

City of Arnold, Missouri

**Work Session
Council Chambers**

**June 9, 2016
7:00 p.m.**

Amended Agenda

1. Melody Lane Storm Water
2. Annexation
3. Adjournment

June 6, 2016

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Cc: Williams, Alicia D; Ed Blattner; Bryan Richison

Subject: RE: City Of Arnold Muddy Creek Drainage Project Draft Report

Josh,

I have read your draft report concerning the Muddy Creek Drainage Project and would make the following comments:

1. Your study revealed that the existing box culvert (61 square feet of conveyance area) is too small and your study proposed that a 128 square feet structure would be needed. This revelation was somewhat of a surprise and revealed the extent of the storm water flow problem.
2. The alternative 1 and 2 approach as presented is most helpful and provides a better understanding of the situation.
3. Under the alternative 1 you indicated some 350 feet of new rock rip rap lined trapezoidal channel would be required. Would such treatment be needed for some distance downstream of the Key West discharge point? Please advise.
4. Alternative 1, Figure 4 shows significant reduction in the 100 year flood plain limits. Alternative 2, Figure 6 shows an even further reduction in the 100 year flood plain limits. Both figures appear to show a slight reduction in floodplain limits downstream of the Key West Drive location. Could another exhibit be prepared to show the blue and red lines all the way down to the outer road for comparison review? Please advise.
5. The alternative 2 plan I believe indicates a 700 feet of new rock rip lined channel improvements upstream of the Melody Lane crossing. If I understand correctly, I believe this would entail the extensive removal of existing tree growth correct? Can you clarify for me what the 3 feet tall soil saver is? I am not sure what the USACOE would say about the proposed channel construction and disturbance of existing conditions. Do you have any thoughts in this regard?
6. Under the listed downstream impacts your table 1 & 2 listed percentages and elevation increases downstream of Key West Drive. Can you tell us how the flow velocities increased as well as that information would be useful for us. Some of the flow elevations increased downstream are of some concern. Your comment about possible various alternatives to develop new storage volume areas would likely be a concern for the City.
7. Your cost estimates for alternate 1 (\$618,012 to \$1,004,416) and alternate 2 (\$850,364 to \$1,381,841) are noted.

General preliminary conclusion:

It appears from your figures showing the 100 year flood plain limits there are some 12 to 14 homes affected. If the homes were not present, then the flood loss risk would be greatly diminished. I would estimate the current market value of the target homes (just a guess) would be in the range of \$100,000 to \$160,000 or value range of \$1,400,000 to \$2,240,000 with average at around \$1,800,000 plus some moving allowance. My thought is the proposed box culvert, channel improvements, and the apparent raise in downstream flood elevations the possible alternate #3 to consider home property buyouts should be considered. Your thoughts please in this regard.

Your timely response in these matters would be most appreciated and look forward to the submission of the final study report.

Thanks,

Ed Blattner, P.E.

Public Works Director - City of Arnold

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From: Yarrow, Josh A [<mailto:josh.yarrow@amecfw.com>]

Sent: Wednesday, June 01, 2016 3:59 PM

To: Ed Blattner

City of Arnold

Muddy Creek Drainage Project



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June 2016
DRAFT

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Background

AMEC Foster Wheeler was hired to explore design alternatives to address a long standing flood mitigation issue for the City of Arnold concerning the flow of storm water constrictions downstream of Key West Drive and Melody Lane area and the possible adverse effects on the residents/properties downstream to I-55.

The current Hydraulic HEC-RAS model for Muddy Creek developed for the Jefferson County National Flood Insurance Program (NFIP) Flood Insurance Study (FIS) update shows a large area of flood inundation of the residential area upstream of Melody Drive not previously shown on the FEMA maps. This inundation area will now be shown on the new effective maps scheduled to be released at a later date due to the Federal Emergency Management Agency (FEMA) requirements to map floodplains up to one square mile drainage area. This additional residential flooding is caused by the constriction at the existing culvert under Key West Drive.

