |              |    |
| 31       |            | V <sub>a</sub> =         | 2.40   | ft/c       |   |           |             |                  |            |              |    |
| 32       |            | d <sub>avg</sub> =       | 0.86   |            |   |           |             |                  |            |              |    |
| 33       |            | D <sub>50</sub> =        |  | inch       | Accum   |           | nd than a   | olouloto if it i | ia atabla  |              |    |
| 33       |            | $\theta =$               |  | degree     | [2.5:1 (H   |           | nu men c    | alculate if it i | is stable. |              |    |
| 35       |            | $\phi =$                 |  | degree     |   |           | 4 of the N  | Anual for ro     | unded ripr | an attacho   | Ч  |
| 36       |            | Ψ                        |  | 409.00     |   | guie 0.1  | 4 OF LICE N |                  | unded ripi | ap - allache | u. |
| 37       | Hence,     |                          |  |            |   |           |             |                  |            |              |    |
| 38       |            | K <sub>1</sub> =         | 0.82   |            |   |           |             |                  |            |              |    |
| 39       |            | d <sub>50</sub> =        | 0.02   | ft         |   |           |             |                  |            |              |    |
| 40       |            | d <sub>50</sub> (inch) = | : 1  | inch       | <d5(< th=""><th>) = 6 ir</th><th>nches is s</th><th>table.</th><th></th><th></th><th></th></d5(<> | ) = 6 ir  | nches is s  | table.           |            |              |    |
| 41       |            |                          |  |            |   |           |             |                  |            |              |    |
| 42       |            |                          |  |            |   |           |             | -                |            |              |    |
| 43       | Therefo    | re, propos               | ed design r  | iprap siz  | e (d <sub>50</sub> ) =  | 6 ii      | nch         |                  |            |              |    |

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Riprap Sizing\Riprap\_size\_ estimates

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Page \_\_\_\_ Date:

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Drop Structure Offsite Sec-1-basin(0.2%slope) Date: 02/12/2009 Time: 10:02 4 RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* WEST Consultants, Inc. 4. \* \* \*  $^{\star}$  $\star$ Version 3.0 March, 2005 \* \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 1 Drop

\_\_\_ USACE Method \_\_\_\_\_

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width

Input Parameters:

Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type Trapezoidal Straight N/A 7.96 ft/s N/A N/A 165. lbs/cu ft 1.00 0.29 ft 2.50 1.1 Channel Bank Angular

Average

Output Results:

Computed D300.60 ftComputed Local Depth Averaged Velocity7.96 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 1.250 ft  |
| Selected Minimum |       | 0.61 ft   |
| Selected Minimum | D90   | 0.88 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 67.<br>34.               | 169.<br>50.    |
|                           | Page 1                   |                |

W15

| ASCE  | Method                               |  |
|---|--------------------------------------|--|
| Input Parameters:   |                                      |  |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement                   | 10                                   | 7.96 ft/s<br>2.50<br>65. lbs/cu ft<br>Channel Bank |
| Output Results:   |                                      |  |
| Computed D50  |                                      | 0.45 ft  |
| *** Using Gradations from CC  | DE ETL 1110-2-120 3                  | * * *  |
| Specific Weight 165.0 lbs/<br>Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |  |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ight, lbs<br>Maximum                               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                   |
| USBR  | Method                               |  |
| Input Parameters:   |                                      |  |
| Average Channel Velocity  |                                      | 7.96 ft/s  |
| Output Results:   |                                      |  |
| Computed D50  |                                      | 0.88 ft  |
| *** Using Gradations from CC  | )e etl 1110-2-120 *                  | * * *  |
| Selected Minimum D30 0.   | cu ft<br>00 ft<br>73 ft<br>06 ft     |  |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                 | ght, lbs<br>Maximum                                |
| w100<br>w50<br>w15  | 117.<br>58.<br>18.                   | 292.<br>86.<br>43.                                 |

3

Input Parameters:

Average Channel Velocity

Output Results:

Computed D50

1.58 ft

7.96 ft/s

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu |    |
|------------------|-------|--------|----|
| Layer Thickness  |       | 2.750  | ft |
| Selected Minimum | D30   | 1.34   | ft |
| Selected Minimum | D90   | 1.94   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 719.                     | 1797.          |
| w50                       | 359.                     | 532.           |
| W15                       | 112.                     | 266.           |

\_\_\_\_\_ Isbash Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity Unit Weight of Stone Turbulence Level 7.96 ft/s 165. lbs/cu ft High

Output Results:

Computed D50

0.81 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 1.500 ft  |
| Selected Minimum | D30   | 0.73 ft   |
| Selected Minimum | D90   | 1.06 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 117.                     | 292.           |
| w50                       | 58.                      | 86.            |
| W15                       | 18.                      | 43.            |
|                           |                          |                |

\_\_\_\_\_ Cal B & SP Method \_\_\_\_\_

Average Channel Velocity Velocity Affecting Bank Unit Weight of Stone Cotangent of Side slope Flow Type

7.96 ft/s 10.61 ft/s 165. lbs/cu ft 2.50 Impinging

## Output Results:

Computed W

40.71 lbs

\*\* CalTrans A Gradation \*\*

(1) Outside Layer:

| Gradation Class<br>Layer Thickness   | 1/2 Ton<br>3.40 ft   |
|--------------------------------------|----------------------|
| Percent Larger than                  | Rock Size (Ton)      |
| 0 - 5<br>50 - 100<br>95 - 100        | 1.00<br>0.50<br>0.25 |
| (2) Inner Layer:                     |                      |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft      |
| (3) Backing:                         |                      |
| Backing Class No.<br>Layer Thickness | 1<br>1.8 ft          |
| (4) Fabric:                          |                      |
| Fabric Type                          | В                    |
| Total Thickness (1)+(2)+(3)+(4):     | 5.2 ft               |
|                                      |                      |

\_\_\_\_\_ HEC-11 Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose

| Dr<br>Riprap Placement<br>Safety Factor | rop Structure Offsite Sec | -1-basin(0.2%slope)<br>Channel Bank<br>1.1 |
|---|---------------------------|--|
| Output Results:                         |                           |  |
| Computed D50                            |                           | 0.30 ft                                    |
|   | ** FHWA Gradation**       |  |
| Gradation Class<br>Layer Thickness      | Facing<br>1.90 ft         |  |
| Percent Smaller by                      | Size Rock Size, ft        | Rock Weight, lbs                           |
| D100<br>D50<br>D10                      | 1.30<br>0.95<br>0.40      | 200.<br>75.<br>5.                          |

Drop Structure Offsite Sec-1-basin\_btm(0.2%slope) Date: 02/12/2009 Time: 10:02  $\star$ RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 1 DROP btm

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 7.96 ft/s N/A N/A 165. lbs/cu ft 1.00 0.29 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.60 ftComputed Local Depth Averaged Velocity7.96 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 1.250 ft  |
| Selected Minimum |       | 0.61 ft   |
| Selected Minimum | D90   | 0.88 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 67.<br>34.               | 169.<br>50.    |
|                           | Page 1                   |                |

| Drop | Structure | Offsite | Sec- | 1-basin <u></u> | _btm(0. | 2%slop | be) |
|------|-----------|---------|------|-----------------|---------|--------|-----|
|      |           |         | 11.  |                 |         | 25.    |     |

W15

| ASCE  | Method                               |  |
|---|--------------------------------------|--|
| Input Parameters:   |                                      |  |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement               | 165<br>Cha                           | 7.96 ft/s<br>N/A<br>. lbs/cu ft<br>nnel Bottom |
| Output Results:   |                                      |  |
| Computed D50  |                                      | 0.42 ft  |
| *** Using Gradations from C   | OE ETL 1110-2-120 **                 | *  |
| Specific Weight 165.0 lbs<br>Layer Thickness 0.<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |  |
| Percent Lighter by Weight   | Stone Weig<br>Minimum                | ht, lbs<br>Maximum                             |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                               |
| USBR  | Method                               |  |
| Input Parameters:   |                                      |  |
| Average Channel Velocity  |                                      | 7.96 ft/s                                      |
| Output Results:   |                                      |  |
| Computed D50  |                                      | 0.88 ft  |
| *** Using Gradations from CC  | DE ETL 1110-2-120 ***                | k.   |
| Selected Minimum D30 0.   | /cu ft<br>500 ft<br>.73 ft<br>.06 ft |  |
| Percent Lighter by Weight   | Stone Weigh<br>Minimum               | nt, lbs<br>Maximum                             |
| w100<br>W50<br>W15  | 117.<br>58.<br>18.                   | 292.<br>86.<br>43.                             |

Input Parameters: \_\_\_\_\_ 7.96 ft/s Average Channel Velocity Output Results: \_\_\_\_\_ 1.58 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 2.750 ft 1.34 ft 1.94 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 1797. w100 719. 359. W50 532. 266. W15 112. \_\_\_\_\_ Isbash Method \_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 7.96 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: 0.81 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 1.500 ft 0.73 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 1.06 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 292. w100 117. W50 58. 86. 18. W15 43. \_\_\_\_ Cal B & SP Method \_\_\_\_\_

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type                                    | 7.96 ft/s<br>10.61 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|--|--|
| Output Results:  |  |
| Computed W   | 40.71 lbs  |
| ** CalTrans A Gradation **   |  |
| (1) Outside Layer:   |  |
| Gradation Class<br>Layer Thickness   | 1/2 Ton<br>3.40 ft   |
| Percent Larger than  | Rock Size (Ton)  |
| 0 - 5<br>50 - 100<br>95 - 100  | $1.00 \\ 0.50 \\ 0.25$   |
| (2) Inner Layer:   |  |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft  |
| (3) Backing:   |  |
| Backing Class No.<br>Layer Thickness   | 1<br>1.8 ft  |
| (4) Fabric:  |  |
| Fabric Type  | В  |
| Total Thickness (1)+(2)+(3)+(4):   | 5.2 ft   |
| HEC-11 Method  |  |
| Input Parameters:<br><br>Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose | 7.96 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>N/A<br>deg.          |

Drop Structure Offsite Sec-1-basin\_btm(0.2%slope) Riprap Placement Channel Bottom Safety Factor 1.1

Output Results:

Computed D50

0.22 ft

,

\*\* FHWA Gradation\*\*

| Gradation Class | Facing  |
|-----------------|---------|
| Layer Thickness | 1.90 Ťt |

| Percent Smaller by Size | Rock Size, ft          | Rock Weight, lbs  |
|-------------------------|------------------------|-------------------|
| D100<br>D50<br>D10      | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5. |

Offsite Channel Sec-1 Date: 02/06/2009 Time: 16:25 \*\*\*\*\*\*\*\*\*\* 4 RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* 2  $\star$ ي. \* Version 3.0 March, 2005 \* \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* 

Project: Cholla Ash Offsite Description: Offsite Channel - Section 1

USACE Method \_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 2.90 ft/s N/A N/A 165. lbs/cu ft 1.00 0.73 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.04 ftComputed Local Depth Averaged Velocity2.90 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.                      | 36.<br>11      |
|                           | Page 1                   |                |

ASCE Method \_\_\_\_

Input Parameters: \_\_\_\_\_ Local Velocity 2.90 ft/s Cotangent of Side slope Unit Weight of Stone 2.50 165. lbs/cu ft Riprap Placement Channel Bank Output Results: \_\_\_\_\_\_ Computed D50 0.06 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft 0.750 ft Specific Weight Layer Thickness Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. w50 7. 11. W15 2. 5. \_\_\_\_ USBR Method \_\_\_\_ Input Parameters: Average Channel Velocity 2.90 ft/s Output Results: \_\_\_\_\_\_ Computed D50 0.11 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. 7. 2. W50 11. W15 5.

Offsite Channel Sec-1 USGS Method \_ Input Parameters: \_\_\_\_\_ 2.90 ft/s Average Channel Velocity Output Results: \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ 0.13 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft 0.750 ft 0.37 ft 0.53 ft Specific Weight Layer Thickness Selected Minimum D30 Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 36. 15. W50 7. 11. 2. 5. W15 Isbash Method \_\_\_\_ Input Parameters: . \_\_\_\_\_\_ Average Channel Velocity 2.90 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: 0.11 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight 0.750 ft 0.37 ft 0.53 ft Layer Thickness Selected Minimum D30 Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. 7. W50 11. 2. W15 5. \_\_\_ Cal B & SP Method \_\_

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type           | 2.90 ft/s<br>3.87 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 0.10 lbs  |
| ** CalTrans A Gradation **  |   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose | 2.90 ft/s<br>3.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

| Riprap Placement<br>Safety Factor  | Offsite Channe    | l Sec-1<br>Channel Bank<br>1.1 |
|------------------------------------|-------------------|--------------------------------|
| Output Results:                    |                   |                                |
| Computed D50                       |                   | 0.02 ft                        |
| **                                 | FHWA Gradation**  |                                |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft |                                |
| Percent Smaller by Size            | Rock Size, ft     | Rock Weight, lbs               |

| D100 | 1.30 | 200. |
|------|------|------|
| D50  | 0.95 | 75.  |
| D10  | 0.40 | 5.   |

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Date: 02/08/2009 Time: 12:42 \*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* RIPRAP DESIGN SYSTEM (RDS) BY WEST Consultants, Inc. \* Version 3.0 March, 2005 \* \* COPYRIGHT (c) 2005 \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* 

Project: Cholla Ash Offsite Description: Offsite Channel - 10 ft bottom width Sect. 1 - btm

Average

Straight

2.90 ft/s

165. lbs/cu ft

Channel Bank

N/A

N/A

N/A

N/A

1.00

2.50

1.1

0.73 ft

Angular

Trapezoidal

\_\_\_\_\_ USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Output Results:

Computed D300.04 ftComputed Local Depth Averaged Velocity2.90 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight  | Minimum   | 27  |
|--|---|---|
| W100<br>W50  | 15.<br>7.   | 36.<br>11.  |
| W15  | 2.  | 5.  |
| ASCE   | Method  |   |
| Input Parameters:  |   |   |
| Local Velocity   |   | 2.90 ft/s   |
| Cotangent of Side slope<br>Unit Weight of Stone  | 14  | 2.50<br>55. lbs/cu ft                               |
| Riprap Placement   |   | Channel Bank  |
| Output Results:  |   |   |
| Computed D50   |   | 0.06 ft   |
| *** Using Gradations from CC   |   |   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.   | 750 ft<br>.37 ft  |   |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.  | 750 ft<br>.37 ft  | .ght, lbs<br>Maximum                                |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight   | 250 ft<br>37 ft<br>53 ft<br>Stone Wei<br>Minimum<br>15.           | Maximum<br>36.                                      |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight   | 250 ft<br>37 ft<br>53 ft<br>Stone Wei<br>Minimum                  | Maximum   |
| W15  | 250 ft<br>.37 ft<br>53 ft<br>Minimum<br>15.<br>7.                 | Maximum<br>36.<br>11.                               |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15   | 250 ft<br>.37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximum<br>36.<br>11.                               |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:  | 250 ft<br>.37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximun<br>36.<br>11.<br>5.                         |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br>Average Channel Velocity                    | 250 ft<br>.37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximun<br>36.<br>11.<br>5.                         |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR   | 250 ft<br>.37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.           | Maximum<br>36.<br>11.                               |
| Layer Thickness 0.7<br>Selected Minimum D30 0.<br>Selected Minimum D90 0.<br>Percent Lighter by Weight<br>W100<br>W50<br>W15<br>USBR<br>Input Parameters:<br>Average Channel Velocity<br>Dutput Results: | 250 ft<br>.37 ft<br>53 ft<br>Minimum<br>15.<br>7.<br>2.<br>Method | Maximun<br>36.<br>11.<br>5.<br>2.90 ft/s<br>0.11 ft |

\*

| Selected | Minimum | D30 | 0.37 | ft |
|----------|---------|-----|------|----|
| Selected | Minimum | D90 | 0.53 | ft |

| Percent Lighter by Weight  | Stone Minimum                         | Weight, lbs<br>Maximum              |
|--|---------------------------------------|-------------------------------------|
| W100<br>W50<br>W15   | 15.<br>7.<br>2.                       | 36.<br>11.<br>5.                    |
| USGS   | Method                                |                                     |
| Input Parameters:  |                                       |                                     |
|  |                                       |                                     |
| Average Channel Velocity   |                                       | 2.90 ft/s                           |
| Output Results:  |                                       |                                     |
| Computed D50   |                                       | 0.13 ft                             |
| *** Using Gradations from CC   | DE ETL 1110-2-120                     | ) ***                               |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.7<br>Selected Minimum D30 0<br>Selected Minimum D90 0. | 750 ft<br>.37 ft<br>.53 ft<br>Stone W | Weight, lbs                         |
| Percent Lighter by Weight  | Minimum                               | Maximum                             |
| W100<br>W50<br>W15   | 15.<br>7.<br>2.                       | 36.<br>11.<br>5.                    |
| Isbasł   | n Method                              |                                     |
| Input Parameters:  |                                       |                                     |
|  |                                       |                                     |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                                   |                                       | 2.90 ft/s<br>165. lbs/cu ft<br>High |
| Output Results:  |                                       |                                     |
|  |                                       | •                                   |
| Computed D50   |                                       | 0.11 ft                             |

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight                       |              |                          |
|---|--------------|--------------------------|
| W100<br>W50                                     | 15.<br>7.    | 36<br>11                 |
| W15   | 2.           | 5                        |
|   | P Method     |                          |
|   |              |                          |
| Input Parameters:                               |              |                          |
| Average Channel Velocity                        |              | 2.90 ft/                 |
| Velocity Affecting Bank<br>Unit Weight of Stone | 1            | 3.87 ft/<br>65. lbs/cu f |
| Cotangent of Side slope                         | 1            | 2.5                      |
| Flow Type                                       |              | Impingin                 |
| Output Results:                                 |              |                          |
| Computed W                                      |              | 0.10 lb:                 |
| ** CalTrans A G                                 | Gradation ** |                          |
| (1) Outside Layer:                              |              |                          |
| Gradation Class                                 |              | 1/2 Toi                  |
| Layer Thickness                                 |              | 3.40 fi                  |
| Percent Larger than                             | Ro           | ck Size (Ton)            |
| 0 - 5   |              | 1.00                     |
| 50 - 100<br>95 - 100                            |              | 0.50<br>0.25             |
| (2) Inner Layer:                                |              |                          |
| Gradation Class<br>Layer Thickness              |              | None<br>0.00 ft          |
|   |              | 0.00 ft                  |
| (3) Backing:                                    |              |                          |

Layer Thickness 1.8 ft (4) Fabric: Fabric Type В Total Thickness (1) + (2) + (3) + (4): 5.2 ft \_\_\_\_\_\_ HEC-11 Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_\_ Average Channel Velocity 2.90 ft/s Average Flow Depth 3.00 ft Unit Weight of Stone 165. lbs/cu ft Cotangent of Side Slope Material Angle of Repose 2.50 41.00 deg. Riprap Placement Channel Bank Safety Factor 1.1 Output Results: Computed D50 0.02 ft \*\* FHWA Gradation\*\* Gradation Class Layer Thickness Facing 1.90 ft Percent Smaller by Size Rock Size, ft Rock Weight, lbs D100 1.30 200. D50 0.95 75. D10 0.40 5.

