National Drinking Water Advisory Council (NDWAC)
Contaminant Candidate List (CCL) Classification Process Work Group

September 17, 2003
Washington, DC

Meeting Summary

The seventh meeting of the NDWAC CCL Classification Process Work Group was held on September 17, 2003. The meeting objectives were

- For all stages of moving from CCL universe to CCL
  - Review and discuss data aggregation and interpretation
- For CCL universe to preliminary CCL (PCCL)
  - Review and discuss QSARs and screening approaches
  - Review and discuss certainty and confidence in the data
- For PCCL to CCL
  - Review and discuss certainty and confidence, and models as well as attribute scoring
- Discuss microbial and transparency issues, next steps
- Decide on next steps for completing the report to the NDWAC
  - Agree on work plan and questions to be addressed in order to develop a recommendation to the NDWAC
  - Agree on tasks to be conducted between September 2003 and end of process, and incrementally for November and two additional meetings

Welcome and Introductions

Facilitator Abby Arnold, RESOLVE, welcomed everyone to the meeting (see attachment A for list of work group members in attendance). Following introductions, the work group reviewed the meeting agenda (see attachment B). Ms. Arnold explained that because the meeting was shortened to one day to avoid problems with the arrival of hurricane Isabel, the group would not get to all of the items on the agenda, particularly those originally scheduled for September 18, but arrangements would be made to continue discussions by conference call or at the next meeting as necessary.

Review of Tasks Conducted and Progress Made and Overview of Next Phase

Tom Carpenter, EPA, presented a summary of activities and next steps (see attachment C). For each step of the proposed CCL process—building the CCL universe, screening from the CCL universe to the PCCL, and classifying from the PCCL to the CCL—he summarized the progress made thus far and identified next steps and critical decisions to be addressed. Work group members generally agreed with the identified steps and decisions. One member requested a diagram to illustrate the steps of the process, as discussed at the July meeting.

CCL Universe: Update on Data Aggregation and Interpretation for Chemicals

Jo Anne Shatkin, Cadmus Group, presented an update on the CCL universe example data set (see attachment D). She reported that since the July work group meeting, two occurrence data sources

were added to the example data set, the classification of data element types was updated, and the gates analyses and summary statistics were updated. The primary changes to the classification of data elements were to reclassify some of the elements from the "other" category into the "health effects information" and "occurrence information" categories. Dr. Shatkin shared the revised summary statistics for the data set with the additional data sources and reclassification of some data elements. The data set includes 11,128 unique chemicals and 150 health effects and occurrence data elements. Of the 11,128 chemicals, 1,741 have data or information on health effects and occurrence and, therefore, could "line up" at the gates to have screening criteria applied in the process currently proposed for screening from the universe to the PCCL.

Dr. Shatkin summarized some lessons learned and next steps:

- Reclassification and the additional occurrence data doubled the number of chemicals that could be screened at the proposed gates. This increase, however, will not continue indefinitely. Broader definitions of screening information affects the gates.
- Currently, the process appears to be limited by occurrence data.
- Next steps include evaluating additional sources, evaluating the quality of the sources, and testing screening approaches.

In response to questions, Dr. Shatkin estimated that about 300 to 400 additional chemicals would line up at the screening gates if estimates from qualitative structure activity relationships (QSAR) were added to the example CCL universe data set. She also commented that the data set was assembled following the principles developed by the work group for building the CCL universe.

A member noted that the high production volume (HPV) information is a subset of the Toxic Substance Control Act (TSCA) information. She commented that using all of TSCA may add data and information that would allow more chemicals to be considered at the screening gates. She suggested that one approach would be to select data from TSCA for those chemicals that already have health effects data or information. Dr. Shatkin commented that this suggestion raises a general question for the work group to consider: how should EPA proceed with adding data sources—by uploading all of the data from each or by selectively uploading certain data?

CCL Universe to PCCL: Update on QSAR Analysis

Charlie Pittinger, Cadmus Group, presented the initial evaluation of the use of QSAR models to provide occurrence and health effects information for screening from the CCL universe to the PCCL (see attachment E). For the analysis, the QSAR program TOPKAT was used to predict oral rat chronic toxicity (i.e., lowest observable adverse effect level (LOAEL)) and two components of EPI-Suite were used to predict water solubility (WSKOWWIN) and biodegradability (BIOWIN). TOPKAT is a commercial package licensed by Accelrys and used by EPA and other regulatory agencies. It uses two-dimensional descriptors of chemical structural information (SMILES) to predict a range of human health properties. EPI-Suite is publicly available through EPA and uses SMILES to predict physical/chemical properties and environmental fate measures.

