



Mann Road Hydraulic Analysis

Analysis Summary and Road Flooding Remediation Recommendations

Prepared by
Snohomish County Surface Water Management

April 12, 2016

Mann Road Hydraulic Analysis Summary and Road Flooding Remediation Recommendations

❖ Study Purpose and Background

The localized region south of the City of Sultan and south of the Skykomish River is a relatively flat area within the Skykomish River floodplain containing a semi-rural community comprised of a large agricultural footprint and a significant number of single family residential structures. There are numerous side channels and sloughs that cross the area as well as a number of county maintained roads and bridges (Figure 1). For the purpose of this summary this area will be called the Mann Road area.

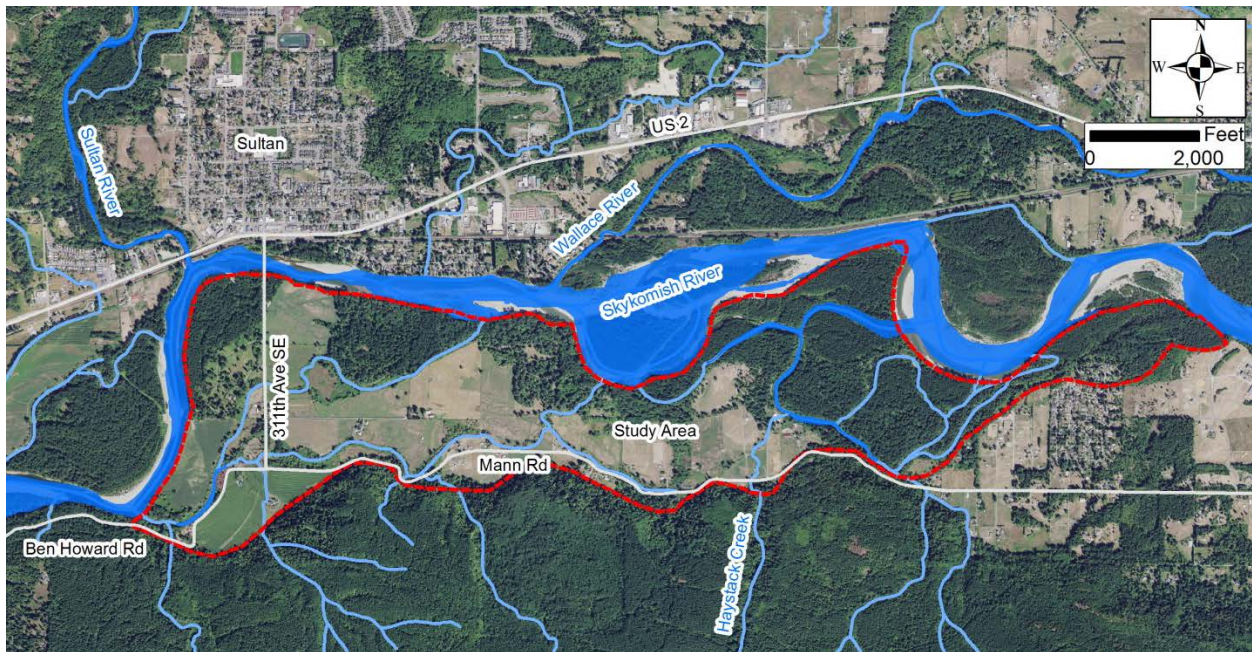


Figure 1: Mann Road Area

The Mann Road area experiences frequent road closures due to chronic inundation resulting from flooding within the Skykomish River floodplain, side channels, and sloughs. These roads are the sole access to the local community and the frequent closures significantly impact commuters, school bus service, maintenance of public infrastructure and utilities, and emergency services.

The frequently recurring road flooding and closures prompted residents to contact Snohomish County council members and County Engineer to voice their concerns and inquire about the county's next steps to address the issues. As a result, an informal public meeting was held on February 13, 2015 with representatives of Snohomish County and the local community in attendance. Discussion at this meeting yielded the following primary concerns as voiced by the community:

- significant flooding of Mann Road near the location known locally as "Devil's Elbow"
- access and safety issues related to the closure of Mann Road due to flooding,
- deterioration of Mann Road, which could be related to underlying flooding issues,

- river flooding along 311th Ave SE, and
- flooding and erosion of private property.

Following the community meeting, Snohomish County officials and subsequently the Snohomish County Surface Water Management Division (SWM) committed to perform an in-depth hydraulic analysis of the area, determine the location, extent, and severity of any road flooding, and conceptualize possible solutions to ease some of the flooding. SWM contracted with northwest hydraulic consultants (nhc) to develop a hydraulic model of the area to aid in evaluating the sources of local flooding, flow thresholds within the area rivers that trigger local road flooding, and the approximate depth and duration of road inundation as it relates to the frequency of runoff events in the area river system. A final report discussing the nhc analysis procedures and results can be found in Appendix A.

In addition to the regional hydraulic analysis, Snohomish County is currently designing a project to address flooding of Mann Road at Haystack Creek. In this location, Haystack Creek is conveyed across Mann Road by twin, corrugated metal culverts which are deteriorated, easily blocked by debris and sediment, and often cause impoundment of water up gradient of the road. Road flooding can occur due to this impoundment of water during large storm events. The current project proposes to replace the existing culverts with a large box culvert and raise an approximately 1200 foot long section of Mann Road. Construction of the project is to be completed summer 2017.

❖ **Study Scope and Methodology**

The hydraulic analysis included a detailed investigation of the Skykomish River left bank floodplain between river miles 12.5 and 17.5. The area is bounded by elevated ground to the south and the Skykomish River to the north. Locally, the Sultan and Wallace Rivers join the Skykomish River from the north and multiple side channels and sloughs diverge from the Skykomish River and bisect the study area (see Figure 1). nhc leveraged the combined 1-dimensional and 2-dimensional flow analysis capabilities of the new HEC-RAS version 5.0 river analysis model (Hydrologic Engineering Center, 2015) to model the connection and interaction between flows in the Skykomish River and the left bank floodplain in the Mann Road area.

The model was constructed using remotely sensed, LiDAR derived topographic information in the floodplain and field surveyed topographic information for the Skykomish River, floodplain side channels, sloughs, bridges, and roads in the study area. The model was calibrated with water surface elevation records for large, historic floods in the Mann Road area and further validated with anecdotal information garnered from long-term residents and direct observation of the timing and flow characteristics of flooding resulting from the Halloween 2015 flood event. Once calibrated and validated, the model was simulated with a steadily increasing Skykomish River discharge to determine the river discharge at which the roads first begin to flood, and when road inundation depths exceed 12 inches (the depth at which Snohomish County typically closes a road).

❖ Study Results

The hydraulic analysis of the Mann Road area resulted in the identification of four locations along the local road network that are sensitive to Skykomish River and side channel flows and first to flood. Figure 2 depicts the four locations. The model showed that the four locations reach incipient overtopping at or less than a 2-year recurrence discharge (approximately 40,800 cfs) within the Skykomish River near Gold Bar. Depths greater than 12 inches occur in the four locations at flows less than a 5-year recurrence interval (approximately 61,700 cfs). The model also showed that the approximate travel time of a flood wave from Gold Bar to the Mann Road area is two hours. Flood discharges in the Skykomish River near Gold Bar are presented in Table 1 while Tables 2 and 3 summarize the discharges in the Skykomish River near Gold Bar when incipient and 12 inch deep inundation occurred at each of the four locations. The discharges shown in Tables 2 and 3 account for the approximately two hour travel time from Gold Bar to the Mann Road area.

