Title

Transportation Project-Level Carbon Monoxide Protocol User Workbook

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DISCLAIMER

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1.0 Introduction

Procedures and guidelines are provided in the Project-Level Carbon Monoxide Protocol (herein referred to as the CO Protocol), for use by agencies that sponsor transportation projects, to evaluate the potential local level carbon monoxide (CO) impacts of a project. This workbook is a supplement to the CO Protocol. Included in this workbook is an outline of the major steps to analyzing project-level CO impacts using the CO Protocol. In addition, several example applications have been constructed to illustrate use of the CO Protocol. Duplication between this workbook and the CO Protocol has been purposely kept to a minimum; the workbook is not to be considered a "stand alone" resource. The user will need to refer to the CO Protocol for definitions, contact lists, glossary terms, analysis procedures and other important material. The CO Protocol provides a structure for documenting project-level air quality analysis that is accepted by regulatory agencies. In most cases, if current analytical procedures are satisfied without modeling, the CO Protocol will not require it.

1.1 Conformity / NEPA / CEQA

The CO Protocol addresses all necessary analyses for project-level air quality issues on most projects. The procedures and guidelines comply with the following regulations without imposing additional requirements: Section 176(c) of the 1990 Clean Air Act Amendments, federal conformity rules, state and local adoptions of the federal conformity rules, the National Environmental Policy Act (NEPA), and the California Environmental Quality Act (CEQA) [Cal. Code Regs., tit. 21, § 1509.3(25)]. CEQA analysis is required for all projects. All projects involving federal funding and/or approval require a conformity analysis and a NEPA analysis.

1.2 Target Audience

The CO Protocol procedures have been designed for use by traffic engineers and other transportation or planning analysts with limited or no air quality background. The users are expected to be primarily Caltrans project sponsors, although the CO Protocol is envisioned as a resource for any organization involved with project-level analyses. It should also be noted that CO Protocol users may need to consult with the local air district, MPO, the California Air Resources Board, Caltrans, US EPA, FHWA, or FTA. Appendix C of the CO Protocol contains contact information should there be a need for consultation.

1.3 Regional vs. Project Level Impacts

The CO Protocol establishes a set of procedures to address local, i.e., "project level" air quality impacts. Projects located in federal CO nonattainment and maintenance areas are also subject to a regional analysis under the federal conformity rule. In general, the CO Protocol does not address regional analyses. The CO Protocol is organized under the assumption that a regional plan has been accepted as conforming. Regional conformity implies that the project being analyzed is included in a conforming Regional Transportation Plan (RTP) and Transportation Improvement Program (TIP), and that the project has not been significantly altered in design concept or scope from that described in the RTP and TIP. Certain types of projects may be exempt from the regional conformity determination or from all conformity analysis. A project in an area that is in attainment for all transportation-related criteria pollutants (O_3, CO, PM_{10}, and NO_2) is exempt from the regional conformity determination. For more information, see Section 2.6 through Section 2.10 and Section 2.14 through Section 2.15 of the CO Protocol.

2.0 How to Navigate the CO Protocol

In general, one of three types of tests will determine the acceptability of project level emissions impacts:

- A qualitative analysis based on the flowchart shown in Figure 3 of the CO Protocol;
- A quantitative screening analysis based on Appendix A of the CO Protocol, or
- A model screening analysis based on Appendix B of the CO Protocol.

Before beginning a project analysis, the analyst should use the CO Protocol to 1) determine if the project requires analysis, and 2) confirm whether the required regional scale air impact analyses have already been performed. This confirmation of regional air impact analysis generally depends on:

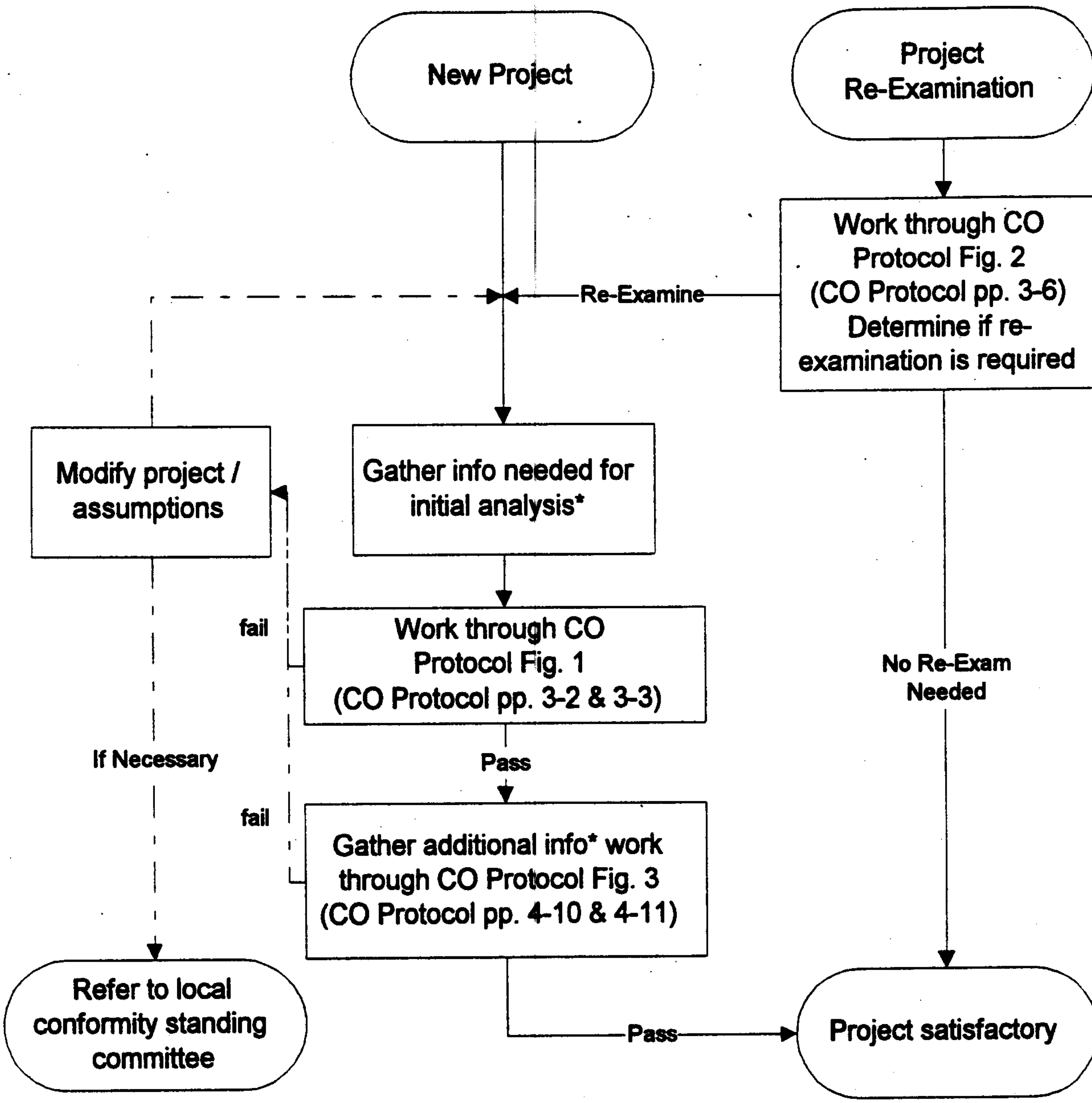
- exemptions built into the various regulations,
- if the project comes from a conforming RTP and TIP, and
- what previous analyses have already been done.

These pre-analysis checks are summarized in Figure 1 of the CO Protocol – "Requirements for New Projects," and Figure 2 of the CO Protocol – "Project Re-Examinations." The Project level analysis itself is summarized in Figure 3 of the CO Protocol – "Local CO Analysis."

If a project fails all screening analyses, then the analyst and the project sponsor(s) should review the project assumptions and scope and consider possible mitigation measures. A re-analysis of the project may then be performed. This procedure is represented by the dashed path in Figure A.

The entire procedure is summarized in Figure A – "Project Analysis," of this workbook.

Figure A. Project Analysis



* Refer to Section 4 of this workbook – "Preparing to Use the CO Protocol" for details

3.0 How to Document the Analysis

As part of the conformity, NEPA and CEQA processes, CO Protocol users need to document their analyses in a CO air quality technical report or memorandum. The CO-specific documentation will be a subset of whatever other environmental documentation is being prepared in response to conformity, NEPA, or CEQA. The CO documentation should describe the analysis results, key assumptions used to evaluate the project and any important concurrence received from consulting staff at other agencies. The goal of the documentation is two-fold. First, the documentation should enable project reviewers to understand key assumptions used during the analysis. Second, the documentation should identify key agreements reached during discussions with planning and air quality agencies. Documenting agreements is particularly important since agency staff may change over time, and future project reviews may need to rely on written records of agreements reached.

For categorically exempt projects, documentation typically consists of a Memo to File. At a minimum, the Memo to File should document one of the following points:

1. The project is exempt from all emissions analysis.
2. The project is exempt from a regional conformity analysis but requires a project-level emissions analysis. Or,
3. The project requires full air quality consideration or special circumstances exist.

For projects that require an emissions analysis, a similar report or memo can be prepared to address the requirements of all three regulatory processes. That report needs to address:

1. What type of study was performed.
2. Why the selected approach was used.
3. The analysis results.
4. The environmental impact threshold against which the results are measured, and,
5. Any agreements reached with various agencies.

