ARAPAHOE COUNTY
TRAFFIC OPERATIONS
POLICY AND PROCEDURES

December 29, 2017

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1A.01

TRAFFIC OPERATIONS POLICY AND PROCEDURES

BACKGROUND

Traffic Operations is responsible for the operation and maintenance of all traffic signals, pedestrian signals, flashing school and warning beacons, radar speed limit signs, all other signal related devices and all signs/markings in unincorporated areas of Arapahoe County. The County has a computerized traffic control signal system which enables the traffic engineer to control the timing and operation of signals that are connected to the system from the County engineering facility. It also enables the traffic engineer to monitor the operation of the signals and notify the engineer of any interruptions to normal operations or malfunctions on a real time basis.

The County retains the services of a private traffic signal maintenance company to maintain its traffic signals and other related signal devices. Technicians are on call 24-hours a day, seven days a week, to handle emergencies.

The first part of this document reflect criteria utilized for day to day operations and criteria that warrant the more frequently requested placement of traffic control devices in Arapahoe County. Actual procedural steps for these day to day and other traffic related operations are outlined in the lateral part of this document.

1A.02 TRAFFIC SIGNS

BACKGROUND

The purpose of a sign is to convey clear, reliable information and guidance so there will be an orderly and predictable movement of traffic. The three basic types of signs and their intended uses are summarized below.

Regulatory

Is used to inform users of traffic laws and regulations which apply at definite locations and at specific times.

Typical uses are:

- Intersection control
- Definition of right-of-way
- Speed limits
- Turning movement control
- Pedestrian control
- Exclusions and prohibitions
- Parking control and limits
- Regulations for maintenance and construction

Warning

Is used to warn traffic of unusual or potentially hazardous condition(s) on or adjacent to a street or highway.

Typical uses are:

- Horizontal and vertical alignment
- School areas
- Crossings and entrances to streets, highways and freeways
- Intersection areas
- Road construction and maintenance

Guide

Is used to provide simple and specific information to aid motorists in reaching their destination.

Typical uses are:

- Route markings
- Destination signing
- Information Signing
- General services
- Parks and recreation signing

Street name signs are placed to serve as guidance and safety devices at various locations.

- **Stop Controlled Intersections (4-way intersections)**
  Street name signs shall be placed above the stop signs at a two-way stop controlled intersections. When the main street is a north/south street the street name signs will be placed on the northeast and southwest corners. When the main street is an east/west street the street name signs will be placed on the northwest and southeast

corners. When the intersection is controlled by an all-way stop the signs will only be placed on the northeast and southwest corners.

- **T-intersections, Right Angle Intersections and Curved Alignment**

Only one location will require a street name sign in these locations. The street name signs shall be located above the stop sign at T-intersections. Right angle intersections will have the sign located on the inside corner of the curve, and likewise for the curved alignment.

- **Signalized Intersections**

Street Name signs shall be placed overhead on the traffic signal mast arm at signalized intersections.

Maintenance of traffic control devices should be to high standards to assure that legibility is retained, that the device is visible, and that it is removed if no longer needed. A portion of the traffic signs will be inspected annually in day and night time conditions to assure that these standards are being met. The signs that are graded as poor will be scheduled for replacement and changed out as soon as possible.

To ensure uniformity, the Manual on Uniform Traffic Control Devices (MUTCD) defines which signs are approved for use across the nation. This includes the color, shape, legend/symbols, lettering, size, reflectorization, and illumination for each sign as well as placement guidelines.

A portion of the traffic signs will be inspected annually in day and night time conditions to assure that these standards are being met. The signs that are graded as poor will be scheduled for replacement and changed out as soon as possible.

Before each sign is installed in the field a trained staff member takes 3 retro readings on the sign to be installed with a County owned Retro Sign GR3 Retroreflectometer.

Background and Legend readings are recorded and written on the back of the sign. The reading is also stored in the County asset management software.

Non-standardized signs, such as “CAUTION – CHILDREN AT PLAY”, “SLOW – CHILDREN”, ETC. will not be installed. The two examples infer that children are permitted to play in the street. On the contrary, every means should be used to discourage children from playing in a roadway. Warning signs such as “DEAF CHILD” are considered a standardized sign, however, because they alert the motorist to a potential problem at a specific location.

1A.03 POLICY SIGNS

Arapahoe County will install standardized signs as specified in the Manual on Uniform Traffic Control. (MUTCD). Federally approved high illumination and/or lighted signs and other ITS related devices used to heighten awareness of a condition will be considered on a case by case basis.

GUIDELINES

The warrants and placement guidelines for all standardized signs are contained in the MUTCD. These guidelines are straightforward and apply to most situations. The major exception, however, pertains to multi-way stop controls in residential areas. To aid county staff and public officials in determining which locations qualify for this type of control, multi-way stops in residential areas will be considered when two or more of the following guidelines are met:

- **Installation**

  Results of engineering studies should indicate the locations of where signs are deemed necessary. The MUTCD gives height and lateral locations for typical installations, of which, the County models. All temporary signage is monitored and is removed when the associated temporary work is completed.

- **Maintenance**

  On-going inspections are conducted to maintain high visibility, reflectivity, day & night and high legibility. Daily inspections are on-going by the Road & Bridge Signs & Markings staff to report deficiencies.

1A.03a MEMORIAL SIGN POLICY

The Department will review and consider for approval all requests for Roadside Memorials in unincorporated Arapahoe County Right of Way according to the following documents which are hereby adopted by the Department. All memorials must meet County criteria described below and be approved by County PWD Traffic Staff.

I. PROCEDURES:

- The Public Works and Development Transportation Division Traffic Section shall review all requests for Roadside Memorial Signs within unincorporated Arapahoe County Right of Way.

- The fee for manufacturing, erecting and maintaining the sign is $100.00.

- Applicant will be required to remit a check payable to Arapahoe County in the amount of $100.00 once sign application is approved.

- Applications should be made within one year of the crash date.

- A Roadside Memorial Sign Application with a County Letter of Consent shall be submitted prior to approval.

- Applications will only be accepted from the family of the victim or other sponsors that have an approved family consent letter.

- Roadside Memorial will consist of signs made by the County to standard specifications to be installed and maintained by the County for the duration of the memorial period.

- Standard sign size will be 24" x 30". Blue background with White lettering. Wording on sign will be approved by County PWD Traffic Staff.

- Arapahoe County will make every effort to install the signs at the approximate location of the crash site. However signs will not be placed in front of a residence or business and cannot create a distraction from traffic control devices.

- Signs will be installed on the right-hand side of the road. No signs will be erected in the median or on the left-hand side of the road.

- Final decision of location and orientation will remain with the County PWD Traffic Section Staff.

- Multiple signs will not be permitted at same location.

- Multiple names associated with the same event will be permitted on the same sign only with approved written consent letter from all families.

- The County reserves the right to reject any application.

- When two year memorial period has concluded or removal of the sign. The sign will be donated to the victim's family. Otherwise the sign shall remain property of Arapahoe County.

- Any request for memorial signs on Colorado State Highways within Unincorporated Arapahoe County. Contact information for Colorado Department of Transportation (CDOT) concerning a memorial sign application can be obtained from the Safety and Traffic Engineering Branch, CDOT (303) 757-9662 or EMAIL: Roadside.Memorial@DOT.State.CO.US

Memorial Erected by a Private Party non- permitted **in Public Right-of-Way**
Because of the emotional significance represented by memorials placed in memory of a deceased person, County PWD Traffic Section staff encountering such memorials should make every effort to identify the owner and try to work with them on finding an alternate location within private property for this memorial. If an alternate location is not available, County Traffic Section staff shall require the owner to remove the unauthorized sign or memorial and as an alternative, pursue the County's Memorial Sign Program to remember and honor the life of a loved one. This Program is available through the County's Public Works Department.

The County has adopted the Model Traffic Code for Colorado. Part 6 Signals, Signs and Markings of the Model Traffic Code, Section 606 states display of unauthorized signs or devices provides for local authority to remove such signs and devices without providing notice. If the owner cannot be located, PWD Traffic Section staff shall have the Road and Bridge Division remove the signs or roadside memorials if they create a visibility concern or hazard in the public right-of-way. The items removed shall be kept and stored for two weeks from the date of removal to allow the owner the opportunity to claim and pick up the items.

1A.04 MULTI-WAY STOPS

- At the intersection of two collector streets that are primary to the area.

- Where there is at least a 60-40 percent volume split for a four-way intersection (i.e. of the total daily volume on both streets, 50 to 60 percent enters the intersection on Street "X" and 40 to 50 percent enters on Street "Y").

- Where there is at least a 75-25 percent volume split for a three-way intersection (i.e. of the total daily volume on both streets, up to 75 percent enters the intersection on Street "X" and 25 percent or more enters on Street "Y").

- Where there are three or more correctable accidents in 1 year

- At designated school crossings (Refer to Crosswalk Guidelines).

- Locations where a road user, after stopping, cannot see conflicting cross traffic and is not able to reasonably, safely negotiate the intersection unless conflicting cross traffic is also required to stop.