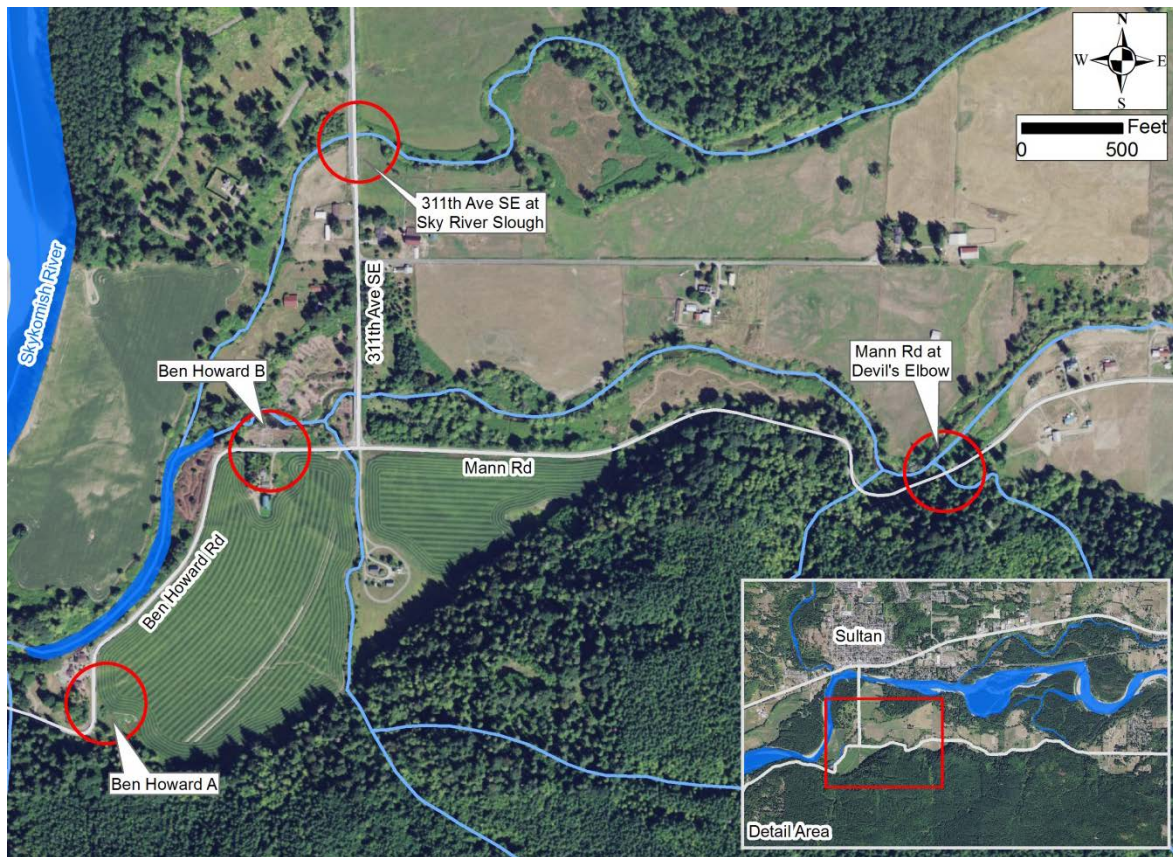


Figure 2: Initial Road Flooding Locations

Table 1: Flood Frequency Flows for the Skykomish River near Gold Bar (nhc, 2015)

Return Period (years)	Discharge (cfs) at Gold Bar Gage
100	123,000
50	108,800
25	94,700
10	76,100
5	61,700
2	40,800
1.01	12,000

Table 2: Discharge Corresponding to Incipient Flooding of Road Crown

Location	Lowest Road Crown Elevation (feet, NAVD 88)	Discharge at Gold Bar Gage (cfs)	Return Period
Devil's Elbow	111.6	32,180	1-2 year
Ben Howard A	106.2	39,980	~2 year
Ben Howard B	106.6	32,180	1-2 year
311 th Ave SE at Sky River Slough	109.1	30,420	1-2 year

Table 3: Discharge Corresponding to 12" Flooding over Road Crown

Location	Lowest Road Crown Elevation (feet, NAVD 88)	Discharge (cfs)	Return Period
Devil's Elbow	111.6	36,270	1-2 year
Ben Howard A	106.2	49,000*	2-5 year
Ben Howard B	106.6	36,270	1-2 year
311 th Ave SE at Sky River Slough	109.1	40,000*	~2 year

*Values derived from constant flow simulation. See nhc final hydraulic modeling report in Appendix A for clarification.

❖ Analysis Discussion

Incipient flooding of the roadways in the Mann Road area occurs at relatively low recurrence intervals (<2 year return period). For the cases of Ben Howard Road sites A and B and Mann Road at Devil's Elbow, the 12 inch deep inundation level is reached with an approximate 4,000 cubic feet per second (cfs) increase in Skykomish River flows from when incipient flooding first occurs. The 12 inch deep inundation level for 311th Ave SE at Sky River Slough is reached when the Skykomish River flows increase above the incipient flooding level flows by approximately 10,000 cfs. The difference in flood level rise and timing between the locations can be attributed to the differing roadway-channel interactions between the sites. Ben Howard Road sites A and B and Mann Road at Devil's Elbow are all located adjacent to a main floodplain slough, South Slough, along the southern boundary of the floodplain. This

type of positioning makes the flooding at these sites very sensitive to the flows in South Slough which conveys water much more readily than the rest of the Skykomish River floodplain. Furthermore, when flooding occurs at each of these locations, flood waters rapidly become too deep to cross but do not spread in area nearly as quickly due to the geometry of each location limiting the amount of road inundation in total linear feet of roadway.

In contrast, 311th Ave SE is a cross-valley road that interacts with flows across the entire floodplain and functions as a hydraulic control on water levels across the entire floodplain. As such, flooding on 311th Ave SE requires a greater increase in Skykomish River and floodplain flows to reach the 12 inch deep inundation level. Similarly, the greater increase of flows required to inundate the road to significant depth also results in much larger overtopping lengths along 311th Ave SE in comparison to the Ben Howard Road and Mann Road flooding sites.

The problem affecting the Mann Road area is based on the relationship of flood events, road closures, and access limitations to residents, service providers, and first responders. Incipient road flooding regularly occurs during Skykomish River flow events having less than a 2-year recurrence interval (approximately 40,800 cfs) and total road inundation occurs when the river experiences a runoff event with a frequency less than the 5-year recurrence interval (approximately 61,700 cfs). The majority of roads in the local area are inundated when Skykomish River flows exceed a 5-year recurrence interval event. As such, elevating the area roads to an elevation where they will never flood is not feasible, but raising them to an elevation that eliminates some of the flooding related to lower level river flows and reducing the amount of inundation time for greater levels of river flow is feasible.