When the full project environmental reports are eventually prepared, more detailed documentation may be required. For example, where it may be appropriate for the CO technical report to simply say that the project passed the qualitative screening procedure from Section 4.7.1 of the CO Protocol, an EIR may require that much of the text from Section 4 of the CO Protocol be transcribed into the EIR. A more detailed discussion of the CO technical report/memo follows.

3.1 Documentation Common to CEQA, NEPA, and Conformity

The sections of the CO technical report/memo that address the level of study performed and the reason for selecting the chosen approach will be virtually identical no matter which type of regulatory analysis is being performed.

WHAT LEVEL / TYPE OF STUDY WAS PERFORMED

This section should document that the CO Protocol was used, describe the procedures from the CO Protocol that were used, and should list any key assumptions. For example, it may state any one or more of the following points:

a) Confirmation as to whether regional air quality issues were addressed through the RTP and TIP process.
b) Whether the project incorporates all applicable TCMs contained in the applicable SIP.
c) Which specific section from the CO Protocol was used to determine project level CO impacts (for example: Section 4.7.2 of the CO Protocol).
d) Key assumptions (for example: if the proposed project was assumed to be similar to an existing facility, what facility, and why).

WHY THE SELECTED APPROACH WAS USED

This section should document the reasons why a particular approach was taken and any contacts/consultations that were made along with resulting agreements. For example, it may state the following points:

a) That the CO Protocol methodologies are approved by U.S. EPA Region 9 as an appropriate analysis tool.
b) That the regional MPO was contacted and Ms./Mr. _______ confirmed that the project is contained in the currently conforming RTP and TIP.
c) Who was consulted, why, and what agreements were reached.
d) What applicable data was used during the analysis (this might be included as an attachment to the CO air quality technical report/memo).

THE RESULTS OF THE ANALYSIS

The contents of this section will vary depending upon the type of analysis used to determine the project level impacts.

- Qualitative Tests: the analyst should explain that none of the Build alternatives will increase ambient CO levels in a manner that will produce new air quality violations, and, in nonattainment areas, will not worsen existing violations or delay timely attainment of the CO air quality standards.
- Analytical Screening Tests: The analyst should determine what the estimated CO concentrations will be.

THE ENVIRONMENTAL IMPACT THRESHOLD AGAINST WHICH THE RESULTS ARE MEASURED

The significance threshold that the analysis results are to be measured against are listed in Section 5 of the CO Protocol. The technical report should discuss the impact thresholds applicable to the analysis but generally will not contain statements regarding the significant impacts of the project. The Project Development Team and Department or Project Managers should make the judgment regarding the significance of the project impacts.

DOCUMENT AGREEMENTS REACHED
This section will document the key agreements reached during discussions with planning and air quality agencies and internally where appropriate.

3.2 Documentation Specific to CEQA

Under CEQA, then the project sponsor can take one of following three actions:

- Issue a *Negative Declaration*, which is a written statement that briefly describes the proposed project and the reasons that the proposed project will have no significant environmental impacts and does not require the preparation of an environmental impact report (EIR).
- Issue a *Mitigated Negative Declaration*, when the project has possible significant environmental impacts that are eliminated by project modifications.
- Prepare and issue an EIR for public comment and review by responsible agencies, if the project has possible significant environmental impacts.

If an EIR or *Mitigated Negative Declaration* is made, the documentation will require more detail. For example, an EIR should contain a detailed assessment of all of the following:

- All significant effects on the environment of the proposed project
- In a separate section:
  - Any significant effect on the environment that cannot be avoided if the project is implemented.
  - Alternatives to the proposed project.
- The growth-inducing impact of the proposed project.

An EIR will also include a statement that briefly describes the reasons for determining that various effects of a project on the environment are not significant and consequently have not been discussed in detail in the EIR. Consequently, if an EIR must be prepared, the analyst may need to revisit the project.

3.3 Documentation Specific to Conformity

Under conformity, a project can not cause or contribute to new violations or worsen existing violations of the federal air quality standard for CO. The significance tests are discussed in detail in Sections 5.2.1 and 5.2.2 of the CO Protocol.

Specific criteria that need to be addressed somewhere in the report include:

- A statement that the project is included in a conforming RTP and TIP and that there have been no substantial changes in the design concept and scope as used in the TIP.
- A statement that includes a specific reference to the particular RTP and TIP conformity finding, and dates of the MPO and FHWA conformity determinations.
- A statement that the conformity determination is based on the latest planning assumptions.

- A statement that the project complies with PM_{10} control measures, as applicable, in the PM_{10} air quality plan.
- A statement that the project-level analysis assumptions are consistent with those in the regional emissions analysis for inputs which are required for both analyses.

3.4 Documentation Specific to NEPA

The NEPA analysis should include a summary of the results from the project's conformity finding. A project level analysis of CO impacts is unnecessary where such impacts (project CO contribution plus background) can be judged to be well below the 1-hr and 8-hr NAAQS (or other applicable state or local standards). The CO Protocol may be used to make this judgment. [Alternatively, this judgement may be based on (1) previous analyses for similar projects; (2) previous general analyses for various classes of projects; or (3) simplified graphical or "look-up" table evaluations. In these cases, a brief statement stating the basis for the judgment is sufficient.]

For projects where a project level CO analysis is performed, each reasonable alternative should be evaluated for the estimated time of completion and design year. A brief summary of the methodologies and assumptions should be included. A comparison between alternatives and to applicable state and national standards should be made.

If a project reduces the severity of (but does not eliminate) an existing violation, NEPA may require additional mitigation. When the preferred alternative is predicted to result in violations of the CO NAAQS, an effort should be made to develop reasonable mitigation measures through early coordination between FHWA, EPA, and appropriate state and local highway and air quality agencies. This section should discuss the proposed mitigation measures and document the coordination between agencies.

3.5 Documentation Examples

Included in Appendix D are two example CO air quality technical reports (based on the examples in Section 5 of the workbook) illustrating how to document the CO analysis results.

4.0 Preparing To Use the CO Protocol

This section of the workbook details the types of information needed to use the CO Protocol. The discussion includes two sections: "Information to Determine Which Analyses to Conduct" and "Information Needed to Conduct Analyses."

4.1. Information to Determine Which Analyses to Conduct

To determine if a study of project level CO impacts is required for a particular project, Figure 1 of the CO Protocol – "Requirements for New Projects," and/or Figure 2 of the CO Protocol – "Project Re-Examinations" must be applied. The information required to complete the analyses contained in Figures 1 and 2 of the CO Protocol is identified below in Table 1 – "Information to Determine Analysis Requirements," along with a CO Protocol reference to more detailed descriptions.

Table 1. Information to Determine Analysis Requirements

	CO Protocol Section	Workbook Section
• Has a Conformity, NEPA, and CEQA analysis already been done (Segmented / Staged Projects)?	2.6, 2.8	
• Is the project exempt from regional and / or project level analysis?	2.14 – 2.15	
• Is the project regionally significant?	2.11	
• What is the region's CO air quality attainment designation (State and Federal)?		4.1.1
• Does the project come from a conforming RTP and TIP?		4.1.3
• If the project comes from a conforming RTP and TIP, have there been any changes to the project's design concept and scope?	2.9	

4.1.1 CO Attainment Area Designations

Before the screening process can proceed, the user must determine the project's CO area attainment status. The state and national designations are published in "Amendments to the Area Designations for State Ambient Air Quality Standards with Maps of Area Designations for the State and National Ambient Air Quality Standards." This document is updated periodically by CARB. The area designations can also be obtained from the local air pollution control district. In California, only Los Angeles County is nonattainment for the federal carbon monoxide standard (as of March 1998, U.S. EPA had proposed to redesignate all CO nonattainment areas in California except for Los Angeles as having attained the CO standard). The current federal and state attainment designations for counties in California are presented in Table 2 – "Federal and State Attainment Status of California Counties."

Table 2. Federal and State Attainment Status of California Counties

Area	California Attainment Status	Federal Attainment Status
Los Angeles County	Nonattainment	Nonattainment
Fresno County**	Nonattainment	Attainment/Maintenance
Imperial County	Nonattainment	Unclassified*
El Dorado County**	Transitional	Attainment/Maintenance
Kern County	Attainment	Attainment/Maintenance
Sacramento County	Attainment	Attainment/Maintenance
Placer County	Attainment	Attainment/Maintenance
San Diego County	Attainment	Attainment/Maintenance
Butte County	Attainment	Attainment/Maintenance
Stanislaus County	Attainment	Attainment/Maintenance
San Joaquin County	Attainment	Attainment/Maintenance
Yolo County	Attainment	Attainment/Maintenance
Alameda County	Attainment	Attainment/Maintenance
Contra Costa County	Attainment	Attainment/Maintenance
Marin County	Attainment	Attainment/Maintenance
Napa County	Attainment	Attainment/Maintenance
San Francisco County	Attainment	Attainment/Maintenance
San Mateo County	Attainment	Attainment/Maintenance
Santa Clara County	Attainment	Attainment/Maintenance
Solano County	Attainment	Attainment/Maintenance
Sonoma County	Attainment	Attainment/Maintenance
All Others	Attainment or unclassified	Attainment or unclassified

*Unclassified areas are not required to conduct conformity analyses. Federal attainment/maintenance status is based on EPA's March 31, 1998 proposal to redesignate all CO nonattainment areas, except Los Angeles, to attainment/maintenance.

** Likely to be redesignated in late 1998 or early 1999 as attainment for California CO standards.

NOTE: Attainment classifications may not encompass entire county. Check with local air pollution control district for more information.