- At intersections where engineering judgement, site characteristics and/or site observations/surveys suggest a multi-way stop would make the intersection safer.

1A.05 SIGN SPECIFICATIONS

1. All Signs shall conform to current Manual on Uniform Traffic Control Devices (MUTCD) Specifications.

2. All signs shall be installed on Telespar post with Telespar anchors at proper heights per current MUTCD Standards.

3. Sign material shall be as follows:

    a. 36” x 36” or less shall be .080 gauge aluminum – pre-punched holes.

    b. 48” x 48” or larger shall be .100 gauge aluminum – pre-punched holes.

    c. 36” x 9” shall be .080 gauge aluminum – pre-punched holes.

    d. 42” x 9” shall be .080 gauge aluminum – pre-punched holes.

4. All signs shall be High Intensity Prismatic (HIP) or Diamond Grade Reflective (DG) Type 11 Sheeting with at least ten year guarantee, or approved equal. Legends and symbols shall be made with Electro Cut (EC) Film may also use traffic grade inks with approved laminate. The County reserves the right to request material changes to signs.

5. Sign sheeting standard, use reflective white background with green EC Film may also use traffic grade inks with approved laminate on top layer with reverse weed which shows the reflective white blocked uppercase and lowercase letters, numbers and arrows.

6. Street and Avenue signs for post mounting shall be aluminum, 9” x 36” (minimum)
   9” x 42” (maximum) in length.

7. Please contact Signs and Markings Supervisor for sign lay out and font sizes. (720) 874-6777

URBAN

RURAL

8. At signalized intersections these signs shall be sized in accordance with Specifications for Oversize Street Signs or approved equal in the Highway Standards. Use Word Font D – Initial uppercase letters at least 12 inches and lowercase letters at least 9 inches in height.

9. All signs shall be mounted with County approved bolts, nut and washers.

10. Telespar type post and anchors shall meet or exceed the following:

    (All Telespar post shall be attached to anchors with 3/8" corner bolt with nut. Rivets will not be allowed)

    a. Post – 1 ¾" x 1 ¾" x 10' – 11' – 12' = 14 gauge, ASTM Specification No. A446, Grade A, Drilled on 1" centers.
    b. Anchors – 2" x 2" x 3', 12 gauge, ASTM Specification No. A446, drilled on 1" centers.

    c. Post – 2" x 2" x 10' – 11' – 12' = 14 gauge, ASTM Specification No. A446, Grade A, Drilled on 1" centers.
    d. Anchors – 2 ¼" x 2 ¼" x 3', 12 gauge, ASTM Specification No. A446, drilled on 1" centers.
    e. All post and anchors shall be galvanized to ASTM Specification A525 coating designation G90

11. Wood/Metal/Fiberglass/post mounting: Band-It Type #201 ¾" stainless steel band, Band-It Type #201 ¾" Ear-Lokt-Buckle, Band-It Type #D022 ¾" Bracket, 5/16" x ¾" Bolt w/six- sided head, 5/16" washer.

12. Sign shall have a seven foot (7') clearance (minimum) from the bottom of sign to the ground at installation, or as approved by MUTCD Standards.

13. All multiple mounted signs on single post, the lowest sign shall be no lower than six (6') feet on urban roadways, with a one (1") gap between signs. The lowest sign shall be seven (7') feet if near pedestrian or parking traffic. All signs placed in rural setting shall be installed to current MUTCD Specifications.

14. All signs placed with the exception of STOP and YIELD signs, Shall be near property lines; they are not to intrude on driveways, doorways or any type of entrance.

15. For all street name signs, the signs shall be bolted at the ends with County approved bolts, nuts and washers.

16. Signs shall be placed behind curb to minimum specifications according to MUTCD. (Part II Signs) Standards.

17. Signs shall be placed a minimum of five (5') feet from fire hydrants.

18. Placement of "STOP" signs shall be in accordance with County Standards. Behind curb, ramp or crosswalk with the minimum of 36" inches behind sidewalk at the radius point or as approved by County Transportation Division.

19. Signs placed in concrete shall be either core drilled with a 4" inch hole, or a piece of 4" inch PVC pipe may be poured into the full depth of the concrete and flush with the top of concrete.

20. All sign placement shall call for current utility locates (**811**) Call before you Dig. Current locates shall be established before final inspection of sign installation.

PROCEDURES: Street name signs are placed to serve as guidance and safety devices at various locations.

- **Stop Controlled Intersections (4-way intersections)**

Street name signs shall be placed above the stop signs at a two-way stop controlled intersections. When the main street is a north/south street the street name signs will be placed on the northeast and southwest corners. When the main street is an east/west street the street name signs will be placed on the northwest and southeast corners. When the intersection is controlled by an all-way stop the signs will only be placed on the northeast and southwest corners.

- **T-intersections, Right Angle Intersections and Curved Alignment**

Only one location will require a street name sign in these locations. The street name signs shall be located above the stop sign at T-intersections. Right angle intersections will have the sign located on the inside corner of the curve, and likewise for the curved alignment.

- **Signalized Intersections**

Street Name signs shall be placed overhead on the traffic signal mast arm at signalized intersections.

1A.06 CROSSWALKS

BACKGROUND

The primary purpose of marked crosswalks is to guide pedestrians in a proper path when crossing the street. Crosswalks can be designated at controlled intersections, uncontrolled intersections, or mid-block locations. When no control is provided, the crosswalks also serve as a warning to motorists that a pedestrian crossing point exists. With uncontrolled crossings, advance warning signs are required.

Crosswalks should be considered whenever there is a clear need for increased visibility and designation of a crossing area. Marked crosswalks are found at:

- Signalized intersections equipped with pedestrian signals
- Designated school crossings
- Crossings at a two-way and four-way stop intersections
- Intersection crossings with unusual geometric design where the pedestrian path is confusing and could lead to potential conflict

1A.06 POLICY CROSSWALKS

Arapahoe County will use the following guidelines for crosswalks:

Functional Classification	General Requirement	Specific Locations
Arterial Streets	Controlled Intersections	Signalized intersections which are equipped with pedestrian signals. Multi-way stop intersections which are designated as approved school crossings.
Collector Streets	Controlled and Uncontrolled Intersections	Signalized intersections which are equipped with pedestrian signals. Any intersection which is designated as an approved school crossing. Any intersection which meets the County's warrants.
Local Streets	Controlled and Uncontrolled Intersection as well As mid-block locations	Any location which is designated as an approved school crossing. Any location which meets the County's warrants.

REQUIREMENTS

In order for Arapahoe County to designate a location as an approved school crossing, the school district MUST submit to the County a probable school-age pedestrian route map(s). The designated route(s) should be designed to assure that the children:

- Form into a group as soon as possible to be more readily visible to motorists.
- Cross the fewest number of streets to reduce vehicle/pedestrian exposures. When determining which streets to cross, factors such as vehicle approach speeds, traffic volumes, and road geometry should be considered.
- Walk on sidewalks or paths where available.
- Walk the shortest possible distance on streets without sidewalks or shoulders.
- Avoid high speed, high volume roadways.
- Make maximum use of protective techniques, (crossing guards, traffic control devices).
- Use easements with walkways through parks or other available areas where student safety is maximized.

County staff will then review the plans and work with School District personnel in determining which crossings should be marked and signed. Engineering judgment which considers factors such as the number of children crossing, the location of crossing with respect to the school, and the physical characteristics of the area will be used in making the final decision.

The Arapahoe County warrants for non-school related crosswalks are listed below:

Functional Classification	Street Volume (1)	Pedestrian Crossing Volume (2)	Speed Limit
Arterial	600	50	35+ MPH
Collector	300	25	25-35 MPH
Local (3)	100	15	20-30 MPH

1. Minimum traffic volume for a 1-hour period.
2. Minimum pedestrian volume for the same 1 hour period

3. The warrants for a local street only apply to a crossing which serves a recreational area or provides continuity in a trail system.

Both Advance and Crossing signs should be used in conjunction with designated crosswalks. The Advance sign should be placed 150 to 200 feet before the crosswalk while the Crossing sign should be located at the actual crosswalk. Crossing signs will not be used at crosswalks that have stop sign control. The design of both signs is governed by the Manual on Uniform Traffic Control. (MUTCD)

Note: Not all conditions/areas may relate to the above criteria for non-school related crosswalks. Engineering judgement should be used where the above conditions cannot be met but may justify marked crosswalks (i.e., parks, seasonal recreation areas, etc.). The MUTCD, however, should be used as a guideline to any crosswalk considerations. MUTCD design sign standards and specifications shall always apply.

1A.07 PAVEMENT MARKINGS

The work in this contract shall consist of the Contractor furnishing all labor, equipment, and materials for removal and installation of permanent pavement markings in arterial, collector, local streets, and selected facilities within the ARAPAHOE COUNTY GOVERNMENT.

The Arapahoe County Road & Bridge maintains the pavement markings on all public right-of-ways after completion of the two (2) year warranty period. All installed pavement markings shall be installed in accordance to the standards and latest revisions of the (MUTCD) Manual on Uniformed Traffic Control Devices, Federal Highway Administration Standard Specifications for Road and Bridge Construction, Colorado DOT, and ARAPAHOE COUNTY GOVERNMENT.