Hydraulic modeling of the Mann Road area predicts incipient flooding to occur in a flow range close to the 30,000 cfs to 40,000 cfs threshold in the Skykomish River at Gold Bar and 12 inch deep inundation to occur within a 36,000 cfs to 49,000 cfs flow range. An analysis of the United States Geological Survey (USGS) Skykomish River gage near Gold Bar was performed to determine the frequency and duration of flows that exceed these levels and quantify the probable amount of road inundation and access limitations in the Mann Road area. Results of this analysis are presented in Table 4.

Table 4: Skykomish River at Gold Bar Flood Frequency and Duration Table*

Discharge (cfs)	Frequency of Events per Year by Discharge (cfs)					
	>35,000	>40,000	>45,000	>50,000	>60,000	>70,000
Total Events (WY 1988- WY 2015)	45	35	25	20	14	9
Avg Events per Year	1.6	1.3	0.9	0.7	0.5	0.3
Avg Days per Year	1.3	0.9	0.7	0.6	0.3	0.2
Avg Hours per Year	30.5	22.3	16.8	13.2	7.2	3.7

*Statistics run on 15-minute records for USGS Gage 12134500, Skykomish River near Gold Bar, WA from Oct. 1, 1987 through Sept. 14, 2015 (28 years). Daily records used when 15-minute records unavailable.

From the USGS gage records it can be shown that as the Skykomish River discharge rate increases, the number of events exceeding that threshold decreases and that the average total hours of exceedance also decreases. Conversely, hydraulic modeling of the area shows that increases in the Skykomish River

discharge rate correlates directly with increasing water surface elevations and inundation depths at the four flooding locations. This relationship lends itself well to a cost-benefit analysis of potential road elevation projects versus reduction of probable access limitations to residents, service providers, and first responders.

❖ **Recommendations**

Potential road elevation projects for Ben Howard Road sites A and B and Mann Road at Devil's Elbow are proposed. An elevation project for 311th Ave SE is not recommended. The exclusion of 311th Ave SE is due to its widespread interaction with flows across the entire floodplain, its hydraulic control of flows within the floodplain, and the fact that raising 311th Ave SE is not necessary to permit access to the Mann Road area once the flooding concerns along Ben Howard are eased as Ben Howard connects to SR 203 west of the Mann Road area and access can be achieved from that direction.

Inundation levels of 12 inches or deeper are predicted to occur at the two Ben Howard Road sites and at Mann Road at Devil's Elbow within the 36,000 cfs to 40,000 cfs Skykomish River flow range. Historically, the Skykomish River at Gold Bar has flows exceeding a 35,000 cfs threshold approximately 1.3 days per water year on average, flows exceeding a 40,000 cfs threshold approximately 0.9 days per water year, and flows exceeding a 45,000 cfs threshold approximately 0.7 days per water year. At the time of writing this analysis summary, there have been 4.9 days exceeding 35,000 cfs, 4.1 days exceeding 40,000 cfs, and 3.4 days exceeding 45,000 cfs in water year 2016 (October 1, 2015-present). For the same time period, Mann Road at Devil's Elbow has been impassable a total of six times, all of which correlate with a Skykomish River flow greater than or equal to 33,000 cfs.

Elevation projects to raise the two Ben Howard Road sites and Mann Road at Devil's Elbow up to an elevation equal to the water surface elevation at each site corresponding to a range of flows in the Skykomish River are proposed for consideration. Tables 5a through 5e below summarize the lowest existing road centerline elevation at each location, the anticipated water surface elevation at each location, average hours per year that the elevated road may be inundated, and the estimated cost of raising the road for each of the analyzed flow thresholds. Cost estimates include construction costs, engineering costs, mitigation costs, and permitting costs. A detailed summary of the cost estimate calculations for each site is presented in Appendix B.

Table 5a: Road Elevation Project Summary (Raising Road to 40,000 cfs Water Level)

Location	Mann Road at Devil's Elbow	Ben Howard A	Ben Howard B	All Sites
Existing Lowest Road Crown Elevation (feet, NAVD88)	111.6	106.2	106.6	-
Average Current Inundation Time (days)	1.2	0.9	1.2	-
Anticipated Water Surface Elevation (40,000 cfs River Discharge)	113.6	106.1	108.3	-
Average Probable Inundation Time (Road Raised to 40,000 cfs River Discharge WSEL*, days)	0.9 ¹	0.9 ²	0.9 ¹	-
Cost to Raise Road to 40,000 cfs River Discharge WSEL*	\$702,000	N/A ³	\$259,000	\$961,000

*: WSEL = Water Surface Elevation

1: 12" inundation depth is reached when river discharge is near 36,000 cfs.

2: Incipient flooding begins when river discharge is near 40,000 cfs.

3: No cost associated with raising Ben Howard A to 40,000 cfs water surface elevation. Site is currently at appropriate elevation.

Table 5b: Road Elevation Project Summary (Raising Road to 45,000 cfs Water Level)

Location	Mann Road at Devil's Elbow	Ben Howard A	Ben Howard B	All Sites
Existing Lowest Road Crown Elevation (feet, NAVD88)	111.6	106.2	106.6	-
Average Current Inundation Time (days)	1.2	0.9	1.2	-
Anticipated Water Surface Elevation (45,000 cfs River Discharge)	114.4	106.8	109.0	-
Average Probable Inundation Time (Road Raised to 45,000 cfs River Discharge WSEL*, days)	0.7	0.7	0.7	-
Cost to Raise Road to 45,000 cfs River Discharge WSEL*	\$761,000	\$251,000	\$314,000	\$1,326,000

*: WSEL = Water Surface Elevation

Table 5c: Road Elevation Project Summary (Raising Road to 50,000 cfs Water Level)

Location	Mann Road at Devil's Elbow	Ben Howard A	Ben Howard B	All Sites
Existing Lowest Road Crown Elevation (feet, NAVD88)	111.6	106.2	106.6	-
Average Current Inundation Time (days)	1.2	0.9	1.2	-
Anticipated Water Surface Elevation (50,000 cfs River Discharge)	115.0	107.3	109.5	-
Average Probable Inundation Time (Road Raised to 50,000 cfs River Discharge WSEL*, days)	0.6	0.6	0.6	-
Cost to Raise Road to 50,000 cfs River Discharge WSEL*	\$865,000	\$284,000	\$457,000	\$1,606,000

*: WSEL = Water Surface Elevation

Table 5d: Road Elevation Project Summary (Raising Road to 60,000 cfs Water Level)

Location	Mann Road at Devil's Elbow	Ben Howard A	Ben Howard B	All Sites
Existing Lowest Road Crown Elevation (feet, NAVD88)	111.6	106.2	106.6	-
Average Current Inundation Time (days)	1.2	0.9	1.2	-
Anticipated Water Surface Elevation (60,000 cfs River Discharge)	116.1	108.3	110.7	-
Average Probable Inundation Time (Road Raised to 60,000 cfs River Discharge WSEL*, days)	0.3	0.3	0.3	-
Cost to Raise Road to 60,000 cfs River Discharge WSEL*. ¹	\$1,090,000	\$347,000	\$556,000	\$1,993,000

*: WSEL = Water Surface Elevation

1: When the river flows reach 60, 000 cfs, two additional areas on Mann Road east of the Devil's Elbow become inundated. The cost to raise these locations is included in the Mann Road at Devil's Elbow estimate.