The City of Arnold estimates around 1970, prior to the City of Arnold incorporating, a developer widened Key West Drive and placed an approximate 76-inch concrete culvert (32 square feet of conduit flow area capacity) under the new roadway which connected into an approximate 6.5 x 6 feet box structure (39 square feet) further connected upstream to an existing 11 x 5.5 feet long box culvert structure (61 square feet). Photos of the existing culvert at Key West Drive can be seen in Figure 1. This decrease in conduit flow area severely reduced the capacity of this road crossing causing the storage of flood waters upstream which was shown the draft flood maps shared at the Flood Study Review Meeting held in Hillsboro on March 30, 2016.



Figure 1: Photos of the Deficient Culvert (Left, Downstream end section: Right, Upstream end section)

Hydrology and Hydraulic

In order to develop design alternatives, the FEMA approved hydrology and hydraulic models, developed by AMEC Foster Wheeler, from the current FEMA floodplain update study for Jefferson County were utilized. The methodology used for modeling and the results will be discussed in the following sections.

Hydrology

The hydrology for the FEMA approved floodplains was computed using HEC-HMS. Pomme Creek and Muddy Creek have a drainage area of approximately 7.5 and 2.5 square miles respectively. These two basins were studied together as part of a single HEC-HMS study (referred to as Pomme Creek study) with two model outlets. There are no significant storage areas included in the Pomme Creek hydrology model and any other storage throughout the basin was represented with the Clark's transform method.

Hydraulics

The hydraulic modeling for the FEMA approved floodplains was completed using a steady state HEC-RAS model. The Muddy Creek steady state HEC-RAS model was developed to model approximately 3.9 miles of Muddy Creek extending from just downstream of Highway 141 to its confluence with Meramec River. Cross Sections were derived off 1-meter, LiDAR data in North American Vertical Datum of 1988 (NAVD 88). Field notes consisting of structure dimensions and channel geometry, as well as structure material (i.e. corrugated metal pipe), were used in conjunction with basic survey data in order to represent the structures. Near structures, contraction and expansion coefficients were set at 0.3 and 0.5, respectively. Manning's "n" roughness coefficients were assigned using engineering judgment based on 2012 aerial photography and field reconnaissance.

Muddy Creek Drainage Alternatives

There are two alternatives for reducing flooding upstream of Key West Drive and Melody Lane. Both alternatives differ in cost and flood reduction benefit. The first is to replace just the culvert at Key West Drive with some channel improvements upstream of Key West Drive. The second involves the replacement of the culverts at both Key West Drive and Melody Lane with channel improvements between both structures and upstream of Melody Lane.

When developing these two alternatives the cities' design requirements were considered. The City has adopted the Metropolitan St. Louis Sewer District Rules and Regulations and Engineering Design Requirements for Sanitary Sewer and Storm Water Drainage Facilities (MSD). The MSD utilizes a 15-year, 20-minute storm event for the design of storm water structures. Increasing the flow area at Key West Drive from the constricting 76-inch pipe with 32 square feet of flow to an area of 96 square feet of flow would be capable of contain the design storm event. However, when considering Melody Lane, a 96 square foot structure at Key West causes tailwater effects on Melody Lane. These tailwater effects are attributed to the fact that the channel invert elevation on the downstream side of Melody Lane is only 2.5 feet higher the channel invert elevation on the upstream side of Key West. When developing Alternative 2 these tailwater effects need to be decreased so the culvert at Melody Lane can meet the design criteria. A 128 square feet culvert is required at Key West to alleviate the tail water effects on Melody Lane so a reasonable culvert can be determined to carry the design storm event. This 128 square foot culvert at Key West Drive was selected for both alternatives, so if Alternative 1 is selected, Alternative 2 could still be implemented in the future without having to replace the culvert at Key West Drive a second time.

Alternative 2 was developed for Melody Lane which has an existing 67-inch x 95-inch CMP arch culvert which the city recognizes as undersized with the roadway being overtopped when approximately the 15-year 20-minute duration storm event occurs. Photos of the existing culvert at Melody Lane can be seen in Figure 2. This section of roadway has flooded a number of times over the last few years. Fortunately, the flooding is short in time as all the flooding in this area section of the Muddy Creek is due to flash flood rain events and nothing to do with the Meramec River. Replacement of this culvert with a larger flow area could alleviate flooding issues upstream of Melody Lane.