At intersections all markings shall be of a permanent type marking, to include but not limited to: Crosswalks, Stop Bars, Arrows, and Onlys.

All new roadways shall be painted using epoxy paint unless otherwise approved by the County Traffic engineer, and shall be painted with a full striping width of 15 mils when applied. Drop on glass beads shall be applied at the rate of no less than seventeen (17), and no more than twenty-five (25) pounds per gallon of paint using Potters P-20+ 80% round.

PART I – GENERAL

All pavement markings shall be placed in accordance with the following requirements:

When the term "full compliance" is used, it means pavement markings shall meet the requirements of these specifications.

A. *Pavement Marking Plan.* When pavement marking location details are not provided in the Contract, the Contractor shall submit a layout of existing conditions to the County for approval or modification. This layout is to be used as the final pavement marking plan. The layout of pavement marking shall be the responsibility of the contractor. The County Project Representative will review each project site for final marking placement.

B. *Roadways Closed to Traffic During Construction.* Full compliance pavement markings shall be in place on all roadways prior to opening traffic. The County Project Representative will determine the location and need for full compliance prior to roadways being open to traffic.

C. *Roadways Constructed Under Traffic.* Full compliance final pavement markings shall be placed within two (2) weeks after final surfacing is completed. Full compliance pavement markings shall also be placed on any roadways open to traffic when the project pavement work is discontinued for more than two (2) weeks. The County Project Representative will be responsible for coordinating the schedule for the installation of the markings within this two (2) week period.

D. Temporary pavement markings and control points for the installation of those pavement markings for roadways that are being constructed under traffic are as follows:

1. When one roadway of a normally physically divided highway is closed, and a crossover is constructed, full compliance pavement marking shall be placed along the tapers and through the median crossovers to the two-way traffic section. Pavement marking through the two-way traffic section shall be as shown on the plans.

   When a two-lane highway is closed, and a bypass detour is provided, full compliance pavement markings shall be placed the full length of the detour prior to operation of the detour.

   In either case, the type of marking materials applied to a final surface, when removed, shall not leave a scar that will conflict with permanent markings.

2. The following criteria apply to all construction and maintenance on roadways open to traffic other than (D) 1 above.

   Control points, four-inch by two-foot marks at 40-foot intervals, are guide

markers for the installation of temporary and/or full compliance markings.

All temporary broken-line pavement markings shall be installed daily and shall be at least 18 inches long with a maximum gap of 38 feet. An 18-inch stripe with a maximum gap of 18 feet shall be used on curves for roadways with severe curvature. A severe curve is defined as a curve whose safe speed is 10 mph or more below the approach posted speed limit.

Temporary pavement markings for "no passing zones" shall be full compliance.
For a short-term situation (3 calendar days or less) where temporary broken center lines are installed, "no passing" restrictions may be identified by appropriate signs including R4-1 and R4-2 until final markings are installed.

For roadways with a volume of 750 ADT or less, "no passing" restrictions can be identified for up to two (2) weeks with appropriate signs.

Temporary pavement stencils (school, railroad, etc.) are not required unless detailed on the plans.

Temporary pavement markings shall be installed per manufacturer's recommendations in such a way that the markings adequately delineate the desired alignment.

E. Control points, temporary pavement markings, and Contractor pavement marking plans will not be paid separately, but shall be included in the work.

PART II – MATERIALS AND EXECUTION

A. Pavement Markings with Paint (Waterborne)

Description. Low VOC, ready mixed, one component, 100% acrylic waterborne traffic paints.

All paints shall be suitable for application to Asphaltic or Portland cement concrete pavements when applied with or without glass beads.

Striping shall be done when the air and pavement temperatures are at least 50° F and rising. The pavement surface and weather conditions shall be conducive to satisfactory results.

Equipment shall be capable of painting a reasonably clean-edged stripe of the designated width (± ¼ in.) and shall have a bead dispenser directly behind synchronized with the paint applicator. For centerlines and lane lines, an automatic skip control shall be used

that will paint a stripe with a gap, as shown on the plans. Machines having multiple applicators shall be used for centerlines with "no passing zones." In areas where machines are not practical, suitable hand-operated equipment shall be used. All stripes shall be protected until dry. Paint and beads shall be applied within the following limits using Potters P20+, 20% DM 80% round.

Application Rate or Coverage per Gallon of Paint

	MINIMUM	MAXIMUM
Paint:	100 sq. ft.	110 sq. ft. (Approximately 15 miles when wet)
Beads:	5 lbs. 13 oz.	6 lbs. 3 oz.

Pavement marking paint shall conform to the requirement listed in the table below. All proportions are by weight.

Pigment composition and vehicle composition shall not vary by more than 1.0 percent of each amount specified.

Characteristics:	YELLOW	WHITE
Viscosity at 77 degrees F, KU	80-90	80-90
Dry to no pick up time, ASTM D-711 without beads, minutes max.	3 max.	3 max.
No-Track time, Actual @ 77 degrees F/50% RH, seconds max.	90 max.	90 max.
Directional Reflectance % min.	87 min.	50 min.
Contrast Ratio @ 15 mils wet min.	0.98 min.	0.95 min.
Scrub test, Cycles min.	1000 min.	1000 min.
Volatile Organic Compound, grams/liter 150	Below 150	Below 150
Total Pigment, % By Weight min.	62 min.	62 min.
Total Solids, % By Weight min.	76 min.	76 min.
Total Solids, % By Volume min.	58 min.	58 min.
PH min.	9.6 min.	9.6 min.

Reportable Components:

YELLOW	Vapor Pressure mm Hg @ Temp °F		Weight Percent
METHYL ALCOHOL	97.68	68	5
QUARTZ SILICA	N/A	N/A	0.32
OSHA PEL = 200 PPM (skin) (260 MG/M3), STEL 250 PPM			
ACGIH TLV = 200 PPM (skin) (260 MG/M3) STEL 250 PPM			
NIOSH = TWA 200 PPM, 800 PPM (CEILING)			
2,2,4 TRIMETHYL - 1,3 - PENTANEDIOL MONOISOBUTYRATE			1
NOISH REL = TWA 0.05 MG/M3, 3,000,000 FIBERS/M3			
OSHA PEL = TWA RESPIRABLE: 0.1 MG/M3 TOTAL DUST: 30 MG/M3			
ACGIH TLV = TWA RESPIRABLE: 0.1 MG/M3			

WHITE	Vapor Pressure mm Hg @ Temp °F		Weight Percent
METHYL ALCOHOL	98.68	68	5
QUARTZ SILICA	N/A	N/A	1.24
OSHA PEL= 200 PPM (SKIN), STEL 250 PPM			
ACGIH = 200 PPM (SKIN), STEL 250 PPM			
NOISH = TWA 200 PPM, 800 PPM (CEILING)			
2,2,4 TRIMETHYL - 1,3 - PENTANEDIOL MONOISOBUTYRATE			1
NIOSH REL = TWA 0.05 MG/M3, 3,000,000 FIBERS M/3			
OSHA PEL = TWA RESPIRABLE: 0.1 MG/M3, TOTAL DUST: 30 MG/M3			
ACGIH = TWA RESPIRABLE: 0.1 MG/M3			

B. Epoxy Pavement Markings

The epoxy pavement-marking compound shall be applied with equipment that will precisely meter the two components.

The equipment shall produce the required amount of heat at the mixing head and gun tip to provide and maintain the temperatures specified.

Before mixing, the individual components A and B shall each be heated to a temperature of 80° F to 140° F. After mixing the application temperature for the combined material at the gun tip shall be 80° F to 140° F. The 140° F upper limit is the maximum temperature under any circumstances.

Both pavement and air temperatures shall be at least 50° F at the time of epoxy

pavement application.

The surface areas of new Portland cement concrete pavement and decks that are to receive markings shall be sandblasted prior to placement of the epoxy pavement marking. The amount of sandblasting shall be sufficient to remove all dirt and curing compound residue.

The surface areas of new asphalt pavement, existing asphalt pavement, and existing concrete pavement that are to receive markings shall be cleaned with a high-pressure air blast to remove loose material prior to placement of the epoxy pavement marking. Any pavement which has become dirty from tracked mud, etc., as determined by the Project Representative and shall be cleaned prior to the placement of the epoxy pavement marking.

When recommended by the epoxy manufacturer, a high-pressure water blast integrated into the gun carriage shall be used to clean the pavement surface prior to epoxy pavement marking application. The water blast shall be followed by a high-pressure air blast to remove all residual water leaving only a damp surface.

Epoxy pavement marking shall be applied to the road surface according to the epoxy manufactures recommended methods at **15 mils minimum thickness**. Glass beads shall be applied into the epoxy pavement marking by means of a pressurized bead applicator at a rate of no less than (17), and no more than (25) pounds per gallon.

Epoxy pavement marking and beads shall be applied within the following limits:

	MINIMUM	MAXIMUM
15 mil Marking:	100 sq. ft.	110 sq. ft.
Beads:	17 lbs.	25 lbs.