4.1.2 Project Re-Examinations

For a variety of reasons, projects often come up for air quality reanalysis. This occurs when projects have been delayed for more than three years, when it is unclear if an earlier project determination applies to the project stage in question, and when a project design concept and/or scope is changed. If federal funds are introduced to a project that previously had no federal money, the project is then subject to NEPA and a federal conformity determination. For a detailed discussion of these elements, refer to CO Protocol Section 2.8 – "Segmented/Staged Projects," CO Protocol Section 2.9 – "Changes in Project Design Concept and Scope," CO Protocol Section 2.10 – "Changes in Funding Sources," CO Protocol Section 5.2.2 – "Federal Conformity," and CO Protocol Section 5.2.3 – "National Environmental Policy Act (NEPA)."

4.1.3 Projects Included in a Conforming RTP and TIP

Projects included in a conforming RTP and TIP can be evaluated using the screening procedure outlined in Section 4 of the CO Protocol. If the design concept or scope of the project has changed from that described in the conforming RTP and TIP, a re-analysis of the project may be required. The project design concept refers to the "type of facility identified by the project, e.g., freeway, expressway, arterial highway, grade-separated highway, reserved right-of-way rail transit, mixed-traffic rail transit, exclusive busway, etc." The project design scope refers to "the design aspects...that affect the proposed facility's impact on emissions, usually as they relate to carrying capacity and control, e.g., the number of lanes or tracks to be constructed or added, length of project, signalization, access control including approximate number and location of interchanges, preferential treatment for high-occupancy vehicles, etc." (CO Protocol, pp. 2-4). If the project's design concept and/or scope changes significantly from that described in the conforming RTP and TIP, then a new regional conformity determination and/or re-examination of local CO impacts may be required (see Section 2.6 and Section 2.9 of the CO Protocol for more information).

If the transportation project is not included in the conforming RTP and TIP or is in an area that does not have a conforming RTP and/or TIP, then the project fails to qualify for an exemption from a regional conformity finding. The project cannot proceed until the region has a currently conforming RTP and TIP, unless it is among those listed in Table 1 or Table 2 of the CO Protocol. The screening procedure for projects in areas with no conforming RTP and/or TIP is described in Section 3.1.11 of the CO Protocol.

Analysts unfamiliar with whether their project is in a conforming RTP and TIP need to contact their MPO. Appendix C in the CO Protocol includes contact information.

4.2 Information Needed to Conduct Analyses

Projects that are not screened out after working through CO Protocol Figures 1 and 2 will require project level CO analyses. CO Protocol Figure 3 – "Local CO Analyses," outlines the procedures involved in conducting the analyses. The following sections describe the information that will be needed to complete the analyses specified in Figure 3 of the CO Protocol. In general, one of three types of tests will determine the acceptability of project level emissions impacts. Projects in California and federal attainment areas, and federal maintenance areas will likely only require a qualitative analysis based on the flowchart contained in Figure 3 itself. Many projects in nonattainment areas are also likely to require only a qualitative analysis based on the Figure 3 flowchart. Some projects in nonattainment areas, or projects that have a potentially greater impact, will proceed from Figure 3 either to a quantitative screening analysis based on Appendix A of the CO Protocol or a model screening analysis based on Appendix B of the CO Protocol.

4.2.1 Project Specific Information

Prior to conducting the analysis, certain project-specific data must be available. Some types of data will be needed for both the quantitative screening analysis outlined in Appendix A of the CO Protocol and the model screening analysis outlined in Appendix B of the CO Protocol, while other data will only be required for the screening analysis outlined in Appendix B. A general summary of the data required is presented in Table 3, "Information Needed For Project Level Analysis."

Table 3. Information Needed for Project Level Analysis

Information Needed for all Analyses	Information Needed Only for Modeling Analysis
• Traffic data - Volumes - Speeds - Signal timing - Cold start percentages - LOS data • Project location • Project completion year • Project horizon year • SIP, RTP, and TIP status • Background CO concentrations	• Meteorological Data (if not using worst case data given in Appendix B of the CO Protocol) - wind speed and direction - standard deviation of wind direction (sigma theta) - stability class - temperature • Elevation • Fleet Mix (for state highway projects only) • Detailed project geometry

4.2.2 LOS D Intersection

Projects involving LOS D intersections may require additional information to determine modeling requirements. This additional information will include, for example, specific knowledge of regional meteorology. These special requirements are addressed in CO Protocol Section 4.7.5. Appendix A of this workbook reviews the necessary meteorological material.

4.2.3 Additional Information for CO Nonattainment Areas

In federal CO nonattainment areas the project analyses may involve a comparison to the intersections modeled in the air quality management plan. At this time Los Angeles County is the only federal CO nonattainment area in California. Appendix B of this workbook contains the modeling information for Los Angeles.

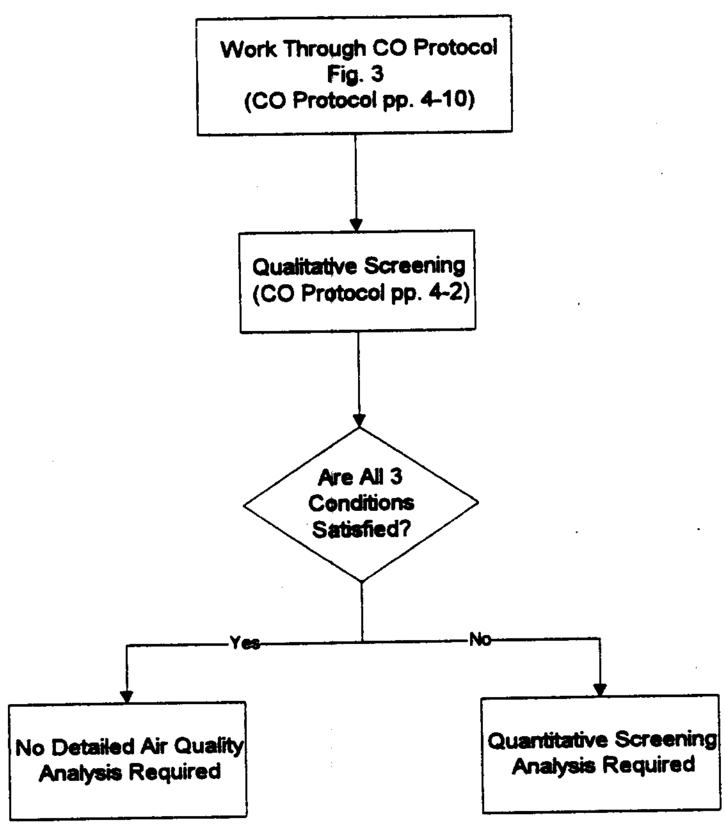
5.0 CO Protocol Example Applications

In this section, two example projects from a conforming RTP and TIP are used to step through the application of the CO Protocol. The first example requires only a qualitative analysis and the second example requires the more detailed quantitative screening analysis. Each example begins with a short description of the project analysis steps. This is followed by a discussion of the data required (and primary source for the data) for completing the analysis. Each example is then walked through the analysis steps.

5.1 Example One: Qualitative Analysis Application

A bypass has been proposed for Sutter Creek and Caltrans must determine if the proposed bypass will need a detailed air quality analysis. As Figure B describes, the user will typically begin by working through Figure 3 of the CO Protocol and determining if three conditions have been satisfied by the project: 1) Does the project significantly increase the cold start percentage?; 2) Does the project significantly increase traffic volumes?; and 3) Does the project improve traffic flow? If all three conditions are satisfied, detailed air quality analysis is not required.

Figure B. Project Analysis Procedure for Qualitative Analysis



To begin, the CO Protocol states that the user must select the 3-worst intersections within the bypass vicinity for inspection. The AMA-104/Ridge Rd. intersection, east of the bypass, has been chosen to use as an example of the qualitative analysis procedures since it is the worst intersection in the project vicinity.

5.1.1 Project Description:

Completing the analysis will require project and regional information from both the project sponsor and other sources, such as the local air pollution control district.

Information from Project Sponsor

The existing state route 49 is a two-lane roadway that runs north-south through Amador County. Route 49 passes through Sutter Creek, a small town that experiences a large amount of tourism. The bypass is being proposed to alleviate the flow of traffic through Sutter Creek and is scheduled for completion in the year 2000.

The area surrounding the existing Route 49 consists mostly of open rural terrain with grassy hills. The cities of Sutter Creek and Amador are located along the route. Both cities consist of many small roadside shops that cater to the town's tourists. The city of Sutter Creek lies in a small valley in the Mountain Counties Air Basin.

Information from Other Sources

The wind patterns are expected to be up-valley (westerly) in the mornings and down-valley (easterly) in the afternoons and evenings. The project is in a CO maintenance area with an approved CO maintenance plan.

Tables 4 and 5 summarize projected traffic volumes, level of service summary, and other project-related information for the intersection for both the Build and No-Build scenarios.

Table 4. Project Information

Project Data		Source
2000 No-Build Traffic		Caltrans
NB approach traffic volume	7100 vpd	
SB approach traffic volume	7600 vpd	
EB approach traffic volume	2800 vpd	
WB approach traffic volume	3500 vpd	
2000 Build		Caltrans
NB approach traffic volume	7000 vpd	
SB approach traffic volume	8900 vpd	
EB approach traffic volume	2600 vpd	
WB approach traffic volume	3000 vpd	
Level of Service Summary	See Table 5	Caltrans
Intersection Geometry	6x6	Caltrans
Attainment status	Maintenance	Local Air District

Table 5. Level of Service Summary

Level of Service	Without Bypass	With Bypass
Eastbound Approach		
- Left-turn	B	A
- Thru	B	A
- Right-turn	B	A
Westbound Approach		
- Left-turn	B	A
- Thru	B	A
- Right-turn	B	A
Northbound Approach		
- Left-turn	B	A
- Thru	C	B
- Right-turn	B	A
Southbound Approach		
- Left-turn	C	B
- Thru	C	B
- Right-turn	C	B

5.1.2 Worksheet Analysis:

In the remainder of this section, each of the tasks associated with completing a qualitative project analysis such as that noted in Figure B are discussed.