Table 5e: Road Elevation Project Summary (Raising Road to 70,000 cfs Water Level)

Location	Mann Road at Devil's Elbow	Ben Howard A	Ben Howard B	All Sites
Existing Lowest Road Crown Elevation (feet, NAVD88)	111.6	106.2	106.6	-
Average Current Inundation Time (days)	1.2	0.9	1.2	-
Anticipated Water Surface Elevation (70,000 cfs River Discharge)	117.0	109.2	111.9	-
Average Probable Inundation Time (Road Raised to 70,000 cfs River Discharge WSEL*, days)	0.2	0.2	0.2	-
Cost to Raise Road to 70,000 cfs River Discharge WSEL* ^{1,2}	\$1,513,000	\$405,000	\$942,000	\$2,860,000

*: WSEL = Water Surface Elevation

1: When the river flows reach 70,000 cfs, two additional areas on Mann Road east of the Devil's Elbow become inundated. The cost to raise these locations is included in the Mann Road at Devil's Elbow estimate.

2: When the river flows reach 70,000 cfs, one additional area on Mann Road immediately east of the Mann Road/Ben Howard intersection becomes inundated. The cost to raise this location is included in the Ben Howard B estimate.

Elevation projects to raise the two Ben Howard Road sites and Mann Road at Devil's Elbow up to an elevation equal to the water surface elevation at each site corresponding to a range of flows in the Skykomish River are proposed for consideration; however, raising the flooding sites to the anticipated water surface elevation at each site corresponding with a 50,000 to 60,000 cfs river flow range is recommended. With an anticipated combined design and construction cost ranging from \$1,606,000 to \$1,993,000, raising the two Ben Howard flooding sites and Mann Road at Devil's Elbow to a 50,000 to 60,000 cfs water surface elevation will reduce the average potential inundation time from 1.2 days (28.8 hours) per year to 0.6 days (14.4 hours) per year at the 50,000 cfs water level or 0.3 days (7.2 hours) per year at the 60,000 cfs water level and reduce potential inundation depths by 1.1 to 5.7 feet. This reduction in inundation time and depth will greatly increase access to the Mann Road area for residents, service providers and first responders.

Appendix A: Skykomish River Sloughs Hydraulic Modeling - Final Report (nhc, 2015)

Appendix B: Planning Level Cost Estimates for Road Elevation Projects (Snohomish County, 2016)

Potential Road Elevation Project Summary

Option 1: Raising Roads to the 40,000 cfs Water Level

Site	Flow at Gold Bar Gage (cfs)	Length of Road Raised (ft)	Maximum Road Elevation Increase (ft)	Cost
Mann Road at Devil's Elbow	40,000	485	2	\$702,000
Ben Howard Site A	40,000	N/A*	N/A*	N/A*
Ben Howard Site B	40,000	260	1.7	\$259,000
Total Cost =				\$961,000

*: Project to raise Ben Howard Site A is not proposed. Site is currently at appropriate elevation.

Option 2: Raising Roads to the 45,000 cfs Water Level

Site	Flow at Gold Bar Gage (cfs)	Length of Road Raised (ft)	Maximum Road Elevation Increase (ft)	Cost
Mann Road at Devil's Elbow	45,000	575	2.8	\$ 761,000
Ben Howard Site A	45,000	390	0.5	\$ 251,000
Ben Howard Site B	45,000	380	2.4	\$ 314,000
Total Cost =				\$ 1,326,000

Option 3: Raising Roads to the 50,000 cfs Water Level

Site	Flow at Gold Bar Gage (cfs)	Length of Road Raised (ft)	Maximum Road Elevation Increase (ft)	Cost
Mann Road at Devil's Elbow	50,000	670	4.4	\$ 865,000
Ben Howard Site A	50,000	410	1.1	\$ 284,000
Ben Howard Site B	50,000	620	2.9	\$ 457,000
Total Cost =				\$ 1,606,000

Option 4: Raising Roads to the 60,000 cfs Water Level

Site	Flow at Gold Bar Gage (cfs)	Length of Road Raised (ft)	Maximum Road Elevation Increase (ft)	Cost
Mann Road at Devil's Elbow	60,000	760	5.7	\$ 1,090,000
Ben Howard Site A	60,000	440	2.1	\$ 347,000
Ben Howard Site B	60,000	600	4.1	\$ 556,000
Total Cost =				\$ 1,993,000

Option 5: Raising Roads to the 70,000 cfs Water Level

Site	Flow at Gold Bar Gage (cfs)	Length of Road Raised (ft)	Maximum Road Elevation Increase (ft)	Cost
Mann Road at Devil's Elbow	70,000	1190	5.4	\$ 1,513,000
Ben Howard Site A	70,000	460	3.0	\$ 405,000
Ben Howard Site B	70,000	1420	5.3	\$ 942,000
Total Cost =				\$ 2,860,000

MANN ROAD A (ELBOW) 40K CFS - PLANNING LEVEL COST ESTIMATE				
<i>Scope: Design for 40,000 cfs. Raise 485' of road by 2' max., include a 12' box culvert and two 48" culverts, maintain 22' road width w/reinforced slope headwalls at box culvert and driveway culvert.</i>				
PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		33,000
CLEARING AND GRUBBING	0.20	ACRE	\$10,000.00	2,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	150	C.Y.	\$25.00	3,750
GRAVEL BORROW INCL. HAUL	1,280	TON	\$25.00	32,000
ROADWAY PULVERIZATION AND GRADING	140	S.Y.	\$5.00	700
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
PRECAST REINF. CONC. BOX CULVERT 12 FT.	1	L.S.	\$120,000.00	120,000
CORRUGATED POLYETHYLENE CULV. PIPE 48 IN. DIAM.	110	L.F.	\$200.00	22,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	340	S.F.	\$20.00	6,800
SURFACING				
CRUSHED SURFACING BASE COURSE	500	TON	\$25.00	12,500
CRUSHED SURFACING TOP COURSE	40	TON	\$35.00	1,400
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	450	TON	\$110.00	49,500
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	20	DAY	\$100.00	2,000
TOPSOIL TYPE A	70	C.Y.	\$35.00	2,450
SEEDING, FERTILIZING, AND MULCHING	0.20	ACRE	\$3,000.00	600
EROSION/WATER POLLUTION CONTROL	5,000	L.S.	\$1.00	5,000
HIGH VISIBILITY FENCE	100	L.F.	\$2.00	200
HIGH VISIBILITY SILT FENCE	1,100	L.F.	\$4.00	4,400
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 9 FT. LONG POST	120	L.F.	\$30.00	3,600
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	2	EA	\$2,100.00	4,200
PAINT LINE	1,940	L.F.	\$1.00	1,940
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	20,000	L.S.	\$1.00	20,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
STRUCTURE EXCAVATION CLASS B INCL. HAUL	70	C.Y.	\$15.00	1,050
ROADWAY SURVEYING	1	L.S.	\$9,600.00	9,600
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				363,000
CONTINGENCY			30%	109,000
CONSTRUCTION SUBTOTAL				472,000
PE ENGINEERING @ 20%			20%	94,000
CE ENGINEERING @ 15%			15%	71,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				57,000
ROW ACQUISITION				7,900
Total Project Cost				\$702,000

BEN HOWARD B_40K CFS - PLANNING LEVEL COST ESTIMATE

Scope: Design for 40,000 cfs. Raise 260' length of road by 1.7' max. depth, include a 48" culvert, maintain 22' roadway width w/ reinforced slope at 48" culvert