-

Offsite Channel Sec-2 Date: 02/06/2009 Time: 16:26 \* 4. RIPRAP DESIGN SYSTEM (RDS) \* ΒY \* \* WEST Consultants, Inc. \* 20 \* \* March, 2005 \* \* Version 3.0 \* \* \* \* \* COPYRIGHT (c) 2005 \* \* \* WEST CONSULTANTS, INC. PH: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE FAX:858-487-9448 \* \* SUITE 340 \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* 

Project: Cholla Ash Offsite Description: Offsite Channel - Section 2

\_\_\_\_\_ USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 4.45 ft/s N/A N/A 165. lbs/cu ft 1.00 1.35 ft 2.50 1.1 Channel Bank Angular

Average

Output Results:

Computed D300.10 ftComputed Local Depth Averaged Velocity4.45 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu |    |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 4.45 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results:

Computed D50

0.14 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weigh<br>Minimum | t, lbs<br>Maximum |
|---------------------------|------------------------|-------------------|
| W100<br>W50<br>W15        | 15.<br>7.<br>2.        | 36.<br>11.<br>5.  |
| USBR                      | Method                 |                   |
| Input Parameters:         |                        |                   |
| Average Channel Velocity  |                        | 4.45 ft/s         |
| Output Results:           |                        |                   |

-----

Computed D50

0.26 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
| W15                       | 2.                       | 5.             |

Offsite Channel Sec-2 USGS Method \_ Input Parameters: \_\_\_\_\_ 4.45 ft/s Average Channel Velocity Output Results: 0.38 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness Selected Minimum D30 0.750 ft 0.37 ft 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. 15. W100 7. 2. 11. W50 5. W15 Isbash Method \_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.45 ft/s 165. lbs/cu ft Unit Weight of Stone High Turbulence Level Output Results: 0.25 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft 0.750 ft 0.37 ft Specific Weight Layer Thickness Selected Minimum D30 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. w100 15. 11. W50 7. 2. 5. W15 \_\_\_\_ Cal B & SP Method \_\_\_\_

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type                     | 4.45 ft/s<br>5.93 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 1.24 lbs  |
| ** CalTrans A Gradation **  | ÷   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Page 4 | 4.45 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

Page 4

| Riprap Placement<br>Safety Factor  | Offsite Channe                         | l Sec-2<br>Channel Bank<br>1.1 |
|------------------------------------|--|--------------------------------|
| Output Results:                    |  |                                |
| Computed D50                       |  | 0.05 ft                        |
| **                                 | FHWA Gradation**                       |                                |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft                      |                                |
| Percent Smaller by Size            | Rock Size, ft                          | Rock Weight, lbs               |
| D100<br>D50<br>D10                 | $     1.30 \\     0.95 \\     0.40   $ | 200.<br>75.<br>5.              |

| Pa | aq | е | - 5 |
|----|----|---|-----|
|    |    |   |     |

Offsite Channel Sec-2\_btm Date: 02/06/2009 Time: 17:01 \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* . WEST Consultants, Inc. \* \* \* ÷ \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 4 \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 2 btm

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement

Average Trapezoidal Straight N/A 4.45 ft/s N/A N/A 165. lbs/cu ft 1.00 1.35 ft 2.50 1.1 Channel Bank Angular

Output Results:

Rock Type

Computed D300.10 ftComputed Local Depth Averaged Velocity4.45 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

W15

W15

\_\_\_\_ ASCE Method \_\_\_\_\_ Input Parameters: Local Velocity 4.45 ft/s Cotangent of Side slope 2.50 Unit Weight of Stone 165. lbs/cu ft Riprap Placement Channel Bank Output Results: \_\_\_\_\_ 0.14 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 0.750 ft 0.37 ft Layer Thickness Selected Minimum D30 0.53 ft Selected Minimum D90 . Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. w100 15. 7. 2. W50 11. W15 5. \_\_\_\_\_ USBR Method \_\_\_ Input Parameters: \_\_\_\_\_ 4.45 ft/s Average Channel Velocity Output Results: \_\_\_\_\_ 0.26 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum 36. w100 15. W50 7. 11.

2.

5.

Offsite Channel Sec-2\_btm USGS Method Input Parameters: Average Channel Velocity 4.45 ft/s Output Results: Computed D50 0.38 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum W100 15. 36. W50 7. 2. 11. W15 5. \_\_\_\_ Isbash Method \_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.45 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: \_\_\_\_\_\_ Computed D50 0.25 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 11. W15 2. 5. \_ Cal B & SP Method \_

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type                     | 4.45 ft/s<br>5.93 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Dutput Results:   |   |
| Computed W  | 1.24 lbs  |
| ** CalTrans A Gradation **  | *   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| otal Thickness (1)+(2)+(3)+(4):   | 5.2 ft  |
| HEC-11 Method   |   |
| nput Parameters:  |   |
| Average Channel Velocity<br>Average Flow Depth<br>Init Weight of Stone<br>Cotangent of Side Slope<br>Naterial Angle of Repose<br>Page 4 | 4.45 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

| Riprap Placement<br>Safety Factor  | Offsite Channel   | Sec-2_btm<br>Channel Bank<br>1.1 |
|------------------------------------|-------------------|----------------------------------|
| Output Results:                    |                   |                                  |
| Computed D50                       |                   | 0.05 ft                          |
| **                                 | FHWA Gradation**  |                                  |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft |                                  |
| Percent Smaller by Size            | Rock Size, ft     | Rock Weight, lbs                 |

| D100 | 1.30 | 200. |
|------|------|------|
| D50  | 0.95 | 75.  |
| D10  | 0.40 | 5.   |

Offsite Channel Sec-3 Date: 02/06/2009 Time: 16:27 \*\*\* \* 2. RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* Version 3.0 March, 2005 × \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC.  $\dot{x}$ \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 3

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Trapezoidal Straight N/A 3.85 ft/s N/A N/A 165. lbs/cu ft 1.00 1.85 ft 2.50 1.1 Channel Bank Angular

Average

Output Results:

Computed D300.06 ftComputed Local Depth Averaged Velocity3.85 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter b | by Weight | Stone Weight<br>Minimum | , lbs<br>Maximum |
|-------------------|-----------|-------------------------|------------------|
| w100<br>w50       |           | 15.<br>7.               | 36.<br>11.       |
|                   |           | Page 1                  |                  |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters: -----

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

3.85 ft/s 2.50 165. lbs/cu ft Channe<sup>1</sup> Bank

Output Results: \_\_\_\_\_\_

Computed D50

0.10 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum   |
|---|--------------------------|------------------|
| w100<br>w50<br>w15  | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |
| USBR M  | ethod                    |                  |
| Input Parameters:   |                          |                  |
| Average Channel Velocity  | 3                        | .85 ft/s         |
| Output Results:   |                          |                  |
| Computed D50  |                          | 0.20 ft          |
| *** Using Gradations from COE   | ETL 1110-2-120 ***       |                  |
| Specific Weight 165.0 lbs/c<br>Layer Thickness 0.75<br>Selected Minimum D30 0.3<br>Selected Minimum D90 0.5 | 0 ft                     |                  |
| Percent Lighter by Weight   | Stone Weight,<br>Minimum | lbs<br>Maximum   |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |

| USG   | Offsite Channel Sec<br>S Method            |                                   |
|---|--|-----------------------------------|
| Input Parameters:   |  |                                   |
| Average Channel Velocity  | -  | 3.85 ft/s                         |
| Output Results:   |  |                                   |
| Computed D50  |  | 0.27 ft                           |
| *** Using Gradations from   | COE ETL 1110-2-120 *                       | * * *                             |
| Specific Weight 165.0 lb<br>Layer Thickness 0<br>Selected Minimum D30<br>Selected Minimum D90 | os/cu ft<br>0.750 ft<br>0.37 ft<br>0.53 ft |                                   |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                       | ght, lbs<br>Maximum               |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                            | 36.<br>11.<br>5.                  |
| Isba  | sh Method                                  |                                   |
| Input Parameters:   |  |                                   |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                          | 16   | 3.85 ft/s<br>5. lbs/cu ft<br>High |
| Output Results:   |  |                                   |
| Computed D50  |  | 0.19 ft                           |
| *** Using Gradations from   | COE ETL 1110-2-120 *                       | **                                |
|   | .750 ft<br>0.37 ft                         |                                   |
| Percent Lighter by Weight   | Stone Wei<br>Minimum                       | ght, lbs<br>Maximum               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                            | 36.<br>11.<br>5.                  |
|   | & SP Method                                |                                   |
|   |  |                                   |

| Average Channel Velocity | 3.85 ft/s      |
|--------------------------|----------------|
| Velocity Affecting Bank  | 5.13 ft/s      |
| Unit Weight of Stone     | 165. lbs/cu ft |
| Cotangent of Side slope  | 2.50           |
| Flow Type                | Impinging      |

Output Results:

Computed W

0.52 lbs

\*\* CalTrans A Gradation \*\*

(1) Outside Layer:

| Gradation Class | 1/2 Ton |
|-----------------|---------|
| Layer Thickness | 3.40 ft |

| Percent Larger than                  | Rock Size (Ton)      |
|--------------------------------------|----------------------|
| 0 - 5<br>50 - 100<br>95 - 100        | 1.00<br>0.50<br>0.25 |
| (2) Inner Layer:                     |                      |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft      |
| (3) Backing:                         |                      |
| Backing Class No.<br>Layer Thickness | 1<br>1.8 ft          |
| (4) Fabric:                          |                      |
| Fabric Type                          | В                    |
| Total Thickness (1)+(2)+(3)+(4):     | 5.2 ft               |
| HEC-11 Method                        |                      |

Input Parameters:

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose

| Riprap Placement<br>Safety Factor  | Offsite Channo     | el Sec-3<br>Channel Bank<br>1.1 |
|------------------------------------|--------------------|---------------------------------|
| Output Results:                    |                    |                                 |
| Computed D50                       |                    | 0.03 ft                         |
| *                                  | * FHWA Gradation** |                                 |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft  |                                 |
| Percent Smaller by Size            | e Rock Size, ft    | Rock Weight, 1bs                |

| 1.30 | 200.                 |
|------|----------------------|
|      | 75.                  |
| 0.40 | 5.                   |
|      | 1.30<br>0.95<br>0.40 |

Offsite Channel Sec-3\_btm Date: 02/06/2009 Time: 17:00 \*\*\*\*\*\*\*\*\*\* RIPRAP DESIGN SYSTEM (RDS) 4. \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* \* Version 3.0 March, 2005 \* \* \*\* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*\*\*\*\*\*\*\*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 3 btm

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 3.85 ft/s N/A N/A 165. lbs/cu ft 1.00 1.85 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.06 ftComputed Local Depth Averaged Velocity3.85 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| W100<br>W50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 3.85 ft/s 2.50 165. lbs/cu ft Channel Bank

## Output Results:

Computed D50

## 0.10 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu |    |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum   |
|---------------------------|--------------------------|------------------|
| W100<br>W50<br>W15        | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |
| US                        | BR Method                |                  |
| Input Parameters:         |                          |                  |
| Average Channel Velocity  | 3                        | .85 ft/s         |

Output Results:

## Computed D50

0.20 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
| w15                       | 2.                       | 5.             |

|  | fsite Channel Sec-3_<br>Method       | _btm                              |
|--|--------------------------------------|-----------------------------------|
| Input Parameters:  |                                      |                                   |
| Average Channel Velocity   |                                      | 3.85 ft/s                         |
| Output Results:  |                                      |                                   |
| Computed D50   |                                      | 0.27 ft                           |
| *** Using Gradations from C  | OE ETL 1110-2-120.*                  | **                                |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                   |
| Percent Lighter by Weight  | Stone Weig<br>Minimum                | ght, lbs<br>Maximum               |
| w100<br>w50<br>w15   | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                  |
| Isbasł   | n Method                             |                                   |
| Input Parameters:  |                                      |                                   |
| Average Channel Velocity<br>Unit weight of Stone<br>Turbulence Level                                 | 165                                  | 3.85 ft/s<br>5. lbs/cu ft<br>High |
| Output Results:  |                                      |                                   |
| Computed D50   |                                      | 0.19 ft                           |
| *** Using Gradations from CC   | DE ETL 1110-2-120 **                 | • *                               |
| Selected Minimum D30 0.  | /cu ft<br>/50 ft<br>37 ft<br>53 ft   |                                   |
| Percent Lighter by Weight  | Stone Weig<br>Minimum                | ht, lbs<br>Maximum                |
| w100<br>w50<br>w15   | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                  |
|  | SP Method                            | J.                                |

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type           | 3.85 ft/s<br>5.13 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 0.52 lbs  |
| ** CalTrans A Gradation **  |   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | $1.00 \\ 0.50 \\ 0.25$  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose | 3.85 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

| Riprap Placement<br>Safety Factor  | Offsite Channel                                       | Sec-3_btm<br>Channel Bank<br>1.1 |
|------------------------------------|---|----------------------------------|
| Output Results:                    |   |                                  |
| Computed D50                       |   | 0.03 ft                          |
| **                                 | FHWA Gradation**                                      |                                  |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft                                     |                                  |
| Percent Smaller by Size            | Rock Size, ft   | Rock Weight, lbs                 |
| D100<br>D50<br>D10                 | $ \begin{array}{r} 1.30 \\ 0.95 \\ 0.40 \end{array} $ | 200.<br>75.<br>5.                |

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Offsite Channel Sec-4 Date: 02/06/2009 Time: 16:31 \*\*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) 2 \* \* ΒY \* WEST Consultants, Inc. \* \* \* \* \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 4. \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 4

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 5.30 ft/s N/A N/A 165. lbs/cu ft 1.00 1.91 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.14 ftComputed Local Depth Averaged Velocity5.30 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
|                           | Page 1                   |                |

W15

.

| ASCE  | Method                               |   |
|---|--------------------------------------|---|
| Input Parameters:   |                                      |   |
| Local Velocity<br>Cotangent of Side slope<br>Unit Weight of Stone<br>Riprap Placement                 | 165<br>C                             | 5.30 ft/s<br>2.50<br>. lbs/cu ft<br>hannel Bank |
| Output Results:   |                                      |   |
| Computed D50  |                                      | 0.20 ft   |
| *** Using Gradations from Co  | DE ETL 1110-2-120 **                 | *   |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.3<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |   |
| Percent Lighter by Weight   | Stone Weigl<br>Minimum               | ht, lbs<br>Maximum                              |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                |
| USBR  | Method                               | · · · · · · · · · · · · · · · · · · ·           |
| Input Parameters:   |                                      |   |
| Average Channel Velocity  |                                      | 5.30 ft/s                                       |
| Output Results:   |                                      |   |
| Computed D50  |                                      | 0.38 ft   |
| *** Using Gradations from CC  | DE ETL 1110-2-120 ***                | *   |
| Selected Minimum D30 0.   | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |   |
| Doncont Lighton by Michael  | Stone Weigł                          |   |
| Percent Lighter by Weight   | Minimum                              | Maximum   |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                                |

| USGS  | Offsite Channel So<br>Method         | ec-4                                |
|---|--------------------------------------|-------------------------------------|
| Input Parameters:   |                                      |                                     |
| Average Channel Velocity  |                                      | 5.30 ft/s                           |
| Output Results:   |                                      |                                     |
| Computed D50  |                                      | 0.59 ft                             |
| *** Using Gradations from Co  | OE ETL 1110-2-120                    | * * *                               |
| Specific Weight 165.0 lbs,<br>Layer Thickness 1.0<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>000 ft<br>.49 ft<br>.70 ft |                                     |
| Percent Lighter by Weight   | Stone Wo<br>Minimum                  | eight, lbs<br>Maximum               |
| w100<br>w50<br>w15  | 35.<br>17.<br>5.                     | 86.<br>26.<br>13.                   |
| Isbash  | n Method                             |                                     |
| Input Parameters:   |                                      |                                     |
| Average Channel Velocity<br>Unit Weight of Stone<br>Curbulence Level                                  | 1                                    | 5.30 ft/s<br>L65. lbs/cu ft<br>High |
| Dutput Results:   |                                      |                                     |
| computed D50  |                                      | 0.36 ft                             |
| *** Using Gradations from CO  | DE ETL 1110-2-120                    | * * *                               |
| pecific Weight 165.0 lbs/<br>ayer Thickness 0.7<br>elected Minimum D30 0.<br>elected Minimum D90 0.   | cu ft<br>50 ft<br>37 ft<br>53 ft     |                                     |
| ercent Lighter by Weight  | Stone We<br>Minimum                  | ight, lbs<br>Maximum                |
| 100<br>w50<br>w15   | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                    |
| Са] в &   | SP Mathad                            |                                     |

|   | Offsite Ch | nannel Sec | -4   |
|---|------------|------------|--|
| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type           |            | 16         | 5.30 ft/s<br>7.07 ft/s<br>55. lbs/cu ft<br>2.50<br>Impinging |
| Output Results:   |            |            |  |
| Computed W  |            |            | 3.55 lbs   |
| ** CalTrans   | A Gradati  | on **      |  |
| (1) Outside Layer:  |            |            |  |
| Gradation Class<br>Layer Thickness  |            |            | 1/2 Ton<br>3.40 ft   |
| Percent Larger than   |            | Roc        | k Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   |            |            | $1.00 \\ 0.50 \\ 0.25$                                       |
| (2) Inner Layer:  |            |            |  |
| Gradation Class<br>Layer Thickness  |            |            | None<br>0.00 ft  |
| (3) Backing:  |            |            |  |
| Backing Class No.<br>Layer Thickness  |            |            | 1<br>1.8 ft  |
| (4) Fabric:   |            |            |  |
| Fabric Type   |            |            | В  |
| Total Thickness (1)+(2)+(3)+(   | 4):        |            | 5.2 ft   |
| HEC-1   | 1 Method   |            |  |
| Input Parameters:   |            |            |  |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose |            | 16<br>ne 4 | 5.30 ft/s<br>4.00 ft<br>55. lbs/cu ft<br>2.50<br>41.00 deg.  |

| Riprap Placement<br>Safety Factor  | Offsite Channe         | l Sec-4<br>Channel Bank<br>1.1 |
|------------------------------------|------------------------|--------------------------------|
| Output Results:                    |                        |                                |
| Computed D50                       |                        | 0.09 ft                        |
| **                                 | FHWA Gradation**       |                                |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft      |                                |
| Percent Smaller by Size            | Rock Size, ft          | Rock Weight, lbs               |
| D100<br>D50<br>D10                 | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5.              |

