Technical Memorandum

To: Kathy Arnold  
From: Seri Park  
Date: June 4, 2009  
Company: Rosemont Copper  
Doc #: 103/09-320842-5.3  
Re: Rosemont “T” Intersection Analysis – Bypass Lane  
CC: Jamie Sturgess (Rosemont)  
David Krizek and Jamie Joggerst (Tt)

1.0 Introduction

This Technical Memorandum was prepared by Tetra Tech and presents design alternatives for the proposed Primary Access Road associated with the Rosemont Copper Project (Rosemont). The Primary Access Road intersection is proposed to consist of a basic “T” intersection that allows access from the mine property to State Route 83 (AZ-83). As shown on Figure 1, the location of the Primary Access Road “T” intersection occurs at Milepost (MP) 46.9 along AZ-83. The current topography conditions at the “T” intersection consist of an undeveloped area. Adding a “T” intersection at this location will require the area to be upgraded per Arizona Department of Transportation (ADOT) and American Association of State Highways and Transportation Officials (AASHTO) roadway design guidelines.

The “T” intersection design presented in the Mine Plan of Operation (MPO) (WestLand, 2007) consisted of the Primary Access Road being “stop” controlled with traffic along AZ-83 being uncontrolled (i.e., no stop sign). The intersection design also included a 500-foot long center lane to the south of the intersection. This center lane would allow northbound traffic to make a left turn onto the Primary Access Road. A 220-foot long deceleration and right turn lane was also proposed along the western edge of AZ-83, north of the intersection. The lane would also continue to the south of the intersection for 500 feet and serve as an accelerating lane for traffic going south on AZ-83. Figure 2 illustrates the “T” intersection configuration and corresponding typical section taken from the MPO.

Tetra Tech completed an in-depth analysis of the “T” intersection in order to assess potential traffic flow issues and to recommend designs that will allow traffic to safely merge from the Primary Access Road onto AZ-83. A total of four (4) alternatives to the MPO design were evaluated for this “T” intersection. These four (4) alternatives include:
2.0 Design Vehicle

In order to assess the various intersection design alternatives for the “T” intersection, the design vehicle must first be established. Based on Table 407.2 in the ADOT Roadway Design Guidelines, a WB-62 type, Interstate Semi Trailer is recommended as the design vehicle for intersections along a State Route. In AASHTO’s Geometric Design of Highways and Streets, a WB-65 type is recommended as the minimum sized design vehicle for intersections on state highways that carry high volumes of traffic and/or provide local access for large trucks. Therefore, in this Technical Memorandum, a WB-65 type was chosen as design vehicle since a safe truck turning with a WB-65 type will also satisfy a safe truck turning for a WB-62 type.

3.0 Bypass Lane Alternative Design Criteria

In this alternative emphasis on channelization by means of traffic control devices are presented. In Section 403.3 of the ADOT Roadway Design Guidelines, it is stated that proper intersection channelization of traffic movement using pavement markings, delineators, or other suitable means will enhance/facilitate safe and orderly intersection traffic flow. Under this alternative, 55 MPH will be maintained as the design speed along AZ-83. Figure 3 describes the proposed alternative layout and Attachment A shows before and after photos to illustrate the visual changes with regards to the corresponding alternative.

Roadway Geometric Element:

In this alternative, in addition to adding a northbound dedicated acceleration lane along AZ-83, a 2-foot buffer between the acceleration lane and the through traffic lane will be added to implement the proposed bypass concept. Therefore, the intersection will be widened to accommodate this 2-foot buffer and channelizers will be placed in the buffer to keep traffic from crossing over into the acceleration lane, thus creating clear and efficient traffic separation. Similar to an acceleration lane design, the inside lane will be at least 650 feet long plus a standard taper, however channelizers will be utilized to force through traffic to stay to the right, allowing proper acceleration of trucks before the two lanes merge. Figure 3 illustrates a typical
section of the bypass lane configuration including the additional 2 feet buffer and the channelizers. The acceleration and through lanes will both be standard 12-foot lanes based on ADOT roadway design guidelines. A truck turning template was also performed to ensure safe truck turns.