PROJECT ESTIMATING DATA

PLANNING LEVEL ESTIMATE

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		10,500
CLEARING AND GRUBBING	0.10	ACRE	\$10,000.00	1,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	50	C.Y.	\$25.00	1,250
GRAVEL BORROW INCL. HAUL	260	TON	\$25.00	6,500
ROADWAY PULVERIZATION AND GRADING	140	S.Y.	\$5.00	700
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	40	L.F.	\$50.00	2,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	170	S.F.	\$20.00	3,400
SURFACING				
CRUSHED SURFACING BASE COURSE	300	TON	\$25.00	7,500
CRUSHED SURFACING TOP COURSE	40	TON	\$35.00	1,400
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	240	TON	\$110.00	26,400
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	20	DAY	\$100.00	2,000
TOPSOIL TYPE A	20	C.Y.	\$35.00	700
SEEDING, FERTILIZING, AND MULCHING	0.10	ACRE	\$3,000.00	300
EROSION/WATER POLLUTION CONTROL	5,000	L.S.	\$1.00	5,000
HIGH VISIBILITY FENCE	100	L.F.	\$2.00	200
HIGH VISIBILITY SILT FENCE	600	L.F.	\$4.00	2,400
TRAFFIC				
PLASTIC LINE	1,040	L.F.	\$1.50	1,560
PERMANENT SIGNING	1	L.S.	\$400.00	400
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$15,000.00	15,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
STRUCTURE EXCAVATION CLASS B INCL. HAUL	40	C.Y.	\$15.00	600
ROADWAY SURVEYING	1	L.S.	\$3,000.00	3,000
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				115,000
CONTINGENCY			30%	35,000
CONSTRUCTION SUBTOTAL				150,000
PE ENGINEERING @ 20%			20%	30,000
CE ENGINEERING @ 15%			15%	23,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				50,300
ROW ACQUISITION				5,500
Total Project Cost				\$259,000

MANN ROAD A (ELBOW) 45k CFS - PLANNING LEVEL COST ESTIMATE				
<i>Scope: Design for 45,000 cfs. Raise 575' of road by 2.8' max., include a 12' box culvert and two 48" culverts, maintain 22' road width w/reinforced slope headwalls at box culvert and driveway culvert.</i>				
PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		36,100
CLEARING AND GRUBBING	0.30	ACRE	\$10,000.00	3,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	190	C.Y.	\$25.00	4,750
GRAVEL BORROW INCL. HAUL	1,740	TON	\$25.00	43,500
ROADWAY PULVERIZATION AND GRADING	140	S.Y.	\$5.00	700
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
PRECAST REINF. CONC. BOX CULVERT 12 FT.	1	L.S.	\$120,000.00	120,000
CORRUGATED POLYETHYLENE CULV. PIPE 48 IN. DIAM.	110	L.F.	\$200.00	22,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	440	S.F.	\$20.00	8,800
SURFACING				
CRUSHED SURFACING BASE COURSE	600	TON	\$25.00	15,000
CRUSHED SURFACING TOP COURSE	50	TON	\$35.00	1,750
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	530	TON	\$110.00	58,300
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	20	DAY	\$100.00	2,000
TOPSOIL TYPE A	90	C.Y.	\$35.00	3,150
SEEDING, FERTILIZING, AND MULCHING	0.30	ACRE	\$3,000.00	900
EROSION/WATER POLLUTION CONTROL	5,000	L.S.	\$1.00	5,000
HIGH VISIBILITY FENCE	100	L.F.	\$2.00	200
HIGH VISIBILITY SILT FENCE	1,300	L.F.	\$4.00	5,200
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 9 FT. LONG POST	120	L.F.	\$30.00	3,600
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	2	EA	\$2,100.00	4,200
PAINT LINE	2,300	L.F.	\$1.00	2,300
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	20,000	L.S.	\$1.00	20,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
STRUCTURE EXCAVATION CLASS B INCL. HAUL	100	C.Y.	\$15.00	1,500
ROADWAY SURVEYING	1	L.S.	\$10,500.00	10,500
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				397,000
CONTINGENCY			30%	119,000
CONSTRUCTION SUBTOTAL				516,000
PE ENGINEERING @ 20%			20%	103,000
CE ENGINEERING @ 15%			15%	77,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				57,000
ROW ACQUISITION				7,900
Total Project Cost				\$761,000

BEN HOWARD A_45K CFS - PLANNING LEVEL COST ESTIMATE

Scope: Design for 45,000 cfs. Raise 390' length of road by 0.5' max., maintain 22' roadway width, include two 48" culverts.

PROJECT ESTIMATING DATA**PLANNING LEVEL ESTIMATE**

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		10,700
CLEARING AND GRUBBING	0.10	ACRE	\$10,000.00	1,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	90	C.Y.	\$25.00	2,250
GRAVEL BORROW INCL. HAUL	200	TON	\$25.00	5,000
ROADWAY PULVERIZATION AND GRADING	140	S.Y.	\$5.00	700
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	70	L.F.	\$50.00	3,500
SURFACING				
CRUSHED SURFACING BASE COURSE	400	TON	\$25.00	10,000
CRUSHED SURFACING TOP COURSE	40	TON	\$35.00	1,400
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	260	TON	\$110.00	28,600
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	10	DAY	\$100.00	1,000
TOPSOIL TYPE A	20	C.Y.	\$35.00	700
SEEDING, FERTILIZING, AND MULCHING	0.10	ACRE	\$3,000.00	300
EROSION/WATER POLLUTION CONTROL	5,000	L.S.	\$1.00	5,000
HIGH VISIBILITY FENCE	100	L.F.	\$2.00	200
HIGH VISIBILITY SILT FENCE	900	L.F.	\$4.00	3,600
TRAFFIC				
PLASTIC LINE	1,600	L.F.	\$1.50	2,400
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	14,000	L.S.	\$1.00	14,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
ROADWAY SURVEYING	1	L.S.	\$3,100.00	3,100
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				118,000
CONTINGENCY			30%	35,000
CONSTRUCTION SUBTOTAL				153,000
PE ENGINEERING @ 20%			20%	31,000
CE ENGINEERING @ 15%			15%	23,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING ROW ACQUISITION (PRELIMINARY DETERMINATION NOT NEEDED)				43,500
Total Project Cost				\$251,000

BEN HOWARD B_45K CFS- PLANNING LEVEL COST ESTIMATE

Scope: Design for 45,000 cfs. Raise 380' length of road by 2.4' max. depth, include a 48" culvert, maintain 22' roadway width w/ reinforced slope at 48" culvert

PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		13,400
CLEARING AND GRUBBING	0.10	ACRE	\$10,000.00	1,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	110	C.Y.	\$25.00	2,750
GRAVEL BORROW INCL. HAUL	630	TON	\$25.00	15,750
ROADWAY PULVERIZATION AND GRADING	140	S.Y.	\$5.00	700
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	40	L.F.	\$50.00	2,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	180	S.F.	\$20.00	3,600
SURFACING				
CRUSHED SURFACING BASE COURSE	400	TON	\$25.00	10,000
CRUSHED SURFACING TOP COURSE	40	TON	\$35.00	1,400
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	350	TON	\$110.00	38,500
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	20	DAY	\$100.00	2,000
TOPSOIL TYPE A	40	C.Y.	\$35.00	1,400
SEEDING, FERTILIZING, AND MULCHING	0.10	ACRE	\$3,000.00	300
EROSION/WATER POLLUTION CONTROL	5,000	L.S.	\$1.00	5,000
HIGH VISIBILITY FENCE	100	L.F.	\$2.00	200
HIGH VISIBILITY SILT FENCE	900	L.F.	\$4.00	3,600
TRAFFIC				
PLASTIC LINE	1,520	L.F.	\$1.50	2,280
PERMANENT SIGNING	1	L.S.	\$400.00	400
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$15,000.00	15,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
STRUCTURE EXCAVATION CLASS B INCL. HAUL	40	C.Y.	\$15.00	600
ROADWAY SURVEYING	1	L.S.	\$3,900.00	3,900
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				147,000
CONTINGENCY			30%	44,000
CONSTRUCTION SUBTOTAL				191,000
PE ENGINEERING @ 20%			20%	38,000
CE ENGINEERING @ 15%			15%	29,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				50,300
ROW ACQUISITION				5,500
Total Project Cost				\$314,000

MANN ROAD A (ELBOW) 50k CFS - PLANNING LEVEL COST ESTIMATE				
<i>Scope: Design for 50,000 cfs. Raise 670' of road by 4.4' max., include a 12' box culvert and two 48" culverts, maintain 22' road width w/reinforced slope headwalls at box culvert and driveway culvert.</i>				
PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		40,800
CLEARING AND GRUBBING	0.30	ACRE	\$10,000.00	3,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,400.00	5,400
GRADING				
ROADWAY EXCAVATION INCL. HAUL	230	C.Y.	\$25.00	5,750
GRAVEL BORROW INCL. HAUL	2,550	TON	\$25.00	63,750
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
PRECAST REINF. CONC. BOX CULVERT 12 FT.	1	L.S.	\$120,000.00	120,000
CORRUGATED POLYETHYLENE CULV. PIPE 48 IN. DIAM.	100	L.F.	\$200.00	20,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	610	S.F.	\$20.00	12,200
SURFACING				
CRUSHED SURFACING BASE COURSE	600	TON	\$25.00	15,000
CRUSHED SURFACING TOP COURSE	50	TON	\$35.00	1,750
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	620	TON	\$110.00	68,200
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	15	DAY	\$100.00	1,500
TOPSOIL TYPE A	90	C.Y.	\$35.00	3,150
SEEDING, FERTILIZING, AND MULCHING	0.30	ACRE	\$3,000.00	900
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
HIGH VISIBILITY SILT FENCE	1,480	L.F.	\$4.00	5,920
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 8 FT. LONG POST	360	L.F.	\$30.00	10,800
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	6	EACH	\$2,100.00	12,600
PAINT LINE	2,680	L.F.	\$1.00	2,680
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$18,000.00	18,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
SHORING OR EXTRA EXCAVATION CLASS B	290	S.F.	\$4.00	1,160
ROADWAY SURVEYING	1	L.S.	\$11,900.00	11,900
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				449,000
CONTINGENCY			30%	135,000
CONSTRUCTION SUBTOTAL				584,000
PE ENGINEERING @ 20%			20%	117,000
CE ENGINEERING @ 15%			15%	88,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				68,000
ROW ACQUISITION				8,000
Total Project Cost				\$865,000

BEN HOWARD A_50K CFS - PLANNING LEVEL COST ESTIMATE

Scope: Design for 50,000 cfs. Raise 410' length of road by 1.1' max., maintain 22' roadway width, include two 48" culverts.

PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		12,400
CLEARING AND GRUBBING	0.10	ACRE	\$10,000.00	1,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	70	C.Y.	\$25.00	1,750
GRAVEL BORROW INCL. HAUL	460	TON	\$25.00	11,500
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	70	L.F.	\$50.00	3,500
SURFACING				
CRUSHED SURFACING BASE COURSE	400	TON	\$25.00	10,000
CRUSHED SURFACING TOP COURSE	40	TON	\$35.00	1,400
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	380	TON	\$110.00	41,800
HMA FOR APPROACH CL 1/2 IN PG 64-22	20	TON	\$150.00	3,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	10	DAY	\$100.00	1,000
TOPSOIL TYPE A	40	C.Y.	\$35.00	1,400
SEEDING, FERTILIZING, AND MULCHING	0.10	ACRE	\$3,000.00	300
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
WATTLE	910	L.F.	\$4.00	3,640
TRAFFIC				
PLASTIC LINE	1,640	L.F.	\$1.50	2,460
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$14,000.00	14,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
ROADWAY SURVEYING	1	L.S.	\$3,600.00	3,600
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				136,000
CONTINGENCY			30%	41,000
CONSTRUCTION SUBTOTAL				177,000
PE ENGINEERING @ 20%			20%	35,000
CE ENGINEERING @ 15%			15%	27,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				45,000
ROW ACQUISITION (PRELIMINARY DETERMINATION NOT NEEDED)				
Total Project Cost				\$284,000

BEN HOWARD B_50K CFS- PLANNING LEVEL COST ESTIMATE

Scope: Design for 50,000 cfs. Raise 620' length of road by 2.9' max. depth, include a 48" culvert, maintain 22' roadway width w/ reinforced slope at 48" culvert

PROJECT ESTIMATING DATA

PLANNING LEVEL ESTIMATE

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		20,500
CLEARING AND GRUBBING	0.20	ACRE	\$10,000.00	2,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$12,500.00	12,500
GRADING				
ROADWAY EXCAVATION INCL. HAUL	250	C.Y.	\$25.00	6,250
GRAVEL BORROW INCL. HAUL	1,130	TON	\$25.00	28,250
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	40	L.F.	\$50.00	2,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	200	S.F.	\$20.00	4,000
SURFACING				
CRUSHED SURFACING BASE COURSE	600	TON	\$25.00	15,000
CRUSHED SURFACING TOP COURSE	50	TON	\$35.00	1,750
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	580	TON	\$110.00	63,800
HMA FOR APPROACH CL 1/2 IN PG 64-22	20	TON	\$150.00	3,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	15	DAY	\$100.00	1,500
TOPSOIL TYPE A	60	C.Y.	\$35.00	2,100
SEEDING, FERTILIZING, AND MULCHING	0.20	ACRE	\$3,000.00	600
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
WATTLE	1,370	L.F.	\$4.00	5,480
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 8 FT. LONG POST	280	L.F.	\$30.00	8,400
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	2	EACH	\$2,100.00	4,200
PLASTIC LINE	2,480	L.F.	\$1.50	3,720
PERMANENT SIGNING	1	L.S.	\$400.00	400
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$15,000.00	15,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
SHORING OR EXTRA EXCAVATION CLASS B	290	S.F.	\$4.00	1,160
ROADWAY SURVEYING	1	L.S.	\$6,000.00	6,000
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				225,000
CONTINGENCY			30%	68,000
CONSTRUCTION SUBTOTAL				293,000
PE ENGINEERING @ 20%				59,000
CE ENGINEERING @ 15%				44,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				55,000
ROW ACQUISITION				5,600
Total Project Cost				\$457,000