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Offsite Channel Sec-4\_btm Date: 02/06/2009 Time: 16:59 \*\*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) \*  $_{\star}$ \* ΒY \* \* WEST Consultants, Inc. \* \* \* 4 \* Version 3.0 March, 2005 \* \* \*  $^{\star}$ \* \* COPYRIGHT (c) 2005 4. \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 4 btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 5.30 ft/s N/A N/A 165. lbs/cu ft 1.00 1.91 ft 2.50 1.1 Channel Bank Angular

Output Results:

| Computed D30<br>Computed Local Depth Averaged Velocity | 0.14 ft<br>5.30 ft/s |
|--|----------------------|
| Local Velocity/Avg. Velocity                           | 1.00                 |
| Side Slope Correction Factor                           | 1.06                 |
| Correction for Layer Thickness                         | 1.00                 |
| Correction for Secondary Currents                      | 1.00                 |

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.                      | 36.<br>11      |
|                           | Page 1                   | • • • •        |

ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 5.30 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results:

Computed D50

0.20 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight  | Stone Weight,<br>Minimum | lbs<br>Maximum   |
|--|--------------------------|------------------|
| W100<br>W50<br>W15   | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |
| USBR M   | ethod                    |                  |
| Input Parameters:  |                          |                  |
| Average Channel Velocity   | 5                        | .30 ft/s         |
| Output Results:  |                          |                  |
| Computed D50   |                          | 0.38 ft          |
| *** Using Gradations from COE  | ETL 1110-2-120 ***       |                  |
| Specific Weight165.0 lbs/clLayer Thickness0.75Selected Minimum D300.3Selected Minimum D900.5 | 0 ft<br>7 ft             |                  |
| Percent Lighter by Weight  | Stone Weight,<br>Minimum | lbs<br>Maximum   |
| w100<br>w50<br>w15   | 15.<br>7.<br>2.          | 36.<br>11.<br>5. |

| USGS  | site Channel Sec<br>Method           | -4_btm                              |
|---|--------------------------------------|-------------------------------------|
| Input Parameters:   |                                      |                                     |
| Average Channel Velocity  |                                      | 5.30 ft/s                           |
| Dutput Results:   |                                      |                                     |
| Computed D50  |                                      | 0.59 ft                             |
| *** Using Gradations from CC  | DE ETL 1110-2-120                    | * * *                               |
| Specific Weight 165.0 lbs/<br>Layer Thickness 1.0<br>Selected Minimum D30 0.<br>Selected Minimum D90 0. | /cu ft<br>000 ft<br>.49 ft<br>.70 ft |                                     |
| Percent Lighter by Weight   | Stone W<br>Minimum                   | eight, lbs<br>Maximum               |
| v100<br>w50<br>w15  | 35.<br>17.<br>5.                     | 86.<br>26.<br>13.                   |
| Isbash  | n Method                             |                                     |
| nput Parameters:  |                                      |                                     |
| verage Channel Velocity<br>nit Weight of Stone<br>urbulence Level                                       |                                      | 5.30 ft/s<br>165. lbs/cu ft<br>High |
| utput Results:  |                                      |                                     |
| mputed D50  |                                      | 0.36 ft                             |
| *** Using Gradations from CO  | DE ETL 1110-2-120                    | ***                                 |
| pecific Weight 165.0 lbs/<br>ayer Thickness 0.7<br>elected Minimum D30 0.<br>elected Minimum D90 0.     | cu ft<br>50 ft<br>37 ft<br>53 ft     |                                     |
| ercent Lighter by Weight  | Stone W<br>Minimum                   | eight, lbs<br>Maximum               |
| 100<br>w50<br>w15   | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                    |
| Са] в &   | SP Method                            |                                     |

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type           | 5.30 ft/s<br>7.07 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 3.55 lbs  |
| ** CalTrans A Gradation **  | *   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose | 5.30 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

Page 4

| Riprap Placement<br>Safety Factor  | Offsite Channel      | Sec-4_btm<br>Channel Bank<br>1.1 |
|------------------------------------|----------------------|----------------------------------|
| Output Results:                    |                      |                                  |
| Computed D50                       |                      | 0.09 ft                          |
| **                                 | FHWA Gradation**     |                                  |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft    |                                  |
| Percent Smaller by Size            | Rock Size, ft        | Rock Weight, lbs                 |
| D100<br>D50<br>D10                 | 1.30<br>0.95<br>0.40 | 200.<br>75.<br>5.                |

Offsite Channel Sec-5&6 Date: 02/06/2009 Time: 16:32 \*\*\*\*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* WEST Consultants, Inc. × \* \* \* \* Version 3.0 March, 2005 \* ÷.,-\* \* \* COPYRIGHT (c) 2005 4 \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Offsite Description: Offsite Channel - Section 5&6

USACE Method \_\_\_\_\_

Input Parameters: Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.39 ft/s N/A N/A 165. lbs/cu ft 1.00 1.36 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.09 ftComputed Local Depth Averaged Velocity4.39 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.                      | 36.<br>11.     |
|                           | Page 1                   |                |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters: \_\_\_\_\_\_

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

4.39 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results: \_\_\_\_\_

Computed D50

0.14 ft

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight    | Stone Weight,<br>Minimum         | lbs<br>Maximum   |
|------------------------------|----------------------------------|------------------|
| w100<br>w50<br>w15           | 15.<br>7.<br>2.                  | 36.<br>11.<br>5. |
| USBR                         | Method                           |                  |
| Input Parameters:            |                                  |                  |
| Average Channel Velocity     | 4                                | .39 ft/s         |
| Output Results:              |                                  |                  |
| Computed D50                 |                                  | 0.26 ft          |
| *** Using Gradations from CO | E ETL 1110-2-120 ***             |                  |
|                              | cu ft<br>50 ft<br>37 ft<br>53 ft |                  |
| Percent Lighter by Weight    | Stone Weight,<br>Minimum         | lbs<br>Maximum   |
| w100<br>w50<br>w15           | 15.<br>7.<br>2.                  | 36.<br>11.<br>5. |

Offsite Channel Sec-5&6 USGS Method \_ Input Parameters: -----Average Channel Velocity 4.39 ft/s Output Results: Computed D50 0.37 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft Specific Weight Layer Thickness 0.750 ft 0.37 ft Selected Minimum D30 Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum W100 15. 36. 7. W50 11. 2. W15 5. \_\_\_\_\_ Isbash Method \_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.39 ft/s 165. lbs/cu ft Unit Weight of Stone Turbulence Level High Output Results: \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ Computed D50 0.25 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight Layer Thickness 165.0 lbs/cu ft 0.750 ft Selected Minimum D30 0.37 ft 0.53 ft Selected Minimum D90 Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. w50 7. 11. W15 2. 5. \_\_\_\_ Cal B & SP Method \_\_

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type           | 4.39 ft/s<br>5.85 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 1.15 lbs  |
| ** CalTrans A Gradation **  |   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose | 4.39 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.  |

Page 4

| Riprap Placement<br>Safety Factor  | Offsite Channel        | Sec-5&6<br>Channel Bank<br>1.1 |
|------------------------------------|------------------------|--------------------------------|
| Output Results:                    |                        |                                |
| Computed D50                       |                        | 0.05 ft                        |
| **                                 | FHWA Gradation**       |                                |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft      |                                |
| Percent Smaller by Size            | Rock Size, ft          | Rock Weight, lbs               |
| D100<br>D50<br>D10                 | $1.30 \\ 0.95 \\ 0.40$ | 200.<br>75.<br>5.              |

Offsite Channel Sec-5&6\_btm Date: 02/06/2009 Time: 16:59 \*\*\*\* \* RIPRAP DESIGN SYSTEM (RDS) \*  $\star$  $\star$ ΒY \* WEST Consultants, Inc. \* \* \* \* \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005  $\frac{1}{2}$ \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Offsite Description: Offsite Channel - section 5&6 btm

USACE Method \_\_\_\_\_

Input Parameters: -----Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 4.39 ft/s N/A N/A 165. lbs/cu ft 1.00 1.36 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.09 ftComputed Local Depth Averaged Velocity4.39 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight<br>Minimum | , lbs<br>Maximum |
|---------------------------|-------------------------|------------------|
| w100<br>w50               | 15.<br>7.               | 36.<br>11.       |
|                           | Page 1                  |                  |

\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 2.40 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results:

Computed D50

0.04 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
| W15                       | 2.                       | 5.             |

\_\_\_\_\_USBR Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity

4.39 ft/s

Output Results:

Computed D50

0.26 ft

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum |       | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
| W15                       | 2.                       | 5.             |

Offsite Channel Sec-5&6\_btm USGS Method Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.39 ft/s Output Results: Computed D50 0.37 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 2. 11. W15 5. Isbash Method \_\_\_\_ Input Parameters: \_\_\_\_\_ Average Channel Velocity 4.39 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High Output Results: \_\_\_\_\_\_ Computed D50 0.25 ft \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft Layer Thickness 0.750 ft Selected Minimum D30 0.37 ft Selected Minimum D90 0.53 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 15. 36. W50 7. 11. W15 2. 5. \_\_\_\_ Cal B & SP Method \_\_

1

| Offsite Ch  | annel Sec-5&6_btm   |
|---|---|
| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type | 4.39 ft/s<br>5.85 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
| Output Results:   |   |
| Computed W  | 1.15 lbs  |
| ** CalTrans A Grada   | tion **   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Tor<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | Е   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Metho  | d   |
| Input Parameters:   |   |
| Average Channel Velocity  | 4.39 ft/s   |

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose Riprap Placement Safety Factor

Output Results: \_\_\_\_\_

Computed D50

0.05 ft

75. 5.

\*\* FHWA Gradation\*\*

Facing 1.90 ft

Gradation Class Layer Thickness

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.30          | 200.             |
| D50                     | 0.95          | 75.              |
| D10                     | 0.40          | 5.               |

Drop Structure Offsite Channel Sec-6(0.2%slope) Date: 02/09/2009 Time: 17:30 \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \*  $_{\star}$ WEST Consultants, Inc. \*  $\dot{\times}$ \* 4 \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. ÷ \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Project: Cholla Ash Offsite Description: Offsite Channel - SEction 6 DROP

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 12.05 ft/s N/A N/A 165. lbs/cu ft 1.00 0.58 ft 2.50 1.1 Channel Bank Angular

Output Results:

| Computed D30<br>Computed Local Depth Averaged Velocity | 1.42 ft<br>12.05 ft/s |
|--|-----------------------|
| Local Velocity/Avg. Velocity                           | 1.00                  |
| Side Slope Correction Factor                           | 1.06                  |
| Correction for Layer Thickness                         | 1.00                  |
| Correction for Secondary Currents                      | 1.00                  |

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 3.000  | ft |
| Selected Minimum |       | 1.46   | ft |
| Selected Minimum | D90   | 2.11   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 933.<br>467.             | 2333.<br>690.  |
|                           | Page 1                   |                |

W15

| ASCE  | Method                               |                                |
|---|--------------------------------------|--------------------------------|
| Input Parameters:   |                                      |                                |
| Local Velocity<br>Cotangent of Side slope   |                                      | 12.05 ft/s<br>2.50             |
| Unit weight of Stone<br>Riprap Placement  |                                      | 165. lbs/cu ft<br>Channel Bank |
| Output Results:   |                                      |                                |
| Computed D50  |                                      | 1.03 ft                        |
| *** Using Gradations from C   | OE ETL 1110-2-12                     | 20 ***                         |
| Specific Weight 165.0 lbs<br>Layer Thickness 1.<br>Selected Minimum D30 0<br>Selected Minimum D90 1 | /cu ft<br>750 ft<br>.85 ft<br>.23 ft | _                              |
| Percent Lighter by Weight   | Stone<br>Minimum                     | Weight, lbs<br>Maximum         |
| W100<br>W50<br>W15  | 185.<br>93.<br>29.                   | 463.<br>137.<br>69.            |
| USBR  | Method                               |                                |
| Input Parameters:   |                                      |                                |
| Average Channel Velocity  |                                      | 12.05 ft/s                     |
| Dutput Results:   |                                      |                                |
| Computed D50  |                                      | 2.06 ft                        |
| *** Using Gradations from C   | DE ETL 1110-2-12                     | 0 ***                          |
| Selected Minimum D30 1  | /cu ft<br>500 ft<br>.70 ft<br>.47 ft |                                |
| Percent Lighter by Weight   | Stone<br>Minimum                     | Weight, lbs<br>Maximum         |
| w100  | 1482.                                | 3704.                          |
| w50<br>w15  | 741.                                 | 1096.<br>548.                  |

| Drop | Structure | Offsite  | Channel | Sec-6(0. | 2%slope) |
|------|-----------|----------|---------|----------|----------|
| -    | USGS      | Method _ |         |          |          |

Input Parameters:

Average Channel Velocity

Cotangent of Side slope

Flow Type

12.05 ft/s

Output Results:

Computed D50

4.34 ft

2.50

Impinging

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Warning: The required stone size is greater than the largest USACE stone gradation.

\_\_\_\_\_ Isbash Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_\_ 12.05 ft/s 165. lbs/cu\_ft Average Channel Velocity Unit Weight of Stone Turbulence Level High Output Results: -----1.86 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft 3.500 ft Specific Weight Layer Thickness Selected Minimum D30 1.70 ft Selected Minimum D90 2.47 ft Stone Weight, 1bs Percent Lighter by Weight Minimum Maximum w100 1482. 3704. W50 741. 1096. W15 232. 548. \_\_\_\_\_ Cal B & SP Method \_\_\_\_\_ Input Parameters: .\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Average Channel Velocity 12.05 ft/s 16.07 ft/s Velocity Affecting Bank Unit Weight of Stone 165. lbs/cu ft

| Output Results:  |  |  |  |
|--|--|--|--|
| Computed W   | 489.90 lbs   |  |  |
| ** CalTrans A Gra  | adation **   |  |  |
| (1) Outside Layer:   |  |  |  |
| Gradation Class<br>Layer Thickness   | 1/2 Ton<br>3.40 ft   |  |  |
| Percent Larger than  | Rock Size (Ton)  |  |  |
| 0 - 5<br>50 - 100<br>95 - 100  | 1.00<br>0.50<br>0.25   |  |  |
| (2) Inner Layer:   |  |  |  |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft  |  |  |
| (3) Backing:   |  |  |  |
| Backing Class No.<br>Layer Thickness   | 1<br>1.8 ft  |  |  |
| (4) Fabric:  |  |  |  |
| Fabric Type  | В  |  |  |
| Total Thickness (1)+(2)+(3)+(4):   | 5.2 ft   |  |  |
| HEC-11 Method  |  |  |  |
| Input Parameters:  |  |  |  |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Riprap Placement<br>Safety Factor | 12.05 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>2.50<br>41.00 deg.<br>Channel Bank<br>1.1 |  |  |
| Output Results:  |  |  |  |
| Computed D50   | 1.03 ft  |  |  |

\*\* FHWA Gradation\*\*

| Gradation Class | Light   |
|-----------------|---------|
| Layer Thickness | 2.60 ft |

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.80          | 500.             |
| D50                     | 1.30          | 200.             |
| D10                     | 0.40          | 5.               |

Drop Structure Offsite Channel Sec-6\_btm(0.2%slope) Date: 02/09/2009 Time: 17:31 \* \* RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* \* \* Version 3.0 March, 2005 \* \*  $^{*}$ ÷ \* \* COPYRIGHT (c) 2005  $^{\star}$ \* \* WEST CONSULTANTS, INC. РН: 858-487-9378 \* \* 16870 WEST BERNARDO DRIVE \* SUITE 340 FAX:858-487-9448 \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \* \*\*\*\*\*\*

Project: Cholla Ash Offsite Description: Offsite Channel - SECTION 6 DROP btm

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 12.05 ft/s N/A 165. lbs/cu ft 1.00 0.58 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D301.42 ftComputed Local Depth Averaged Velocity12.05 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 3.000  | ft |
| Selected Minimum | D30   | 1.46   | ft |
| Selected Minimum | D90   | 2.11   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 933.<br>467.             | 2333.<br>690.  |
|                           | Page 1                   |                |

W15

W100

w50

W15

\_\_\_\_ ASCE Method \_\_ Input Parameters: \_\_\_\_\_ 12.05 ft/s Local Velocity Cotangent of Side slope N/A Unit Weight of Stone 165. lbs/cu ft Riprap Placement Channel Bottom Output Results: \_\_\_\_\_\_ 0.95 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* 165.0 lbs/cu ft 1.750 ft 0.85 ft Specific Weight Layer Thickness Selected Minimum D30 1.23 ft Selected Minimum D90 Stone Weight, 1bs Maximum Percent Lighter by Weight Minimum 185. 463. W100 93. 137. W50 29. 69. W15 \_\_\_\_\_ USBR Method \_\_\_\_\_ Input Parameters: \_\_\_\_\_ 12.05 ft/s Average Channel Velocity Output Results: \_\_\_\_\_\_ 2.06 ft Computed D50 \*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\* Specific Weight 165.0 lbs/cu ft 3.500 ft Layer Thickness Selected Minimum D30 1.70 ft Selected Minimum D90 2.47 ft Stone Weight, 1bs Maximum Percent Lighter by Weight Minimum 3704.

1482.

741.

232.

1096.

548.

Input Parameters:

Average Channel Velocity

Output Results:

Computed D50

4.34 ft

12.05 ft/s

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

Warning: The required stone size is greater than the largest USACE stone gradation.