Epoxy Pavement Marking Material:

1. *Formulation*. Epoxy pavement marking material shall be a two component, 100% solids, material formulated to provide simple volumetric mixing ratio of two volumes of component A and one volume of component B, unless otherwise recommended by the material manufacturer.
2. *Composition.* The component A of both white and yellow shall be within the following limits:

Pigments:	White:	Yellow:
	Min% by weight 18% Titanium Dioxide, (ASTM D 476 Type II)	Min% by weight 23% Chrome Yellow,(ASTM D 211,Type III)
Epoxy Resin	75-82%	70-77%

3. *Epoxy Number.* The epoxy number of the epoxy resin shall be 0.38 ± 0.05 as determined by ASTM D1652 for white and yellow Component A on pigment free basis.

4. *Amine Number.* The Amine number on the curing agent (Component B) shall be 410 ± 50 per ASTM D2071.

5. *Toxicity.* Upon heating to application temperature, the material shall not produce fumes, which are toxic or injurious to persons or property.

6. *Color and Weather Resistance.* The mixed epoxy compound, both white and yellow, when applied to 3-inch by 6-inch aluminum panels at 15 ± ½ mils of thickness with no glass beads and exposed in the Q.U.V.

   Environmental Testing Chamber as described in ASTM G 53 shall conform to the following minimum requirements: (The test shall be conducted for 75 hours at 50° C, 4 hours humidity, and 4 hours U.V., in alternating cycles. The prepared panels shall be cured at 77° F for 72 hours prior to exposure.) The color of the white epoxy system shall not be darker than Federal Standard No. 595A17778. The color of the yellow epoxy system shall conform to Federal Standard No. 595A13538. The gloss values of both samples shall not be less than 70° after the test.

7. *Drying Time.* The epoxy pavement marking material shall have a setting time to a no-tracking condition of not more than 25 minutes at a temperature of 73° F and above.

8. *Curing.* The epoxy material shall be capable of fully curing under the constant surface temperature condition of 25° F and above.

9. *Adhesion to concrete.* The catalyzed epoxy pavement marking material, when tested according to ACI Method 503, shall have such a high degree of adhesion to the specified (4,000 psi minimum) concrete surface that there shall be a 100% concrete failure in the performance of this test.

10. *Hardness.* The epoxy pavement marking materials, when tested according to ASTM D 2240, shall have a Shore D Hardness between 75 and 100. Samples shall be allowed to cure at room temperature (75° F ± 2°F) for a minimum of 12 hours and a maximum of 48 hours prior to performing the indicated test.

11. *Abrasion Resistance.* The abrasion resistance shall be evaluated on Taber Abrader with a 1000-gram load and CS-17 wheels. The wear index shall be calculated based on ASTM test Method C-501 and the wear index for the catalyzed material shall not be more than 70. The test shall be run on

cured samples of material, which have been applied at film thickness of 15 ± ½ mils to code S-16 stainless steel plates. The samples shall be allowed to cure at 75° ± 2° F for a minimum of 48 hours prior to performing the indicated tests.

12. *Tensile Strength.* When tested according to ASTM D 638, the epoxy pavement marking materials shall have a tensile strength of not less than 6,000 pounds per square inch. The Type IV Specimens shall be cast in a suitable dynamic testing machine. The samples shall be allowed to cure at room temperature (75° F ± 2° F) for a minimum of 12 hours and a maximum of 48 hours prior to performing the indicated tests.

13. *Compressive Strength.* When tested according to ASTM D 695, the catalyzed epoxy pavement marking materials shall have a compressive strength of not less than 12,000 pounds per square inch. The cast sample shall be conditioned at room temperature (75° F ± 2° F) for a minimum of 12 hours and a maximum of 48 hours prior to performing the tests. The rate of compression of these samples shall be no more than 1/4-inch per minute.

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C. Types of equipment:

1. *Portable applicator*. The portable applicator shall be a device typically used for painting crosswalk lines, stop bars, short lane lines, and short lane center lines. The applicator shall be easily maneuverable and capable of being propelled by the operator.

2. *Mobile applicator*. The mobile applicator shall contain equipment to provide for automatic installation of skip lines in any combination of line and skip up to 40 feet. The mobile applicator shall be moved in conjunction with the melting and heating kettles in such a manner as to provide continuous highway operation of the kettles and the mobile applicator as an integral unit.

3. *Epoxy Primer Equipment.* The epoxy primer application shall be accomplished using equipment having the following features:

   a. The main storage tank shall be equipped with a visible gauge which will allow the Engineer to readily ascertain the rate of application.

   b. The main storage tank shall be equipped with a heating device which will maintain the epoxy at a constant efficient temperature.

   c. The spray nozzle and epoxy spray shall be protected from the action of wind to insure placement where needed.

4. *Cleaning Equipment.* Equipment must be provided to ensure removal of dust, debris, paint, and other foreign matter from the road surface immediately prior to the installation of the composition, or immediately prior to the application of primer.

D. Pavement Primers

The type and application rate of epoxy resin primer shall be as recommended by the thermoplastic or preformed plastic pavement marking manufacturer.

A primer application rate of zero will not be accepted, except for thermoplastic marking and inlaid preformed plastic pavement marking placed on new asphalt surfaces as recommended by the manufacturer and approved in writing by the Engineer. However, if the Engineer determines that a new asphalt surface has become soiled, prior to placement of the pavement markings, pavement primer will be required and shall be applied as approved.

The epoxy resin primer material may be accepted at the job site on the basis of a manufacturer's certification, or a sample may be sent to the Laboratory for testing, in which case three weeks shall be allowed between sampling and intended use.

E. Preform Thermoplastic / Existing Overlay or Older Top Surface Application:

1. All symbols and legends shall comply with the Manual on Uniformed Traffic Control Devices including metric requirements.

2. After the marking has cooled down, a chisel test shall be performed to ensure that a proper bond has been achieved.
3. Road and ambient temperature should have no effect on the performance of the marking material.

4. Dry asphalt of existing moisture. Do not install marking if it is raining or snowing. Wait to install marking 24 hours after it has stopped raining.

5. Do not apply marking on top of salt or other deicers. Wait for 2 or 3 heavy rainfalls prior to installing the marking material, or use a pressure washer.

6. The road must be free of dirt, dust, chemicals, and significant oily

substances.

7. The material can be placed over existing preformed thermoplastic, if existing material has been heated with a torch, and the majority has been lifted with a shovel.

8. On Portland cement concrete roads, a sealant may be needed to ensure a proper bond. **(Check manufacturer's recommended instructions for installations.)**

9. Curing compounds must be sandblasted or grinded on new Portland cement concrete to ensure adequate bonding.

10. All leading edges of the pavement markings shall be feathered due to snowplow damage.

11. Glass beads shall be sprinkled onto the pavement marking material surface. This will enhance initial retro-reflectivity and aide in cooling the markings. It is important to keep all traffic off the pavement marking material to prevent damage.

12. Crosswalks, stop bars, sidewalks, and access ramps that have any loose glass beads shall be cleaned thoroughly with a leaf blower immediately after pavement marking is installed.

Pavement marking tape (removable) shall be installed in accordance with the manufacturer's recommendations and maintained throughout the required construction phase at no additional cost to the County.

Pavement marking tape designated in the pay item as removable shall conform to ASTM D 4592, Type I, and shall be 4 ± 0.1 inches wide.

1. *Description.* The marking tape shall consist of weather and traffic resistant yellow or white colored reflective material. The material shall consist of conformable (metal foil) backing with a pressure-sensitive adhesive design for adhesion to asphalt or concrete surfaces.

2. *Requirements:*
   a. *Color.* The color of the visible or outer surface shall closely match the white or yellow traffic marking paint specified for highway delineation. Glass beads shall be strongly adhered to the tape.

   b. *Reflectance.* The white and yellow tapes shall have the following initial minimum reflectance values at 0.2° and 0.5° observation angles and 86.0° entrance angles as measured in accordance with

the testing procedures of Federal Test Method Standard 370. The photometric quantity measured is specific luminance (SL) and is expressed as millicandelas per square foot per foot-candle.

Color	White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°
Specific Luminance	1360	760	820	510

a. *Adhesive.* The striping tape shall be supplied in rolls ready for application and have a protected pressure sensitive adhesive, which shall not have a protective liner nor require a solvent activator.

b. *Adhesion.* The material shall adhere to asphalt and concrete surfaces when applied at surface temperatures of 35° F and above. Once applied, the tape shall adhere to the pavement at sub-freezing temperatures.

c. *Conformability.* The material shall be thin, flexible, conformable, and show no cracking, flaking, or bead loss. Following application, the tape shall remain conformed to the texture of the pavement surface. The thickness shall not be less than 17 mils.

d. *Removeability.* The tape shall be removable by following manufacturer's recommendations, so long as the material is substantially intact. Removal shall not require sandblast, solvents, or grinding methods.

e. *Durability.* The striping material applied in accordance with manufacturer's recommended procedures shall be weather resistant and show no appreciable fading, lifting, or shrinkage during the useful life of the line.

f. *Packaging and Delivery*. The striping material as supplied shall be of good appearance and free of cracks. The edges shall be true, straight, and unbroken.

g. The Contractor shall specify the material used for temporary pavement markings. Materials shall be durable enough to maintain a minimum reflectivity of 100 millicandelas throughout the life of the detour or their intended use. This may require many applications of temporary pavement markings as determined by the County.

h. Where temporary pavement marking materials are used on new or existing pavement surfaces, temporary pavement markings, or other material shall be used so it can be removed from surface without scarring.

i. The striping material shall be packaged in accordance with accepted commercial standards to prevent damage during shipment and storage. The tape as supplied shall be suitable for use for a period of at least one year following delivery when stored at

temperatures of 100° F or below.