Sign and Channelizer Installation:

When an extra lane is provided for slower moving traffic, a sign stating “LANE ENDS” or a sign showing a lane ends symbol (W4-2) should be installed in advance of the end of the acceleration lane. Per MUTCD Table 2C-4 (Attachment B), the advanced warning sign should be placed at 950 feet ahead of the end of the acceleration lane for a posted speed limit of 55 MPH. Since the length of the proposed acceleration lane is less than 950 feet, it is recommended that the W4-2 sign be placed at the beginning of the acceleration lane. For the Primary Access Road, a “STOP” (R1-1) sign and a “STOP AHEAD” (W3-1) sign should be placed 125 feet apart from each other as per Table 2C-4 of the MUTCD (Attachment B). In regards to sign installation, Section 303.2 in the ADOT Roadway Design Guidelines states:

“Roadside obstacles, non-traversable hazards and fixed objects, should be removed, made ‘breakaway’, relocated or shielded by barrier if they are within the minimum recovery area width”

Therefore, all new signs will need to be “breakaway” and any existing signs will need to be evaluated in order to ensure they meet the breakaway criteria. In addition, roadside clearing of large trees will need to be coordinated with ADOT in order to maintain a safe clear recovery area beyond the pavement limits. Clearing and Grubbing will conform to the guidelines specified in the Landscape and Irrigation Design Guidelines for Arizona Department of Transportation Encroachment Permit Applications (Attachment C).

Channelizers will be placed from the beginning of the 250-foot left turn pocket and extend until approximately 400 feet into the proposed acceleration lane. The spacing between each channelizer will be 25 feet based on the standard channelizer spacing stated in the MUTCD.

3.1 Bypass Lane alternative Advantage and Disadvantage

Advantages:

- Creates a clear safety buffer between through traffic and accelerating/left turning traffic
- Minimizes delay caused by accelerating traffic, especially left turning truck traffic onto AZ-83 from the Primary Access Road
- Increases roadway capacity by allowing easier though-traffic flow

Disadvantages:

- Increased cost to widen the intersection to accommodate the acceleration lane, merging taper, additional 2-foot buffer zone and the cost for purchasing channelizers
- Unusual design may confuse drivers unfamiliar with the area
REFERENCES


Arizona Department of Transportation (2007) *Roadway Design Guidelines*


U.S. Department of Transportation Federal Highway Administration (2004) *Standard Highway Signs*

FIGURES
Intersection Widening Designed Per:

Legend:
ROW - Right of Way
Location:
Mile Post 46.9
Intersection of SR-83 and Primary Access Road
ATTACHMENT A
PHOTOS FOR THE BYPASS LANE ALTERNATIVE
Existing Roadway Layout at the Primary Access Road (Milepost 46.9 – looking south)
Existing Roadway Layout at the Primary Access Road (Milepost 46.9 – looking north)
ATTACHMENT B
TABLE 2C-4 IN MANUAL ON UNIFORM TRAFFIC
CONTROL DEVICES (MUTCD)
Table 2C-4. Guidelines for Advance Placement of Warning Signs
(English Units)

<table>
<thead>
<tr>
<th>Posted or 85th-Percentile Speed</th>
<th>Condition A: Speed reduction and lane changing in heavy traffic</th>
<th>Condition B: Deceleration to the listed advisory speed (mph) for the condition</th>
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<tbody>
<tr>
<td>20 mph</td>
<td>10 20 30 40 50 60 70</td>
<td>0 10 20 30 40 50 60 70</td>
</tr>
<tr>
<td>25 mph</td>
<td>225 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>175 ft 125 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>30 mph</td>
<td>325 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>250 ft 200 ft 150 ft 100 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>35 mph</td>
<td>450 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>325 ft 275 ft 225 ft 175 ft 100 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>40 mph</td>
<td>550 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>400 ft 350 ft 300 ft 250 ft 175 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
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<tr>
<td>45 mph</td>
<td>650 ft 125 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>475 ft 425 ft 400 ft 350 ft 275 ft 175 ft N/A³ N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>50 mph</td>
<td>750 ft 175 ft 125 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>550 ft 500 ft 425 ft 350 ft 250 ft 150 ft N/A³ N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>55 mph</td>
<td>850 ft 250 ft 200 ft 150 ft 100 ft N/A³ N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>625 ft 575 ft 500 ft 425 ft 350 ft 250 ft 150 ft N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>60 mph</td>
<td>950 ft 325 ft 275 ft 225 ft 175 ft 100 ft N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>625 ft 600 ft 525 ft 450 ft 350 ft 250 ft 100 ft N/A³ N/A³ N/A³ N/A³</td>
</tr>
<tr>
<td>65 mph</td>
<td>1100 ft 400 ft 350 ft 300 ft 250 ft 175 ft N/A³ N/A³ N/A³ N/A³ N/A³</td>
<td>750 ft 700 ft 625 ft 550 ft 475 ft 400 ft 300 ft N/A³ N/A³ N/A³ N/A³</td>
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<td>1200 ft 475 ft 425 ft 400 ft 350 ft 275 ft 175 ft N/A³ N/A³ N/A³ N/A³</td>
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<tr>
<td>75 mph</td>
<td>1350 ft 650 ft 625 ft 600 ft 525 ft 450 ft 350 ft 250 ft 100 ft</td>
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</table>