Step 1: Start with Level 1, Fig. 3 of CO Protocol (CO Protocol pp. 4-10)

Level 1

The project is in a CO maintenance area and continued attainment has been verified. Therefore, the user proceeds to Level 7 of the CO Protocol.

Level 7

There are three conditions that must be satisfied for question 1 of the level 7 analysis:

(a) Project does not significantly increase cold start percentage
(b) Project does not significantly increase traffic volumes
(c) Project improves traffic flow

A qualitative screening is performed to check each of the above three conditions. If all three conditions are satisfied, then the project does not require additional air quality analysis. If any of the conditions are not all satisfied, the user would then need to proceed to question 2.

Step 2: Qualitative Screening (CO Protocol pp. 4-5)

Condition (1): Does any current Build alternative have at least 2% more traffic operating in cold-start mode than the No-Build alternative?

The proposed bypass would be located in mostly open rural terrain with no significant increase in near-by retail activity or visitation to tourist attractions. None of the Build alternatives will result in an increase in vehicles operating in cold-start mode that is 2% or greater than the No-Build alternative.

Condition (2): Does any current Build alternative significantly increase traffic volumes above the No-Build volumes?

The user will need to add the approach average daily traffic volume on each road at the intersection to determine if there is more than a 5% increase in traffic volumes for the Build alternative.

For the 2000 No-Build scenario the total average daily traffic volume is computed as:

$$7100 + 7600 + 2800 + 3500 = 21000 \text{ vpd}$$

For the 2000 Build scenario the total average daily traffic volume is computed:

$$7000 + 8900 + 2600 + 3000 = 21500 \text{ vpd}$$

It can be seen that the increase in traffic volume is only 2.4% (i.e., (21500-21000)/21000 *100 = 2.4%). Therefore, the project does not significantly increase traffic volumes.

Condition (3): Does any current Build alternative improve traffic flow?

From the AMA-104/Ridge Rd. intersection level of service summary data shown in Table 5, it can be seen that with the proposed bypass, flow of traffic improves at the intersection (Table 5).

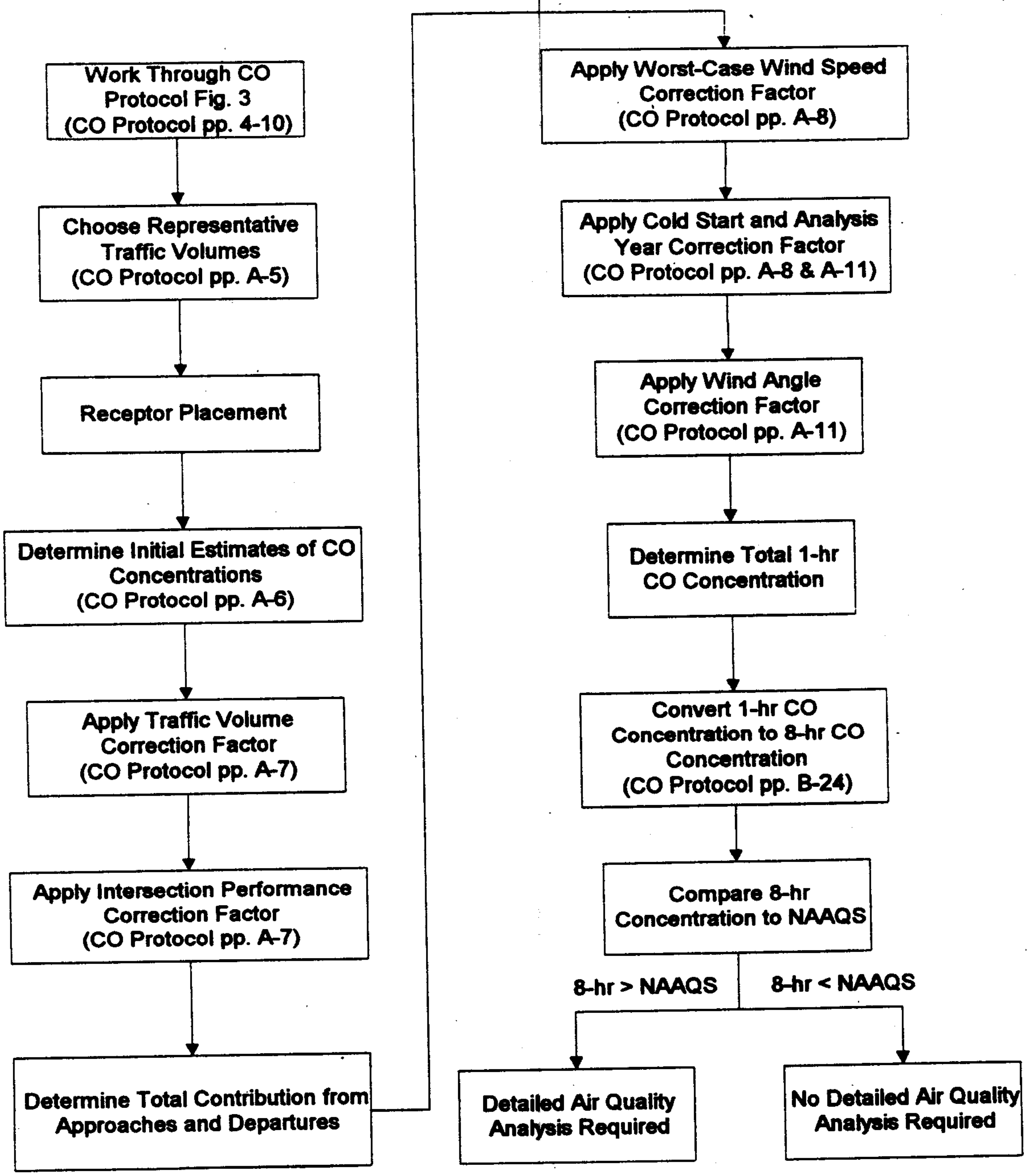
5.1.3 Analysis Results

All three conditions in question 1, Level 7 are satisfied. The project does not require a quantitative screening analysis.

5.2 Example Two: Quantitative Screening Analysis

For this example the project sponsor wants to determine if adding a turn lane to an existing intersection will create an exceedance of the 8-hour CO standard. The intersection has been designed to handle increased traffic flow from a nearby proposed residential development that is expected to increase cold starts by more than 2%. Figure C outlines the general analysis steps the user will follow for the quantitative screening process.

Figure C. Quantitative Analysis Steps



5.2.1 Project Description:

As with the previous example, the user begins by collecting basic project data.

Information from Project Sponsor

The intersection is located in Sacramento, a geographic area typical of the Central Valley. The project is scheduled for completion by the year 2000. There are 6 approach/departure lanes for the N-S road and 6 approach/departure lanes for the E-W road. By default, the receptor is located 3m from the NB lane and 3m from the WB lane (CO Protocol, Section B.4.4). The percent red time for the N-S through movement is 60% while the percent red time for the E-W through movement is 80%. The percentage of vehicles operating in the cold mode is estimated to be 30% (CO Protocol Table B.6, pp. B-6). The average cruise speeds are 30 mph for both N-S and E-W traffic.

The traffic volumes are as follow:

NB approach traffic volume	178 vphpl
SB approach traffic volume	317 vphpl
EB approach traffic volume	158 vphpl
WB approach traffic volume	158 vphpl

Information from Other Sources

The background CO concentration is 1.0 ppm. The meteorological data, which can be found from the local air pollution control district, are as follows:

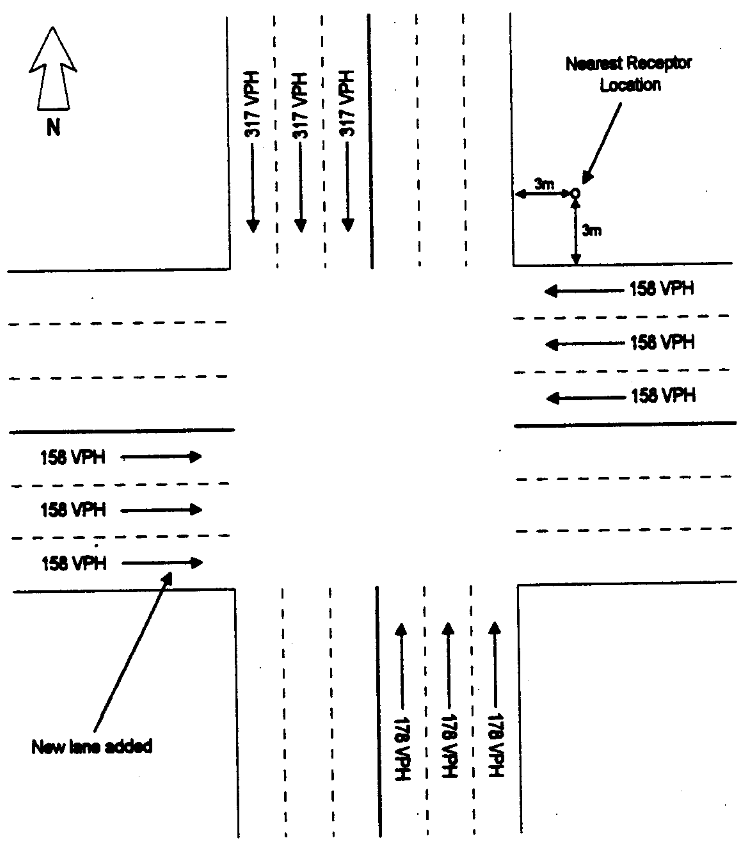
Temperature	50 °F
Wind Speed	1 m/s
Wind Direction	varies

The data required to complete the analysis has also been summarized in Table 6 and the intersection geometry is presented in Figure D.