Two categories of chemicals were included in the test set contaminants: those with existing empirical data for evaluating how well the models performed, and those without empirical data

for evaluating the applicability of models to contaminants lacking data. Dr. Pittinger explained how the contaminants were selected, compiled, and sorted for the evaluation. He shared the results of statistical analyses comparing TOPKAT predictions to empirical LOAELs, WSKOWWIN predictions to measured solubility, and BIOWIN predictions to empirical measurements of biodegradability. He then shared the following overall conclusions from the initial evaluation:

- QSAR modeling with EPI-Suite appears feasible for predicting water solubility and biodegradability for use in CCL Universe to PCCL screening
- QSAR modeling using TOPKAT for health effects appears possible, but may require greater selectivity in chemicals and health effects modeled
- Comparison of QSAR model results to empirical data was limited by missing and highly variable measurements reported. This may generally limit the ability to fully evaluate QSAR model predictions for chemicals outside their respective training sets.
- Initial QSAR modeling suggests QSARs more readily generate information on occurrence-related properties than human health effects endpoints for large and diverse chemical sets.
- Chemical input development may be more resource-intensive than actual QSAR modeling.
- Processing thousands of chemicals using QSAR models would be facilitated by efficient batch mode operations.

Several members voiced concern about using a proprietary model. A member noted that proprietary models raise issues of transparency. Another commented that without access to the algorithm and training data set, it is not possible to evaluate whether the model is biased away from the purpose for which it would be used in the CCL process. Dr. Pittinger acknowledged these concerns but commented that TOPKAT is currently the only QSAR model for health effects. Some members suggested that EPA could consider developing its own QSAR model for toxicity values. A member commented, however, that if a model exists that is sufficiently accurate for screening, EPA should not invest resources in developing a different model.

A member observed that the statistical analysis of the TOPKAT estimates did not show a very tight relationship with the empirical values. Dr. Pittinger commented that a range of different empirical LOAELs were used in the analysis, which is one reason the comparison is not as tight as it could me. A member observed that for use at the screening stage of the process, the concern would be those chemicals for which the model overestimates the LOAEL. Another member suggested evaluating predictions for lethal doses (LD_{50}s) to determine whether they are more accurate than LOAEL predictions. She noted that the question of whether LD_{50}s are sufficient for screening would have to be considered. A member offered another suggestion, that estimates from the upper confidence levels could be used to be conservative. He noted that without using QSAR model estimates, there will be insufficient information for screening for most of the chemicals in the CCL universe.

After this discussion and consideration of the results of the preliminary analysis on binning as a screening approach (see below), the work group decided to recommend the use of QSAR models to fill data gaps for screening from the CCL universe to the PCCL. They decided also to recommend that EPA use non-proprietary models, if possible, and explore models for LD_{50}s or other toxicity values. A member suggested that QSAR models should be run for all possible

chemicals in the CCL universe, but the group did not thoroughly discuss the question of when QSAR models should be used.

CCL Universe to PCCL: Update on Screening and Binning

Dr. Shatkin presented a summary of preliminary analysis on using binning approach to screen from the CCL universe to the PCCL (see attachment F). She noted that in different documents and discussions, the work group has referred to this approach also as the semi-quantitative approach and the risk approximation approach. She explained that at the July meeting, members asked the technical team to test the binning approach, particularly to help determine whether a two by three matrix of high, medium, and low for toxicity and occurrence would work for screening or whether the matrix would need more separation among contaminants.

For the evaluation, QSAR estimates and empirical (measured) data were separated into three "bins" of high values, medium values, and low values. The contaminants evaluated in the preliminary analysis were LOAELs and water solubility. In one set of analyses, the bins were divided by percentages of chemicals (i.e., the 33% of the chemicals with the lowest LOAELs (the most potent chemicals) were placed in the high bin). In the other set of analyses, the bins were divided by value (i.e., all chemicals with a LOAEL of 0 to 9.9 were placed in the high bin). The QSAR data and empirical data were binned separately to allow comparison between them.