F. Temporary Marking Tabs

Raised pavement markers (temporary) shall be installed on centerlines, edge lines, and lane lines where specified in the contract. Single markers shall be installed at 20' intervals for solid lines. A group of three markers at three-foot spacing and at 40-foot intervals shall be installed for skip lines.

When chip seals, slurry seals, or tack coats are used, temporary marking tabs with covers shall be used, or protect the markers with an approved protective cover, which is removed after the asphalt material is sprayed.

G. Grooved Concrete for Inlay Applications

Prior to installation operation, the Contractor shall submit to the Traffic Engineer instructions from the preformed plastic pavement manufacturer detailing surface preparation, grooving requirements, and material application. The instructions shall include the following:

1. Equipment Requirements
2. Approved Work Methods and Procedures
3. Material Application Temperature Requirements
4. Weather Limitations
5. Special Limitations
6. Special Precautions
7. Any other requirements necessary for successful installation and satisfactory performance of the material.

All materials for use by the County shall have manufacture's installation specifications for installation and shall be supplied to the project representative.

The bottom of the groove shall have a smooth, flat finished surface. This shall be accomplished by utilizing gang-stacking cutting heads having diamond tipped cutting blades. The spacers between each blade shall be such that there will be less than a 10-mil rise in the finished groove between the blades.

The edges of the preformed plastic pavement marking shall be straight and uniform, and uniformly adhere to the pavement.

Grooves shall be clean, dry and free of oil, dirt, grease, paint or other foreign contaminants. Contractor shall protect the grooves from traffic and re-clean grooves as necessary prior to application of the preformed plastic pavement markings.

Grooved width shall be the tape width plus ∀ ¼″. Grooved depth shall be 100% of the tape and adhesive thickness plus 15%. For Series A380-I of A381-I tape,

the grooved depth shall be 80 mils ∀ 10 mils.

Groove position shall be a minimum of 2″ from the edge of the tape to the longitudinal pavement joint.

H. Pavement Marking and Striping Installation

ARAPAHOE COUNTY GOVERNMENT shall make the final determination in regards to the type and location of pavement markings and striping within the right-of-way during the review of the project signing and striping plans.

1. Pavement Markings (Symbols and Legends)

All symbols and legends shall comply with the Manual on Uniformed Traffic Control Devices including metric requirements.

The use of preformed pavement markings shall be used with the installation of all symbols and legends; such as, all arrows, "onlys," school x-ings, bike lane symbols, railroad, etc. on new and overlay streets.

2. Crosswalks

General – Crosswalks shall be used at all signalized intersections where pedestrian signal indications are located and approved pedestrian and school crossing locations.

a. *Standard Crosswalk.* White 8′ long x 12″ wide "Continental" or standard style bars. The placement of these bars shall be 6′ centers

b. *Transverse Crosswalk.* Where applicable, shall be a white 12″ Crosswalk bar on both sides of the designated walkway area, and shall be installed the full asphalt or concrete width of the roadway minus the gutter pans.

3. Stop Bars

a. Stop bars are required at all signalized intersections and locations specified by the County.

b. All stop bars shall be white 24″ wide, the full width of the appropriate travel lane including the designated bike lane, not closer than 4′ from the closest edge of the crosswalk.

4. Bicycle Markings

a. Bike lane markings shall be used on all streets where designated bike lanes are established. These lanes require a bike rider symbol and an arrow symbol (only).

5. Stencil Painting

All stencils used shall conform to MUTCD standards for shapes and sizes.

I. Striping Requirements

Striping over existing markings shall not vary ¼″ along the edge of existing marking. The Contractor may be required to apply markings by means of hand-operated equipment in order to accurately match existing striping at tight radius curves.

The Contractor shall provide flaggers, signs, barricades, cones, or other devices needed to ensure sufficient safety for the motoring public and pedestrian traffic. When parked vehicles interfere with the installation of any pavement markings, the Contractor shall provide a (3) three day notification to the homeowner, tenant, or any business for vehicle removal.
Any tire tracking of paint shall be the Contractor's responsibility for the removal.

J. Removal

Pavement markings removal will be paid by the square foot.

The Contractor shall remove all pavement markings listed in Tabulation of Adjustments.
The following are the required procedures / practices for removal:

a. Pavement markings shall be removed by using a rotary type grinder (a drum type grinder manufactured for this purpose), sandblasting, or by hydro-blasting.
b. Preform plastic material may require using a weed-burning torch.
c. The roadway shall have no more than ¼″ damage after removal of pavement markings.
d. Disposal of materials, as a result of removal, are the responsibility of the Contractor.

The Contractor at his expense shall legally dispose of the material.

1A.08 SPEED LIMITS

BACKGROUND

In the state of Colorado, the following speed limits are applicable if no special hazards exist and there are no posted limits:

- 25 MPH is any business district
- 30 MPH in any residential district
- 55 MPH on paved highways

The maximum safe speed, however, is defined as follows:

"No person shall drive a vehicle at a speed greater than is reasonable and prudent under the conditions and having regard to the actual and potential hazards then existing. Consistent with the foregoing, every person shall drive at a safe and appropriate speed when approaching and crossing an intersection or railroad grade crossing, when approaching and going around a curve, when approaching a hill crest with respect to pedestrians or other traffic or by reason of weather or highway conditions."

As specified in the State Statutes, a local jurisdiction has the authority to change the above speed limits if the adjustment is warranted based on an engineering study. During the study the following factors should be considered.

1. Road surface characteristics, shoulder condition, grade alignment and sight distance.
2. The 85-percentile speed and pace speed.
3. Roadside development and culture, and roadside friction.
4. Safe speed for curves or hazardous locations within the zone.
5. Parking practices and pedestrian activity.
6. Reported accident experience for a recent 12-month period.

In all cases, the maximum posted speed limit cannot exceed 55 MPH. In a school area, special speed limits can be set for certain hours or periods of the day. The speed limits cannot be less than 25 MPH on a State Highway or arterial nor less than 20 MPH on any other road or street. These special speed limits only apply at times when the special condition exists.

1A.08 POLICY SPEED LIMITS

The appropriate State Statutory speed limits will apply on all County roads unless otherwise posted. The posted speed limit, if different from the statutory limit, will be based on the findings of a detailed engineering study.

In all school zones (i.e. Elementary, Junior High and Senior High) within the county, the minimum posted speed limit will be 20 MPH. This limit will only apply during hours of activity defined by the School District and evaluated by County Staff. Specific hours will be shown with the speed limit sign instead of "When Children are Present". Experience has shown that the listing of specific hours is easier to enforce and is more readily understood by the motorists. The extent of the posted school speed zone will be determined during the detailed engineering study.

Requirements

-Prevailing vehicle speeds

- 85 percentile speed
- Pace
- Average test run speeds
- Speed distribution data

-Physical features

- Design speed
- Measurable physical features
    - Maximum comfortable speed on curves
    - Spacing of intersections
    - Number of roadside businesses per mile
    - Sight distance
    - Location of school property

-Roadway surface characteristics and conditions

- Slipperiness of pavement
- Roughness of pavement
- Presence of transverse dips and bumps
- Presence and condition of shoulders
- Presence and width of median
- Presence of bus loading areas

-Accident experience for a recent twelve-month period.

-Traffic characteristics and control

- Traffic Volumes
- Parking and loading vehicles
- Commercial vehicles
- Turn movements and control
- Traffic signals and other traffic control devices that affect or are affected by vehicle speeds
- Pedestrian activity and designation of school routes
- Crosswalks

The results of the analysis, coupled with engineering judgment and input from interested parties, will be used in determining the appropriate speed limit.

1A.09 FLASHING BEACONS

BACKGROUND

Flashing beacons are used to supplement an appropriate warning or regulatory sign/marker when it is necessary to attract more driver attention and to ensure a high probability of driver compliance. Typical applications include:

- Obstructions in or immediately adjacent to the roadway
- Supplemental to advance warning signs
- At mid-block crosswalks
- At intersections where warning is required (e.g. limited sight distance)
- Supplemental to regulatory signs, except the STOP, YIELD, and DO NOT ENTER signs.

The various design and placement requirements for flashing beacons are contained in the Manual on Uniform Traffic Control Devices. (MUTCD)

1A.09 POLICY FLASHING BEACONS

In potentially hazardous locations, Arapahoe County will install a flashing beacon if it is required based on an engineering study.

