INTRO

PROPOSAL
02/02/10

FEASIBILITY STUDY
03/18/10

PRELIMINARY ENGINEERING REPORT
04/29/10
OVERVIEW

- Roadway Improvement
- Hydrology
- Bridge
- Geotechnical
- Conclusion / Recommendations
Roadway

Ben Shewell
INTRODUCTION

ROADWAY

- Cottonwood Canyon crossing realignment
- Common roadway deficiencies
- Spot improvement procedure
- Cost analysis
- Roadway recommendations
COMMON DEFICIENCIES

ROADWAY

Erosion

Rutting
Spot Improvements

Roadway

- Scarify roadway surface 2 to 6 inches deep
- Apply organic binder
- Mix soil and binder solution
- Lay mixed soil and binder in 2 inch layers
- Compact each layer
- Close road for 1 hour
SPOT IMPROVEMENTS

ROADWAY

Courtesy of: www.volvo.com

Courtesy of: www.volvo.com
ROADWAY

- Roadway Realignment Capital Cost: $40,800
- Spot Improvement Capital Cost: $700
- Spot Improvement 50 Year Life Cycle Cost: $14,200
SUMMARY

- Cottonwood Canyon realignment
- Repair spot deficiencies
HYDROLOGY

Nate Christensen
and
James Hammon
INTRODUCTION

- Hydrologic Analysis - Line & Cottonwood Canyons
  - Stream flow at the road crossing
  - 100-yr floodplain boundary
  - Stream bank stabilization

- Ford Crossing Option

- Global Change Model
HYDROLOGIC ANALYSIS

- Watershed Delineation
  - DEM – Digital Elevation Model
  - WMS 8.2

- Modeling Peak Discharge
  - NOAA Atlas 14 – Dewey Station
  - HEC-HMS
  - 100-yr, 50-yr, 25-yr, 10-yr storm events
HYDROLOGIC ANALYSIS

- Floodplain Boundary
  - DEM
  - HEC-RAS & GIS
  - Wash cross-sections
  - Flow depth and velocity
5 Meter Raster Digital Elevation Model
HYDROLOGIC ANALYSIS

5 Meter Digital Elevation Model
### WATERSHED DELINEATION
#### LINE CANYON

<table>
<thead>
<tr>
<th>Basin ID</th>
<th>Drainage Area (mi²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Canyon</td>
<td></td>
</tr>
<tr>
<td>Upper Basin (11B)</td>
<td>1.76</td>
</tr>
<tr>
<td>Lower Basin (10B)</td>
<td>2.91</td>
</tr>
</tbody>
</table>

The image shows a map of Line Canyon with delineated basins and labels for Upper Basin (11B) and Lower Basin (10B). The map indicates the drainage areas for these basins, with Upper Basin having 1.76 mi² and Lower Basin having 2.91 mi².
HEC-HMS MODEL
LINE CANYON

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Peak Discharge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-yr, 3-hr</td>
<td>1114.3</td>
</tr>
<tr>
<td>50-yr, 3-hr</td>
<td>724.2</td>
</tr>
<tr>
<td>25-yr, 3-hr</td>
<td>447.9</td>
</tr>
<tr>
<td>10-yr, 3-hr</td>
<td>200.3</td>
</tr>
</tbody>
</table>
WASH CROSS-SECTION
LINE CANYON

linecanyon2  Plan: Plan 05  4/12/2010
line canyon crossing

Legend

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WS PF 3</td>
<td></td>
</tr>
<tr>
<td>WS PF 2</td>
<td></td>
</tr>
<tr>
<td>WS PF 1</td>
<td></td>
</tr>
<tr>
<td>WS PF 4</td>
<td></td>
</tr>
<tr>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>Bank Sta</td>
<td></td>
</tr>
</tbody>
</table>

Elevation (ft)

Station (ft)
3D FLOW PROFILE
LINE CANYON

HYDROLOGY
## Floodplain Boundary

**Line Canyon**

<table>
<thead>
<tr>
<th>HEC-RAS 25-year Channel Flow Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Discharge (cfs)</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>449</td>
</tr>
</tbody>
</table>

### 100-yr Floodplain Boundary
STREAM BANK STABILIZATION LINE CANYON

Cost: $5,300
HYDROLOGY

COTTONWOOD CANYON
Basis of Design
COTTONWOOD

- Hydrologic Analysis
- 100-yr flood inundation boundary
- Design culvert for:
  - Overtopping from 100-yr storm discharge
  - Convey 10-yr storm discharge
Watershed Delineation
Cottonwood

- 7040 acres
- 5 Sub-basins
- Less than 2,000 acres

Cottonwood Canyon Watershed
## HEC-HMS Model

### Cottonwood

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Peak Discharge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-yr, 3-hr</td>
<td>2300</td>
</tr>
<tr>
<td>50-yr, 3-hr</td>
<td>1380</td>
</tr>
<tr>
<td>10-yr, 3-hr</td>
<td>350</td>
</tr>
</tbody>
</table>

HMS Model Screen Shot
Defining Floodplain Parameters:
• Conducted Steady Flow simulation with peak discharges

Modeling Culvert
• Selected Location for Culvert
• Input Corrugated Steel Culvert Properties
• Iterated Culvert sizes to Accommodate 10-yr Flows
FLOODPLAIN ANALYSIS
COTTONWOOD