Table 6. Data to Complete Quantitative Analysis

Project Information		Source
N-S road average cruise speed E-W road average cruise speed	30 mph 30 mph	Caltrans
NB approach traffic volume SB approach traffic volume EB approach traffic volume WB approach traffic volume	178 vphpl 317 vphpl 158 vphpl 158 vphpl	Caltrans
N-S road thru red time E-W road thru red time	60% 80%	Caltrans
Percentage of cold start	30%	Caltrans
Temperature Wind speed Wind direction	50 °F 1 m/s varies	Local Air District
Background CO concentration	1.0 ppm	Local Air District

Figure D. Intersection Geometry



5.2.2 Worksheet Analysis:

Step 1: Start with Fig. 3 of CO Protocol (CO Protocol pp. 4-10)

The project is in a CO maintenance area and continued attainment has been verified. Therefore, the user proceeds to Level 7 of the CO Protocol. Because the proposed modification of the intersection will increase cold starts by more than 2%, the project fails to pass the qualitative analysis. Therefore a more detailed quantitative analysis is needed, using Appendix A of the CO Protocol.

Step 2: Choose Representative Rounded Up Traffic Volumes (CO Protocol pp. A-5)

To apply the CO Protocol the user must round (up) traffic volumes for the N-S road and the E-W road. Rounding up ensures that a conservative estimate of the CO concentration contributed by each roadway is made. The representative traffic volumes for each road of the intersection are found as follows. The N-S road has different traffic volumes in each direction. Since the receptor is located on the side of the road with lower traffic volume, the traffic volume is taken as the average of the two volumes, i.e., 248 vphpl. For the E-W road, the traffic volume is the same in both directions and so the representative volume used is 158 vphpl.

Using Table A.2 (CO Protocol pp. A-5), the user must choose rounded up values for the traffic volumes. Choose the value in the table that is closest to the true traffic estimates, but not lower. The results for this example are presented below in Table 7:

Table 7. Representative Traffic Volumes for the N-S and E-W Approaches

Location	Traffic Volumes	Rounded Values
N-S road traffic volume	248 vphpl	300 vphpl
E-W road traffic volume	158 vphpl	200 vphpl

Step 3: Receptor Placement

A receptor is a measuring device for CO concentration at a given location. Since protection of public health is the ultimate objective of receptor placement selection, a receptor represents an actual person standing at the edge of the roadway breathing in CO. By default, the receptor is placed at 3 m from the NB lane and 3 m from the WB lane for this study. For the proper receptor locations criteria please refer to Section B.4.4 (CO Protocol pp. B-15).

Step 4: Determine Initial Estimates of CO Concentrations (CO Protocol pp. A-6)

Using Table A.3 (for the Central Valley), select four initial estimates of CO concentrations based on the approaches and departures at the intersection. For the N-S road, read the approach and departure CO concentrations from the Table A.3 for a 6-lane road with receptor to road distance of 3 m:

N-S road approach contribution	86.9 ppm
N-S road departure contribution	25.0 ppm

For the E-W road, use the approach and departure values from Table A.3 for a 6-lane road with a receptor distance of 3 m:

E-W road approach contribution	86.9 ppm
E-W road departure contribution	25.0 ppm

Step 5: Apply Traffic Volume Correction Factor (CO Protocol pp. A-7)

The initial estimates of CO concentration contributions must be adjusted for the representative traffic volumes determined in Step 2. Using Table A.5, we find that the correction factor for the N-S representative traffic volume of 300 vphpl is 0.37. The correction factor for the E-W representative traffic volume of 200 vphpl is 0.27. The adjusted concentration contributions become:

N-S road approach contribution	86.9 * 0.37 = 32.2 ppm
N-S road departure contribution	25.0 * 0.37 = 9.3 ppm
E-W road approach contribution	86.9 * 0.27 = 23.5 ppm
E-W road departure contribution	25.0 * 0.27 = 6.8 ppm

Step 6: Apply Intersection Performance Correction Factor (CO Protocol pp. A-7)

The intersection performance correction factors are obtained from Table A.6 (for approaches) and Table A.7 (for departures) using the average cruise speed, percentage red time, and representative traffic volume for each road determined in Step 2.

N-S road approach correction factor	0.39
N-S road departure correction factor	0.14
E-W road approach correction factor	0.62
E-W road departure correction factor	0.18

Application of these corrections factor yields: (e.g., N-S road approach contribution = 0.39 * 32.2 = 12.6 ppm)

N-S road approach contribution	12.6 ppm
N-S road departure contribution	1.3 ppm
E-W road approach contribution	14.6 ppm
E-W road departure contribution	1.2 ppm

Step 7: Determine Total Contribution from Approaches and Departures

Sum of contributions	29.7 ppm

Step 8: Apply Worst-Case Wind Speed Correction Factor (CO Protocol pp. A-8)

The total contribution obtained in the previous step is based on a worst-case wind speed of 0.5 m/s. Since the wind speed for this project is 1 m/s, it would be closer to actual conditions to assume a worst-case wind speed of 1.0 m/s instead of 0.5 m/s. Therefore, the total contribution should be multiplied by 0.7 (CO Protocol Section A.2.6, pp. A-8), which gives a corrected contribution of 20.8 ppm.

Step 9: Cold Start & Analysis Year Correction Factor (CO Protocol pp. A-8 & A-11)

The correction factor for cold starts and the analysis year is found using Table A.8. Using a cold start percentage of 30% and analysis year of 2000, a correction factor of 0.49 is found. Application of this correction factor gives a corrected total contribution of 10.2 ppm (20.8 * 0.49 = 10.2).

Step 10: Apply Wind Angle Correction Factor (CO Protocol pp. A-11)

The correction factor for the wind angle (as a function of traffic volume ratio and receptor location) can be found using Table A.9 and the criteria in Section A.2.9 (CO Protocol pp. A-6). The wind angle correction factor is a traffic volume ratio and receptor location correction. The user begins by computing the traffic volume ratio by dividing the highest traffic volume by the lowest traffic volume.

Ratio = 300 vphpl / 200 vphpl = 1.5

Next, the receptor location parameter is the longest distance from either road to the receptor, which is 3 m in the example case. The wind angle correction factor is found to be 0.81 using Table A.9. The resulting corrected total contribution is:

10.2 ppm * 0.81 = 8.3 ppm

Step 11: Determine Total 1-hour CO Concentration

The total 1-hour CO concentration is obtained by adding the project contribution (8.3 ppm) to the 1-hour background concentration (1.0 ppm, CO Protocol Sect. B.4.1, pp. B-9):

Total 1-hr CO Concentration = 8.3 + 1.0 = 9.3 ppm

Step 12: Convert from 1-hour to 8-hour CO Contribution (CO Protocol pp. B-24)

The 1-hr concentrations are converted to 8-hr concentrations by applying a persistence factor. The persistence factor is the ratio between the 8-hr and 1-hr CO concentration. When available, persistence factors provide a rapid method to estimate 8-hr CO concentrations based on 1-hr estimates. In this example, generalized persistence factors could be used. Generalized persistence factors have been developed based on studies from several locations. They are likely to provide a conservative estimate in most situations. Since this project is located in an urban area, a persistence factor of 0.7 is chosen from Table B.15. Therefore, total 8-hr CO concentration can be computed as:

Total 8-hr CO Concentration = 9.3 ppm * 0.7 = 6.5 ppm

5.2.3 Final Results

The total 8-hr CO concentration is estimated to be 6.5 ppm. This value can be compared to the National Ambient Air Quality 8-hr CO Standard of 9 ppm and the California Air Quality 8-hr CO Standard, which is also 9 ppm (CO Protocol Section 5).

APPENDIX A. Supplemental Information For Analyzing LOS D Intersections

The CO Protocol notes (pp. 4-7) that under certain special conditions LOS D (as opposed to LOS E) intersections must be analyzed further. In particular, detailed analysis should be considered for

1) pretimed LOS D intersections which also experience meteorological conditions favorable to the formation of higher CO concentrations and,
2) actuated LOS D intersections where enough traffic is queued to create problematic CO emissions and meteorological conditions are favorable to the formation of higher CO concentrations.

This section illustrates a method for determining whether or not meteorological conditions favorable to the formation of higher CO concentrations exist. Specifically the CO Protocol indicates that,

> *Meteorology favorable to higher CO concentrations can be characterized as stable air conditions (atmospheric stability of "E" or "F"), relatively slow wind speeds (less than 1.5 meters per second, or 3.5 mph) that persist for at least six hours, and with consistent wind direction having greater than a 50% frequency of occurrence into a single 45 degree sector during an inclusive 8-hr period (i.e., the wind blows into the same 45 degree sector at least 4 hours out of any given inclusive 8-hr period). (CO Protocol, pp. 4-8)*

To conduct the determination, meteorological data from the appropriate air district should be collected. While the data may come in several ASCII file formats, typically the data will include the year, month, day, hour, wind direction, wind speed, temperature, and stability class. One possible format for the data is shown in Table A1 where 12 hours of example data for January 1, 1981 have been collected. The meteorological files will usually include each day's hourly reading for the entire year.