Figure2: Photos of the undersized culvert (Left, Downstream end section; Right, Upstream end section)

Alternative 1: Replacing Key West Drive Culvert

A new double -foot by 8-foot culvert was determined to be the best culvert size to replace the existing culvert at Key West drive. This alternative also recommends dropping the culvert and channel invert elevations at Key West Drive by 2.5 feet and utilizing a trapezoidal channel with a 12-foot bottom and uniformly tapering the cut back to the natural channel approximately 350 feet upstream of Key West Drive and just downstream of Melody Lane. The new trapezoidal channel will be lined with rip rap for bank stabilization and protection. The full length of the existing culvert is purposed to be replaced in Alternative 1. However, the western 130 feet of the culvert travels under an empty lot. So the culvert length could be reduced and an open channel created where this empty lot stands reducing the cost estimate for Alternative 1.

This culvert replacement and channel improvements at and just upstream of Key West Drive will decrease the 100-year flood elevation by 6 feet between Key West Drive and Melody lane and approximately 2 feet just upstream of Melody lane. The channel improvements and decrease in the design storm water surface elevations can be seen in the profile of Muddy Creek in Figure 3. A comparison of the FEMA approved 100-year floodplain and the Alternative 1 100-year floodplain can be seen in Figure 4. The 100-year, 24-hour storm event produces peak flows within 5% of the 15-year, 20-minute storm event peak flows for this area. These plotted 100-year floodplains are similar to what the 15-year, 20-minute storm event floodplains would look like.