MANN ROAD A (ELBOW) 60k CFS - PLANNING LEVEL COST ESTIMATE				
Scope: Design for 60,000 cfs. Raise 760' of road by 5.7' max., include a 12' box culvert and two 48" culverts, maintain 22' road width w/reinforced slope headwalls at box culvert and driveway culvert. Two additional sites would also need to be raised due to the flooding extent are included.				
PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		48,200
CLEARING AND GRUBBING	0.40	ACRE	\$10,000.00	4,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$6,600.00	6,600
GRADING				
ROADWAY EXCAVATION INCL. HAUL	180	C.Y.	\$25.00	4,500
GRAVEL BORROW INCL. HAUL	4,290	TON	\$25.00	107,250
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
PRECAST REINF. CONC. BOX CULVERT 12 FT.	1	L.S.	\$120,000.00	120,000
CORRUGATED POLYETHYLENE CULV. PIPE 48 IN. DIAM.	110	L.F.	\$200.00	22,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	700	S.F.	\$20.00	14,000
SURFACING				
CRUSHED SURFACING BASE COURSE	700	TON	\$25.00	17,500
CRUSHED SURFACING TOP COURSE	80	TON	\$35.00	2,800
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	700	TON	\$110.00	77,000
HMA FOR APPROACH CL 1/2 IN PG 64-22	70	TON	\$150.00	10,500
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	20	DAY	\$100.00	2,000
TOPSOIL TYPE A	150	C.Y.	\$35.00	5,250
SEEDING, FERTILIZING, AND MULCHING	0.40	ACRE	\$3,000.00	1,200
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
HIGH VISIBILITY SILT FENCE	1,680	L.F.	\$4.00	6,720
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 8 FT. LONG POST	360	L.F.	\$30.00	10,800
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	6	EA	\$2,100.00	12,600
PAINT LINE	3,040	L.F.	\$1.00	3,040
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$20,000.00	20,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
SHORING OR EXTRA EXCAVATION CLASS B	290	S.F.	\$4.00	1,160
ROADWAY SURVEYING	1	L.S.	\$14,000.00	14,000
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	1	L.S.	\$500.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
Site B - Overlay 100' of road with 0.7' HMA				19,000
Site C - Overlay 285' of road with 0.2' HMA				16,000
SUBTOTAL				564,000
CONTINGENCY			30%	169,000
CONSTRUCTION SUBTOTAL				733,000
PE ENGINEERING @ 20%			20%	147,000
CE ENGINEERING @ 15%			15%	110,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				90,000
ROW ACQUISITION				10,000
Total Project Cost				\$1,090,000

BEN HOWARD A_60K CFS - PLANNING LEVEL COST ESTIMATE

Scope: Design for 60,000 cfs. Raise 440' length of road by 2.1' max., maintain 22' roadway width, include two 48" culverts.

PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		15,200
CLEARING AND GRUBBING	0.20	ACRE	\$10,000.00	2,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	50	C.Y.	\$25.00	1,250
GRAVEL BORROW INCL. HAUL	1,310	TON	\$25.00	32,750
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	90	L.F.	\$50.00	4,500
SURFACING				
CRUSHED SURFACING BASE COURSE	400	TON	\$25.00	10,000
CRUSHED SURFACING TOP COURSE	30	TON	\$35.00	1,050
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	410	TON	\$110.00	45,100
HMA FOR APPROACH CL 1/2 IN PG 64-22	20	TON	\$150.00	3,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	10	DAY	\$100.00	1,000
TOPSOIL TYPE A	60	C.Y.	\$35.00	2,100
SEEDING, FERTILIZING, AND MULCHING	0.20	ACRE	\$3,000.00	600
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
WATTLE	970	L.F.	\$4.00	3,880
TRAFFIC				
PLASTIC LINE	1,760	L.F.	\$1.50	2,640
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$14,000.00	14,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
ROADWAY SURVEYING	1	L.S.	\$4,400.00	4,400
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				167,000
CONTINGENCY			30%	50,000
CONSTRUCTION SUBTOTAL				217,000
PE ENGINEERING @ 20%			20%	43,000
CE ENGINEERING @ 15%			15%	33,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				54,000
ROW ACQUISITION (PRELIMINARY DETERMINATION NOT NEEDED)				
Total Project Cost				\$347,000

BEN HOWARD B_60K CFS- PLANNING LEVEL COST ESTIMATE

Scope: Design for 60,000 cfs. Raise 600' length of road by 4.1' max. depth, include a 48" culvert, maintain 22' roadway width w/ reinforced slope at 48" culvert

PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		25,000
CLEARING AND GRUBBING	0.30	ACRE	\$10,000.00	3,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$12,500.00	12,500
GRADING				
ROADWAY EXCAVATION INCL. HAUL	510	C.Y.	\$25.00	12,750
GRAVEL BORROW INCL. HAUL	2,590	TON	\$25.00	64,750
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	40	L.F.	\$50.00	2,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	240	S.F.	\$20.00	4,800
SURFACING				
CRUSHED SURFACING BASE COURSE	600	TON	\$25.00	15,000
CRUSHED SURFACING TOP COURSE	50	TON	\$35.00	1,750
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	560	TON	\$110.00	61,600
HMA FOR APPROACH CL 1/2 IN PG 64-22	20	TON	\$150.00	3,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	20	DAY	\$100.00	2,000
TOPSOIL TYPE A	90	C.Y.	\$35.00	3,150
SEEDING, FERTILIZING, AND MULCHING	0.20	ACRE	\$3,000.00	600
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
WATTLE	1,320	L.F.	\$4.00	5,280
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 8 FT. LONG POST	280	L.F.	\$30.00	8,400
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	2	EACH	\$2,100.00	4,200
PLASTIC LINE	2,400	L.F.	\$1.50	3,600
PERMANENT SIGNING	1	L.S.	\$400.00	400
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$15,000.00	15,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
SHORING OR EXTRA EXCAVATION CLASS B	290	S.F.	\$4.00	1,160
ROADWAY SURVEYING	1	L.S.	\$7,300.00	7,300
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				275,000
CONTINGENCY			30%	83,000
CONSTRUCTION SUBTOTAL				358,000
PE ENGINEERING @ 20%			20%	72,000
CE ENGINEERING @ 15%			15%	54,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				66,000
ROW ACQUISITION				6,000
Total Project Cost				\$556,000