In school zones, Arapahoe County will install a flashing beacon if it is warranted.

GUIDELINES

Arapahoe County will only fund for and install/maintain flashing beacons for school zones when 2 or more of the following criteria are met OR will allow for the installation of flashing beacons in school zone areas if the devices are funded with other than County funds (i.e., local school district, etc):

- Pedestrian Volume: at least 60 school age pedestrians crossing during a 2-hour period of a typical school day.
- Vehicle Volume: at least 600 vehicles per hour during a period that students cross the street.
- Vehicle Speed: Where the 85th percentile speed is in excess of 35 MPH. (Note: Vehicle speed refers to that of vehicles approaching the beacon)
- Roadway Geometrics: There is no other crossing controlled by a signal, stop sign, or crossing guard within 800 feet of the proposed location.
- Geometry: Where there is a sight distance problem in seeing the school zone.

The flashers will be used with both the advance warning sign and/or the school speed zone signing. The operation of the beacon will be based on procedures contained in the Manual on Uniform Traffic Control Devices (MUTCD).

1A.10 TRAFFIC SIGNALS

BACKGROUND / POLICY

Before a traffic signal can be considered for installation, it must first meet at least one of the eight warrants found in the Manual On Uniform Traffic Control Devices (MUTCD). The MUTCD is a federal document that is adopted by the Colorado Department of Transportation for the State of Colorado that lists guidelines and/or sets of criteria that justify the placement of traffic control devices, including traffic signals.

For traffic signals, the MUTCD lists eight warrants or sets of criteria that justify traffic signal installations. For an intersection to be considered for signalization in Arapahoe County, the intersection must meet at least one of the eight warrants found in the

MUTCD. The eight warrants are primarily based on traffic volume requirements and/or accident history and other elements associated with signal operations. It should be noted, however, that even if a location meets one or more of the eight warrants, a traffic signal should not be installed unless an engineering study indicates that installing a traffic signal will improve the overall safety and/or operation of the intersection.

2A.01 TRAFFIC PROGRAMS

2A.02 NEIGHBORHOOD TRAFFIC MANAGEMENT

BACKGROUND

The Traffic Operations Section receives a very large number of neighborhood related requests for the installation of various traffic control related devices. Typically these requests are handled on case by case basis and investigated/evaluated based on guidelines/criteria that either warrants or does not warrant their placement.

An example of these type requests would be for multi-way stops, speed limit reduction, warning signs, etc. These type devices are considered "passive" in nature and are considered/handled in normal everyday activities by the traffic operations staff. These type activities are identified as Stage 1 in the County's Neighborhood Traffic Management Program (NTMP and covered in detail below) and do not involve physical type control devices that would alter the roadway. For requests that involve physical type control installation, identified as Stage 2 in the County's NTMP, a much higher level of evaluation and neighborhood involvement is required.

The criteria/warrants for these and other requested devices are found in this document, the Arapahoe County Neighborhood Traffic Management Program manual (NTMP) and/or The Manual On Uniform Traffic Control Devices (MUTCD).

2A.03

- **NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM (NTMP)**

BACKGROUND

There is a growing concern that some residential streets do not function as multi-use areas in the true sense of the term. A multi-use area is one that is not dominated by vehicles, but shared by the pedestrians, bicyclists and vehicles. The multi-use concept for residential streets recognizes that there are corridors devoted to the efficient, rapid movement of vehicles, but requires that residential areas be serviced by roads designed to accommodate vehicular circulation in a non-threatening, non-intrusive manner. When severe speeding or volume problems exist on residential street quality of life is negatively affected. Methods to address these issues must be defined so that complaints registered regarding neighborhood traffic problems can be effectively and efficiently handled. This NTMP manual has been developed as a guide to understanding how Arapahoe County will receive, evaluate and address a majority of neighborhood traffic issues.

2A.04

TYPES OF NEIGHBORHOOD TRAFFIC PROBLEMS

Speed

Speeding generally occurs on roadways, which by design allow the driver to feel safe while exceeding the posted speed limit. Factors, which contribute to this perception, include long, unbroken street grade sight distances, steep roadway grades, overly wide roadways, low-density development, low pedestrian activity, and deep building setbacks. While young drivers and "outsiders" are popularly accused of speeding, the blame does not entirely lie with those two groups. Often those drivers who consistently violate posted speed limits are local residents.

The 85th percentile rule is generally used to measure speed on any given street. The 85th percentile speed is the speed at which 85% of the vehicles are travelling at or below. If the 85th percentile speed is below the speed limit, a speeding problem is judged not to exist. However, if the 85th percentile speed is above the posted speed limit, either the speed limit is not appropriate or a speeding problem may exist. Obviously, the more above the speed limit, the greater the potential is for a problem.

There are two schools of thought regarding the responsibility to control neighborhood speed limits:

1. First and foremost, roadways are designed to safely accommodate vehicular traffic and it is up to drivers to obey the law regardless of how fast they feel the roadway will safely accommodate traffic. Failing driver compliance, it is up to the local law enforcement agency to enforce safe speeds. This theory places the responsibility on the enforcement agency to maintain safe speeds.

2. The second school of thought submits that drivers will regularly and habitually violate the posted speed limit if they feel safe and comfortable doing so. It is therefore up to the planner and engineer to propose solutions that will make drivers feel uncomfortable exceeding the posted speed limit. In this scenario, it is up to the planner and engineer to control speed through educational programs and/or the physical design or alteration of the roadway.

Intrusion

Intrusion is the result of increased volume or excessive non-local traffic on a neighborhood street. Often this intrusion is caused by drivers using a local street to cut through a neighborhood and save time in their commute. Local streets, which are less impeded than others within the same neighborhood, invite cut-through traffic. Drivers are naturally drawn to those routes, which they perceive will save them time, even if that route does not provide the most direct path from point A to B. This increased cut-through-traffic can cause a local street to function as collector. The current maximum volume allocated for a local street in Arapahoe County is 1,500 vehicles per day (VPD).

Much like speeding, intrusion can be promoted or discouraged by street network design. If there is not a logical hierarchy of streets, traffic volume will not be suitably distributed. Likewise, land uses adjacent to roadways must be appropriately matched based on expected traffic volumes. The local neighborhood street should serve as the final destination roadway for the immediate residents of that neighborhood.

Accidents/Safety

Safety is an implied concern on streets experiencing speeding vehicles and/or intrusive traffic. There are however, cases where a particular intersection or pedestrian crossing is considered dangerous because of its location, the design of the street, and/or the behavior of the average driver. Of particular concern are locations near neighborhood schools and parks, which often generate high volumes of pedestrian activity. These areas require special consideration for the mobility and safety of the pedestrian.

In addition to high volume pedestrian areas, accident-prone intersections are a major concern. The accident rate at an intersection may not be particularly high, but its design and driver behavior might lead people to perceive that a higher than normal accident probability exists.

2A.05 STRATEGIES

Range of Strategies

Traffic calming strategies can be grouped into three categories: 1. education, 2. enforcement, and 3. engineering. In general, only comprehensive and continued education and enforcement programs have met with long term success. The public will usually forget the lessons learned from short-term education and enforcement programs unless they are continually and creatively reinforced. However, a well planned and executed education program, if continually reinforced, can preclude the need for enforcement or re-engineering. Education should be the first step in any traffic-calming effort. Engineering refers to the physical alteration of the roadway. Typical engineering alternatives are more expensive to implement and may require additional maintenance, but they are also permanent in their effectiveness. Arapahoe County strives to have a well balanced neighborhood traffic program that includes emphasis on education and enforcement, but also allows the opportunity for physical engineering solutions when warranted.

EMERGENCY VEHICLE RESPONSE CONSIDERATIONS

Emergency vehicle response is a basic requirement whenever physical street modifications are considered as part of a proposed neighborhood traffic management program. Changes in roadway physical characteristics that may be considered appropriate from a neighborhood traffic management viewpoint must be considered in the context of meeting adopted emergency vehicle response standards.

Figure 1 shows the primary emergency response routes for the urbanized area of Arapahoe County. These are considered of such importance that physical street modifications that would reduce or lower the level of service for emergency response activities will not be considered.

For those neighborhood streets not shown on this emergency vehicle priority route map, consideration of emergency vehicle access must be made on a case-by-case basis.

In the final analysis, it is recognized that there must be a balance as can only be determined on a case-by-case basis. The total involvement of the particular study process determines the relative importance of emergency vehicle response level of service versus the change in level of service for neighborhood residents with implementation of the physical changes. It is clear that the affected emergency response agencies should be involved early in the consideration of possible street physical changes and, should not be notified after the neighborhood has “bought in” to a particular scheme of changes to improve speed levels and/or volume conditions.

2A.06 THE PROPOSED PROGRAM

INTRODUCTION

The proposed neighborhood traffic-management program consists of two stages:

- Stage 1 – Normal activities by the Traffic engineering staff.
- Stage 2 – Consideration of physical street modification necessitated by the inadequacy of Stage 1 actions in order in order to achieve the adopted acceptable speed and traffic volume standards.