Notes:
1. The distances are adjusted for a sign legibility distance of 175 ft for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 ft, which is appropriate for an alignment warning symbol sign.
2. Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PIEV time of 14.0 to 14.5 seconds for vehicle maneuvers (2001 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 175 ft for the appropriate sign.
3. Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are based on the 2001 AASHTO Policy, Stopping Sight Distance, Exhibit 3-1, providing a PIEV time of 2.5 seconds, a deceleration rate of 11.2 ft/second², minus the sign legibility distance of 175 ft.
4. Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PIEV time, a vehicle deceleration rate of 10 ft/second², minus the sign legibility distance of 250 ft.
5. No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing to provide an adequate advance warning for the driver.
ATTACHMENT C
LANDSCAPE AND IRRIGATION DESIGN GUIDELINES FOR ARIZONA DEPARTMENT OF TRANSPORTATION ENCROACHMENT PERMIT APPLICATION
LANDSCAPE AND IRRIGATION
DESIGN GUIDELINES
ARIZONA DEPARTMENT OF TRANSPORTATION
ENCROACHMENT PERMIT APPLICATIONS

PREPARED BY:
ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
ROADSIDE DEVELOPMENT SERVICES

0967r
INTRODUCTION

The Arizona Department of Transportation, Highways Division, encourages the landscaping of its rights of way through the cooperative efforts with local governments and adjacent property owners. Because the right of way is a public area, of prime importance with relation to landscaping is the protection of the public and its safe access to the facilities as well as the improvement of aesthetic considerations.

Landscaping, being composed of living plant material, is in a constant state of change and must consider the ultimate growth of plants. Additionally, other considerations are the use of low water requirement plant materials and any other local jurisdictional requirements, such as sidewalks, signing setbacks and other requirements in relation to each specific roadway. After all of these factors have been considered the completion of the landscaping can greatly enhance the beauty of the roadway and the community.
LANDSCAPING

I. GENERAL

An approved Encroachment Permit is required before any landscape improvements may be incorporated within the ADOT Highway right-of-way. This applies to work performed under nationwide programs such as Global Releaf as well as individual efforts. Landscaping by local governments may be constructed and maintained within the control of access on the crossroads of major highways under a fully executed Intergovernmental Landscape Maintenance Agreement prepared by the State and an approved Encroachment Permit.

The highway roadside is an integral unit of a total highway facility. The term "roadside" generally refers to the area between the outer edge of the roadway and the right-of-way boundary. These include all unpaved areas within the right-of-way.

Permit applicants are encouraged to employ competent design professionals such as Registered Landscape Architects, Architects or Engineers, and to direct their work toward securing a product that fully represents the owner's needs and desires and meets the Arizona Department of Transportation (ADOT) standards, before submitting such plans for review and approval. Permit applicants and design professionals are encouraged
to discuss landscape needs and proposals with District Permits Supervisors and Roadside Development Services Landscape Architects before commencing work on final construction plans.

All plans and specifications shall be sufficiently complete and detailed for easy analysis and compliance inspection. Plans shall be designed to select plant materials appropriate for the intended use and location, to arrange plants for optimum effect of color, texture, form and to ensure reasonable maintenance within the capability of the proposed permittee. Permit applications will be reviewed for consideration of the following factors which can affect the safe and efficient operation of the highway facility.

II. DRAWINGS

A. PLANS:

Drawings must be legible, accurate and drawn to scale. They shall include a north arrow, name of development, designer and design firm with appropriate phone numbers and location of project.

B. PLANT MATERIALS:

Plants proposed for use must be clearly located, showing mature sizes, and identified as to botanical name (genus species, variety), planting size, quantity and spacing used.
Areas within an Arizona Department of Water Resources Active Management Areas must adhere to the plant list provided for that area. (See attached Plant Lists.)

C. EXISTING FEATURES:

Existing features such as curbs, sidewalks, pipe culverts, drainage structures, retention basins, driveways, highway and non-highway signs, overhead lines, underground utilities, irrigation lines, manholes, service cabinets, etc, shall be shown. In addition, the posted speed limit for the highway shall be indicated. Existing trees and shrubs shall be incorporated into the design wherever feasible. Clearing of trees and shrubs will not be permitted unless approved through the permit process. When planters are cut out of existing sidewalk areas, sufficient space must remain for compliance with ARS statutes relating to accessibility by the physically handicapped. The use of steel tree grates is recommended to maximize usable sidewalk space and to maintain a safe walking surface.

D. SLOPES:

Existing or proposed slopes shall be identified with respect to elevation differences between top and bottom and rate of slope between.
III. DESIGN

A. EROSION CONTROL:

Erosion control measures must be employed to prevent surface drainage from eroding soil surfaces and carrying the resultant silt into natural or man made drainage systems, highways or private properties.