\_\_\_\_\_ Isbash Method \_\_\_\_\_ Input Parameters: ------Average Channel Velocity 12.05 ft/s Unit Weight of Stone 165. lbs/cu ft Turbulence Level High

Output Results:

Computed D50

1.86 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 3.500  | ft |
| Selected Minimum |       | 1.70   | ft |
| Selected Minimum | D90   | 2.47   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 1482.                    | 3704.          |
| w50                       | 741.                     | 1096.          |
| w15                       | 232.                     | 548.           |

Cal B & SP Method \_\_\_\_\_

Input Parameters:

Average Channel Velocity Velocity Affecting Bank Unit Weight of Stone Cotangent of Side slope Flow Type 12.05 ft/s 16.07 ft/s 165. lbs/cu ft 2.50 Impinging

| Output Results:  |   |
|--|---|
| Computed W   | 489.90 lbs  |
| ** CalTrans A Gradation  | ۱ **  |
| (1) Outside Layer:   |   |
| Gradation Class<br>Layer Thickness   | 1/2 Ton<br>3.40 ft  |
| Percent Larger than  | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100  | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:   |   |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft   |
| (3) Backing:   |   |
| Backing Class No.<br>Layer Thickness   | 1.8 ft  |
| (4) Fabric:  |   |
| Fabric Type  | В   |
| Total Thickness (1)+(2)+(3)+(4):   | 5.2 ft  |
| HEC-11 Method  |   |
| Input Parameters:  |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Riprap Placement<br>Safety Factor | 12.05 ft/s<br>4.00 ft<br>165. lbs/cu ft<br>N/A<br>deg.<br>Channel Bottom<br>1.1 |
| Output Results:  |   |
| Computed D50   | 0.77 ft   |

\*\* FHWA Gradation\*\*

| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft    |                   |
|------------------------------------|----------------------|-------------------|
| Percent Smaller by Size            | Rock Size, ft        | Rock Weight, lbs  |
| D100<br>D50<br>D10                 | 1.30<br>0.95<br>0.40 | 200.<br>75.<br>5. |

Offsite Channel Sec-7 Date: 02/06/2009 Time: 16:32 \* RIPRAP DESIGN SYSTEM (RDS) \* \* \* ΒY \* \* WEST Consultants, Inc. \* \* \* ÷ \* Version 3.0 March, 2005 \* \* \* \* \* COPYRIGHT (c) 2005 4 \* WEST CONSULTANTS, INC. \* \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* WEB:WWW.WESTCONSULTANTS.COM \* \* SAN DIEGO, CA 92127 

Project: Cholla Ash Offsite Description: Offsite Channel - Section 7

USACE Method \_\_\_\_\_

Input Parameters:

Velocity Type Channel Shape Channel Type Bend Angle (deg) Average Channel Velocity Bottom width Bend Radius Top Width Unit Weight of Stone Riprap Layer Thickness Local Flow Depth Cotangent of Side Slope Safety Factor Riprap Placement Rock Type

Average Trapezoidal Straight N/A 2.40 ft/s N/A 165. lbs/cu ft 1.00 0.86 ft 2.50 1.1 Channel Bank Angular

Output Results:

Computed D300.02 ftComputed Local Depth Averaged Velocity2.40 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu ft |
|------------------|-------|-----------|
| Layer Thickness  |       | 0.750 ft  |
| Selected Minimum | D30   | 0.37 ft   |
| Selected Minimum | D90   | 0.53 ft   |

| Percent Lighter by Weight | Stone Weight<br>Minimum | , lbs<br>Maximum |
|---------------------------|-------------------------|------------------|
| w100<br>w50               | 15.<br>7.               | 36.<br>11.       |
|                           | Page 1                  |                  |

.

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement 2.40 ft/s 2.50 165. lbs/cu ft Channel Bank

Output Results:

Computed D50

0.04 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight  | Stone Weigh <sup>.</sup><br>Minimum      | t, lbs<br>Maximum |
|--|--|-------------------|
| W100<br>W50<br>W15   | 15.<br>7.<br>2.                          | 36.<br>11.<br>5.  |
| USBF   | R Method                                 |                   |
| Input Parameters:  |  |                   |
| Average Channel Velocity   |  | 2.40 ft/s         |
| Output Results:  |  |                   |
| Computed D50   |  | 0.07 ft           |
| *** Using Gradations from (  | COE ETL 1110-2-120 ***                   |                   |
| Specific Weight 165.0 lbs<br>Layer Thickness 0<br>Selected Minimum D30 (<br>Selected Minimum D90 ( | s/cu ft<br>.750 ft<br>).37 ft<br>).53 ft |                   |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100                      | 15.                      | 36.            |
| w50                       | 7.                       | 11.            |
| w15                       | 2.                       | 5.             |

|   | fsite Channel Sec-<br>Nethod                          |  |
|---|---|--|
| Input Parameters:   |   |  |
| Average Channel Velocity  |   | 2.40 ft/s                              |
| Output Results:   |   |  |
| Computed D50  |   | 0.08 ft                                |
| *** Using Gradations from COE   | ETL 1110-2-120 **                                     | * *                                    |
| Specific Weight165.0 lbs/cLayer Thickness0.75Selected Minimum D300.3Selected Minimum D900.5   | u ft<br>O ft<br>7 ft<br>3 ft                          |  |
| Percent Lighter by Weight   | Stone Weig<br>Minimum                                 | ght, lbs<br>Maximum                    |
| W100<br>W50<br>W15  | 15.<br>7.<br>2.                                       | 36.<br>11.<br>5.                       |
| Isbash  | Method  |  |
| Input Parameters:   |   |  |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level  | 165   | 2.40 ft/s<br>5. lbs/cu ft<br>High      |
| Output Results:   |   |  |
| Computed D50  |   | 0.07 ft                                |
| *** Using Gradations from COE   | ETL 1110-2-120 **                                     | **                                     |
|   |   |  |
| Specific Weight165.0lbs/cdLayer Thickness0.75Selected Minimum D300.3Selected Minimum D900.5   | u ft<br>O ft<br>7 ft<br>3 ft                          |  |
| Specific Weight 165.0 lbs/cu<br>Layer Thickness 0.756<br>Selected Minimum D30 0.3<br>Selected Minimum D90 0.55<br>Percent Lighter by Weight | u ft<br>O ft<br>7 ft<br>3 ft<br>Stone Weig<br>Minimum |  |
| Selected Minimum D30 0.3<br>Selected Minimum D90 0.5  | 7 ft<br>3 ft<br>Stone Weig                            | ht, 1bs<br>Maximum<br>36.<br>11.<br>5. |

| Average Channel Velocity | 2.40 ft/s      |
|--------------------------|----------------|
| Velocity Affecting Bank  | 3.20 ft/s      |
| Unit Weight of Stone     | 165. lbs/cu ft |
| Cotangent of Side slope  | 2.50           |
| Flow Type                | Impinging      |

Output Results:

-----

Computed W

0.03 lbs

\*\* CalTrans A Gradation \*\*

### (1) Outside Layer:

| Gradation Class | 1/2 Ton |
|-----------------|---------|
| Layer Thickness | 3.40 ft |

| Percent Larger than                  | Rock Size (Ton)      |
|--------------------------------------|----------------------|
| 0 - 5<br>50 - 100<br>95 - 100        | 1.00<br>0.50<br>0.25 |
| (2) Inner Layer:                     |                      |
| Gradation Class<br>Layer Thickness   | None<br>0.00 ft      |
| (3) Backing:                         |                      |
| Backing Class No.<br>Layer Thickness | 1.8 ft               |
| (4) Fabric:                          |                      |

Total Thickness (1)+(2)+(3)+(4): 5.2 ft

\_\_\_\_\_ HEC-11 Method \_\_\_\_\_

Input Parameters:

Fabric Type

Average Channel Velocity Average Flow Depth Unit Weight of Stone Cotangent of Side Slope Material Angle of Repose 2.40 ft/s 3.00 ft 165. lbs/cu ft 2.50 41.00 deg.

В

| Riprap Placement<br>Safety Factor  | Offsite Channe                         | l Sec-7<br>Channel Bank<br>1.1 |
|------------------------------------|--|--------------------------------|
| Output Results:                    |  |                                |
| Computed D50                       |  | 0.01 ft                        |
| **                                 | FHWA Gradation**                       |                                |
| Gradation Class<br>Layer Thickness | Facing<br>1.90 ft                      |                                |
| Percent Smaller by Size            | Rock Size, ft                          | Rock Weight, lbs               |
| D100<br>D50<br>D10                 | $     1.30 \\     0.95 \\     0.40   $ | 200.<br>75.<br>5.              |

Date: 02/06/2009 Time: 16:58 4 \* RIPRAP DESIGN SYSTEM (RDS) \* \* ΒY \* \* WEST Consultants, Inc. ÷ \* \* \* \* Version 3.0 March, 2005 \* ÷ \* \* \* \* \* COPYRIGHT (c) 2005 \* \* WEST CONSULTANTS, INC. \* 16870 WEST BERNARDO DRIVE PH: 858-487-9378 \* \* SUITE 340 FAX:858-487-9448 \* WEB:WWW.WESTCONSULTANTS.COM \* \* SAN DIEGO, CA 92127 WEB:WWW.WESTCONSULTANTS.COM \*

Offsite Channel Sec-7\_btm

Project: Cholla Ash Offsite Description: Offsite Channel - Section 7 btm

USACE Method \_\_\_\_\_

Average Trapezoidal Straight N/A 2.40 ft/s N/A 165. lbs/cu ft 1.00 0.86 ft N/A 1.1 Channel Bottom Angular

Output Results:

Computed D300.02 ftComputed Local Depth Averaged Velocity2.40 ft/sLocal Velocity/Avg. Velocity1.00Side Slope Correction Factor1.06Correction for Layer Thickness1.00Correction for Secondary Currents1.00

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum | D30   | 0.37   | ft |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight | Stone Weight,<br>Minimum | lbs<br>Maximum |
|---------------------------|--------------------------|----------------|
| w100<br>w50               | 15.<br>7.                | 36.<br>11.     |
|                           | Page 1                   |                |

\_\_\_\_\_ ASCE Method \_\_\_\_\_

Input Parameters:

Local Velocity Cotangent of Side slope Unit Weight of Stone Riprap Placement

2.40 ft/s N/A 165. lbs/cu ft Channel Bottom

Output Results:

Computed D50

0.04 ft

\*\*\* Using Gradations from COE ETL 1110-2-120 \*\*\*

| Specific Weight  | 165.0 | lbs/cu | ft |
|------------------|-------|--------|----|
| Layer Thickness  |       | 0.750  | ft |
| Selected Minimum |       | 0.37   |    |
| Selected Minimum | D90   | 0.53   | ft |

| Percent Lighter by Weight  | Stone Weight,<br>t Minimum | lbs<br>Maximum   |
|--|----------------------------|------------------|
| W100<br>W50<br>W15   | 15.<br>7.<br>2.            | 36.<br>11.<br>5. |
|  | USBR Method                |                  |
| Input Parameters:  |                            |                  |
| Average Channel Velocity   | 2                          | .40 ft/s         |
| ,<br>Output Results:   |                            |                  |
| Computed D50   |                            | 0.07 ft          |
| *** Using Gradations fr  | rom COE ETL 1110-2-120 *** |                  |
| Specific Weight 165.(<br>Layer Thickness<br>Selected Minimum D30<br>Selected Minimum D90 | 0.37 ft                    |                  |
| Percent Lighter by Weight  | Stone Weight,<br>Minimum   | lbs<br>Maximum   |
| w100<br>w50<br>w15   | 15.<br>7.<br>2.            | 36.<br>11.<br>5. |

W15

|   | fsite Channel Sec-<br>Method         |                                     |
|---|--------------------------------------|-------------------------------------|
| Input Parameters:   |                                      |                                     |
| Average Channel Velocity  |                                      | 2.40 ft/s                           |
| Output Results:   |                                      |                                     |
| Computed D50  |                                      | 0.08 ft                             |
| *** Using Gradations from C   | OE ETL 1110-2-120                    | ***                                 |
| Specific Weight 165.0 lbs,<br>Layer Thickness 0.7<br>Selected Minimum D30 0<br>Selected Minimum D90 0 | /cu ft<br>750 ft<br>.37 ft<br>.53 ft |                                     |
| Percent Lighter by Weight   | Stone We<br>Minimum                  | eight, lbs<br>Maximun               |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                    |
| Isbasł  | h Method                             |                                     |
| Input Parameters:   |                                      |                                     |
| Average Channel Velocity<br>Unit Weight of Stone<br>Turbulence Level                                  | 1                                    | 2.40 ft/s<br>.65. lbs/cu ft<br>High |
| Output Results:   |                                      |                                     |
| Computed D50  |                                      | 0.07 ft                             |
| *** Using Gradations from CC  | DE ETL 1110-2-120                    | * * *                               |
|   | 750 ft<br>.37 ft                     |                                     |
| Percent Lighter by Weight   | Stone We<br>Minimum                  | ight, lbs<br>Maximum                |
| w100<br>w50<br>w15  | 15.<br>7.<br>2.                      | 36.<br>11.<br>5.                    |
| са] в &   | SP Method                            |                                     |

| Average Channel Velocity<br>Velocity Affecting Bank<br>Unit Weight of Stone<br>Cotangent of Side slope<br>Flow Type                     | 2.40 ft/s<br>3.20 ft/s<br>165. lbs/cu ft<br>2.50<br>Impinging |
|---|---|
| Output Results:   |   |
| Computed W  | 0.03 lbs  |
| ** CalTrans A Gradation **  |   |
| (1) Outside Layer:  |   |
| Gradation Class<br>Layer Thickness  | 1/2 Ton<br>3.40 ft  |
| Percent Larger than   | Rock Size (Ton)   |
| 0 - 5<br>50 - 100<br>95 - 100   | 1.00<br>0.50<br>0.25  |
| (2) Inner Layer:  |   |
| Gradation Class<br>Layer Thickness  | None<br>0.00 ft   |
| (3) Backing:  |   |
| Backing Class No.<br>Layer Thickness  | 1<br>1.8 ft   |
| (4) Fabric:   |   |
| Fabric Type   | В   |
| Total Thickness (1)+(2)+(3)+(4):  | 5.2 ft  |
| HEC-11 Method   |   |
| Input Parameters:   |   |
| Average Channel Velocity<br>Average Flow Depth<br>Unit Weight of Stone<br>Cotangent of Side Slope<br>Material Angle of Repose<br>Page 4 | 2.40 ft/s<br>3.00 ft<br>165. lbs/cu ft<br>N/A<br>deg.         |

Offsite Channel Sec-7\_btm Channel Bottom 1.1

Riprap Placement Safety Factor

Output Results:

Computed D50

0.01 ft

\*\* FHWA Gradation\*\*

Gradation Class Facing Layer Thickness 1.90 ft

| Percent Smaller by Size | Rock Size, ft | Rock Weight, lbs |
|-------------------------|---------------|------------------|
| D100                    | 1.30          | 200.             |
| D50                     | 0.95          | 75.              |
| D10                     | 0.40          | 5.               |

i

# **OFF-SITE CHANNEL**

# **DROP STRUCTURE CALCULATIONS**

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Report\Draft Drainage Report.doc

#### Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Offsite Drop Structure Channel Section 1 Into Basir

|    | Offsite Drop Structure Channel Section 1 Into Basin |                 |   |                    |                           |                           |                   |                |   |          |
|----|---|-----------------|---|--------------------|---------------------------|---------------------------|-------------------|----------------|---|----------|
|    | A   | В               | С   | D                  | Е                         | F                         | G                 | Н              |   | J        |
| 1  | Riprap Ba   | sin Sizing      |   |                    |                           | •                         |                   |                |   |          |
| 2  | ]   | -               |   |                    |                           |                           |                   |                |   |          |
| 3  | Q=  | 25              | cfs   | flow rate fo       | r section 1               | just before               | brink of drop     | )              |   |          |
| 4  | Vallow=   | 0.001           | ft/s  | velocity for       |                           |                           | ,                 |                |   |          |
| 5  | TW=   | 10              |   | normal dep         | · •                       | •                         |                   |                |   |          |
| 6  | Wo=   | 10              | ft  | channel bo         |                           |                           |                   |                |   |          |
| 7  |   |                 |   |                    |                           |                           |                   |                |   |          |
| 8  | From FHW  | A Hydraulic     | Design of E                                   | nergy Dissig       | pators for C              | ulverts and               | Channels, J       | luly 2006      |   |          |
| 9  |   |                 | o), depth (yo                                 |                    |                           |                           |                   | •              |   |          |
| 10 | 1   |                 | <i>,,</i> , , , , , , , , , , , , , , , , , , | ,,                 |                           | ~ ,                       |                   |                |   |          |
| 11 | From Flow   | master outp     | out files:                                    |                    |                           |                           |                   |                |   |          |
|    | yo= ye=   | 0.29            |   | normal dep         | th for drop               |                           |                   |                |   |          |
|    | Vo=   | 7.96            |   | velocity for       | -                         |                           |                   |                |   |          |
|    | Fr=   | 2.68            |   | Froude nur         |                           | qc                        |                   |                |   |          |
| 15 | 1   |                 |   |                    |                           |                           |                   |                |   |          |
|    | 2) Select tr  | ial D50 and     | obtain hs/ye                                  | from Equat         | ion 10.1.                 |                           |                   |                |   |          |
| 17 | , í   | <b></b>         |   | ·                  |                           |                           |                   |                |   |          |
| 18 | Equation 10   | $h_s$           | $= 0.86 \left( \frac{D_{50}}{D_{50}} \right)$ | $V_{o}$            |                           |                           |                   |                |   |          |
| 19 |   | $\frac{1}{v}$   | $= 0.86 \left( \frac{D_{50}}{y_e} \right)$    |                    | $= \left  -C_{o} \right $ |                           |                   |                |   |          |
| 20 |   | У e             | ( ye  | $\int \sqrt{gy_e}$ |                           |                           |                   |                |   |          |
| 21 |   |                 |   |                    |                           | -                         |                   |                |   |          |
| 22 | Get tailwate  | er paramete     | er Co:  |                    |                           | , r                       | SIPATOR POOL      | APRON          | CHANNEL   |          |
| 23 | Co =  | 1.4             | if TW/ye < 0                                  | .75                | γ <sub>0</sub> =          | Ye 🕇                      | Ls                | LA             | *   |          |
| 24 | Co =  | 136.331         | if 0.75 < TW                                  | /ye < 1.0          |                           |                           | TOP OF RIPRAP     |                | The second se |          |
|    | Co =  | 3               | if 1.0 < TW/y                                 | /e                 |                           |                           | <u>Iw</u>         | ) mut          |   | <u>ئ</u> |
| 26 |   |                 |   |                    | ~                         |                           |                   | COLORED C      |   | 11       |
|    | TW/ye =   | 34.48276        |   |                    | 3 d                       | jo or 2 d <sub>inax</sub> | 2d50 or 1.5d      | - ( 1          | 1740 - AC   | 9        |
| 28 |   |                 |   |                    |                           |                           |                   | max            |   |          |
|    | D50 =   | 0.11            | ft  | D50 of ripra       | ар 🗀                      | Fia                       | ure 10.1. Profile | of Riprap Basi | n   |          |
| 30 |   |                 |   |                    |                           |                           |                   |                |   |          |
|    |   |                 | 50 >= 2 and                                   |                    | >= 0.1.                   |                           |                   |                |   |          |
|    | D50/ye =  | 0.37931         |   | OK                 |                           |                           |                   |                |   |          |
|    | g =   | 32.2            | tt/s2   |                    |                           |                           |                   |                |   |          |
|    | hs/ye =   | 0.928133        | 0   |                    |                           |                           |                   |                |   |          |
|    | hs =  | 0.269159        |   | scour depth        | 1                         |                           |                   |                |   |          |
|    | hs/D50 =  | 2.446896        | >=2.0   | OK                 |                           |                           |                   |                |   |          |
| 37 | 2) Cime 44  | haain           |   |                    |                           |                           |                   |                |   |          |
|    | 3) Size the   |                 | 0.00  | £1                 |                           | De al 1 11                |                   |                |   |          |
|    |   | 10*hs =         | 2.69  |                    | uissipator                | Pool Length               | 1                 |                |   |          |
|    | Lsmin =   | 3Wo =           | 30  | π                  |                           |                           |                   |                |   |          |
| 41 | Lb =  | 15bc -          | 104   | ft                 | Total Dack                | lonath                    |                   |                |   |          |
|    | Lb =<br>Lbmin =                                     | 15hs =<br>4Wo = | 4.04<br><b>40</b>                             |                    | Total Pool                | Length                    |                   |                |   |          |
|    | Lomin =<br>La =                                     |                 |   |                    | th                        |                           |                   |                |   |          |
|    | La =<br>Wb =  | <b>10</b><br>10 |   | Apron Leng         |                           | ottom donth               |                   |                |   |          |
| 45 | vvD –   | 10              | IL .  | maintaining        | channel D                 | uttorn depth              | I                 |                |   |          |
| 40 |   |                 |   |                    |                           |                           |                   |                |   |          |

#### Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Offsite Drop Structure Chappel Section 1 Into Basir

|    | Offsite Drop Structure Channel Section 1 Into Basin   |                     |  |                   |                                |            |                    |  |                  |                      |                  |  |
|----|---|---------------------|--|-------------------|--------------------------------|------------|--------------------|--|------------------|----------------------|------------------|--|
|    | A   | В                   | С                                      | D                 | E                              | F          | G                  | H  | 1                | l                    | J                |  |
| 47 | Hydraulic   | : Jump              |  |                   |                                |            | ·                  |  | I                |                      | ·                |  |
| 48 | From Dra  | inage Design        | Manual for                             | Maricopa C        | ounty, Hydra                   | aulics: Hy | /draulic Stru      | uctures, 2   | 003              |                      |                  |  |
| 49 | Y1 =  | 0.29 1              |  |                   | normal depti                   |            |                    |  |                  |                      |                  |  |
| 50 | Ydn =   | 10 1                | ft                                     |                   | am normal (                    |            |                    |  |                  |                      |                  |  |
| 51 | Q =   | 25 (                | cfs                                    | flow throug       |                                | •          |                    |  |                  |                      |                  |  |
| 52 | ]g =  | 32.2 f              |  |                   | ,                              |            |                    |  |                  |                      |                  |  |
| 53 | A1 =  | 3.14 f              |  | area of flow      | v through th                   | e drop     |                    |  |                  |                      |                  |  |
| 54 | A2 =  | 10.43 f             |  |                   | v in next sec                  |            |                    |  |                  |                      |                  |  |
| 55 | z =   | 2.5 f               |  | sideslope I       |                                |            |                    |  |                  |                      |                  |  |
| 56 | b =   | 10 f                |  |                   | th of channe                   |            | (1) A              | (2)  | Ū U              | ЭВ                   | 2 <u> </u>       |  |
| 57 | 1   | ,                   |  |                   |                                |            | . 55               |  | V1 V1            | 103                  | <u>y</u>         |  |
|    | 2) Calcula  | te sequant he       | eight of ium                           | า                 |                                | φ,         |                    | $\overline{v_2}$ $\overline{v_2}$ $\overline{v_2}$ | \$( )~           | <u> </u>             |                  |  |
| 59 | 9 Equation 7.2  |                     |  |                   |                                |            |                    |  |                  |                      |                  |  |
| 60 |   | 1                   | [( ]                                   | <u>, 1</u>        |                                |            | v <sub>1</sub> (P) | _ <sup>(2)</sup> T                                 | <                | $\mathbf{\hat{l}}$ ( | २                |  |
| 61 |   | $Y_2 = \frac{1}{2}$ | $Y_{1} \left( 1 + 8F_{r1}^{2} \right)$ | $)^{2} - 1$       |                                |            |                    | y <sub>2</sub>                                     |                  | (C 2 2 2 -           | - y <sub>2</sub> |  |
| 62 |   | 2                   |  |                   |                                |            | y1                 |  | v <sup>y</sup> 1 |                      |                  |  |
|    | Y2 =  | <b>0.96</b> f       | ft                                     | ОК                | height of jui                  | mn         | <b>₽</b> <u></u>   | ~ 2  |                  | ·                    |                  |  |
| 64 |   | 0.001               |  | on                | fielgint of jui                |            | С                  |  |                  | D                    |                  |  |
| L  | Figure 6.10. Hydraulic Jump Types Sloping Channels (Bradley, 1961)<br>3) Another check on sequant height of jump. |                     |  |                   |                                |            |                    |  |                  |                      |                  |  |
| 66 | Use Fig. 7  |                     | quantinoigh                            | t or jump.        |                                |            |                    |  |                  |                      |                  |  |
| 67 | 000   .g. /   |                     | √=                                     | 7.96              | ft/s                           |            |                    |  |                  |                      |                  |  |
|    | Fr1 =   | **                  | op width =                             | 11.46             |                                |            |                    |  |                  |                      |                  |  |
| 69 |   |                     | /m =                                   | 0.27              |                                | = flow a   | ea / top wid       | 1th  |                  |                      |                  |  |
| 70 |   |                     | -r1 =                                  | 2.68              | it.                            | – now a    | ear top wit        |  |                  |                      |                  |  |
| 71 | •   | · ·                 |  | 2.00              |                                |            |                    |  |                  |                      |                  |  |
| 72 | $J = Y2 / Y^{-1}$   | 1                   |  | t = b/(zy1)       |                                |            |                    |  |                  |                      |                  |  |
|    | J =   | 3.1                 |  | t =               | 13.79                          |            |                    |  |                  |                      |                  |  |
| 74 | Y2 =  | <b>0.899</b> f      | 't                                     |                   | height of jur                  | mn         |                    |  |                  |                      |                  |  |
| 75 |   |                     |  | dee la gel        | noight of jui                  | np         |                    |  |                  |                      |                  |  |
|    | 1) Calcula  | te depth at be      | ainnina loc:                           | ation of ium      | n                              |            |                    |  |                  |                      |                  |  |
| 77 | Equation 7  | .3                  |  |                   |                                |            |                    |  |                  |                      |                  |  |
| 78 |   | $ZY_1^3$ Z          | $ZY_1^2 \cup Q$                        | $ZY_2^3$ b        | $Y_{2}^{2}  Q$                 |            |                    |  |                  |                      |                  |  |
| 79 |   | 3+-                 | $\frac{1}{2} + \frac{1}{gA_1}$         | $=\frac{-2}{3}+-$ | $\frac{1}{3} + \frac{1}{gA_2}$ |            |                    |  |                  |                      |                  |  |
| 80 |   |                     | - 511                                  |                   | $5 \delta^{\prime 1}2$         |            |                    |  |                  |                      |                  |  |
|    | Leq =   | 0.373 F             | Rea =                                  | 0 375             | (Plug in v                     | alues for  | Y2 until bo        | th sides o   | (Isun            |                      |                  |  |
|    | Yb =  | 0.29 ft             |  | OK 0.070          | depth at jur                   | nn locatic | n and bu           |  | quarj            |                      |                  |  |
| 83 |   | 0.20                | •                                      | U.V.              | aoptiratjan                    | ip loodic  |                    |  |                  |                      |                  |  |
|    | 4) Calculat   | te length of ju     | imp.                                   |                   |                                |            |                    |  |                  |                      |                  |  |
|    | Use Fig. 7  |                     | imp.                                   |                   |                                |            |                    |  |                  |                      |                  |  |
|    | Lj / y1 =   | 33                  |  |                   |                                |            |                    |  |                  |                      |                  |  |
|    | Lj =  | 9.57 ft             | t                                      | = jump leng       | ith                            |            |                    |  |                  |                      |                  |  |
| 88 | J   | 0.07 11             | •                                      | Jamb iong         | j., (                          |            |                    |  |                  |                      |                  |  |
| 89 | Therefor  | e: Min. Lengtl      | h of iumn =                            | 30                | ft                             |            |                    |  |                  |                      |                  |  |
| 90 | THEFEIOF  | Min. Length         |  | 10                |                                | •          |                    |  |                  |                      |                  |  |
| 90 |   | Total Length        |  | 40                |                                |            |                    |  |                  |                      |                  |  |
| 31 |   | i otai Lengti       | i ui uasiii -                          | 40                | 1 L                            |            |                    |  |                  |                      |                  |  |

#### Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Offsite Drop Structure Channel Section 6