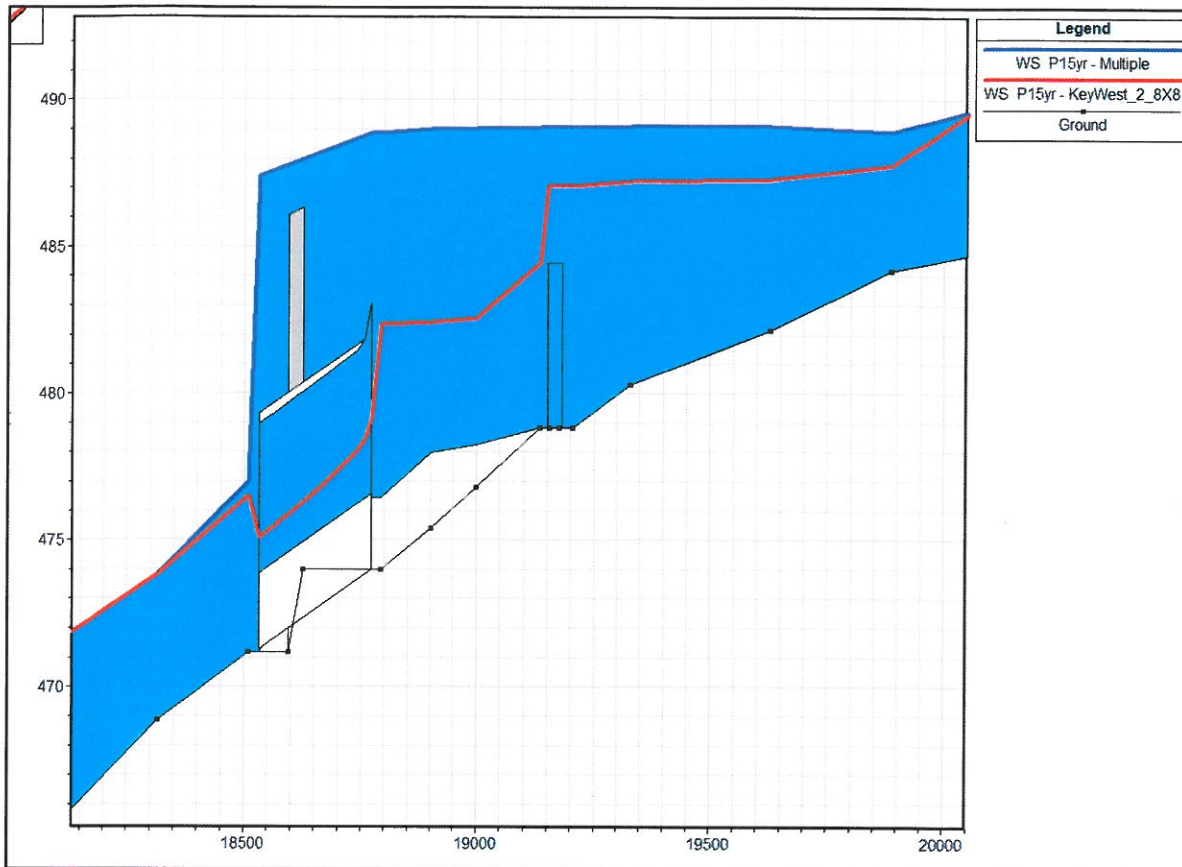


Figure3: Blue Line - existing conditions design storm water surface elevation. Red Line – Alternative 1 design storm water surface elevations.



Figure4: Blue Line – FEMA approved 100yr floodplain. Red Line – Alternative 1, 100yr floodplain.

Alternative 1: Cost

Construction Cost	\$ 687,627
Engineering Cost	\$ 85,000
TOTAL	\$ 772,627

Alternative 2: Replacing Key West Drive and Melody Lane Culverts

In order to decrease the flooding upstream of Key West Drive and Melody Lane further than Alternative 1 a second alternative has been developed. This alternative includes the replacement of both structures at Key West Drive and Melody Lane with matching double 8 foot by 8 foot culverts. This alternative would lower the culvert and channel invert elevations at Key West Drive by 2.5 feet. In addition to the culvert and channel invert elevations at Melody Lane would be lowered by approximately 4 feet. A trapezoidal channel with a 12-foot bottom will be cut between Key West Drive and Melody Lane. A 3-foot tall soil saver will be utilized on the upstream side of the box at Melody Lane and a trapezoidal channel with a 12-foot bottom will be cut upstream of the soil saver and uniformly tapering the cut back to the natural channel, approximately 700 feet upstream of Melody Lane. The new trapezoidal channel between the two culverts and upstream of the soil saver on Melody lane will be lined with rip rap for bank stabilization and protection.

The replacement of both culverts and channel improvements between Key West Drive and Melody Lane as well as upstream of Melody Lane will decrease the 100-yr flood elevation by 6 feet between Key West Drive and Melody lane and approximately 5-feet just upstream of Melody lane. The channel improvements and decrease in the design storm water surface elevations can be seen in the profile of Muddy Creek in Figure 5. A comparison of the FEMA approved 100-year floodplain and the Alternative 1 100-year floodplain can be seen in Figure 6.