STAGE 1

Stage 1 activities are focused on excessive or perceived excessive speeds utilizing the following countermeasures:

- Education of the neighbors about excessive speeds by the neighborhood residents. This would also include continuing speed awareness activities within the neighborhood.
- Traditional enforcement by the Sheriff's Department.
- Deployment of the radar speed trailer.
- Installation of signs and markings that are considered by the Traffic Engineer to be appropriate after a review of the particular situation.

The Stage 1 activities listed above can be expected to satisfy about 90-95% of the complaints.

STAGE 2

Introduction

Stage 2 activities would be considered only after the following criteria have been satisfied:

1. Stage 1 activities have failed to solve the actual or perceived problem(s), and

2. The speed and/or traffic volumes exceed the following limits on a local residential street:

   - 85^{th} percentile speed exceeds the posted speed limit by 5 mph or more and/or

   - Volume exceeds 800 vehicles per day, and

3. At least 51% of the residents (one signature per address) in an area designated by the Traffic Engineer have signed a petition (wording approved by the Traffic Engineer) in favor of conducting a study that may show that one or more streets in the area may be impacted by the installation of the defined Stage 2 techniques or tools.

4. Staff deems safety issues may warrant intervention.

The Stage 2 traffic management program discussed here is to be considered only after the Traffic Engineer has determined that techniques such as personal contact, education, radar speed trailer use, and other traditional techniques have been tried and have been determined unsuccessful in satisfying the particular problem. Also, this program applies to local streets with more than 800 ADT and/or 85^{th} percentile speeds greater than 5mph over the posted speed limit.

The goals of the Stage 2 program are to provide a methodology of solving problems that could not be solved under Stage 1**.**

2A.07 Types of Projects

The Stage 2 TMP encompasses two types of projects:

1. Internal Neighborhood Residential Collector Streets
2. Local Residential Streets

These projects are intended to decrease the negative impact of speeding on primarily residential internal neighborhood collector streets that have direct residential access, and to improve safety for all. These collector street functions to distribute traffic from higher classification streets to local streets. Because of this function, these should not be

physical diversion on these streets. Projects are however intended to make the streets safer by reducing speeds.

Major project steps:

A. Ranking and Selection

At least 75% of properties fronting on the street must be zoned residential in order for the street to be considered. Those street segments that meet this qualification will be ranked using the criteria shown in Appendix A. This criterion gives the highest importance to speed, as high speeds can be the chief detractor of safety and livability on residential collectors. It is also the element that can best be mitigated by the traffic management devices available.

Project selection reviews will begin with those streets ranking highest. The Traffic Engineer will review potential projects by looking at their size/complexity, compatibility with other Department projects, budget availability, and other factors. In addition to the identified high-ranking segments, projects may also include additional segments or portions thereof to ensure that street system continuity is maintained.

Procedure

The procedure for implementation of residential collector projects is outlined in Appendix C. The procedure will enable Traffic Engineering staff to measure project area residents' support for the project, and to allow for public participation. A project area meeting will be held, followed by additional meetings to work with residents to develop the traffic management plan. A petition will be required to show area support and a public hearing may be held. A close dialogue with project area residents will be provided for and encouraged throughout the process, with the end result being a project developed and supported by both staff and residents.

Local Residential Streets

The major steps that a project will go through are outlined as follows:

A. Initiation

These projects are citizen initiated. Residents and/or a neighborhood association contact the Traffic Engineer to express concerns about the traffic conditions on their streets. A Traffic Engineering Services (TES) Attachment Z application must be completed at this time. These concerns are reviewed by the Traffic Engineering staff, who collects preliminary data about the traffic conditions on the streets,

including volume, speed, and accident information. If there is no immediate solution and the Traffic Engineer deems it appropriate or it is specifically requested, the request is evaluated for a traffic management program. Remember that Stage 1 activities must be tried and those efforts exhausted before Stage 2 program methods will be considered.

B. Ranking and Selection

The street will be ranked using the criteria shown in Appendix B. This criteria gives equal importance to speed and volume, as neither high speeds nor volume are appropriate on local streets.

C. Procedure

A procedure for the implementation of local street projects has been developed to enable the Traffic Engineering staff to work with project area residents and to measure their support for the project. A project area meeting will be held, followed by additional meetings (if required) to work with residents to develop the traffic management plan. A petition will be required within the area, and a public hearing may be held. A close dialogue with project area residents is provided for and encouraged throughout the process, with the end result being a project developed and supported by both the Traffic Engineering staff and by residents. The detailed steps and requirements of this procedure are outlined in Appendix C.

NOTE: The Neighborhood Traffic Management Program (NTMP) manual is a separate document and can be found in the Transportation Division library.

2A.08

- **TRAFFIC SIGNAL HEALTH INDEX PROGRAM**

BACKGROUND

Arapahoe County's Traffic Signal Health Index Program was developed to improve upon the evaluation process of the County's traffic signals as a whole, along with individual components and sub-systems of the traffic signal outside of the normal realm of routine maintenance services. For Arapahoe County, it is meant to serve as a compliment to the County's preventive maintenance program. Under the Traffic Signal Health Index process, various components of the traffic signal are inspected and, unlike the normal PM routine, then rated and weighted to provide and overall condition or "health" rating for

each traffic signal. The components are categorized as **Structural** which includes poles/foundations; **Overhead** including detection/signal heads/supports; **Underground** including communication infrastructure, conduits/wiring and **Auxiliary** components such as cabinets/controllers, etc. These individual component ratings are then rolled up into an overall condition rating for the traffic signal based on weighting of each component area. This rating provides the County with a better overall understanding of the traffic signal's current condition or "health" in part and in whole as related to operations/maintenance and public safety thereby assisting the County in defining responsible longer term budget requirements. This system of rating shows better defined trends in deterioration of signals and signal components which helps County staff make reliable prediction of immediate and more importantly, future needs which the County can then better forecast long term budget needs. Ultimately, this program is far more extensive in nature to normal preventive maintenance efforts that when used in coordination with PM programs, provide a much more comprehensive look into a traffic signal's overall actual condition or "health". This program provides a systematic way of managing traffic signal infrastructure and truly making it part of a strategic planning effort of needs rather than reactive maintenance.

2A.09 METHODOLOGY

To start the process, a yearly review of all Annual Preventive Maintenance (APM) reports, Quarterly Preventive Maintenance (QPM) reports, and trouble call reports will be completed and will include all reports from the previous 12 months. Information gathered through this review will be consolidated into a single report for quick reference and shall include, but not be limited to, failed equipment yet to be repaired, and components which, in the opinion of the technician, face imminent failure.

The report will also identify locations which required the greatest amount of service over the past 12 months, along with the most common failures at each of these locations. The number of locations identified will be limited to 10% of the total locations owned by the agency. Areas of concern which require further investigation shall be noted as part of this report and may include, but not be limited to, dented poles, pole/mast arms with rust, and poles/mast arms with fading paint.

A report is generated and reviewed by County staff by assigned date to assist in better defining budget requirements for the following year.

Traffic Signal Health Index

Overview:

Along with a yearly review as outlined above, a Traffic Signal Health Index study which includes a Cantilever Inspection Report will be completed a minimum of every 3-5 years or as recommended. As part of the Traffic Signal Health Index study, the traffic signal as a whole, along with individual components and sub-systems of the traffic signal, will be rated; providing the agency with a better understanding of the traffic signal's current health in part and whole, and assisting the agency in defining longer term budget requirements. Only existing components will be considered during the Traffic Signal Health Index study. Suggested and proposed upgrades for expansion will not be considered.
Through multi-year Traffic Signal Health Index studies, the County can better determine component and sub-system life expectancies, and better manage long term budgets through forecasting efforts. As part of the Traffic Signal Health Index study the County and/or assigned evaluates and rates components, and sub-systems, using defined, non-biased criteria.

2A.10 *Pre-requisites:*

1. Ultrasonic testing of poles and mast-arms:
   Ultrasonic testing of every traffic signal pole and mast arm is recommended every five years, unless the most current test results deem that testing be completed at shorter intervals. For the purposes of this article, there were eight traffic signal locations that were selected for ultra-sonic testing.

2A.11 *Inclusions:*

Inclusions as part of this health index study are grouped and defined below. Groups and individual components have been given a Health Index Weight (HIW) to assist in health index calculations.

Major Component Rating:

Major components include all components which commonly fail over time and which present the greatest liability to the public. Major components present a major impact on the agencies budget. Categories for major components include structural, overhead underground, and auxiliary.