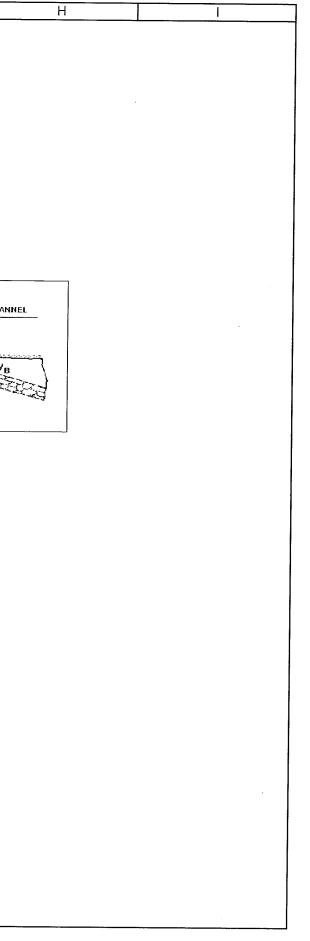
| 1       Riprap Basin Sizing   |  | A            | В                 | С             | D                | E                  | F                    | G                                     | Н  | 1              | J         |  |
|---|--|--------------|-------------------|---------------|------------------|--------------------|----------------------|---------------------------------------|--|----------------|-----------|--|
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $   | 1  | 1            | _                 |               | _L               |                    | I                    | <u> </u>                              | L  | l'             | V         |  |
| $3 \ Oc^{-1}$ B0 of sflow rate for section 6, just before brink of drop $4 \ Vallow 4 3.9 \ W' velocity for section 5, past drop6 \ Wo^{-1}10 ft6 \ Wo^{-1}10 ft6 \ Wo^{-1}10 ft7 \ Wo^{-1}10 ft7 \ Wo^{-1}10 ft7 \ Wo^{-1}10 ft7 \ Wo^{-1}10 ft1 \ Get initial velocity (vo), depth (vo), and Froude Number (Fr) for brink conditions1 \ Wo^{-1}12 for yee1 \ Wo^{-1}2.96 Froude number for drop12 \ Vo^{-1} \ Ye^{-1}2.96 Froude number for drop13 \ Vo^{-1}2.96 ft12 \ Setect trial DS0 and obtain hskye from Equation 10.1.13 \ Vo^{-1}\frac{1}{\mu_{e}} = 0.86 \left(\frac{D \cdot y}{\mu_{e}}\right)^{0.5} \left(\frac{V}{\sqrt{g} y_{e}}\right) - C_{e}22 \ Get tailwater parameter Co:\frac{1}{\mu_{e}} = 0.86 \left(\frac{D \cdot y}{\mu_{e}}\right)^{0.5} \left(\frac{V}{\sqrt{g} y_{e}}\right) - C_{e}22 \ DS0 = 0.25 \ ftD50 of riprap32 \ DS0 = 0.25 \ ftD50 of riprap33 \ ps^{-2} = 3.2 \ Mis234 \ hslye = 1.04337633 \ ps^{-2} = 3.2 \ Mis233 \ hslye = 1.04337635 \ hs^{-2} = 0.060 \ ft36 \ hslybolog = 2.42224 >= 2.0 \ OK37 \ rots = 10^{11} \ ho^{-1} \ Aron Length39 \ hs^{-2} = 10^{11} \ Aron Length41 \ hslye = 10 \ ft42 \ b = 10^{11} \ Mon For the rots work work work work work work work work$   | -  |              | on orang          |               |                  |                    |                      |                                       |  |                |           |  |
|   | -  | 0-           | 0/                | ) of s        | flow rate fo     | r contion C        | just before          | brink of d                            | 2  |                |           |  |
| 5TW=1.36 ftnormal depth for section 5, past drop6Wor10 ftchannel bottom width7From FHWA Hydraulic Design of Energy Dissipators for Culvents and Channels, July 20061010 set intial velocity (Vo), depth (yo), and Froude Number (Fr) for brink conditions11From Flowmaster output files:12yoe yoe0.58 ft13by yee0.26 ft14Fra2.9615Stelect trial D50 and obtain hslye from Equation 10.11617Equation 10.117Equation 10.1 $\frac{h_{y}}{y_{y}} = 0.86 (\frac{D_{xy}}{y_{y}})^{-S} (\frac{y_{x}}{\sqrt{y_{y}}}) - C_{x}$ 18Equation 10.1 $\frac{h_{y}}{y_{y}} = 0.86 (\frac{D_{xy}}{y_{y}})^{-S} (\frac{y_{x}}{\sqrt{y_{y}}}) - C_{x}$ 17Equation 10.1 $\frac{h_{y}}{y_{y}} = 0.86 (\frac{D_{xy}}{y_{y}})^{-S} (\frac{y_{x}}{\sqrt{y_{y}}}) - C_{x}$ 18Equation 10.1 $\frac{h_{y,y}}{y_{y}} = 0.86 (\frac{D_{xy}}{y_{y}})^{-S} (\frac{y_{x}}{\sqrt{y_{y}}}) - C_{x}$ 19Co =1.1 tributy e < 0.75  | -  |              |                   |               |                  |                    |                      | DHINK OF GEO                          | h  |                |           |  |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $   |  | 4            |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 7<br>1From FHWA Hydraulic Design of Energy Dissipators for Culverts and Channels, July 200691) Get Intial velocity (Vo), depth (yo), and Froude Number (Fr) for brink conditions10From Flowmaster output files:<br>12 yoer yee12 yoer yee0.58 ft13 Voe12.05 ft/s14 Fre2.9615Froude number for drop1516162) Select trial DS0 and obtain hsiye from Equation 10.1.17Equation 10.116 $h_{r_{e}} = 0.86 (\frac{D_{eq}}{P_{e}})^{4/3} (\frac{V_{g}}{Q_{e}}) - C_{e}$ 12Coe1.4 if TWiye < 0.75  | <b>—</b>   | 4            |                   |               |                  |                    | on 5, past di        | rop                                   |  |                |           |  |
| Image: Some FHWA Hydraulic Design of Energy Dissipators for Culverts and Channels, July 2006         1) Get initial velocity (Vo), depth (yo), and Froude Number (Fr) for brink conditions         10       From Flowmaster output files:         12       yo= yee       0.56 ft         13       Vo=       1.05 ft/s       velocity for drop         14       Free       2.66       Froude number for drop         15       Equation 10.1  |  | vvo=         | 1(                | л             | channel bo       | ttom width         |                      |                                       |  |                |           |  |
| Image: Section of the sector of the secto   |  |              |                   |               | _                |                    |                      |                                       |  |                |           |  |
| 10       From Flowmaster output files:         12       yoe yee       0.58 ft       normal depth for drop         13       Yoe       12.05 ft/s       velocity for drop         14       Fre       2.36       Froude number for drop         15       16       2) Select trial D50 and obtain hs/ye from Equation 10.1.         16       13       Equation 10.1 $\frac{h_r}{r_r} = 0.86 \left( \frac{D_{sy}}{y_r} \right)^{0.55} \left( \frac{V_s}{\sqrt{gy_r}} - C_s \right)^{-1/2}$ 21       Cet tailwater parameter Co:       Co       1.4 if TW/ye < 0.75   | -  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 11       From Flowmaster output files:         12       yo= ye=       0.58 ft       normal depth for drop         14       Fr=       2.96       Froude number for drop         15       Solution 10.1 $\frac{h_{z}}{P_{z}} = 0.86 \left( \frac{D_{su}}{P_{z}} \right)^{-1.3} \left( \frac{V_{z}}{\sqrt{g_{z}}} - C_{a} \right)^{-1.3}$ 16       2) Select trial D50 and obtain hs/ye from Equation 10.1.         17       Equation 10.1 $\frac{h_{z}}{P_{z}} = 0.86 \left( \frac{D_{su}}{P_{z}} \right)^{-1.3} \left( \frac{V_{z}}{\sqrt{g_{z}}} - C_{a} \right)^{-1.3}$ 21       Get tailwater parameter Co: $v_{s} = \sqrt{v_{s}} + \sqrt$ |  | 1) Get intia | al velocity ('    | Vo), depth (y | o), and Frou     | de Number          | (Fr) for brinl       | k conditions                          | ;  |                |           |  |
| 12       you  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 13       Voc       12.05 ft/s       velocity for drop         15       Froude number for drop         16       2) Select trial D50 and obtain hs/ye from Equation 10.1.         17       Image: The trial D50 and obtain hs/ye from Equation 10.1.         18       Equation 10.1 $h_{f_{r}} = 0.86 \left( \frac{D_{s_{0}}}{y_{r}} \right)^{-0.53} \left( \frac{y_{s}}{\sqrt{gy_{r}}} - C_{o} \right)$ 21       Get tailwater parameter Co:       Image: The trial D50 of triprap       Image: The trial D50 of triprap         22       Co =       3 if 1.0 < TW/ye < 1.0       Image: The trial D50 of triprap       Image: The trial D50 of triprap         23       D50 =       0.25 ft       D50 of triprap       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Oxe       The triprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Oxe       The triprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Oxe       The triprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Dissipator Pool Length         36       hs/ye =       1.043976       Sourd triprap         37       33       Size the basin       39       Size the basin         38       Ls =       10 ft <td>11</td> <td>From Flow</td> <td>master out</td> <td>put files:</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>  | 11   | From Flow    | master out        | put files:    |                  |                    |                      |                                       |  |                |           |  |
| 13       Voc       12.05 ft/s       velocity for drop         15       Froude number for drop         16       2) Select trial D50 and obtain hs/ye from Equation 10.1.         17       Image: The trial D50 and obtain hs/ye from Equation 10.1.         18       Equation 10.1 $h_{f_{r}} = 0.86 \left( \frac{D_{s_{0}}}{y_{r}} \right)^{-0.53} \left( \frac{y_{s}}{\sqrt{gy_{r}}} - C_{o} \right)$ 21       Get tailwater parameter Co:       Image: The trial D50 of triprap       Image: The trial D50 of triprap         22       Co =       3 if 1.0 < TW/ye < 1.0       Image: The trial D50 of triprap       Image: The trial D50 of triprap         23       D50 =       0.25 ft       D50 of triprap       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Oxe       The triprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Oxe       The triprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Oxe       The triprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Dissipator Pool Length         36       hs/ye =       1.043976       Sourd triprap         37       33       Size the basin       39       Size the basin         38       Ls =       10 ft <td>12</td> <td>yo= ye=</td> <td>0.58</td> <td>3 ft</td> <td>normal dep</td> <td>th for drop</td> <td></td> <td></td> <td></td> <td></td> <td></td>   | 12   | yo= ye=      | 0.58              | 3 ft          | normal dep       | th for drop        |                      |                                       |  |                |           |  |
| 14Fr=2.96Froude number for drop152) Select trial D50 and obtain hs/ye from Equation 10.1.17Equation 10.1 $h_r = 0.86 \left( \frac{D_{sh}}{y_r} \right)^{-0.55} \left( \frac{y_o}{\sqrt{gy_r}} \right) - C_o \right)$ 2122Get tailwater parameter Co:23Co =1.4 if TW/ye < 0.75   | 13   | Vo=          | 12.05             | 5 ft/s        |                  |                    |                      |                                       |  |                |           |  |
| $\frac{15}{12}$ Select trial D50 and obtain hs/ye from Equation 10.1.<br>$\frac{h_{z}}{V_{p}} = 0.86 \left(\frac{D_{z_{0}}}{y_{p}}\right)^{-0.55} \left(\frac{V_{z}}{\sqrt{gy_{p}}}\right) - C_{z}$ Equation 10.1<br>$\frac{h_{z}}{12} = 0.86 \left(\frac{D_{z_{0}}}{y_{p}}\right)^{-0.55} \left(\frac{V_{z}}{\sqrt{gy_{p}}}\right) - C_{z}$ Co = 1.4.4 if TW/ye < 0.75<br>22. Co = 1.4.1 if TW/ye < 0.75<br>23. Co = 3 if 1.0 < TW/ye < 1.0<br>25. Co = 3 if 1.0 < TW/ye < 1.0<br>27. TW/ye = 2.344628<br>29. D50 = 0.25 ft D50 of riprap<br>Boy = 0.431034 > 0.1 OK<br>33. g = 3.2.2 ft/s2<br>34. hs/ye = 1.043976<br>35. hs = 0.605506 ft scour depth<br>36. hs/D50 = 2.422024 >= 2.0 OK<br>37.<br>38. 3) Size the basin<br>39. Ls = 10 <sup>th</sup> s = 6.06 ft Dissipator Pool Length<br>40. Lsmin = 3Wo = 30 ft<br>41. La = 10 <sup>th</sup> s = 9.08 ft Total Pool Length<br>42. Lb = 15 hs = 9.08 ft Total Pool Length<br>43. Lbmin = 4Wo = 40 ft maintaining channel bottom depth<br>44. La = 0 ft Apron Length<br>45. Wb = 10 ft maintaining channel bottom depth<br>44. La = $\frac{\pi D_{z}^{2}}{4} = y_{w}W_{w}^{2}$<br>55. LDE = 2.72<br>56. LDE L (t) VV/0 (Fig. VI/W) Fig. D50 (ti)<br>57. 3.673857 10 0.95 11.4475 0.65<br>58. 7.389714 20 0.75 9.0375 0.53<br>59. 11.03857 0.30 0.5 6.025 0.24  | 14   | Fr=          | 2.96              | 6             |                  |                    | a                    |                                       |  |                |           |  |
| 16       2 Select trial DS0 and obtain hs/ye from Equation 10.1.         17       18       Equation 10.1 $h_{r} = 0.86 \left( \frac{D_{so}}{y_{r}} \right)^{-0.55} \left( \frac{V}{\sqrt{gy_{r}}} \right)^{-C_{o}}$ 23       Cet tailwater parameter Co:         23       Cet tailwater parameter Co:         24       Ce = 7.77931 if 0.75 TW/ye < 1.0.         26       TWye = 2.344528         26       Figure 10.1. Profile of Riprap Basin         Solo = 0.25 ft       D50 of riprap         Figure 10.1. Profile of Riprap Basin         31         Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.         20         33         39         32         10.43765         38         33         33         34         30         32         10.43765         34         33         35         30         30 <td cols<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td>F</td><td></td><td></td><td></td><td></td></td>  | <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>F</td> <td></td> <td></td> <td></td> <td></td> |              |                   |               |                  |                    |                      | F                                     |  |                |           |  |
| $\frac{17}{18} Equation 10.1 \qquad \qquad$  |  | 2) Select to | rial D50 and      | d obtain hs/v | e from Fouat     | ion 10 1           |                      | •                                     |  |                |           |  |
| Image: Sequence of the second sec  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 13       y.       (y.       (y. <th)< th="">       (y.       (y.<!--</td--><td></td><td>Faultion 1</td><td>0.1 h</td><td>( D.,</td><td><math>)^{-0.55} (V)</math></td><td></td><td></td><td></td><td></td><td></td><td></td></th)<>   |  | Faultion 1   | 0.1 h             | ( D.,         | $)^{-0.55} (V)$  |                    |                      |                                       |  |                |           |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $  |  | -930.001     |                   |               |                  | $=  -C_o $         |                      |                                       |  |                |           |  |
| 21       22       Get tailwater parameter Co:       23       Co =       1.4 if TW/ye < 0.75   |  |              | $\mathcal{Y}_{e}$ | ( Ye          | $\int \sqrt{gy}$ | , )                |                      |                                       |  |                |           |  |
|   | 20   |              |                   |               | <b>\</b>         |                    |                      |                                       |  |                |           |  |
| 23       Co =       1.4 if TW/ye < 0.75   |  | Cot toil     | or porcest        | or Co:        |                  |                    | -                    |                                       |  |                |           |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $  |  |              | •                 |               |                  |                    | •                    |                                       |  | CHANNEL        |           |  |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$  |  |              |                   |               |                  | У <sub>0</sub> = У | 'e                   | -                                     |  |                |           |  |
| <sup>26</sup><br><sup>27</sup>  |  |              |                   |               | *                | H<                 |                      | <u> <u> </u></u>                      |  | 22             |           |  |
| 27       TW/ye = 2.344828       1 dig or 1.5 dig   |  | Co =         | 3                 | 3 if 1.0 < TW | ye               |                    | ye                   | TW                                    | Land                                     | YB             | 3         |  |
| 28       D50 =       0.25 ft       D50 of riprap       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       So 0/44 = 10.1. Profile of Riprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       OK         32       D50/ye =       0.431034 >= 0.1       OK         33       g =       32.2 ft/s2         34       hs/ye =       1.043976         35 hs =       0.605506 ft       scour depth         36 hs/D50 =       2.422024 >= 2.0       OK         37       33 Size the basin       39         39 Ls =       10*hs =       6.06 ft         Lsmin =       3Wo =       30 ft         41       41       42         42       Lb =       15hs =       9.08 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       44         43       Las =       10 ft       maintaining channel bottom depth         44       44       La =       10 ft       maintaining channel bottom depth         45       Wb =       10 ft       maintaining channel bottom depth         46       4) Assess need for downstream riprap due to TW/ye >0.74       4 $= \pi D_$   |  |              |                   |               |                  |                    |                      |                                       | C. C |                |           |  |
| 28       D50 =       0.25 ft       D50 of riprap       Figure 10.1. Profile of Riprap Basin         30       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.       Figure 10.1. Profile of Riprap Basin         32       D50/ye =       0.431034 >= 0.1       OK         33       g =       32.2 ft/s2       hs/ye =       1.043976         34       hs/ye =       1.043976       sour depth         35       hs =       0.605506 ft       sour depth         36       ns/ye =       1.043976       sour depth         35       hs =       0.605506 ft       sour depth         36       1055 =       2.422024 >= 2.0       OK         37       38       3) Size the basin       30       ft         40       Lsmin =       3Wo =       30 ft       41         41       Lb =       15hs =       9.08 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       44       La =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74       48       Using Figure 10.3 $A $   |  | TW/ye =      | 2.344828          | 3             |                  | 3 45               | n or 2 dimax         | 2/10/01/15/                           |  | 150 - 1CE      | a<br>a    |  |
| Figure 10.1. Promis of Kiprap dasin         Figure 10.1. Promis of Kiprap dasin         Signe 10.43976         Signe 10.430976         Signe 10.75 Signe 2.422024 >= 2.0         OK         30 Size the basin         Signe 10.16 ft         Lissipator Pool Length         Add to ft         A signe 10 downstream riprap due to TW/ye >0.74         A signe   | 28   |              |                   |               |                  |                    |                      | 2050 41 1.50                          | max                                      |                |           |  |
| Figure 10.1. Promis of Kiprap dasin         Figure 10.1. Promis of Kiprap dasin         Signe 10.43976         Signe 10.430976         Signe 10.75 Signe 2.422024 >= 2.0         OK         30 Size the basin         Signe 10.16 ft         Lissipator Pool Length         Add to ft         A signe 10 downstream riprap due to TW/ye >0.74         A signe   |  | D50 =        | 0.25              | i ft          | D50 of ripra     | ар Ц               |                      | - 10 1                                |  |                |           |  |
| 31       Check to see that hs/D50 >= 2 and that D50/ye >= 0.1.         32       D50/ye = 0.431034 >= 0.1       OK         33       g = 3.22 ft/s2         34       hs/pe = 1.043976         35       hs = 0.605506 ft       scour depth         36       scour depth         37       37         38       3) Size the basin         32       Ls = 10*hs = 6.06 ft       Dissipator Pool Length         40       Lsmin = 3Wo = 30 ft         41       La = 10 ft       Apron Length         43       Lbmin = 4Wo = 40 ft         44       La = 10 ft       Apron Length         45       Wb = 10 ft       maintaining channel bottom depth         46       Vb = 5.8       Scourd equivalent circular diameter, De, for brink area         51       De = 2.72       Scourd equivalent circular diameter, De, for brink area         52       Sa       Rock size for riprap after energy dissipators - Equation 10.6         53       Sock size for riprap after energy dissipators - Equation 10.6 $D_{30} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 54       S = 2.64 specific gravity of rock $D_{30} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 55       L/De       L (ft)       10.39 VI (ftys)       D50 (ft)         58<  |  |              |                   |               | •                |                    | Figu                 | ire 10.1. Profile                     | or Riprap Basin                          |                |           |  |
| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$  |  | Check to s   | ee that hs/l      | D50 >= 2 and  | I that D50/ve    | >= 0.1.            |                      |                                       |  |                |           |  |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$   |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$  |  | -            |                   |               | 011              |                    |                      |                                       |  |                |           |  |
| $\frac{35}{36} \text{ hs} = 0.605506 \text{ ft} \text{ scour depth} \\ \text{hs/D50} = 2.422024 >= 2.0 \text{ OK} \\ 37 \\ 37 \\ 38 \text{ 3} \text{ Size the basin} \\ 39 \text{ Ls} = 10^{\text{h}\text{hs}} = 6.06 \text{ ft} \text{ Dissipator Pool Length} \\ 40 \text{ Lsmin} = 3Wo = 30 \text{ ft} \\ 41 \\ 42 \text{ Lb} = 15\text{ hs} = 9.08 \text{ ft} \text{ Total Pool Length} \\ 43 \text{ Lbmin} = 4Wo = 40 \text{ ft} \\ 44 \text{ La} = 10 \text{ ft} \text{ Apron Length} \\ 44 \text{ Vb} = 10 \text{ ft} \text{ maintaining channel bottom depth} \\ 46 \\ 47 \text{ 4} \text{ Assess need for downstream riprap due to TW/ye > 0.74} \\ 48 \text{ Using Figure 10.3} \\ 10 \text{ compute equivalent circular diameter, De, for brink area} \\ 50 \text{ A}^{\text{a}} = 5.8 \\ 51 \text{ De} = 2.72 \\ 52 \\ 53 \text{ Rock size for riprap after energy dissipators - Equation 10.6} \\ 5 = 2.64 \text{ specific gravity of rock} \\ 55 \\ 56 \\ 56 \\ 57 \\ 3.673857 \\ 10 \\ 0.95 \\ 11.03957 \\ 30 \\ 0.5 \\ 59 \\ 11.03957 \\ 30 \\ 0.5 \\ 60 \\ 14.71943 \\ 40 \\ 0.4 \\ 4.82 \\ 0.15 \\ \end{array}$   |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 36       hs/D50 =       2.422024 >= 2.0       OK         37       3) Size the basin       3)       3) Size the basin         38       LS =       10*hs =       6.06 ft       Dissipator Pool Length         40       Lsmin =       3Wo =       30 ft         41       Lb =       15hs =       9.08 ft       Total Pool Length         42       Lb =       15hs =       9.08 ft       Total Pool Length         44       La =       10 ft       Apron Length         44       La =       10 ft       Maintaining channel bottom depth         46       Vib =       10 ft       maintaining channel bottom depth         47       4) Assess need for downstream riprap due to TW/ye >0.74       Image: State  |  | -            |                   |               | scour denth      | h                  |                      |                                       |  |                |           |  |
| 37       38       3) Size the basin         39       Ls = 10*hs = 6.06 ft       Dissipator Pool Length         40       Lsmin = 3Wo = 30 ft         41       41         42       Lb = 15hs = 9.08 ft       Total Pool Length         43       Lbmin = 4Wo = 40 ft         44       La = 10 ft       Apron Length         45       Wb = 10 ft       maintaining channel bottom depth         46       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_a W_a$ 50       A = 5.8       5.8         51       De = 2.72 $De = 2.72$ 52       S       2.64 specific gravity of rock $D_{s0} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 55 $V/Vv$ (Fig.       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15  |  |              |                   |               |                  | 1                  |                      |                                       |  |                |           |  |
| 38       3) Size the basin         39       Ls = 10*hs = 6.06 ft       Dissipator Pool Length         40       Lsmin = 3Wo =       30 ft         41       42       Lb = 15hs = 9.08 ft       Total Pool Length         43       Lbmin = 4Wo =       40 ft         44       La =       10 ft       Apron Length         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3 $A = 5.8$ 51       De =       2.72         52       Se = 2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 53       Rock size for riprap after energy dissipators - Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       VI/Vo (Fig.       D50 (ft)         57       3.679857       10       0.95       11.4475         58       7.359714       20       0.75       9.0375         59       11.03957       30       0.5       6.025         60       14.71943       40       0.4       4.82 <t< td=""><td></td><td>13/00/</td><td>2.722024</td><td>-2.0</td><td>UN</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>  |  | 13/00/       | 2.722024          | -2.0          | UN               |                    |                      |                                       |  |                |           |  |
| 39       Ls =       10*hs =       6.06 ft       Dissipator Pool Length         40       Lsmin =       3Wo =       30 ft         41  |  | 3) Siza tha  | basin             |               |                  |                    |                      |                                       |  |                |           |  |
| 40       Lsmin = 3Wo =       30 ft         41       42       Lb =       15hs =       9.08 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft       44         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3       49         49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o^2$ 50       A =       5.8         51       De =       2.72         52       53       Rock size for riprap after energy dissipators - Equation 10.6         54       S =       2.64 specific gravity of rock         55       55 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.65         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15 <td></td> <td>•</td> <td></td> <td>6.00</td> <td>: <b>f</b>+</td> <td>Dissinctor</td> <td>Dool Longet</td> <td></td> <td></td> <td></td> <td></td>   |  | •            |                   | 6.00          | : <b>f</b> +     | Dissinctor         | Dool Longet          |                                       |  |                |           |  |
| 41         42       Lb =       15hs =       9.08 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft         43       Lbmin =       4Wo =       40 ft         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3       49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50       A =       5.8       51       De =       2.72         52       53       Rock size for riprap after energy dissipators - Equation 10.6 $D_{s0} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15   |  |              |                   |               |                  | ussipator I        | -001 Length          |                                       |  |                |           |  |
| 42       Lb =       15hs =       9.08 ft       Total Pool Length         43       Lbmin =       4Wo =       40 ft         44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3       40       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_c^2}{4} = y_o W_o$ 50       A =       5.8       51       De =       2.72         52       53       Rock size for riprap after energy dissipators - Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       VI/Vo (Fig.       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15   |  | Lsmin =      | 3000 =            | 30            | i it             |                    |                      |                                       |  |                |           |  |
| 43       Lbmin = 4Wo = 40 ft         44       La = 10 ft       Apron Length         45       Wb = 10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3 $A = \frac{\pi D_c^2}{4} = y_o W_o$ 50       A = 5.8 $A = 5.8$ 51       De = 2.72 $A = \frac{\pi D_c^2}{4} = y_o W_o$ 52       S       Rock size for riprap after energy dissipators - Equation 10.6         54       S = 2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15  |  |              | 4 5 1 .           |               |                  | <b>- -</b>         |                      |                                       |  |                |           |  |
| 44       La =       10 ft       Apron Length         45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3 $A = 5.8$ 49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_c^2}{4} = y_o W_o$ 50 $A = 5.8$ $De = 2.72$ 52       Bock size for riprap after energy dissipators - Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 53       Rock size for riprap after energy dissipators - Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15   |  |              |                   |               |                  | i otal Pool I      | ength                |                                       |  |                |           |  |
| 45       Wb =       10 ft       maintaining channel bottom depth         46       47       4) Assess need for downstream riprap due to TW/ye >0.74         48       Using Figure 10.3 $A = \frac{\pi D_e^2}{4} = y_o W_o$ 49       Compute equivalent circular diameter, De, for brink area $A = \frac{\pi D_e^2}{4} = y_o W_o$ 50       A =       5.8         51       De =       2.72         52       S       Cock size for riprap after energy dissipators - Equation 10.6         54       S =       2.64 specific gravity of rock         55 $D_{50} = \frac{0.692}{S-1} \left( \frac{V^2}{2g} \right)$ 56       L/De       L (ft)       10.3)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| $\frac{46}{47}$ 4) Assess need for downstream riprap due to TW/ye >0.74 $\frac{48}{49}$ Using Figure 10.3 $\frac{49}{50}$ Compute equivalent circular diameter, De, for brink area $50$ $A = 5.8$ $51$ $De = 2.72$ $52$ $Be = 2.72$ $53$ Rock size for riprap after energy dissipators - Equation 10.6 $54$ $S = 2.64$ specific gravity of rock $55$ $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ $56$ $L/De$ $L$ (ft) $10.33$ VI (ft/s) $57$ $3.679857$ $10$ $0.95$ $58$ $7.359714$ $20$ $0.75$ $9.0375$ $0.53$ $59$ $11.03957$ $30$ $0.5$ $6.025$ $0.24$ $60$ $14.71943$ $40$ $0.4$ $4.82$ $0.15$   |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 474) Assess need for downstream riprap due to TW/ye >0.7448Using Figure 10.349Compute equivalent circular diameter, De, for brink area50A =51De =522.72525354S =552.64 specific gravity of rock56L/DeL (ft)573.6798575911.039575911.039575911.03957500.535911.039575011.039575011.0395750   |  | Wb =         | 10                | ft            | maintaining      | channel bo         | ottom depth          |                                       |  |                |           |  |
| 48<br>49<br>50<br>50<br>51<br>52<br>52<br>53<br>54<br>55Using Figure 10.3<br>Compute equivalent circular diameter, De, for brink area<br>5.8<br>De = 5.8<br>52<br>53<br>54<br>55 $A = 5.8$<br>5.7<br>56 $A = 2.72$<br>$A = 2.72$ 53<br>54<br>55Be = 2.72<br>2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 54<br>55S = 2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56<br>57L/De<br>56L/De<br>1.03957VI/Vo (Fig.<br>10.0395759<br>5911.039570.550.5359<br>5911.03957300.560<br>5914.71943400.44.820.150.15  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 49       Compute equivalent circular diameter, De, for brink area $A = \frac{D_e}{4} = y_o W_o$ 50       A = 5.8         51       De = 2.72         52       Rock size for riprap after energy dissipators - Equation 10.6         54       S = 2.64 specific gravity of rock         56       L/De       L (ft)         57       3.679857       10       0.95         58       7.359714       20       0.75         59       11.03957       30       0.5         60       14.71943       40       0.4  |  |              |                   | wnstream rip  | rap due to T     | W/ye >0.74         |                      |                                       |  |                |           |  |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$   |  |              |                   |               |                  |                    | $\pi D^2$            |                                       |  |                |           |  |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$   |  |              |                   | ircular diame | ter, De, for b   | rink area          | $A = \frac{nD_e}{n}$ | $-= y_{1}W_{1}$                       |  |                |           |  |
| 51       De =       2.72         52       53       Rock size for riprap after energy dissipators - Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 53       S =       2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15   |  | •            | •                 |               |                  |                    | 4                    | 20.0                                  |  |                |           |  |
| 52       S       Rock size for riprap after energy dissipators - Equation 10.6 $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 54       S =       2.64 specific gravity of rock $D_{50} = \frac{0.692}{S-1} \left(\frac{V^2}{2g}\right)$ 56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15   |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 53       Rock size for riprap after energy dissipators - Equation 10.6         54       S =       2.64 specific gravity of rock         55       VI/Vo (Fig.         56       L/De       L (ft)       10.3)       VI (ft/s)       D50 (ft)         57       3.679857       10       0.95       11.4475       0.86         58       7.359714       20       0.75       9.0375       0.53         59       11.03957       30       0.5       6.025       0.24         60       14.71943       40       0.4       4.82       0.15  |  | -            |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 55         VI/Vo (Fig.           56         L/De         L (ft)         10.3)         VI (ft/s)         D50 (ft)           57         3.679857         10         0.95         11.4475         0.86           58         7.359714         20         0.75         9.0375         0.53           59         11.03957         30         0.5         6.025         0.24           60         14.71943         40         0.4         4.82         0.15  |  | Rock size f  | or rinran of      | ter enerav di | ssinatore - E    | ouation 10 4       | 3 0                  | $692 (V^2)$                           |  |                |           |  |
| 55         VI/Vo (Fig.           56         L/De         L (ft)         10.3)         VI (ft/s)         D50 (ft)           57         3.679857         10         0.95         11.4475         0.86           58         7.359714         20         0.75         9.0375         0.53           59         11.03957         30         0.5         6.025         0.24           60         14.71943         40         0.4         4.82         0.15  |  |              |                   |               |                  | 40000110.0         | $D_{50} = -$         |                                       |  |                |           |  |
| 56         L/De         L (ft)         10.3)         VI (ft/s)         D50 (ft)           57         3.679857         10         0.95         11.4475         0.86           58         7.359714         20         0.75         9.0375         0.53           59         11.03957         30         0.5         6.025         0.24           60         14.71943         40         0.4         4.82         0.15   |  | 0 -          | 2.04              | specific yrav | INCY OF TOOK     |                    |                      | S-1 (2g)                              | Л  |                |           |  |
| 56         L/De         L (ft)         10.3         VI (ft/s)         D50 (ft)           57         3.679857         10         0.95         11.4475         0.86           58         7.359714         20         0.75         9.0375         0.53           59         11.03957         30         0.5         6.025         0.24           60         14.71943         40         0.4         4.82         0.15  |  |              |                   |               | T                | 1                  |                      | · · · · · · · · · · · · · · · · · · · | <u> </u>                                 |                |           |  |
| 573.679857100.9511.44750.86587.359714200.759.03750.535911.03957300.56.0250.246014.71943400.44.820.15  | 50   | L /D -       | 1 /4->            |               |                  |                    |                      |                                       |  |                |           |  |
| 587.359714200.759.03750.535911.03957300.56.0250.246014.71943400.44.820.15   |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 59         11.03957         30         0.5         6.025         0.24           60         14.71943         40         0.4         4.82         0.15  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 60 14.71943 40 0.4 4.82 0.15  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
|   |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
| 61 17.29533 47 0.36 4.338 0.12 Riprap placement required for 47 ft from brink.  |  |              |                   |               |                  |                    |                      |                                       |  |                |           |  |
|   | 61   | 17.29533     | 47                | 0.36          | 4.338            | 0.12               | Rip                  | rap placem                            | ent required                             | l for 47 ft fr | om brink. |  |