B. SAFETY SETBACKS FOR FIXED OBJECTS:

Minimum setbacks from the travel way for newly planted trees with an ultimate trunk diameter of more than 4 inches or other hazardous fixed objects should be as follows:

1. **50 MPH or Greater Design Speed:**

   a. Minimum setback from the edge of the traffic lane should be 35 feet unless one of the following reasons will allow for a lesser distance.

   1) Cuts of 3 to 1 or steeper - obstacles are allowed 10 feet behind the point of vertical intersection (P.V.I.) at the toe of the slope. (See illustration 'A'.)

   2) Where concrete barriers, walls, abutments, or other rigid obstructions are used - fixed objects may be placed 4' behind the obstructions. (See illustration 'B')
3) Where flexible guardrail (box-beam, w-beam, or cable) is used - 6 to 20 feet behind the face of the guardrail, depending upon the type. (See illustration 'C'.)

4) Where there are barrier curbs (5" or more vertical face) near a traveled lane 6 feet behind the face of the curb (see illustration 'D'); adjacent to a parking lane - no definite setback distance.

b. Where limited right-of-way or the necessity for planting would result in less clearance, all factors in the particular problem area should be weighed to decide if a special exception is warranted.

2. 50 MPH or less design speed:

a. Minimum setback of a fixed object from the edge of the traffic lane may be 30 feet unless one of the reasons set forth under (1) will allow for a lesser distance.

b. On curves, adequate sight distance for the design speed of the highway must be maintained.

C. REQUIREMENTS FOR SIGHT DISTANCE:

A clear line of sight must be maintained at all highway intersections and entrances. Generally, shrubs, plantings or other obstructions in
this zone must be limited to an ultimate height of 18" or less to allow a clear line of sight down the highway in either direction for at least 400' from the front of the vehicle located 10' behind the edge of the highway to be entered. (See illustration 'E'.)

D. CULTURAL REQUIREMENTS FOR PLANTS:

Use plants that require minimal maintenance and are hardy to the area. Avoid plants that are messy, brittle, short lived or subject to infestations of insects or disease. Plants used in areas where sight distance must be maintained shall have a mature height of 18" or less.

E. VISIBILITY OF HIGHWAY FEATURES:

The visibility of highway signs, delineators, edges of sidewalks, curbs, roadway or guardrail must be maintained at all times. Therefore, provide sufficient plant setbacks and plants with mature sizes that will not outgrow spaces to avoid costly trimming as plants mature.

IV. DETAILS

A. Plans shall include, as appropriate, planting details for trees, shrubs, ground cover, vines, and cacti showing size of planting pit in relation to size of plant ball. (See planting details.)
B. Plans should include staking or guying details as required by the size and species of plant proposed. (See planting/staking details.)

C. Plans should identify problem soils and propose appropriate measures to overcome them.

D. If a mineral surface treatment is proposed, details should be included to indicate the depth, gradation, color and the vertical relationship to the roadway curb or sidewalk. A pre-emergent herbicide should be specified to preclude weeds in these areas. (See Granite and Rock Mulch details.)

E. Details for headers, signs, walls, sidewalks, planters, etc., should be included whenever proposed.

V. MAINTENANCE

A. Problems in maintenance shall be anticipated during the design phase. Changes in environmental conditions should be anticipated.

B. It shall be the responsibility of the permittee to assure that all landscaping and irrigation can be maintained to the satisfaction of ADOT.
ILLUSTRATION 'C'
ILLUSTRATION 'D'

TREE or OTHER FIXED OBJECT

6' Min.

ROADWAY

5"+ HIGH CURB
204.3 - Grades

A) Minimum grades: The desirable minimum grade for a highway with a curb and gutter section is 0.4 percent. Special care should be taken in checking storm water drainage requirements to keep the spread of water on the traveled way within tolerable limits.

Above 4000 ft elevation the minimum grade for roadways with curb and gutter shall be 0.5 percent.

Level grades may be used on rural highways below 4000 ft elevation with adequate roadway crown and with proper consideration of drainage requirements.

B) Maximum grades: The maximum grades which may be used are shown in Table 204.3 for each type of highway and its allowable range of design speeds.

Exceptions to the maximums shown in Table 204.3 shall require the approval of the Assistant State Engineer, Roadway Engineering Group.

<table>
<thead>
<tr>
<th>Table 204.3</th>
<th>Relation of Highway Types to Maximum Grades</th>
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<tbody>
<tr>
<td>Conditions</td>
<td>Design Speed (mph)</td>
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<tr>
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<td>Controlled Access Highways</td>
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<td>Level Terrain</td>
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<td>Rural Divided Highways</td>
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<tr>
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Note: Maximum grades shown in **bold** correspond to the design speed for given conditions, see Table 101.3. Grades at other design speeds are for information only.