For the analyses, a chemical was considered to pass through the "screen" onto the PCCL if it was 1) in the high bin for both LOAELs and solubility, 2) in the high bin for LOAELs and the medium bin for solubility, or 3) in the medium bin for LOAELs and the high bin for solubility. Dr. Shatkin reported that

- using measured LOAELs and measured solubility, binned by percentages, 31 chemicals (33%) met the criteria to pass onto the PCCL;
- using measured LOAELs and measured solubility, binned by values, 49 chemicals (52%) met the criteria to pass onto the PCCL;
- using QSAR estimated LOAELs and QSAR estimated solubility, binned by percentages, 121 chemicals (31%) met the criteria to pass onto the PCCL.

Dr. Shatkin summarized some initial findings:

- The binning approach is straightforward.
- Generally, similar results are seen in bins whether segregated by percentages or values, but more contaminants passed to the PCCL when segregated by value.
- The percentages of contaminants passing to the PCCL using QSAR estimated values were similar to those produced using measured values.
- It is possible to bin by percentage or values to select candidates.

She also suggested possible next steps:

- Bin a subset of chemicals with both empirical and QSAR-modeled data
- Bin a larger data set of empirical data supplemented with QSAR results
- Add a third binning parameter (half-life - persistence)
- Bin by quintiles

A member commented on some of the limitations of a binning approach. He noted that range in the bins depends on the data set, and where the line is drawn between bins greatly influences the results. Drawing a sharp boundary between bins results, for example, in a contaminant with a LOAEL of 8 milligrams per kilogram per day (mg/kg/d) being in a different bin from a contaminant with a LOAEL of 7 mg/kg/d but in the same bin with a contaminant with a LOAEL of 125 mg/kg/d. The member also commented that the approach is not transparent because it is not clear what high (or medium or low) means. He suggested using a ranking approach rather than binning, and making one judgment at the end as to the cut-off point to separate the contaminants to be placed onto the PCCL. He commented that a ranking approach would better utilize the data and information for each contaminant. He explained that ranking could be done by normalizing the toxicity value (e.g., LD_{50}) and the solubility value for each chemical and adding or multiplying the two values. Chemicals could then be ranked by the resulting sums or products, and a cut-off point chosen.

A member suggested that rather than use a ranking approach, a binning approach could be used and the results could be checked with the quantitative data for chemicals that have them. Another member commented that she was comfortable with a binning approach because any approach is an approximation given the amount of uncertainty for many of the data being used. A couple of members commented that they did not feel that transparency is lost with the binning approach.

A member observed that whether binning or ranking is used, the approach is one of prioritization; it would prioritize the contaminants and select the top group for the PCCL. He noted that this approach is different from one that would somehow distinguish between "bad" chemicals and "OK" chemicals. Another member commented that the binning or ranking approach would not select an arbitrary fraction of chemicals; the intent is to identify those that pose a risk. A third member commented that the question to consider for the PCCL is whether it includes a reasonable selection of contaminants from which to choose the CCL.

A member suggested that it may be helpful to evaluate the contaminants within each gate separately. She suggested that different cut-off points may be appropriate for different gates.

A member suggested considering measures other than solubility as an indication of occurrence. Members of the technical team noted that the group should further discuss the general question of what data to use for each of the gates.

Next Steps

A member proposed an analysis to provide the group more information:

- Apply the binning approach to chemicals within each of the gates. Then, for chemicals that pass to the PCCL through gate I (i.e., chemicals with effects data and occurrence data), apply the quantitative approach discussed by the group at previous meetings. Divide the chronic LOAEL by 1000 and compare the quotient to the chemical's solubility. If the quotient is higher than the solubility, remove the chemical from the PCCL.
- Apply the suggested ranking approach to the chemicals.
- Compare the results of the two approaches.

PCCL to CCL: Data Extraction

Dr. Shatkin summarized the progress and lessons learned from assembling a data set for testing proposed attribute scoring approaches for PCCL to CCL classification (see attachment G). Forty chemicals with a range of data availability were randomly selected. Data for the chemicals were extracted from eighteen sources with a range of data types and formats, and extraction issues were noted as they arose. Tabular sources were downloaded to Microsoft Excel and imported to Microsoft Access. For monographic sources, text and data were copied into Access as textual memo fields. Bibliographic sources were downloaded to Endnote. Dr. Shatkin reported that the level of effort required for data extraction varied from a couple of hours for some of the tabular sources to ten days for some of the bibliographic sources, depending on several factors. She offered some examples of issues for specific sources and the solutions used to address them. She commented that much was learned from this exercise about how to make the extraction and organization process more efficient.