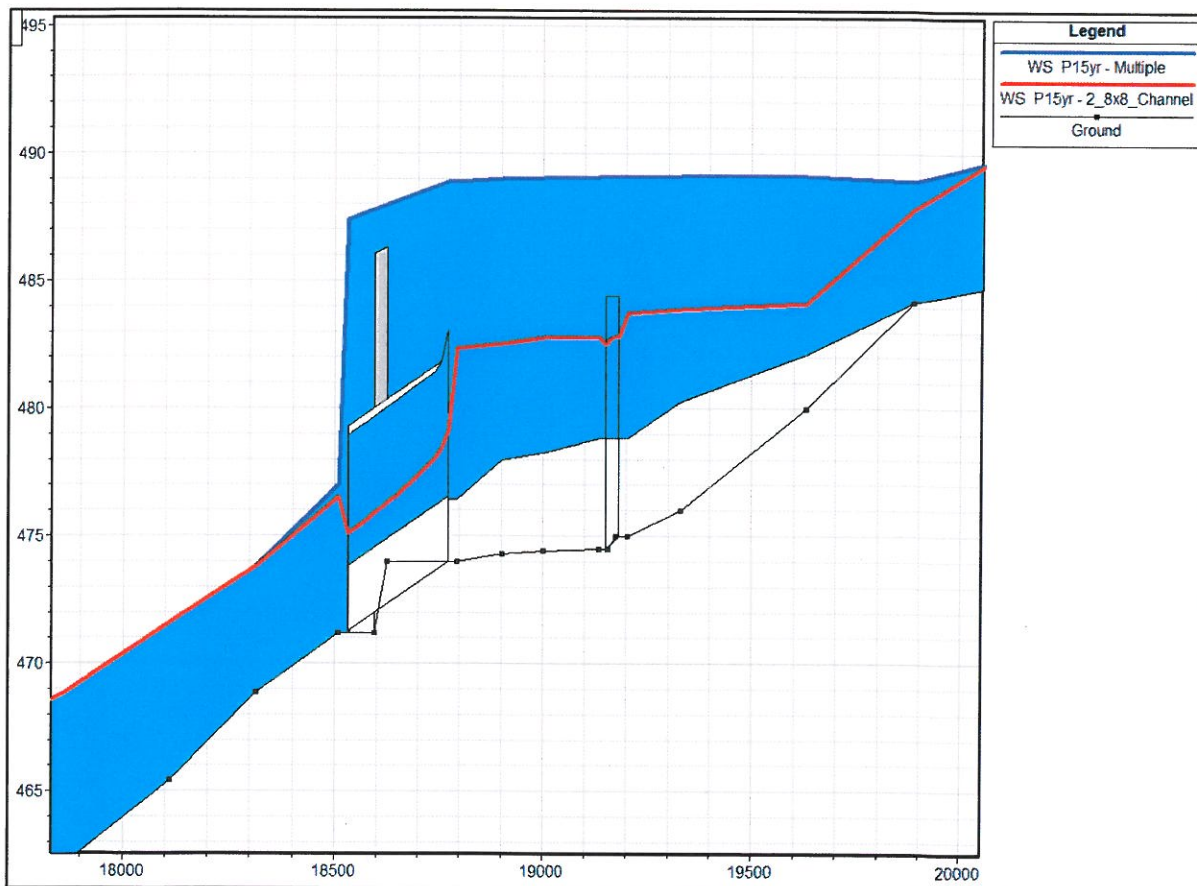


Figure5: Blue Line - existing conditions design storm water surface elevation. Red Line – Alternative 2 design storm water surface elevations.



Figure6: Blue Line – FEMA approved 100yr floodplain. Red Line – Alternative 2, 100yr floodplain.

Alternative 2: Cost

Construction Cost	\$ 952,955
Engineering Cost	\$ 110,000
TOTAL	\$1,062,955

Downstream Impacts

Increasing the capacity of the culverts in both scenarios will release more flow downstream causing an increase in flows and a rise in water surface elevations. Table 1 shows a comparison of the peak 100 year flows derived from the modeling of both alternatives with the existing condition modeling.

Location	Alternative 1	Alternative 2
Upstream of Bender Lane	2.1%	1.9%
Downstream of Bender Lane	3.0%	3.0%
Highway 55	4.1%	4.9%
Jeffco Blvd	5.6%	7.1%
Tenbrook Road	5.9%	7.7%
Starling Airport Road	7.6%	11.1%

Table 1: Percent Change in alternative 100-year flows compared to the existing conditions modeling.

The percent increase in flows continues to gradually increase downstream as the new slightly larger hydrograph being released in the alternatives is combining with hydrographs of tributaries that flow into Muddy Creek downstream of Key West drive. Table 2 shows how much this increase in flow impacts water surface elevations down stream of Key West Drive. Table 2 is a comparison of the 100 year water surface elevations derived from the modeling of both alternatives with the existing condition modeling.