## Cholla Ash Monofill Riprap Basin Sizing and Hydraulic Jump Offsite Drop Structure Channel Section 6

|  |              |                       |   |                       | op Structure          | 0.10.110.0   | bollon o            |   |                      |                           |  |
|--|--------------|-----------------------|---|-----------------------|-----------------------|--------------|---------------------|---|----------------------|---------------------------|--|
|  | A            | В                     | С   | D                     | E                     | F            | G                   | Н   | I                    | J                         |  |
| 62   | Hydraulic    | Jump                  |   |                       |                       | -            | -                   |   |                      |                           |  |
| 63   | From Drair   | age Desigr            | Manual for  | Maricopa C            | ounty, Hydr           | aulics: Hydi | aulic Struct        | ures, 2003  |                      |                           |  |
|  | Y1 =         | 0.58                  |   |                       | normal dept           |              |                     |   |                      |                           |  |
| 65   | Ydn =        | 1.36                  | ft  |                       | am normal             |              |                     |   |                      |                           |  |
| 66   | Q =          |                       | cfs   |                       | gh the drop           |              |                     |   |                      |                           |  |
|  | g =          |                       | ft/s2   |                       | gir the drop          |              |                     |   |                      |                           |  |
|  | A1 =         | 6.64                  |   | area of flo           | w through th          | ne dron      |                     |   |                      |                           |  |
|  | A2 =         | 18.22                 |   |                       | w in next se          |              |                     |   |                      |                           |  |
|  | z =          | 2.5                   |   | sideslope             |                       |              |                     |   |                      |                           |  |
|  | 2 =<br>b =   | 2.0                   |   | •                     | th of chann           | a.           | (1) A               | $\langle \widehat{2} \rangle = \langle \widehat{1} \rangle$ | В                    | (2)                       |  |
| 72   | – u          | 10                    | 11  | DOLION WIL            |                       |              | 1                   | V1 V1   |                      | T 1/2                     |  |
|  |              |                       |   |                       |                       | 4            | 105                 | . V2 Y2 +   |                      | V2 TW +                   |  |
|  |              |                       | eight of jump   | ο.                    |                       |              | / ┝───L-            | +   |                      |                           |  |
| 14   |              |                       |   |                       |                       |              |                     |   |                      |                           |  |
| 75   |              | $Y_{2} = \frac{1}{2}$ | $Y_{\rm I} \left  \left( 1 + 8F_{r1}^2 \right) \right $ | $)\bar{2} - 1$        |                       |              | X 3 J               | - y <sub>2</sub>  |                      |                           |  |
| 76   |              | 2                     | -1 (- · · · - r   | / -                   |                       | ¥1           |                     |   |                      | <b>-</b><br>₩ <del></del> |  |
| 77   |              | L                     |   | ]                     |                       |              | *                   | $\overline{v_2}$  | ¢                    | $\overline{V_2}$          |  |
|  | Y2 =         | 2.15                  | ft  | OK                    | height of ju          | imp          |                     | ו   | D                    | <  ]                      |  |
| 79   |              |                       |   |                       |                       | L            | Figure 6.10. Hydrau | lic Jump Types Stoping                                      | Channels (Bradley, 1 | 961)                      |  |
|  |              |                       | equant heigh  | t of jump.            |                       |              |                     |   |                      |                           |  |
|  | Use Fig. 7-  |                       |   |                       |                       |              |                     |   |                      |                           |  |
| 82   | Г            |                       | V=  | 12.05                 | ft/s                  |              |                     |   |                      |                           |  |
|  | Fr1 =        | <u></u>               | top width =   | 12.90                 | ft                    |              |                     |   |                      |                           |  |
| 84   |              | $\sqrt{gy_m}$         | ym =  | 0.51                  | ft                    | = flow are   | a / top width       | ł   |                      |                           |  |
| 85   |              | <b>V</b> 85 m         | Fr1 =   | 2.96                  |                       |              |                     |   |                      |                           |  |
| 86   |              |                       |   |                       |                       | -            |                     |   |                      |                           |  |
| 87   | J = Y2 / Y1  |                       |   | t = b/(zy1)           |                       |              |                     |   |                      |                           |  |
| 88   | J =          | 3.5                   |   | t =                   | 6.90                  |              |                     |   |                      |                           |  |
| 89   | Y2 =         | 2.03                  | ft  | use larger            | height of ju          | mp           |                     |   |                      |                           |  |
| 90   |              |                       |   | 0                     | 0 ,                   | •            |                     |   |                      |                           |  |
| 91   | 1) Calculate | e depth at b          | eginning loc  | ation of jum          | p.                    |              |                     |   |                      |                           |  |
|  | Equation 7.  |                       |   |                       |                       |              |                     |   |                      |                           |  |
| 93   |              | $ZY_1^{3}$            | $ZY_1^+ \perp Q$  | $-\frac{ZY_2^3}{2}+b$ | $PY_2^2 \downarrow Q$ |              |                     |   |                      |                           |  |
| 94   |              | 3                     | $\frac{1}{2} \int \frac{1}{gA}$                         | 3                     | $3 + \frac{1}{gA_2}$  |              |                     |   |                      |                           |  |
| 95   |              |                       | 0-1   | -                     | 02                    |              |                     |   |                      |                           |  |
|  | Leq =        | 0.957                 | Reg =   | 0.959                 | (Plua in v            | values for Y | 2 until both        | sides equal)  |                      |                           |  |
| the state of the s | Yb =         | 0.47                  |   | OK                    | depth at ju           |              |                     |   |                      |                           |  |
| 98   |              |                       |   |                       | 1 <b>)</b>            |              |                     |   |                      |                           |  |
|  | 4) Calculate | e lenath of i         | ump.  |                       |                       |              |                     |   |                      |                           |  |
|  | Use Fig. 7-  |                       |   |                       |                       |              |                     |   |                      |                           |  |
|  | Lj / y1 =    | 55                    |   |                       |                       |              |                     |   |                      |                           |  |
|  | Lj =         | 31.9                  | ft  | = jump len            | ath                   |              |                     |   |                      |                           |  |
| 102  | -,           | 01.0                  |   | Jamp Ion              | 9                     |              |                     |   |                      |                           |  |
| 103  | Therefore    | Min Lenc              | th of jump =  | 32                    | ft                    |              |                     |   |                      |                           |  |
| 105  | mereiule     | -                     | h of apron =  | 32<br>10              |                       |              |                     |   |                      |                           |  |
| 105  |              |                       | th of basin =   | 42                    |                       |              |                     |   |                      |                           |  |
| 100  |              |                       |   | 42<br>47              |                       | (from briel) | of dran)            |   |                      |                           |  |
| 107  | TOTALLE      | ngui or requ          | uired riprap=   | 4/                    | п                     | (from brink  | or arop)            |   |                      |                           |  |
|  |              |                       |   |                       |                       |              |                     |   |                      |                           |  |

|              |   |   |                                  | Riprap                     | Cholla Ash<br>Sloping Drop<br>Sizing and Hydra | Structure                                | Formulas              |                           |              |       |
|--------------|---|---|----------------------------------|----------------------------|--|--|-----------------------|---------------------------|--------------|-------|
|              | A   | В   |                                  | С                          | D  | E  | F                     |                           | G            |       |
|              | Riprap Basin Sizing                         |   |                                  |                            |  |  |                       |                           |              | ,     |
| 2            | Q=  | 00  |                                  |                            |  |  |                       |                           |              |       |
| 4            | Vallow=                                     | 80<br>4.39  | •                                | cfs                        |  |  | ust before brink of d | rop                       |              |       |
| 5            | TW=   | 1.36  |                                  | ft/s                       | velocity for s                                 |  |                       |                           |              |       |
| 6            | Wo=   | 10  |                                  | ft                         |  |  | n 5, past drop        |                           |              |       |
| 7            | 100-  | 10  |                                  | ft                         | channel bott                                   | om w                                     |                       |                           |              |       |
| 8<br>9<br>10 | 1) Get intial velocity (∨                   | c Design of Energy Dissipators for Culverts<br>/o), depth (yo), and Froude Number (Fr) for  | and Channels,<br>brink condition | July 2006<br>s             |  |  |                       |                           |              |       |
|              | From Flowmaster outp                        |   |                                  |                            |  |  |                       |                           |              |       |
|              | yo= ye=                                     | 0.58  |                                  | ft                         | normal depth                                   |  |                       |                           |              |       |
|              | Vo=<br>Fr=                                  | 12.05   |                                  | ft/s                       | velocity for d                                 |  |                       |                           |              |       |
| 14           |   | 2.96  |                                  |                            | Froude num                                     | ber for drop                             |                       |                           |              |       |
|              | 2) Select trial D50 and                     | obtain hs/ye from Equation 10.1.  |                                  |                            | ſ  |  |                       |                           |              |       |
|              | Equation 10.1 $\frac{h_s}{y_e}$ =           | $= 0.86 \left(\frac{D_{50}}{y_e}\right)^{-0.55} \left(\frac{V_o}{\sqrt{gy_e}}\right) - C_o$ |                                  |                            |  | y <sub>o</sub> =y <sub>e</sub><br>⊢===== |                       |                           |              | CHANN |
| 22           | Get tailwater paramete                      |   |                                  |                            |  | ye ye                                    |                       | <u>.</u>                  |              | VB    |
| 23           |   | 1.4   |                                  | if TM/wo <                 | 0.75   | - A                                      |                       | -OF                       |              |       |
|              |   | =4*B5/B12-1.6   |                                  | if TW/ye <<br>if 0.75 < TV |  | ≯<br>3 d <sub>50</sub> or 2              |                       |                           |              | 84    |
|              |   | 3   |                                  | if 1.0 < TW                |  | <b>JU</b> -                              | - hax · 205           | ) er 1.5d <sub>-máx</sub> |              |       |
| 26           |   | =B5/B12   |                                  | 11 1.0 - 1 1 1             | ,ye L  |  | Figure 10.1. I        | Profile of F              | Riprap Basin |       |
|              | D50 =                                       | 0.25  |                                  | ft                         | D50 of riprap                                  |  |                       |                           |              |       |
|              | Check to see that hs/D                      | /50 >= 2 and that D50/ye >= 0.1.  |                                  |                            |  |  |                       |                           |              |       |
| 32           |   | =B29/B12  |                                  | >= 0.1                     | ОК   |  |                       |                           |              |       |
| 33           | q =   | 32.2  |                                  | ft/s2                      | UK   |  |                       |                           |              |       |
| 34           |   | =0.86*((B32)^(-0.55))*(B14)-B25   |                                  | 10.52                      |  |  |                       |                           |              |       |
| 35           |   | =B34*B12  |                                  | ft                         | scour depth                                    |  |                       |                           |              |       |
|              | hs/D50 =                                    | =B35/B29  |                                  | >=2.0                      | OK   |  |                       |                           |              |       |
| 37           |   |   |                                  |                            |  |  |                       |                           |              |       |
|              | <ol><li>Size the basin</li></ol>            |   |                                  |                            |  |  |                       |                           |              |       |
|              |   | 10*hs =   |                                  | =10*B35                    | ft   | Dissipa                                  | ator Pool Length      |                           |              |       |
|              | Lsmin =                                     | 3Wo =   |                                  | =3*B6                      | ft   |  | Ŭ                     |                           |              |       |
| 41           |   |   |                                  |                            |  |  |                       |                           |              |       |
|              |   | 15hs =  |                                  | =15*B35                    | ft   | Total P                                  | ool Length            |                           |              |       |
|              |   | 4Wo =   |                                  | =4*B6                      | ft   |  |                       |                           |              |       |
|              |   | =C43-C40  |                                  | ft                         | Apron Length                                   |  |                       |                           |              |       |
| 45           | Wb =  | 10  |                                  | ft                         | maintaining cl                                 | hannel botto                             | om depth              |                           |              |       |
| 47           | 4) Assess need for dow<br>Using Figure 10.3 | vnstream riprap due to TW/ye >0.74 ( <b>for Dr</b>  |                                  |                            | nly)   |  |                       |                           |              |       |
|              |   | cular diameter, De, for brink area  | $A = \frac{\pi D_e^2}{4}$        |                            |  |  |                       |                           |              |       |
| 50           |   | =B5*B12   | $A = -\frac{e}{\Lambda}$         | $= y_o W_o$                |  |  |                       |                           |              |       |
| 51           |   | =(B50*4/PI())^0.5   | L4                               |                            |  |  |                       |                           |              |       |
| 52           |   |   |                                  |                            |  |  |                       |                           |              |       |
|              | Rock size for riprap aft                    |   |                                  |                            |  |  | 0.692(                | $V^2$                     |              |       |
| 54           |   | =165/62.4   |                                  | 000                        | ecific gravity of ro                           | D  | $P_{eo} =$            | <u> </u>                  |              |       |
| 55           |   |   |                                  | spe                        | For gravity of ro                              | JUK                                      | S - 1                 | 2g ]                      |              |       |
| ۰            |   |   |                                  |                            | · · · · · · · · · · · · · · · · · · ·          |  |                       |                           |              |       |