NOTE: **Shown calculation percentages are an example only. Actual percentage figures for each category should be based on each individual agencies level of importance relative to each category.**

1. *Structural (HIW: 30%)*

   The County's traffic signal poles and mast arm specifications adhere to AASHTO specifications and have a 50 year design life rating given proper installation, wind loading within specifications, and without physical damage including that caused

when subjected to a magnesium chloride solution. Older poles have a reduced design life rating.

a. *Poles (HIW: 40%)*

i. *Street Light Pole*

- Ultrasonic test results will be used to define health, and will be conducted at regular intervals of five years or less, depending upon the recommendations of the testing firm.
- Additional testing is recommended whenever damage occurs as a result of an accident.
- Field replaceable hardware is not being considered as part of the HIW. Hardware requiring replacement will be defined during the inspection. Hardware requiring replacement will be replaced by the maintenance contractor as required.

ii. *Traffic Signal Pole*

- Ultrasonic test results will be used to define health, and will be conducted at regular intervals of five years or less, depending upon the recommendations of the testing firm.
- Additional testing is recommended whenever damage occurs as a result of an accident.
- Field replaceable hardware is not being considered as part of the HIW. Hardware requiring replacement will be defined during the inspection. Hardware requiring replacement will be replaced by the maintenance contractor as required.

iii. *Span Pole*

- Following criteria will be used:
    a. No damage or indication of rust;
    b. Minor dents, surface rust, failing/fading paint;
    c. Major rust with coverage exceeding 10 % of pole;
    d. Malformation of the pole with curvature and/or bending of pole.
    e.

b. *Mounting Structure (HIW: 40%)*

i. *Mast arms*

- Ultrasonic test results will be used to define health, and will be conducted at regular intervals of five years or less, depending upon the recommendations of the testing firm.

- Additional testing is recommended whenever damage occurs as a result of an accident.
- Field replaceable hardware is not being considered as part of the HIW. Hardware requiring replacement will be defined during the inspection. Hardware requiring replacement will be replaced by the maintenance contractor as required.

ii. Span/Tether

- Following criteria will be used:
    a. No splices;
    b. One Splice;
    c. More than one splice.

c. Foundations (HIW: 20%)

i. Street Light Pole/Traffic Signal Pole
(Determine testing options for the foundations in conjunction with pole and mast/arm ultrasonic testing)

ii. Span Pole

- Following criteria will be used:
    a. Span pole standing properly;
    b. Span pole leaning **without** guy wires or additional anchoring;
    c. Span pole leaning **with** guy wires or additional anchoring.

2. Overhead (HIW: 30%)

The life expectancy of polymer signal heads appear may be 20 years or more. Damage due to external influences including, but not limited to hail and UV exposure may however significantly reduce the life expectance.

a. Signal Heads (HIW: 34%)

i. Traffic Signal
- *New/Like New;*
- *Color fading:*
- *Cracked/Chipped/Warping without water penetration;*
- *Cracked/Chipped/Warping with water penetration;*
- Burned out LED percentage;

ii. Pedestrian Signal
(Review number of indication failures throughout the year)

b. Backplates (HIW: 33%)
c. Indications, LED (HIW: 33%)

3. Underground (HIW: 20%)
a. Wiring (HIW: 40%)
b. Conduit (HIW: 30%)
c. Pull Boxes (HIW: 30%)
(As part of pull boxes, consider drainage)

4. Auxiliary (HIW: 20%)
a. Cabinet (HIW: 75%)
b. Local Controller (HIW: 25%)

Minor Component Rating:
Minor components include all components which commonly fail quickly, require immediate replacement, and minimally impact the agencies budget. Additionally, during signal rebuilds, these components are not normally salvageable but are replaced as part of the rebuild. Minor components impact on the overall health index study is considered low.

1. Master Controller
2. Communications Hardware
   (Consider copper, wireless, and fiber)
3. Detection
   c. Vehicle
   d. Pedestrian
   e. Emergency
5. Uninterruptible Power Supply
4. Signs and Markings
   a. Signs
   b. Markings
      i. Crosswalk
      ii. Stop Bar
      iii. Instructional

Summary of Condition Findings and Recommendations:
After all associated health index inspections/calculations are completed, a final report is generated outlining all condition findings and recommended action.

2A.12 Overall Rating:

To complete the health index process, an overall rating is provided for each signal based on the above major component calculation procedure and determined by an agency specific formula.

The final rating range is defined below:

6.0 = Imminent failure, requires immediate attention.
5.0 = Poor condition, repairs recommended within 6 months.
4.0 = Below average condition, requires monitoring.
3.0 = Average condition.
2.0 = Above average condition.
1.0 = New/Like new condition.

Arapahoe County's overall rating formula is based on a rating system of various traffic signal component and traffic signal engineering criteria that determines the final rating indicated above. This "health" rating along with the final conditions report enables the County to responsibly and accurately chart recent and historic information of its traffic signals/equipment, prioritize/determine minor and major repair schedules and plan for both short and long range funding.

NOTE:

Examples of final calculations worksheet / report for previous studies can be found in the Transportation Division electronic files: G:\dsim\he\cipdocs\trafficsignals

3A.01

- # TRAFFIC VOLUME COUNT PROGRAM

BACKGROUND

Traffic Operations staff conducts 24 hour traffic volume counts annually at various locations. At the time of this report, counts are taken at approximately 35 locations. Every year the list of count locations is reviewed and counts are either added or deleted based on this staff review.

4A.01

- # ACCIDENT ANALYSIS PROGRAM

BACKGROUND

In 2011, Traffic Operations installed a very sophisticated accident software program called “Crossroads”. The procedure in obtaining accident records allows the County to coordinate with the Department of Revenue (DOR) to complete an annual “dump” of accident record information into the program. Once the dump is complete, the County has access to all the accidents that have occurred in the County for the past year as well as accidents from previous years. Annually, Traffic Operations compile a list of the highest recorded accident locations (usually the top 20) along with severity and rate. This information is considered public record so the general public can request accident information from operations staff.

5A.01

- # DAY TO DAY PUBLIC RESPONSE OPERATIONS

BACKGROUND

The Traffic Operations Section receives a very large number of citizen/public requests for various traffic related issues. These requests are handled a number of ways ranging from simple telephone conversations to traffic engineering studies involving site analysis. In short and in most cases, if an actual traffic study is required, the request is initiated by the applicant contacting the field services staff and initiating a service request. The request is assigned a case number for tracking and then forwarded to the Traffic Operations staff for evaluation/response.

COMMONLY ASKED QUESTIONS AND PROCEDURES

- **How do I request a traffic sign be installed?**
    - You may submit a request via mail, email, or telephone. Please describe the concern you have and what type of sign you feel will resolve the issue. Your request will be input to our electronic tracking system. We will then schedule a site/field study to determine the best solution to your concern. Once this step is complete we will notify of what type of action, if any, is warranted and when the solution will be implemented.

- **How do I request that a traffic study be conducted in my area?**
    - Please contact the Public Works Department via mail, email, or telephone. Describe the type of study you wish to be completed. Explain the concerns you wish to be addressed. Traffic will then schedule a traffic study and identify and problems or concerns. You will then be notified of measures that may be taken to alleviate the traffic concerns you have.
- **Are speed bumps/humps allowed on my street?**
    - No, Arapahoe County will not install speed humps/bumps. It has been proven that these devices not only slow emergency response time but can also cause damage to the emergency vehicles. They also increase traffic noise in a residential area.
- **What is the speed limit for residential areas?**
    - The prima facia speed limit in a residential area is 30 miles per hour unless otherwise posted.
- **How are speed limits established?**
    - Speed limits are established based on road design, type of road and also using the 85^{th} percentile speed.
- **How do I request that my street be used for a block party?**
    - Please submit your request at least two weeks prior to your event. Request must be sent in writing and include a map you're the area in which the event will take place. Once approved you will be given specific conditions and requirements to close off your street for your party. Fire Districts and the Sheriffs office will be notified of your closure.
- **How do I request the installation of a street light?**
    - Arapahoe County does not install street lighting. Depending on where you live you will need to contact with IREA or Xcel

- **How do I obtain traffic information (i.e, volume counts, accidents, etc)?**
    - Arapahoe County makes every effort to keep our website update with the most current traffic counts and accident data. If you can not find what you are looking for please contact Public Works for further assistance. Please keep in mind, traffic counts are not conducted on all roads/streets within Arapahoe County. Usually just the arterials and major collectors are included in the annual traffic count program.

6A.01 AGENCY COORDINATION

The Transportation/Traffic Operations Division(s) frequently coordinate efforts between other County and non-County agencies to resolve issues relative to each agency. The following are <u>some</u> important agencies that the Transportation/Traffic Operations Division work with on a frequent basis:

- **COUNTY SIGNAL CONTRACTOR** W.L. CONTRACTORS -- TELEPHONE MAIN 303-422-7985
- **SHERIFF'S OFFICE** TELEPHONE MAIN -- 303-795-4711
- **SCHOOL DISTRICTS**

  CHERRY CREEK SCHOOLS TRANSPORTATION -- 720-886-4188

  LITTLETON SCHOOLS -- 303-347-4775
- **OTHER COUNTY AND CITY GOVERNMENTS**
- **DENVER REGIONAL COUNCIL OF GOVERNMENTS (DRCOG)**

  TELEPHONE MAIN -- 303-480-6790
- **UTILITY COMPANIES**
- **HOMEOWNERS ASSOCIATIONS (HOA'S)**
- **BUSINESS PARKS**
- **PRIVATE CONTRACTORS**
- **PRIVATE CONSULTANTS**
- **PRIVATE BUSINESSES**

NOTE: Other contact information for the above can be found on County directories and/ or company specific web-sites.