Table A1. Example of Possible Meteorological Data Format

YEAR	MONTH	DAY	HOUR	TEMP	WIND SPD	STAB CLS	WIND DIR
81	1	1	1	284.3	1	7	292.3
81	1	1	2	284.3	0	7	282.39
81	1	1	3	283.1	0	7	287.5
81	1	1	4	283.1	0	7	301.01
81	1	1	5	282.6	0	7	286.48
81	1	1	6	283.1	0	7	297.03
81	1	1	7	285.4	0	6	297.01
81	1	1	8	287.6	1	5	314.65
81	1	1	9	289.8	1	4	299
81	1	1	10	291.5	1.34	3	54.15
81	1	1	11	294.3	1.79	3	89.11
81	1	1	12	297.6	1.34	2	103.06

NOTE: Atmospheric stability class is referred to either in numeric or letter formats. A stability class of "6" or "7" represents very stable conditions and is synonymous with a letter rating of "E" or "F".
* Temperatures are in Kelvin

Generally there are several pre-analysis steps that can be taken to reduce the amount of data that then must be reviewed. These steps are outlined below:

1. Select data from winter months only.
2. From the reduced data, select those data with wind speeds less than 1.5 m/s **and** a stability class of 6 or 7 (which translates to "E" or "F" noted in the CO Protocol)

With the subset of data now selected, individually examine each inclusive 8-hour period and determine if:

- low speed wind conditions and stability class persist for 6 hours **and**
- the wind blows into the same 45 degree sector for at least 4 hours out of any given inclusive 8-hr period.

For example, consider the subset of data shown in Table A2 which meet wind speed and stability conditions. It is clear that both stability class and low wind speeds persist for at least 6 out of the 8 hours.

Table A2. Data Subset Example

YEAR	MONTH	DAY	HOUR	TEMP	WIND SPD	STAB CLS	WIND DIR
81	1	1	1	284.30	1.00	7	262.30
81	1	1	2	284.30	1.00	7	262.39
81	1	1	3	283.10	1.00	7	287.50
81	1	1	4	283.10	1.00	7	301.01
81	1	1	5	282.60	1.00	7	224.48
81	1	1	6	283.10	1.00	7	297.03
81	1	1	7	285.40	1.00	6	267.01
81	1	1	8	285.40	1.00	7	220.45

The wind direction frequency can be summarized as shown in Table A3 where the wind blows approximately 37% (or 3 hours) from the same direction during the 8-hour period. This would indicate that favorable meteorological conditions did not exist during this 8-hour (i.e., at least 4 of the 8 hours should have the same wind direction). The next step would be to examine the next 8-hour inclusive period in a similar manner.

Table A3. Wind Direction

SECTOR	FREQUENCY	PERCENT
0-45		
46-90		
91-135		
136-180		
181-225	2	25
226-270	3	37.5
271-315	3	37.5
316-360		

APPENDIX B. Supplemental Modeling Information for Los Angeles Area Intersections

This appendix describes the modeling analysis conducted by the South Coast Air Quality Management District and included in the CO state implementation plan (SIP) for the South Coast Air Basin. Four intersections were chosen for this analysis. The descriptions of these four intersections are presented in Table B1. The CAL3QHC model was applied to the four intersections to estimate the CO impacts from motor vehicles traveling at roadway intersections. Input variables of the CAL3QHC model are summarized in Tables B2 and B3. CO concentrations were estimated for both the 1989 base year and for the year 2000 based on projected traffic volume and emission factors; they are presented in Tables B4 and B5. The variables used for the CAL3QHC model analysis are explained in the following sections. Note that all of the information presented below is included in the CO SIP for the South Coast Basin. On April 21, 1998, the U.S. EPA gave final approval to the CO SIP; the information in this Appendix is likely to be relevant until the South Coast attains the federal CO air quality standards.

B.1 Traffic Variables

Traffic volume, clearance lost time (the time lost to clear the intersection resulting from change of direction of the traffic flow, i.e. from north-south to east-west or vice versa), and signal timing information such as average signal cycle length and average "red light" time length are required to account for the CO concentration from vehicles in an idling state. At three intersections, this traffic and signal information was acquired from the City of Los Angeles. The Department of Transportation of the City of Los Angeles conducted a special intensive traffic monitoring program at the intersections of Wilshire – Veteran (W-V), Highland – Sunset (H-S), and Century – La Cienega (C-L).

Traffic counts at the intersection of Long Beach Boulevard and Imperial Highway in Lynwood were obtained from a special CO study sponsored by the California Air Resources Board (CARB). Right and left turn traffic counts were not available. However, based on past estimates, 5 and 10 percent of the approaching traffic were assumed for the right and left turn traffic counts, respectively.

Site-specific clearance lost time was not available; therefore, a default value of 2 seconds was used for all the modeling intersections.

B.2 Site Variables

Site geometry of the intersections such as the number of traveling lanes and lane width was either obtained from the City of Los Angeles or measured at the intersection.

B.3 Emission Variables

CO emission factors were estimated from the EMFAC7EP (Emission Factor Model for California, version 7EP). Both a composite running exhaust emission factor for free flow and an idling exhaust emission factor for queue link were estimated. Estimates of the emission factors are functions of: 1) the emitting process, such as running exhaust emissions, cold-start emissions, hot-start emissions, hot soak evaporative emissions, and evaporative running losses; 2) the vehicle type, such as light-duty auto mobile or heavy-duty truck, and technology group – catalyst, non-catalyst, or diesel; 3) ambient temperature; 4) vehicle speed; and 5) calendar year. All the vehicles traveling the intersection are assumed to be in a fully warmed-up mode. For the CO SIP analysis only the exhaust emission factors from EMFAC7EP were used for the CAL3QHC model applications.

Average vehicle speed and ambient temperature data at the intersections are required to estimate the composite running exhaust emission factors for free flow and idling exhaust emission factors for queue link from EMFAC7EP. Since data for average vehicle speeds at the intersections were not available, an average vehicle speed of 30 mph was assumed for free flow and 5 mph for queue link. Ambient temperatures at the intersections were estimated from the interpolations of the temperatures at the monitoring stations nearby.

B.4 Meteorological Variables

Wind speed and stability class were set to reflect the worst-case scenario. For all the modeling intersections, wind speed was assumed to be 1m/s, which is the minimum speed allowed for the CAL3QHC model. Stability class was set to a near-stable classification (Class D) and the mixing height was set at 1000 meters (the default value). Sensitivity analysis of the mixing height showed that mixing heights with extremely low values (less than 10 meters) can significantly influence the modeling analysis.

B.5 Other Variables

The surface roughness coefficient depends on the type of surface; its value is listed in Table 1 of the User's Guide to CAL3QHC (EPA, 1990) for the various types of surfaces. The surface type used for the modeled intersections is the office building category, which has a value of 175 cm. Settling velocity and deposition velocity were assumed to be zero cm/s.

Table B1. Selected Intersections for the CAL3QHC Modeling Analysis

Intersection	Receptor	Description
Long Beach Blvd Imperial Highway	Lynwood Air Monitoring Station	The peak CO concentration occurred at this station in 1989. The station recorded 31 ppm and 21.8 ppm for 1-hour and 8-hour averages. The second highest concentration was 18.3 ppm. CARB's Lynwood CO study is used to develop certain model inputs.
Wilshire Blvd/ Veteran Ave.	No Air Monitoring Station	The most congested intersection in Los Angeles County. The average daily traffic volume is about 100,000 vehicle/day. The intersection study has been conducted and traffic data is available.
Highland Ave./ Sunset Blvd	No Air Monitoring Station	One of the most congested intersection in the City of Los Angeles. The intersection study has been conducted and traffic data is available.
Century Blvd/ La Cienega Blvd	No Air Monitoring Station	One of the most congested intersection in the City of Los Angeles. The intersection study has been conducted and traffic data is available.

Table B2. Summary of CAL3QHC Model Input Data for the Base Year 1989

	Wilshire – Veteran		Sunset - Highland	
	A.M.	P.M.	A.M.	P.M.
TRAFFIC VARIABLES				
Traffic Counts				
East Bound Approach	4951	2069	1417	1764
West Bound Approach	1830	3317	1342	1540
South Bound Approach	721	1400	2304	1832
North Bound Approach	560	933	1551	2238
Left Turn				
East Bound	384	319	200	263
West Bound	53	84	164	212
South Bound	94	49	66	1
North Bound	132	128	74	0
Right Turn				
East Bound	-	-	-	-
West Bound	-	-	-	-
South Bound	325	780	-	-
North Bound	89	110	-	-
Signal Cycle Length	150	150	90	90
Red Time Length				
North - South				
Through Traffic	113	109	40	40
Left Turn	113	109	40	40
Right Turn	79	90	-	-
East - West				
Through Traffic	71	60	61	61
Left Turn	116	131	80	80
Right Turn	-	-	-	-
Clearance Lost Time	2	2	2	2
EMISSION VARIABLES				
Running Exhaust Emission Factor (g/mile)	16.1	13.9	15.1	14.0
Idling Emission Factor (g/min)	6.63	5.69	6.22	5.69
SITE VARIABLES				
Number of Lanes	4	4	3	3
Lane Width (meter)	3	3	3	3
METEOROLOGICAL VARIABLES				
Wind Speed (m/sec)	1	1	1	1
Stability Class	D	D	D	D
Mixing Height (meter)	1000	1000	1000	1000
OTHER VARIABLES				
Deposition Velocity (cm/sec)	0	0	0	0
Surface Roughness (cm)	175	175	175	175
Settling Velocity (cm/sec)	0	0	0	0