Location	Alternative 1 (Feet)	Alternative 2 (Feet)
Upstream of Bender Lane	0.07	0.07
Downstream of Bender Lane	0.05	0.05
Upstream of Arlene Drive	0.13	0.13
Downstream of Arlene Drive	0.09	0.09
Upstream of Maple Drive	0.22	0.27
Downstream of Maple Drive	0.20	0.23
Upstream of W Outer Road	0.24	0.27
Downstream of W Outer Road	0.29	0.34
Upstream of I-55	0.26	0.31
Downstream of I-55	0.07	0.09
Upstream of Jeffco Blvd	0.24	0.30
Downstream of Jeffco Blvd	0.24	0.31
Upstream of Tenbrook Road	0.39	0.52
Downstream of Tenbrook Road	0.14	0.18
Upstream of Dudler Drive	0.46	0.59
Downstream of Dudler Drive	0.29	0.37
Upstream of Starling Airport Road	0.26	0.35
Downstream of Starling Airport Road	0.44	0.59

Table 2: Change in alternative 100-year water surface elevations compared to existing condition modeling.

The City of Arnold will need to develop criteria for the maximum amount of water surface change is allowed downstream of Key West Drive. If it is determined that the amount of water surface increase is not acceptable, various alternatives could be developed to store the additional volume of water that is being released on downstream of Key West Drive. For example, a storage area could be developed in the head waters of Muddy Creek, just upstream of Highway 141 where there is existing open space used for recreation.

Floodplain Update

If any of the flood mitigation alternatives are implemented, the floodplains will change significantly. A Letter of Map Revision (LOMR) could be completed to remove several properties from the floodplain. These services can be included in Phase II, depending on the options selected by the City of Arnold.

Appendix A – Detailed Cost Estimates

Cost Estimate for Key West Dr. Culvert Replacement					
Pay Item No	Item		Qty.	Unit Price	Item Cost
	ENGINEERING				
	SURVEY				\$10,000
	GEOTECHNICAL INVESTIGATION				\$15,000
	DESIGN				\$60,000
	CONSTRUCTION				
	ROADWAY PAY ITEMS				
6181000	MOBILIZATION (10%)	LUMP SUM	1	\$62,330	\$62,330
6274000	CONTRACTOR FURNISHED SURVEYING AND STAKING	LUMP SUM	1	\$2,000	\$2,000
2013000	CLEARING AND GRUBBING	ACRE	2	\$4,000	\$8,000
3040163	TYPE 1 AGGREGATE FOR BASE (6 IN. THICK)	SQUARE YARD	70	\$20	\$1,400
4011207	BITUMINOUS PAVEMENT MIXTURE PG70-22, (BP-1)	TONS	8	\$200	\$1,600
4013000	BITUMINOUS PAVEMENT MIXTURE PG64-22 (BASE)	TONS	15	\$200	\$3,000
4071005	TACK COAT	GALLON	5	\$10	\$50
6061010	GUARDRAIL TYPE A	LINEAR FOOT	0	\$25	\$0
6063015	TYPE A CRASHWORTHY END TERMINAL	EACH	0	\$2,300	\$0
6092030	CONCRETE CURB LOW PROFILE TYPE F	LINEAR FOOT	60	\$40	\$2,400
9039904	ROADWAY SIGNAGE	SQUARE FOOT	30	\$40	\$1,200
8069901	SWPPP	LUMP SUM	1	\$5,000	\$5,000
6169901	TRAFFIC CONTROL	LUMP SUM	1	\$2,500	\$2,500
1099901	UTILITY RELOCATION	LUMP SUM	1	\$5,000	\$5,000
8052000A	SEEDING (NON STREAMBANK AREAS)	ACRE	1	\$3,000	\$3,000
	CULVERT PAY ITEMS				
2022010	REMOVAL OF IMPROVEMENTS	LUMP SUM	1	\$20,000	\$20,000
2063300	CLASS 4 EXCAVATION	CUBIC YARD	1140	\$18	\$20,520
7039903	DUAL CELL 8' X 8' PRECAST REINFORCED CONCRETE BOX CULVERT	LINEAR FOOT	260	\$1,600	\$416,000
7034041	CLASS B-1 CONCRETE (CULVERTS)	CUBIC YARD	0	\$1,500	\$0
7061030	REINFORCING STEEL (CULVERTS)	POUNDS	0	\$3	\$0
	STREAM BANK STABILIZATION				
2072000	LINEAR GRADING (STEEP SLOPES)	SQUARE YARD	1009	\$2.50	\$2,523
2029907	SITE EARTHWORK (EXCAVATION, HAULING & DISPOSAL)	CUBIC YARD	710	\$34	\$24,140
8069903	STREAM BANK STABILIZATION (RIP RAP OF INLET & OUTLET OF CULVERT)	SQUARE YARD	1009	\$106	\$106,965