MANN ROAD A (ELBOW) 70k CFS - PLANNING LEVEL COST ESTIMATE				
Scope: Design for 70,000 cfs. Raise 1190' of road by 5.4' max., include a 12' box culvert and two 48" culverts, maintain 22' road width w/reinforced slope headwalls at box culvert and driveway culvert. Two additional sites would also need to be raised due to the flooding extent are included.				
PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		59,400
CLEARING AND GRUBBING	0.50	ACRE	\$10,000.00	5,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$9,200.00	9,200
GRADING				
ROADWAY EXCAVATION INCL. HAUL	250	C.Y.	\$25.00	6,250
GRAVEL BORROW INCL. HAUL	5,730	TON	\$25.00	143,250
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
PRECAST REINF. CONC. BOX CULVERT 12 FT.	1	L.S.	\$120,000.00	120,000
CORRUGATED POLYETHYLENE CULV. PIPE 48 IN. DIAM.	120	L.F.	\$200.00	24,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	690	S.F.	\$20.00	13,800
SURFACING				
CRUSHED SURFACING BASE COURSE	1,100	TON	\$25.00	27,500
CRUSHED SURFACING TOP COURSE	110	TON	\$35.00	3,850
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	1,100	TON	\$110.00	121,000
HMA FOR APPROACH CL 1/2 IN PG 64-22	40	TON	\$150.00	6,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	25	DAY	\$100.00	2,500
TOPSOIL TYPE A	180	C.Y.	\$35.00	6,300
SEEDING, FERTILIZING, AND MULCHING	0.50	ACRE	\$3,000.00	1,500
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$7,000.00	7,000
HIGH VISIBILITY SILT FENCE	2,620	L.F.	\$4.00	10,480
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 8 FT. LONG POST	420	L.F.	\$30.00	12,600
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	6	EA	\$2,100.00	12,600
PAINT LINE	4,760	L.F.	\$1.00	4,760
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$24,000.00	24,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
SHORING OR EXTRA EXCAVATION CLASS B	290	S.F.	\$4.00	1,160
ROADWAY SURVEYING	1	L.S.	\$17,300.00	17,300
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	1	L.S.	\$500.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
Site B - Raise 205' of road by 1.5' max.				42,000
Site C - Raise 630' of road by 1.0' max.				101,000
SUBTOTAL				796,000
CONTINGENCY			30%	239,000
CONSTRUCTION SUBTOTAL				1,035,000
PE ENGINEERING @ 20%			20%	207,000
CE ENGINEERING @ 15%			15%	155,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				105,000
ROW ACQUISITION				11,000
Total Project Cost				\$1,513,000

BEN HOWARD A_70K CFS - PLANNING LEVEL COST ESTIMATE

Scope: Design for 70,000 cfs. Raise 460' length of road by 3.0' max., maintain 22' roadway width, include two 48" culverts.

PROJECT ESTIMATING DATA			PLANNING LEVEL ESTIMATE	
ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		17,600
CLEARING AND GRUBBING	0.20	ACRE	\$10,000.00	2,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$5,000.00	5,000
GRADING				
ROADWAY EXCAVATION INCL. HAUL	60	C.Y.	\$25.00	1,500
GRAVEL BORROW INCL. HAUL	1,890	TON	\$25.00	47,250
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	100	L.F.	\$50.00	5,000
SURFACING				
CRUSHED SURFACING BASE COURSE	500	TON	\$25.00	12,500
CRUSHED SURFACING TOP COURSE	30	TON	\$35.00	1,050
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	430	TON	\$110.00	47,300
HMA FOR APPROACH CL 1/2 IN PG 64-22	20	TON	\$150.00	3,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	12	DAY	\$100.00	1,200
TOPSOIL TYPE A	70	C.Y.	\$35.00	2,450
SEEDING, FERTILIZING, AND MULCHING	0.20	ACRE	\$3,000.00	600
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$6,000.00	6,000
WATTLE	1,020	L.F.	\$4.00	4,080
TRAFFIC				
PLASTIC LINE	1,840	L.F.	\$1.50	2,760
PERMANENT SIGNING	1	L.S.	\$600.00	600
PROJECT TEMPORARY TRAFFIC CONTROL	16,000	L.S.	\$1.00	16,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
ROADWAY SURVEYING	1	L.S.	\$5,100.00	5,100
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	500	L.S.	\$1.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				194,000
CONTINGENCY			30%	58,000
CONSTRUCTION SUBTOTAL				252,000
PE ENGINEERING @ 20%			20%	50,000
CE ENGINEERING @ 15%			15%	38,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				59,000
ROW ACQUISITION				5,600
Total Project Cost				\$405,000

BEN HOWARD B_70K CFS- PLANNING LEVEL COST ESTIMATE

Scope: Design for 70,000 cfs. Raise 1420' length of road by 5.3' max. depth, include a 48" culvert, maintain 22' roadway width w/ reinforced slope at 48" culvert. Includes raising Mann Rd for approximately 500' east of Ben Howard Rd.

PROJECT ESTIMATING DATA

PLANNING LEVEL ESTIMATE

ITEM	QUANTITY	UNIT	UNIT COST	TOTAL COST
PREPARATION				
MOBILIZATION	1	L.S.		43,400
CLEARING AND GRUBBING	0.40	ACRE	\$10,000.00	4,000
REMOVAL OF STRUCTURE AND OBSTRUCTION	1	L.S.	\$12,500.00	12,500
GRADING				
ROADWAY EXCAVATION INCL. HAUL	240	C.Y.	\$25.00	6,000
GRAVEL BORROW INCL. HAUL	5,040	TON	\$25.00	126,000
DRAINAGE				
QUARRY SPALLS	30	TON	\$30.00	900
CORRUGATED POLYETHYLENE CULV. PIPE 18 IN. DIAM.	30	L.F.	\$50.00	1,500
CORRUGATED METAL CULV. PIPE 48 IN. DIAM.	40	L.F.	\$50.00	2,000
STRUCTURE				
GEOGRID REINFORCED EARTH SLOPE	280	S.F.	\$20.00	5,600
SURFACING				
CRUSHED SURFACING BASE COURSE	1,300	TON	\$25.00	32,500
CRUSHED SURFACING TOP COURSE	80	TON	\$35.00	2,800
HOT MIX ASPHALT				
PLANING BITUMINOUS PAVEMENT	140	SY	\$18.00	2,520
HMA CL. 1/2 IN. PG 64-22	1,310	TON	\$110.00	144,100
HMA FOR APPROACH CL 1/2 IN PG 64-22	20	TON	\$150.00	3,000
EROSION CONTROL AND ROADSIDE RESTORATION				
ESC LEAD	25	DAY	\$100.00	2,500
TOPSOIL TYPE A	170	C.Y.	\$35.00	5,950
SEEDING, FERTILIZING, AND MULCHING	0.40	ACRE	\$3,000.00	1,200
EROSION/WATER POLLUTION CONTROL	1	L.S.	\$5,000.00	5,000
WATTLE	3,130	L.F.	\$4.00	12,520
TRAFFIC				
BEAM GUARDRAIL TYPE 31 - 8 FT. LONG POST	280	L.F.	\$30.00	8,400
BEAM GUARDRAIL TYPE 31 NON-FLARED TERMINAL	2	EACH	\$2,100.00	4,200
PLASTIC LINE	5,680	L.F.	\$1.50	8,520
PERMANENT SIGNING	1	L.S.	\$400.00	400
PROJECT TEMPORARY TRAFFIC CONTROL	1	L.S.	\$20,000.00	20,000
CONSTRUCTION SIGNS CLASS "A"	120	SF	\$15.00	1,800
OTHER				
SHORING OR EXTRA EXCAVATION CLASS B	290	S.F.	\$4.00	1,160
ROADWAY SURVEYING	1	L.S.	\$12,600.00	12,600
ROADSIDE CLEANUP	5,000	EST	\$1.00	5,000
SPCC PLAN	1	L.S.	\$500.00	500
MAILBOX SUPPORT TYPE 1	1	EACH	\$400.00	400
SUBTOTAL				477,000
CONTINGENCY			30%	143,000
CONSTRUCTION SUBTOTAL				620,000
PE ENGINEERING @ 20%			20%	124,000
CE ENGINEERING @ 15%			15%	93,000
CRITICAL AREA IMPACTS MITIGATION INCLUDING PERMITTING				98,000
ROW ACQUISITION				7,000
Total Project Cost				\$942,000