Table B2. Continued

	La Cienega – Century		Long Beach - Imperial		
	A.M.	P.M.	A.M.	P.M.	Peak
TRAFFIC VARIABLES					
Traffic Counts					
East Bound Approach	2540	2243	1217	2020	543
West Bound Approach	1890	2728	1760	1400	507
South Bound Approach	1384	2029	479	944	374
North Bound Approach	821	1674	756	1150	406
Left Turn					
East Bound	258	109	122	202	54
West Bound	111	139	176	140	51
South Bound	104	236	48	94	37
North Bound	88	86	76	115	41
Right Turn					
East Bound	374	147	-	-	-
West Bound	696	755	-	-	-
South Bound	700	588	-	-	-
North Bound	342	1187	38	58	20
Signal Cycle Length	120	125	90	90	90
Red Time Length					
North - South					
Through Traffic	85	89	70	70	70
Left Turn	110	108	80	80	80
Right Turn	53	73	45	45	45
East - West					
Through Traffic	77	69	45	45	45
Left Turn	88	109	80	80	80
Right Turn	67	52	-	-	-
Clearance Lost Time	2	2	2	2	2
EMISSION VARIABLES					
Running Exhaust Emission Factor (g/mile)	15.7	14.2	16.9	14.1	15.5
Idling Emission Factor (g/min)	6.44	5.80	6.98	5.75	6.39
SITE VARIABLES					
Number of Lanes	4	4	3	3	3
Lane Width (meter)	3	3	3	3	3
METEOROLOGICAL VARIABLES					
Wind Speed (m/sec)	1	1	1	1	1
Stability Class	D	D	D	D	D
Mixing Height (meter)	1000	1000	1000	1000	1000
OTHER VARIABLES					
Deposition Velocity (cm/sec)	0	0	0	0	0
Surface Roughness (cm)	175	175	175	175	175
Settling Velocity (cm/sec)	0	0	0	0	0

Table B3. Summary of CAL3QHC Model Input Data for the Year 2000

	Wilshire – Veteran		Sunset - Highland	
	A.M.	P.M.	A.M.	P.M.
TRAFFIC VARIABLES				
Traffic Counts				
East Bound Approach	4951	2069	1417	1764
West Bound Approach	1830	3317	1342	1540
South Bound Approach	721	1400	2304	1832
North Bound Approach	560	933	1551	2238
Left Turn				
East Bound	384	319	200	263
West Bound	53	84	164	212
South Bound	94	49	66	1
North Bound	132	128	74	0
Right Turn				
East Bound	-	-	-	-
West Bound	-	-	-	-
South Bound	325	780	-	-
North Bound	89	110	-	-
Signal Cycle Length	150	150	90	90
Red Time Length				
North - South				
Through Traffic	113	109	40	40
Left Turn	113	109	40	40
Right Turn	79	90	-	-
East - West				
Through Traffic	71	60	61	61
Left Turn	116	131	80	80
Right Turn	-	-	-	-
Clearance Lost Time	2	2	2	2
EMISSION VARIABLES				
Running Exhaust Emission Factor (g/mile)	3.1	3.0	3.0	3.0
Idling Emission Factor (g/min)	1.19	1.12	1.15	1.12
SITE VARIABLES				
Number of Lanes	4	4	3	3
Lane Width (meter)	3	3	3	3
METEOROLOGICAL VARIABLES				
Wind Speed (m/sec)	1	1	1	1
Stability Class	D	D	D	D
Mixing Height (meter)	1000	1000	1000	1000
OTHER VARIABLES				
Deposition Velocity (cm/sec)	0	0	0	0
Surface Roughness (cm)	175	175	175	175
Settling Velocity (cm/sec)	0	0	0	0

Table B3. Continued

	La Cienega – Century		Long Beach - Imperial		
	A.M.	P.M.	A.M.	P.M.	Peak
TRAFFIC VARIABLES					
Traffic Counts					
East Bound Approach	2540	2243	1217	2020	543
West Bound Approach	1890	2728	1760	1400	507
South Bound Approach	1384	2029	479	944	374
North Bound Approach	821	1674	756	1150	406
Left Turn					
East Bound	258	109	122	202	54
West Bound	111	139	176	140	51
South Bound	104	236	48	94	37
North Bound	88	86	76	115	41
Right Turn					
East Bound	374	147	-	-	-
West Bound	696	755	-	-	-
South Bound	700	588	-	-	-
North Bound	342	1187	38	58	20
Signal Cycle Length	120	125	90	90	90
Red Time Length					
North - South					
Through Traffic	85	89	70	70	70
Left Turn	110	108	80	80	80
Right Turn	53	73	45	45	45
East - West					
Through Traffic	77	69	45	45	45
Left Turn	88	109	80	80	80
Right Turn	67	52	-	-	-
Clearance Lost Time	2	2	2	2	2
EMISSION VARIABLES					
Running Exhaust Emission Factor (g/mile)	3.1	3.0	3.2	3.0	3.1
Idling Emission Factor (g/min)	1.17	1.12	1.22	1.12	1.17
SITE VARIABLES					
Number of Lanes	4	4	3	3	3
Lane Width (meter)	3	3	3	3	3
METEOROLOGICAL VARIABLES					
Wind Speed (m/sec)	1	1	1	1	1
Stability Class	D	D	D	D	D
Mixing Height (meter)	1000	1000	1000	1000	1000
OTHER VARIABLES					
Deposition Velocity (cm/sec)	0	0	0	0	0
Surface Roughness (cm)	175	175	175	175	175
Settling Velocity (cm/sec)	0	0	0	0	0

Table B4. Year 1989 1-Hour Average Carbon Monoxide Concentrations Calculated from the CAL3QHC Model

	Morning*	Afternoon+	Peak++
Wilshire – Veteran	18.2	10.9	-
Sunset – Highland	17.0	15.3	-
La Cienega – Century	14.3	12.9	-
Long Beach – Imperial	13.9	11.4	9.0

* Morning: 7-8 a.m. for Long Beach – Imperial, 8-9 a.m. for the other three intersections
+ Afternoon: 4-5 p.m. for Long Beach – Imperial, 5-6 p.m. for the other three intersections
++ Peak: 9-10 p.m. (concentration at the hour of the observed peak)

Table B5. Year 2000 1-Hour Average Carbon Monoxide Concentrations Calculated from the CAL3QHC Model

	Morning*	Afternoon+	Peak++
Wilshire – Veteran	3.2	1.9	-
Sunset – Highland	2.8	2.7	-
La Cienega – Century	2.6	2.3	-
Long Beach – Imperial	2.5	2.0	1.4

* Morning: 7-8 a.m. for Long Beach – Imperial, 8-9 a.m. for the other three intersections
+ Afternoon: 4-5 p.m. for Long Beach – Imperial, 5-6 p.m. for the other three intersections
++ Peak: 9-10 p.m. (concentration at the hour of the observed peak)

APPENDIX C. Analysis Checklist

This appendix is provided as checklist that CO Protocol users can photocopy and use to track their progress through project analyses.