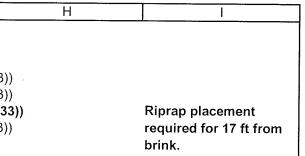
P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Hydraulics\Riprap Basin Sizing-Hydraulic Jump\Riprap Basin Sizing

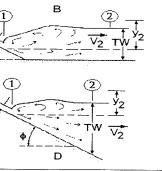


2/13/2009

# Cholla Ash Monofill Sloping Drop Structure

|                   |   | · •   | Ripr                  | ap Sizi          | ng and Hydraulic   | Jump F       | ormulas     |                  |   |                     |
|-------------------|---|---|-----------------------|------------------|--------------------|--------------|-------------|------------------|---|---------------------|
|                   | Α                                       | В   | C                     |                  | D                  | E            |             | F                | G   |                     |
| 56                | L/De                                    | 9   | L (ft)                | o (Fig.<br>10.3) | VI (ft/s           | )<br>D50 (ft | )           |                  |   |                     |
| 57                | =B57/\$B\$51                            | 10  | 0.42                  |                  | =C57*\$B\$13       |              |             | 1))*((D57^2)/(   | 2*'Drop Off-basii                             | n'!\$B\$33))        |
| 58                | =B58/\$B\$51                            | 15  | 0.4                   |                  | =C58*\$B\$13       |              |             |                  | 2*'Drop Off-basii                             |                     |
| 59                | =B59/\$B\$51                            | 17  | 0.38                  |                  | =C59*\$B\$13       |              |             |                  | 2*'Drop Off-bas                               |                     |
|                   | =B60/\$B\$51                            | 20  | 0.3                   |                  | =C60*\$B\$13       |              |             |                  | 2*'Drop Off-basir                             |                     |
| 61                |   |   |                       |                  |                    |              |             |                  |   |                     |
|                   | Hydraulic Jump                          |   |                       |                  |                    |              |             |                  |   |                     |
| 63                | From Drainage Desig                     | n Manual for Maricopa County, Hydraulics: Hydra   | ulic Structures, 2003 |                  |                    |              |             |                  |   |                     |
|                   | Y1 =                                    | 0.58  | ft                    |                  | upstream normal    |              |             |                  |   |                     |
|                   | Ydn =                                   | 1.36  | ft                    |                  | downstream no      |              | oth section | on 5             |   |                     |
|                   | Q =                                     | 80  | cfs                   | 1                | flow through the o | b            |             |                  |   |                     |
| 67                |   | 32.2  | ft/s2                 |                  |                    |              |             |                  |   |                     |
|                   | A1 =                                    | 6.64  | ft2                   |                  | area of flow throu |              |             |                  |   |                     |
|                   | A2 =                                    | 10.43   | ft2                   |                  | area of flow in ne | xt sectio    | n           |                  |   |                     |
|                   | Z =                                     | 2.5   | ft                    |                  | sideslope H:1      |              | Γ           |                  | A   |                     |
| 71<br>72          | b =                                     | 10  | ft                    | ł                | bottom width of c  | hannel       |             | V. (1)           |   | $2 \sim 10^{\circ}$ |
|                   | 2) Coloulate assumed                    | a similar of issues   |                       |                  |                    |              |             |                  | 557   |                     |
| 73                | 2) Calculate sequant I                  | leight of jump.   |                       |                  |                    |              |             |                  | V2  | 2 4/                |
| 74                | Equation 7.2                            | $1 \left[ \left( \begin{array}{c} -x \right)^{\frac{1}{2}} \right]$   |                       |                  |                    |              |             | У <sub>1</sub> ́ | L   | 4                   |
| 75                |   | $Y_{2} = \frac{1}{2}Y_{1} \left[ \left( 1 + 8F_{r1}^{2} \right)^{\frac{1}{2}} - 1 \right]$                    |                       |                  |                    |              |             | V1 (1)           | <b>2</b> 7                                    | $v_1$               |
| 70                |   |   |                       |                  |                    |              |             |                  | 5 ) ' ¥2-                                     | T 📉                 |
|                   | Y2 =                                    |   | <i>c</i> ,            |                  | 214                |              |             | y <sub>1</sub>   | <u>, , , , , , , , , , , , , , , , , , , </u> |                     |
| 79                | 12 -                                    | =0.5*B64*(((1+8*(D85^2))^0.5)-1)  | ft                    | C                | ЭК                 | height       |             |                  | $\overline{V_2}$                              |                     |
|                   | 3) Another check on s                   | equant height of jump.  |                       |                  |                    |              |             |                  | >   | <b>t</b>            |
| 81                | Use Fig. 7-8                            | equalit height of jump.   |                       |                  |                    |              | L           | Figure           | 5.10. Hydraulic Jump T                        | ypes Sloping C      |
| 82                | V                                       |   | V=                    | _                | =B66/B68           | ft/s         |             |                  |   |                     |
|                   | $Fr1 = \left  \frac{V}{\Gamma} \right $ |   | top width             |                  | -800/808           | ft           |             |                  |   |                     |
| 84                | $\sqrt{gy_m}$                           |   | ym =                  |                  | =B68/D83           |              | = flow are  | ea / top width   |   |                     |
| 85                |   |   | Fr1 =                 |                  | =D82/SQRT(B67*     |              | now are     |                  |   |                     |
| 84<br>85<br>86    |   |   | , , , ,               |                  |                    | 504/         |             |                  |   |                     |
| 87                | J = Y2 / Y1                             |   |                       | t                | = b/(zy1)          |              |             |                  |   |                     |
| 88 .              |   | 3.5   |                       |                  | =                  | =B71/(F      | 70*B64)     |                  |   |                     |
| 89                | Y2 =                                    | =B88*B64  | ft                    |                  |                    | height c     | ,           |                  |   |                     |
| 90                |   |   |                       | ŭ                |                    |              | . 1200 P    |                  |   |                     |
|                   | 1) Calculate depth at b                 | beginning location of jump.   |                       |                  |                    |              |             |                  |   |                     |
|                   | Equation 7.3                            |   |                       |                  |                    |              |             |                  |   |                     |
| 93                | $ZY_1$                                  | $\frac{3}{2} + \frac{ZY_1^2}{ZY_1} + \frac{Q}{Z} = \frac{ZY_2^3}{ZY_2^3} + \frac{bY_2^2}{ZY_2} + \frac{Q}{Z}$ |                       |                  |                    |              |             |                  |   |                     |
| 94                | 3                                       | $-+\frac{1}{2}+\frac{1}{gA_1}-\frac{1}{3}+\frac{1}{3}+\frac{1}{gA_2}$   |                       |                  |                    |              |             |                  |   |                     |
| 95                | L                                       |   |                       |                  |                    |              |             |                  |   |                     |
| 96 [              | Leq =                                   | =(B70*(B64^3)/3)+(B70*(B64^2)/2)+(B66/(B67*B  | 68)) Req =            | =                | (B70*B97^3/3)+(    | B71*B97      | 7^2/3)+(B   | 66/(B67*B69))    |   | (Plu                |
| 97                | Yb =                                    | 0.44  | ft                    |                  |                    |              | jump loc:   |                  |   | unti                |
| 98                |   |   |                       | •                |                    |              |             |                  |   | unu                 |
|                   | 4) Calculate length of j                | ump.  |                       |                  |                    |              |             |                  |   |                     |
|                   | Jse Fig. 7-9                            |   |                       |                  |                    |              |             |                  |   |                     |
|                   | _j / y1 =                               | 55  |                       |                  |                    |              |             |                  |   |                     |
| 102 l             | _j =                                    | =B101*B64   | ft                    | =                | jump length        |              |             |                  |   |                     |
| 103               |   |   | -                     |                  | ,                  |              |             |                  |   |                     |
| 104               |   | Therefor  | e: Min. Length of jur | np = 3           | 2                  | ft           |             |                  |   |                     |
| 105               |   |   | Min. Length of apr    | •                |                    | ft           |             |                  |   |                     |
| 104<br>105<br>106 |   |   | Total Length of bas   |                  |                    | ft           |             |                  |   |                     |
| L                 |   |   |                       |                  |                    | • •          |             |                  |   |                     |





Channels (Bradley, 1961)

(Plug in values for Y2 until both sides equal)

2/13/2009

# **OFF-SITE CHANNEL**

# **CULVERT AND WEIR CALCULATIONS**

P:\WRES\Arizona\_Public\_Service\23445548\_Cholla\_Ash Monofill APP\Channel Design\Report\Draft Drainage Report.doc

## EXHIBIT 4.7-2

## URS

## CALCULATION COVER SHEET

| Client: Arizona P  | ublic Service                        | Project Name:        | Cholla Ash Monofill |
|--|--------------------------------------|----------------------|---------------------|
| Project/Calculation  | Number: 23445548                     |                      |                     |
| Title: Weir Equat  | ion Calculation                      |                      |                     |
| Total Number of Pa   | ges (including cover sheet): _6      |                      |                     |
| Total Number of Co   | omputer Runs:                        |                      |                     |
|  | chelle C. West, EIT                  |                      | Date: 2/12/09       |
|  |                                      |                      | Date:               |
| drainage channel.<br>The inputs were cale<br>Design Basis/Refere | ned as broad crested and have a weir | ched.                |                     |
| Remarks/Conclusion<br>See attached printou<br>Calculation Approv | its.                                 |                      |                     |
|  |                                      | Project Manager/Date | e                   |
| Revision No.:  | Description of Revision:             | A                    | pproved by:         |
|  |                                      | Project Manager/I    | Date                |

|  | <b>A</b>           | Page _ 2 of _ 6 |
|--|--------------------|-----------------|
|  | Project No23445548 | Sheet of        |
| Description Weir Calculation - Offsite | Computed by MCW    | Date 2-12-09    |
|  | Checked by         | Date            |

Reference

Weir 1 (Nor the Weir) elevation - 5081 ft  
Depth = 1.07 ft = H  
Length = 20 ft = L  
Weir Coefficient (Broad (rested Weir) = 2.7 = 0  

$$Q = C \times L \times (H)^{3/2} = 2.7 (20) (1.07)^{3/2}$$
  
 $Q = 59.8 cfs$   
 $Q = 60 cfs$ 

Weir 2 (South Weir) elevation - 5076.03, ft Depth = 0.96 ft = H Length = 20 ft = L Weir Coeff. = d.7 = C $Q = 2.7 (20) (0.96)^{3/2} = 50.8 cfs$  $Q \cong 51 cfs$ 

- Inputs from Culvert master

# **Culvert Designer/Analyzer Report** South Culvert (Sta. 7+50 to 8+00)

| Analysis Co       | omponent                             |                  |                    |                  |           |
|-------------------|--------------------------------------|------------------|--------------------|------------------|-----------|
| Storm Eve         | nt                                   | Design E         | )ischarge          |                  | 25.00 cfs |
| Peak Disch        | narge Method: User-Sp                | pecified         |                    |                  |           |
| Design Dis        | charge                               | 25.00 cfs C      | heck Dischar       | ge               | 25.00 cfs |
| Tailwater C       | conditions: Constant Ta              | ailwater         |                    |                  |           |
| Tailwater E       | Elevation                            | N/A ft           |                    |                  |           |
| Name              | Description                          | Discharge        | HW Elev.           | Velocity         |           |
| Culvert-1<br>Weir | 1-30 inch Circular<br>Not Considered | 25.00 cfs<br>N/A | 5,076.99 ft<br>N/A | 7.01 ft/s<br>N/A |           |

# Culvert Designer/Analyzer Report South Culvert (Sta. 7+50 to 8+00)

Component:Culvert-1

| Culvert Summary           |              |      |                        |                |       |
|---------------------------|--------------|------|------------------------|----------------|-------|
| Computed Headwater Eleva  | 5,076.99     | ft   | Discharge              | 25.00          | cfs   |
| Inlet Control HW Elev.    | 5,076.47     | ft   | Tailwater Elevation    | N/A            | ft    |
| Outlet Control HW Elev.   | 5,076.99     | ft   | Control Type           | Outlet Control |       |
| Headwater Depth/Height    | 1.27         |      | · ·                    |                |       |
| Grades                    |              |      |                        |                |       |
| Upstream Invert           | 5,073.80     | ft   | Downstream Invert      | 5,073.70       | ft    |
| Length                    | 50.00        | ft   | Constructed Slope      | 0.002000       | ft/ft |
| Hydraulic Profile         |              |      |                        |                |       |
| Profile CompositeM2Pre    | ssureProfile |      | Depth, Downstream      | 1.70           | ft    |
| Slope Type                | Mild         |      | Normal Depth           | N/A            | ft    |
| Flow Regime               | Subcritical  |      | Critical Depth         | 1.70           | ft    |
| Velocity Downstream       | 7.01         | ft/s | Critical Slope         | 0.019391       | ft/ft |
| Section                   |              |      |                        |                |       |
| Section Shape             | Circular     |      | Mannings Coefficient   | 0.024          |       |
| Section Material          | CMP          |      | Span                   | 2.50           | ft    |
| Section Size              | 30 inch      |      | Rise                   | 2.50           | ft    |
| Number Sections           | 1            |      |                        |                |       |
| Outlet Control Properties |              |      |                        |                |       |
| Outlet Control HW Elev.   | 5,076.99     | ft   | Upstream Velocity Head | 0.40           | ft    |
| Ke                        | 0.50         |      | Entrance Loss          | 0.20           | ft    |
| Inlet Control Properties  |              |      |                        |                |       |
| Inlet Control HW Elev.    | 5,076.47     | ft   | Flow Control           | Unsubmerged    |       |
| Inlet Type                | Headwall     |      | Area Full              | 4.9            | ft²   |
| К                         | 0.00780      |      | HDS 5 Chart            | 2              |       |
| M                         | 2.00000      |      | HDS 5 Scale            | 1              |       |
| C                         | 0.03790      |      | Equation Form          | 1              |       |
| Y                         | 0.69000      |      |                        |                |       |

## Culvert Designer/Analyzer Report North Culvert (Sta. 11+00 to 11+50)

| Analysis C        | omponent                          |                        |                  |                       |           |
|-------------------|-----------------------------------|------------------------|------------------|-----------------------|-----------|
| Storm Eve         | nt                                | Design [               | Design Discharge |                       | 80.00 cfs |
|                   |                                   |                        |                  |                       |           |
| Peak Disch        | arge Method: User-S               | pecified               |                  |                       |           |
| Design Dis        | charge                            | 80.00 cfs (            | Check Dischar    | ge                    | 80.00 cfs |
| Tailwater C       | onditions: Constant T             | ailwater               |                  |                       |           |
| Tailwater E       | Elevation                         | N/A ft                 |                  |                       |           |
|                   |                                   |                        |                  |                       |           |
| Name              | Description                       | Discharge              | HW Elev.         | Velocity              |           |
| Name<br>Culvert-1 | Description<br>2-30 inch Circular | Discharge<br>80.00 cfs |                  | Velocity<br>8.98 ft/s |           |

# Culvert Designer/Analyzer Report North Culvert (Sta. 11+00 to 11+50)

Component:Culvert-1

| Culvert Summary               |              |      |  |                |       |
|-------------------------------|--------------|------|--|----------------|-------|
| Computed Headwater Eleva      | 5,082.07     | ft   | Discharge                              | 80.00          | cfs   |
| Inlet Control HW Elev.        | 5,081.82     | ft   | Tailwater Elevation                    | N/A            | ft    |
| Outlet Control HW Elev.       | 5,082.07     | ft   | Control Type                           | Outlet Control |       |
| Headwater Depth/Height        | 1.63         |      |  |                |       |
| Grades                        |              |      |  |                |       |
| Upstream Invert               | 5,078.00     | ft   | Downstream Invert                      | 5,076.93       | ft    |
| Length                        | 50.00        |      | Constructed Slope                      | 0.021400       |       |
| Hydraulic Profile             |              |      | · · · · · · · · · · · · · · · · · · ·  |                |       |
| Profile CompositeM2Pres       | sureProfile  |      | Depth, Downstream                      | 2.13           | ft    |
| Slope Type                    | Mild         |      | Normal Depth                           | N/A            | ft    |
| Flow Regime                   | Subcritical  |      | Critical Depth                         | 2.13           | ft    |
| Velocity Downstream           | 8.98         | ft/s | Critical Slope                         | 0.030441       | ft/ft |
| Section                       |              |      | ······································ |                |       |
| Section Shape                 | Circular     |      | Mannings Coefficient                   | 0.024          |       |
| Section Material              | CMP          |      | Span                                   | 2.50           | ft    |
| Section Size                  | 30 inch      |      | Rise                                   | 2.50           | ft    |
| Number Sections               | 2            |      |  |                | -     |
| Outlet Control Properties     |              |      |  | <u></u>        |       |
| Outlet Control HW Elev.       | 5,082.07     | ft   | Upstream Velocity Head                 | 1.03           | ft    |
| Ke                            | 0.20         |      | Entrance Loss                          | 0.21           | ft    |
| Inlet Control Properties      |              |      | <u></u>                                | ······         |       |
| Inlet Control HW Elev.        | 5.081.82     | ft   | Flow Control                           | N/A            |       |
| Inlet TypeBeveled ring, 45° ( | ,            |      | Area Full                              | 9.8            | ft²   |
| K                             | ,<br>0.00180 |      | HDS 5 Chart                            | 3              |       |
| Μ                             | 2.50000      |      | HDS 5 Scale                            | А              |       |
| С                             | 0.03000      |      | Equation Form                          | 1              |       |
| Y                             | 0.74000      |      |  |                |       |

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