Dr. Shatkin summarized some of the general lessons learned:

- The exercise demonstrated that it is feasible to extract and develop data.
- The level of effort to obtain data ranges from hours to days.
- Obtaining data from text sources requires programs with flexibility to account for exceptions to patterns and may still require some manual entry.

Recommendations and next steps included the following:

- Develop a hierarchical approach for data gathering.
- Continue to develop and test parsing programs to obtain the data needed.
- Develop an approach for inorganics.
- Create and track a consistent approach.

Following the presentation, members generally agreed with the lessons learned. Technical team member Jeff Rosen, Perot Systems Environmental Services, commented that the message from participants of the American Water Works Association (AWWA) workshop held in June was similar to the one presented by Dr. Shatkin. He recalled that the overall message from the workshop was that data extraction is feasible but some of the details will be challenging, such as parsing the data and choosing among multiple data points.

A member observed that if the desired data elements were known, the process could be tailored more efficiently. Dr. Shatkin commented that the question of a hierarchy of data elements and a hierarchy of sources for each data element remains to be resolved.

PCCL to CCL: Certainty and Confidence in the Data

George Hallberg, Cadmus Group, shared a presentation on accounting for certainty/confidence in attribute scoring (see attachment H). He reviewed some of the National Research Council (NRC) recommendations and other points previously discussed by the work group. The general question the work group has posed is whether some indication or measure of certainty/confidence should be captured in the process, and if so, how. The group has discussed some of the issues and options related to this question. Dr. Hallberg outlined some of the perspectives that have been

offered in the various discussions, including the paradox of whether an attribute score should be raised or lowered because of lower certainty/confidence.

He summarized five options that have been considered by the group:

1) Include certainty/confidence adjustment factors in scoring the attributes
2) Assign 5 separate certainty/confidence scores to the data (one for each attribute); use these scores in the classification algorithm
3) Assign 1 combined certainty/confidence score to the data (a combined score for all attributes for a contaminant); use this score in the classification algorithm
4) Assign separate certainty/confidence "flags" to the data for each attribute; record the flags and use them in expert reviews after the classification algorithm has produced a list
5) Ignore certainty/confidence at this stage of the process (attribute scoring)

Dr. Hallberg noted that several discussions have leaned toward pursuing option 4. Dr. Hallberg also noted that data quality considerations will factor into decisions at other points in the process, such as selecting hierarchies of data elements for screening and classification.

A member observed that inherent in several of the options is the challenge of quantifying certainty/confidence. He suggested that rather than "ignoring" certainty/confidence, option 5 should be a transparent option: EPA should simply be clear about what data were used and where they came from, and let people make their own decisions about certainty/confidence. Another member suggested that option 4 could also be simple and transparent. He explained that the contaminants could have a flag for each attribute, indicating whether the likely bias direction for that score (i.e., higher or lower). Experts could use these flags to review the model output and decide which should be on the CCL and which should not. A member commented that with a flagging approach, the key decision is made when the flag is added, while the proposed "transparent" option leaves the decision of bias and direction open for an individual to make based on the information about the data. Another member explained that the situation will be one of having a selection of contaminants from the model output, some with high confidence and some with low confidence, and the level of confidence will be one consideration in making the final choice of what to include on the CCL.

Several members expressed support for either option 4 or the proposed "transparent" approach. One member commented that whether the other flagging approach for the transparent approach is used, EPA will explain how the contaminants were selected, and the data will be available for people to review and evaluate.

A member of the technical team commented that he disagreed with the direction of the discussion and felt that the two options being discussed oversimplified the issue of certainty/confidence. He noted that the question of certainty/confidence is a question of whether a contaminant with a score of 5 is really a 5, or something between 2 and an 8.

The work group agreed to have a conference call to continue the discussion of how to address certainty/confidence.

PCCL to CCL: Classification Models Update

Work group member Craig Stow shared some perspectives on the CCL classification process and prototype modeling and addressed some of the issues related to the process and use of the models (see attachment I). He noted that CCL classification is a judgment process. Using a model will help to make the process more transparent and consistent; it will not eliminate subjectivity, but will make the judgments more explicit. He explained that the model is a pattern recognition algorithm. It will replicate past decisions that were made regarding the contaminants in the training data set. He cautioned against implying unjustified precision, as the process will remain inherently judgmental.