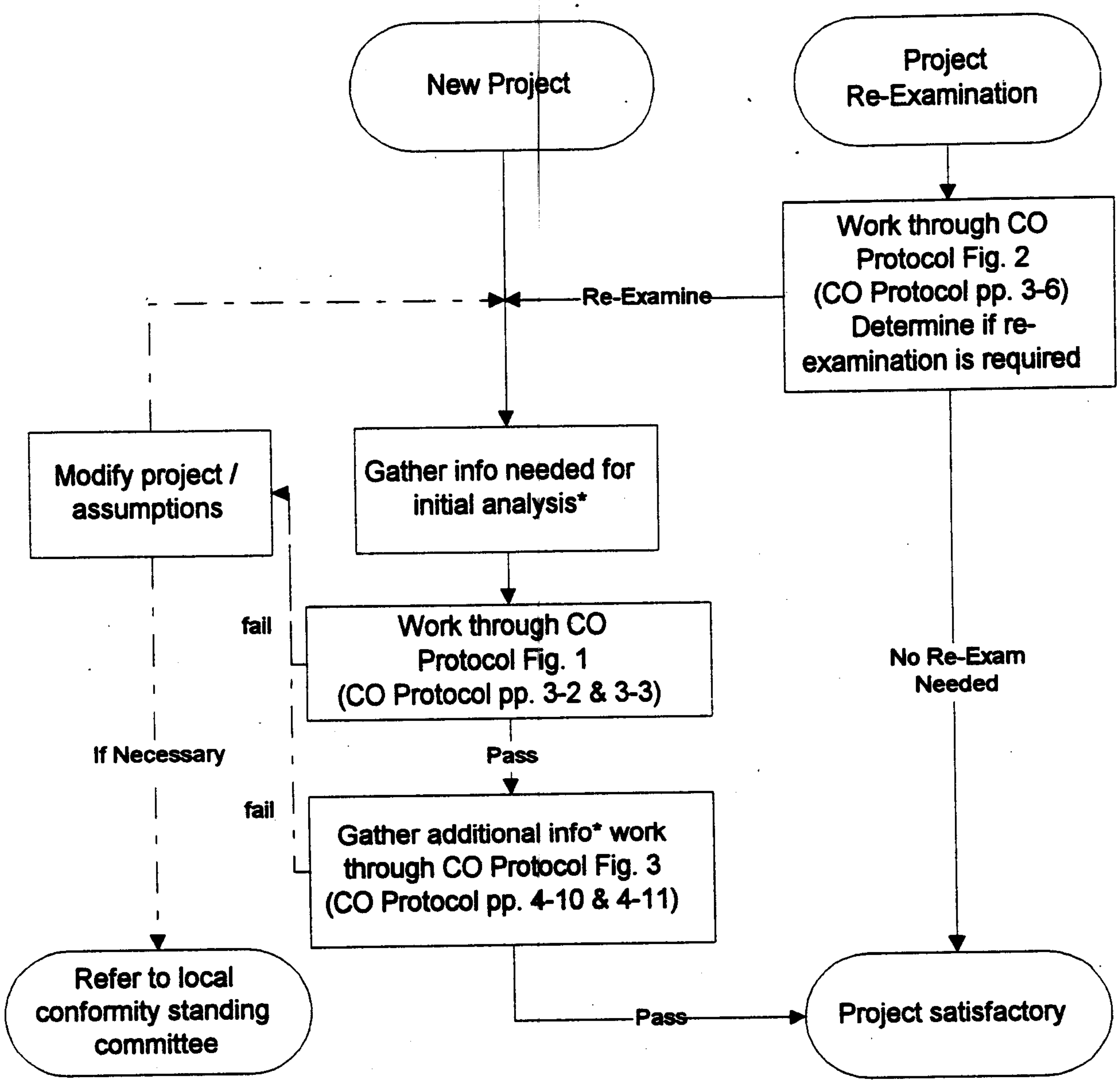
CO Protocol Worksheet

The following is a checklist of the steps most analyses should generally follow when working through the protocol. Usually the CO Protocol's Flow Diagram (CO Protocol Fig. 3, pp. 4-10 and 4-11) will be sufficient to analyze the project and flowchart results will indicate:

- whether or not the project requires more detailed analysis using Appendix A of the CO Protocol (a more detailed screening test). If Appendix A is required, then,
- Appendix A results will indicate whether or not the project requires more complex analysis such as that described in the CO Protocol's Appendix B.

The analysis steps a user can generally expect to follow include those illustrated in Figure C.1 and described in the text following the figure.

Figure C1. General Steps to Using the CO Protocol



Step 1. Gather Preliminary Information

The project region's air quality designation (attainment, nonattainment, and maintenance) and the RTP and TIP status (i.e., does the project come from a conforming RTP and TIP?).

Step 2. Work Through Figure 1 in the CO Protocol (CO Protocol pp. 3-2 and 3-3)

Step 3. Work Through Figure 2 in the CO Protocol (CO Protocol p. 3-6).

Step 4. Collect Materials For Projects Requiring Further Analysis.

Not all analyses will require all of the information listed in the CO Protocol or identified in this workbook; however, this checklist will help analysts anticipate most of the tasks and information needed. Note that for much of the information listed below, the CO Protocol provides conservative default values, guidance on how to calculate values, or instructions on how to obtain the information.

<u>For All Types of Analyses</u> *(i.e., Flow Diagram, Appendix A & Appendix B)*

The following project specific information must be collected for all types of analysis:

- Intersection Geometry
- Traffic Volumes
- LOS
- Speed
- Signalization plan (e.g., timing, cycles, etc.)
- Percent change in vehicles operating in "cold start" mode

<u>Additional Information for CO Nonattainment Areas</u>

Description of the intersection modeling included in the air quality plan (see Appendix B of this workbook for South Coast Air Quality Management District information).

<u>Additional Information for CO Protocol Appendix A Analyses</u>
(see page A-4 of CO Protocol)

Percent of Red Time
Analysis Year
Average Cruise Speeds
Background CO Concentration

Additional Information for CO Protocol Appendix B Modeling

- Percent of traffic as trucks, light duty autos, buses and motorcycles
- Meteorological data:
  - air temperature
  - wind speed
  - wind direction
  - standard deviation of the wind angle (sigma theta)
  - stability class
- I/M ("Smog Check") program status in modeling area
- Coded Link geometry (i.e., coordinates)
- Emission factors
- Elevation

Step 5. Work Through Figure 3 in the CO Protocol (CO Protocol pp. 4-10 and 4-11).

Step 6. Make an Analysis Determination.

Step 7. Document Your Findings.

APPENDIX D. Sample Documentation

The documentation procedure for project level CO analyses is presented in Section 3 of this workbook. This appendix contains sample documentation for the qualitative and quantitative screening examples presented in Section 5.1 and Section 5.2 of the workbook, respectively.

Example One: Qualitative Analysis Documentation

What level/type of study was performed:

The project level analysis procedure outlined in Section 4 of the Transportation Project-Level Carbon Monoxide Protocol (herein referred to as the CO Protocol; Caltrans, 1997) was followed for the Qualitative Analysis application. Specifically, Figure 3 of the CO Protocol (pp. 4-10) was used to determine that a qualitative analysis was warranted. The qualitative analysis described in Level 7 in Figure 3 of the CO Protocol was used to analyze the project. Only project level CO impacts were considered, as regional air quality issues were addressed in the RTP and TIP analyses.

Why the selected approach was used:

The CO Protocol methodologies have been approved by the U.S. EPA Region 9 as an appropriate analysis. The California Air Resources Board was contacted and Mr. CARB confirmed that the project is located in a state CO maintenance area with an approved maintenance plan. The regional MPO was contacted and Mr. MPO confirmed that the project is included in the conforming RTP and TIP. Based on the above information, it was determined that the project was subject to the qualitative analysis in Level 7 of Figure 3 in the CO Protocol. The traffic data used to conduct the qualitative analysis were obtained from Ms. so-and-so of Caltrans.

Results of the analysis:

The conclusions from the qualitative analysis are as follows:

- The Build alternative will not significantly increase cold start percentages above the No-Build levels.
- The Build alternative will not significantly increase traffic volumes above the No-Build levels.
- The Build alternative will improve traffic flow.

The environmental impact threshold against which the results are measured

The significance thresholds to which the analysis results are to be measured against are listed in Section 5 of the CO Protocol.

Consultation Agreements Reached

[There were no significant consultation agreements, so nothing would be documented.]

Documentation Specific to CEQA

[Significance of impacts with regards to CEQA to be determined by Project Development Team and Department or Project Managers].

Documentation Specific to Conformity

The qualitative analysis of the project indicates that it will not lead to a new violation or worsen an existing violation of the Federal CO standard. The project is included in the currently conforming RTP and TIP. A conformity determination was made on dd/mm/yy by the MPO and on dd/mm/yy by the FHWA. The assumptions made in the project level analysis are consistent with the assumptions used in the regional emissions analysis in the RTP. Therefore, the project satisfies conformity regulations.

Documentation Specific to NEPA

[Significance of impacts with regards to NEPA to be determined by Project Development Team and Department or Project Managers].

Example Two: Quantitative Analysis Documentation

What level/type of study was performed:

The project level analysis procedure outlined in Section 4 of the Transportation Project-Level Carbon Monoxide Protocol (herein referred to as the CO Protocol) (Caltrans, 1997) was followed for the Quantitative Analysis application. Specifically, Level 7 of Figure 3 (pp. 4-10) was used to perform a qualitative analysis. From this qualitative analysis, it was determined that a quantitative analysis was required. The analysis described in Appendix A of the CO Protocol was used to analyze the project quantitatively. Only project level CO impacts were considered, as regional air quality issues were addressed in the RTP and TIP analyses.

Why the selected approach was used:

The CO Protocol methodologies have been approved by the U.S. EPA Region 9 as an appropriate analysis. The California Air Resources Board was contacted and Mr. CARB confirmed that the project is located in a state and federal CO maintenance area. The regional MPO was contacted and Mr. MPO confirmed that the project is included in the conforming RTP and TIP. The traffic data used to conduct the qualitative and quantitative analyses were obtained from Mr. so-and-so of Caltrans. A qualitative analysis was performed using Level 7 of Figure 3, of the CO Protocol. Based on the traffic data, it was determined that the project is expected to significantly increase cold start percentages in the area. Therefore, a quantitative analysis based on Appendix A of the CO Protocol was conducted. The meteorological data and the background CO concentrations used in the quantitative analysis were obtained from Ms. so-and-so from the Local Air Pollution Control District.

Results of the analysis:

The conclusions from the quantitative analysis are as follows:

- The total 1-hour CO concentration (background plus project contribution) is estimated to be 9.3 ppm.
- The total 8-hour CO concentration (background plus project contribution) is estimated to be 6.5 ppm.

The environmental impact threshold against which the results are measured

The significance thresholds to which the analysis results are to be measured against are listed in Section 5 of the CO Protocol.

Consultation Agreements Reached

On xx/yy/zz date, the project sponsors met with Mr. AirDistrict and agreed on the use of the meteorological and background concentration assumptions utilized during the analyses. The specific assumptions agreed to include: [in this hypothetical example, you would list out the meteorological and background concentration assumptions agreed to and used in the analyses.]

<u>Documentation Specific to CEQA</u>

[Significance of impacts with regards to CEQA to be determined by Project Development Team and Department or Project Managers].

<u>Documentation Specific to Conformity</u>

The quantitative analysis of the project indicates that it will not lead to a new violation or worsen an existing violation of the Federal CO standard. The project is included in the currently conforming RTP and TIP. A conformity determination was made on dd/mm/yy by the MPO and on dd/mm/yy by the FHWA. The assumptions made in the project level analysis are consistent with the assumptions used in the regional emissions analysis in the RTP.

<u>Documentation Specific to NEPA</u>

[Significance of impacts with regards to NEPA to be determined by Project Development Team and Department or Project Managers].