Design Culvert
FLOODPLAIN ANALYSIS
COTTONWOOD

HYDROLOGY

3D Floodplain Plot
Final Floodplain
STREAM BANK STABILIZATION
COTTONWOOD

- Rip-Rap Design Analysis
  - 11 inch Diameter Boulders
  - 72 Cubic Yards Required
  - Upstream and Downstream of Culvert

- Cost
  - $4,300
FORD ALTERNATIVE
COTTONWOOD

- 6 inch Concrete Slab Poured in Place
- 11 yards of Concrete
- $3,500 Installed

Concrete Ford Crossings
Ford Crossing Option:
- Banks need to be graded back
- Easy Installation
- Maintenance after flooding
- Signage required for safety
GLOBAL CHANGE MODEL

- Observe Climate Change
  - Precipitation Data Changes the Stream Discharge
- Investigate on a local level
Global Change Model

- David Meko, University of Arizona, 2006
- Stream Flow Reconstruction from Tree Rings
- Upper Colorado Basin (Lee’s Ferry)
- Flow in the Colorado River was reconstructed for 1,250 years
Colorado River at Lees Ferry, AZ

Reconstructed Annual Flow (http://treeflow.info/upco/images/coloradoleesmekoFig3.png)
GLOBAL CHANGE MODEL

HYDROLOGY

10-year Running Mean (http://treeflow.info/upco/images/coloradoleesmekeoFig4.png)
Mean Annual Flow

Approx. 100 years of gage data
GLOBAL CHANGE MODEL

- Climate Changes in a Cycle
- Design Storm Conservative
- Based on Reconstructed Data:
  - Precipitation will most likely decrease
  - Stream Discharge will decrease
Cottonwood Canyon Bridge

Shane Taggart
CORRUGATED STEEL CULVERT

CONTECH
Basis of Design

- Design Standards
  - AASHTO Bridge Design Specifications
- Design Vehicle
  - HL-93
- Design Service Life
  - 50 yrs
- Functional Capacity
  - 1 vehicular lane – 10-feet
  - Total Width – 12-feet

Figure 5.2: Culvert
Courtesy Wikimedia.org

Culvert [Wikimedia.org]
Corrugated Steel Culvert
- 16’-5” span
- 4’-7” height
- Corrugation 16x6

Design Storm
- 10-year flood, 3 hour
- 100-year flood, 3 hour
COST ANALYSIS

- Capital Cost: $58,400
- 50 Year Life Cycle Cost: $67,400
SUMMARY

- Maintenance
  - Regular
  - 2-year
  - Remove debris

- Proper Signage
  - 10 ft from culvert
  - 50 ft from culvert
Line Canyon Bridge

Carlos Jimenez
RECOMMENDATION

Precast Concrete Culvert (co.delaware.oh.us)
Basis of Design

- AASHTO LRFD Bridge Design, 4th edition

LRFD Bridge Design
(techstreet.com)
BASIS OF DESIGN

- Design Storm
  - 25-yr., 3-hr

- Design Service Life
  - 50-yr

- Design Vehicle
  - HS20-44

HS20 Loading (trhrc.gov)
Overview

- Precast Concrete Culvert
  - 16-ft span
  - 10-ft wide
  - 7-ft rise
- Three sided
- Wing walls
- 2–ft soil overlay

LC BRIDGE

Three Sided Culvert
(Crest Precast Concrete)
COST SUMMARY

LC BRIDGE

- Capital cost: $39,330
- 50 year Life Cycle Cost: $46,377
SUMMARY

- Precast Concrete Culvert
  - 16-ft span
  - 10-ft wide
  - 7-ft rise

- 2-ft soil overlay

- Total Cost = $46,377

Box Culvert (trhrc.gov)
Geotechnical

Conrad Nagel
RECOMMENDATIONS

Precast footing

Geotextile

(homenkobuilders.com) (gcbl.org)
PRECAST FOOTING

(fhwa.dot.gov)
PRECAST FOOTING

- Precast off site
- Transported to site
- Installation

(kalgoorlieconcrete.com)
PRECAST FOOTING

- High standard of quality
- Reduced construction schedule and on-site work
- Curing
- Simplicity

Footing Placement
(genevacapipe.com)
COST ANALYSIS

- Precast Footing Capital Cost: $13,789
Geotextile Fabric

GEOTECH

Filter Fabric Rolls

(myeugene.com)

(facstaff.bucknell.edu)
GEOTECH

- Prevent erosion
- Placement
- Backfilled

Geofabric Placed (discoverwilliamstown.com)
GEOTEXTILE FABRIC

- Easy installation
- Availability
- Long life span
- Low cost

(slvc.vic.gov.au)
COST ANALYSIS

- Geotextile Fabric Capital Cost: $3,978
- Geotextile Life Cycle Cost: $8,508
SUMMARY

- **Precast Footing**
  - 2’ x 4’ x 12’
  - Cost: $13,789

- **Filter Fabric**
  - Placed with Rip-Rap
  - Cost: $8,508

(Millstonehomes.com)

(lawn365.com)
Conclusion

Ada Van Zanten
RECOMMENDATIONS

- Cottonwood Canyon: $147,000
- Line Canyon: $67,500
- Roadway Improvements: $14,200
THANK YOU

Sylvia Torti
Rio Mesa Advisory Board

Steven Burian
Ryan Smith
Pedro Romero
Evert Lawton

Larry Reaveley
Brett Raddon
Elinor Christopher
Jennifer Gibbs