In regard to attribute scoring, Dr. Stow commented that if the same data were available for all contaminants now and in the future, scoring would not be necessary. Because the kind of data available will vary over time and by contaminant, using a scoring system allows EPA to keep the model input consistent. Dr. Stow observed that there is imprecision embedded in the range of data elements, and some approaches to handling uncertainty/confidence imply false precision in the assessment. He also noted that a scale of 1 to 10 for scoring is consistent with the level of precision in the process. He commented that establishing defined scales/calibration and scoring processes for the attributes improves transparency and consistency and documents decisions. In defining scales, experts make, for example, 50 decisions upfront versus trying to make individual decisions on 1000 contaminants. Dr. Stow explained that the same scales must be used for the training data and for all subsequent contaminants evaluated, unless the models are recalibrated. He added that the scales must cover the range of conditions expected and should not cluster around one or two scores.

He observed that some members have expressed concern about the relationship between magnitude and potency scoring. He explained that the usefulness of the model is not contingent on an assumption of independence among the attributes. He noted that the final model is likely to use a subset of the five attributes, and if two attributes are highly correlated, the model probably will not select both of them.

Dr. Stow observed another concern about a lack of data for some contaminants for some of the attributes and the question of whether persistence-mobility should be scored for all contaminants or just those with no occurrence data. He explained that not all of the model types being considered can deal with “missing” data, and no models deal well with “either-or” situations.

In closing, Dr. Stow reflected on some of the questions the work group has raised regarding the differences between chemical and microbiological contaminants:

- What if it is not feasible to use/score all attributes for microbiological contaminants at this time?
- What if the attributes require different definitions and scales for microbes than for chemicals?

Dr. Stow commented that there are several options for addressing these issues, such as the using separate models for chemicals and for attributes were including a “dummy” (indicator) attribute to indicate whether a contaminant is a chemical or a microbe. He noted again that the final model

will not likely use all of the attributes and suggested that the models could be tested to see what is necessary for chemicals and for microbes.

Members thanked Dr. Stow for explaining and clarifying these points. The facilitation team will work with Dr. Stow and other members to summarize these points to include as an introduction to the chapter on classification models in work group's report to the NDWAC.

PCCL to CCL: Update on Potency Scoring Protocol for Chemicals

Joyce Donohue, EPA, presented an update on the work done to calibrate data and develop a scoring scheme for potency (see attachment J). She explained that the purpose of the analysis was to examine the distribution of potency values for a set of contaminants better representative of chemicals likely to be in the CCL universe, and then utilize the knowledge gained to calibrate one or more approaches to scoring potency. She described the composition of the set of chemicals used for the analysis and noted that the potency measures collected included reference dose (RfD), E^{-4} cancer risk concentration in water, no observable adverse effect level (NOAEL) from the critical study, LOAEL from the critical study, and rat oral LD_{50}. For each of these measures, the range of the values was divided into tenths (deciles) and arrayed in a histogram. The rounded $\log_{10}$s were also calculated for the potency values and arrayed in histograms.

Dr. Donohue reviewed the histograms for the various measures. She explained that the $\log_{10}$s gave a better distribution than the decile delineation for each of the potency measures, so the $\log_{10}$s were used to develop the scoring equations. An equation was developed for each potency measure by equating the modal $\log_{10}$ for that measure to a score of 5 and relating the rest of the range of $\log_{10}$s to a range of scores from 1 to 10. The equations were used to develop a set of scores for each chemical: a score based on the RfD, a score based on the NOAEL, a score based on the LOAEL, and a score based on the LD_{50}. Dr. Donohue summarized the scoring results for a sample of chemicals. She explained that the purpose of the analysis was to evaluate how the scores from the different potency measures compare to each other for a given chemical. This comparison can help to address the question of how to deal with the challenge of not having values for the same potency measure for all chemicals.

Dr. Donohue's conclusions from the analysis included the following:

- Scores are fairly consistent for a given chemical.
- Though uncertainty factors increased the spread of scores between RfD, NOAEL, and LOAEL.
- LD_{50}s for inorganics must be for a relevant form of the chemical.
- Options exist for refining the process.

Following the presentation, a member summarized that the underlying challenge is how to use various potency measures to map all of the chemicals onto a consistent potency scales. A member suggested using a regression approach to predict a RfD for every chemical using whatever potency measure is available for that chemical (if a RfD is not already available), and then scoring all of the chemicals based on RfDs. A member responded that methods are available for estimating RfDs based on LOAELs and NOAELs using uncertainty factors, but the problem with this approach is that the CCL becomes filled with chemicals that have high scores primarily because they have limited data. He explained that he and another member had discussed a

possible way to address this issue, which would be to use the chronic animal LOAEL to score potency.