Engineering Cost = \$85,000
Construction Cost = \$687,627

TOTAL PROJECT COST = \$772,627
ESTIMATED RANGE - LOW END = -20% = \$618,102
ESTIMATED RANGE - MEAN COST = \$811,259
ESTIMATED RANGE - HIGH END = +30% = \$1,004,416

Cost Estimate for Key West Dr. and Melody Ln. Culvert Replacement					
Pay Item No	Item		Qty.	Unit Price	Item Cost
	ENGINEERING				
	SURVEY				\$10,000
	GEOTECHNICAL INVESTIGATION				\$20,000
	DESIGN				\$80,000
	CONSTRUCTION				
	ROADWAY PAY ITEMS				
6181000	MOBILIZATION (10%)	LUMP SUM	1	\$86,360	\$86,360
6274000	CONTRACTOR FURNISHED SURVEYING AND STAKING	LUMP SUM	1	\$3,000	\$3,000
2013000	CLEARING AND GRUBBING	ACRE	3	\$4,000	\$12,000
3040163	TYPE 1 AGGREGATE FOR BASE (6 IN. THICK)	SQUARE YARD	140	\$20	\$2,800
4011207	BITUMINOUS PAVEMENT MIXTURE PG70-22, (BP-1)	TONS	16	\$200	\$3,200
4013000	BITUMINOUS PAVEMENT MIXTURE PG64-22 (BASE)	TONS	30	\$200	\$6,000
4071005	TACK COAT	GALLON	10	\$10	\$100
6061010	GUARDRAIL TYPE A	LINEAR FOOT	100	\$25	\$2,500
6063015	TYPE A CRASHWORTHY END TERMINAL	EACH	2	\$2,300	\$4,600
6092030	CONCRETE CURB LOW PROFILE TYPE F	LINEAR FOOT	120	\$40	\$4,800
9039904	ROADWAY SIGNAGE	SQUARE FOOT	60	\$40	\$2,400
8069901	SWPPP	LUMP SUM	1	\$8,000	\$8,000
6169901	TRAFFIC CONTROL	LUMP SUM	1	\$4,000	\$4,000
1099901	UTILITY RELOCATION	LUMP SUM	1	\$7,500	\$7,500
8052000A	SEEDING (NON STREAMBANK AREAS)	ACRE	2	\$3,000	\$6,000
	CULVERT PAY ITEMS				
2022010	REMOVAL OF IMPROVEMENTS	LUMP SUM	1	\$30,000	\$30,000
2063300	CLASS 4 EXCAVATION	CUBIC YARD	1500	\$18	\$27,000
7039903	DUAL CELL 8' X 8' PRECAST REINFORCED CONCRETE BOX CULVERT	LINEAR FOOT	300	\$1,600	\$480,000
7034041	CLASS B-1 CONCRETE (CULVERTS)	CUBIC YARD	4	\$1,500	\$6,000
7061030	REINFORCING STEEL (CULVERTS)	POUNDS	600	\$3	\$1,800
	STREAM BANK STABILIZATION				
	LINEAR GRADING (STEEP SLOPES)	SQUARE YARD	1769.5	\$2.50	\$4,424
	SITE EARTHWORK (EXCAVATION, HAULING & DISPOSAL)	CUBIC YARD	1850	\$34	\$62,900
	STREAM BANK STABILIZATION (RIP RAP OF INLET & OUTLET OF CULVERT)	SQUARE YARD	1770	\$106	\$187,571

Engineering Cost = \$110,000
 Construction Cost = \$952,955

TOTAL PROJECT COST = \$1,062,955
 ESTIMATED RANGE - LOW END = -20% = \$850,364
 ESTIMATED RANGE - MEAN COST = \$1,116,102
 ESTIMATED RANGE - HIGH END = +30% = \$1,381,841