A member suggested that an approach of using normalized data may be preferable to the approach presented by Dr. Donohue. Another member suggested that an analysis be done to compare the two approaches.

PCCL to CCL: Update on Severity Scoring Protocol for Chemicals

Octavia Conerly, EPA, summarized the progress made on developing a scoring scale for severity (see attachment K). She explained that the group of EPA staff working on the scoring scheme used the NRC proposed scale as a starting point. They applied the scale to a sample data set, assessed the scoring difficulties, revised the scale to address those difficulties, and applied the revised to scale to a sample data set. Dr. Conerly explained that three cycles of the review/revision process were completed, with the work group assisting with some of the review. She outlined the guiding principles used in applying the scales insured some examples of critical effect descriptors. She reviewed the NRC scoring scale and the three revised scales.

Dr. Conerly explained that EPA staff are now conducting an exercise to further improve the scoring scheme by scoring actual effects as they can be downloaded from the Integrated Risk Information System (IRIS) database. The exercise also will experiment with "binning" critical effects and help to develop a working vocabulary of critical effect descriptors. Dr. Conerly shared some examples of binned critical effects and said that staff are now looking at whether the scheme gives a clear progression of severity moving up the scale and whether the effects placed in each score are comparable.

In closing, Dr. Conerly outlined some ongoing issues, next steps, and questions to consider:

Issues
- Middle scores remain difficult to differentiate.
- Difficulties in placing different types of reproductive and developmental effects.
- How to score chemicals lacking critical effects.

Next Steps
- Expand the mean exercises to include data sources other than IRIS and continue to develop a glossary of terms.
- Continue to revise scoring scheme based on lessons learned.

Questions to Consider
- Should the scale be convinced to contain fewer categories?
- Should "death" be included as a separate category?

A member shared some insights from working on the scoring protocols for microbes. He suggested that if it is difficult to distinguish among the effects in, for example, the scores of 3, 4, and 5, the three scores could be collapsed into a score of 4 that includes all of the effects. He also suggested that if there is no critical effect for a chemical, it should not be scored. He commented that death should be kept as a separate category, and if many contaminants have death as a critical effect and, therefore, fall into the same score, the other attributes can be used to differentiate among them.

Additional suggestions from members included the following:

- Irritant effects should be included in on the scoring scale.
- It may be helpful to have a physician in the group that is developing the scale.
- It may be fine to have developmental effects and reproductive effects as a separate categories. Another option is to leave them in one category and score the effects of offspring.

Members generally commented that they could see the rationale of the scoring scale and asked EPA to continue refining the scale.

Public Comment

No members of the public expressed an interest in making comments to the work group at this meeting.

Next Steps

The technical/facilitation team will develop a set of next steps based on the work group discussions for members to review. The team will also identify questions to raise at the next work group meeting and propose a plan for continuing to draft, review, and revise the sections for the work group report to the NDWAC.

Future Meetings

The work group agreed on dates for two additional meetings beyond the previously scheduled November meeting. The remaining work group meetings in 2003 are listed below. It is expected that all meetings will be held at the RESOLVE offices.

- November 13-14, 2003
- January 22-23, 2004
- March 4-5, 2004

Attachments

A. Work Group Members in Attendance
B. Agenda
C. Summary of Activities
D. Update on the CCL Universe Example Data Set
E. Update on QSAR Analysis
F. Update on Screening and Binning
G. Data Extraction
H. Accounting for Certainty/Confidence in Attribute Scoring
I. Perspectives on the CCL Classification Process and Prototype Modeling
J. Potency Calibration and Scoring
K. Developing a Scoring Scale for Severity

Attachment A

CCL Process Work Group Members Present at the Meeting

Dr. Laura Anderko
Dr. Michael Dourson
Dr. Alan Elzerman
Dr. Jeff Griffiths
Dr. Wendy Heiger-Bernays
Mr. Buck Henderson
Dr. Nancy Kim
Mr. Ephraim King
Ms. Carol Kochiesen (alternate for Dr. Benson Kirkman)
Mr. Gary Lynch
Mr. Ken Merry
Dr. Graciela Ramirez-Toro
Dr. O. Colin Stine
Ms. Lynn Thorp
Dr. Daniel Wartenberg