RALPH J. STEPHENSON, P.E., P.C.
CONSULTING ENGINEER

June 9, 1984

Subject: Report #1

Flint Water Treatment and Distribution System Futures Analysis

Flint, Michigan

Project: 84:26

Date of Meeting: June 4, 1984

Actions taken:

- Met with Mr. William Ewing, P.E., superintendent Water Supply and Pollution Control and Mr. John W. Weisenberger, Supervisor, Water Plant
- Inspected water treatment facilties
- Took several photos of various components of the water treatment facilities

General Summary

Prior to the meeting on June 4, 1984 Mr. Ewing provided me with a copy of the Report on Alternate Water Supply Study for Flint, Michigan by Black & Veech, engineers and architects. This study was prepared in 1983 and presented an analysis of the existing plant with suggestions as to the possible alternatives to providing alternate water supplies for Flint and its water market area. I was able to read enough of the report to allow a reasonably intelligent understanding of the problem and the current solutions being considered. A more thorough study of the report will be made prior to our next meeting.

From the discussions and the inspection in this first meeting, I recommend we look at the water supply problem facing the City of Flint as a determination of the existing plant's future role in the total water treatment and distribution process engaged in by Flint and the surrounding areas. This total water system includes:

- the existing physical plant formerly used to treat raw water from the Flint River
- the treated water distribution system
- the operating and maintenance staff of the water system and their organization

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- the political entity of the City of Flint
- the political entity of Genessee County
- the political entity of Detroit
- the interconnecting supply system from Detroit
- the rate structure for buying and selling water
- the requirements and desires of the Michigan State Public Health Department
- the attitudes, needs, and demands of the users
- the financing constraints placed upon the system both operationally and in relation to capital expenditure needs
- others to be determined

Thus, what we are doing is considering a full system in which obviously the requirements for existing plant operation must play a major role. Insofar as the Black & Veech study is concerned, it represents a considered series of discussions and alternatives upon which there probably would be little chance of getting total agreement. However, the study is structured such that it furnishes a relatively valid point of departure for additional analysis. I suggested to Mr. Weisenberger and to Mr. Ewing that we begin our work by discussion and preparation of a decision tree. In the decision tree we would take several basic alternatives and moving outwards from these alternatives discuss, and identify graphically the courses of action that could be followed if the alternative leading to the course of act ion was one to be followed. For instance, a basic course of action that should always be incorporated into a decision tree is one that says, do nothing. From this will be generated a series of alternatives based upon leaving things as they are and identifying what would happen.

Another basic course of action that could start the decision tree from the time point now might be demolish (or fully deactivate) part of plant #1. From that course of action would be determined several alternatives which would detail which portion of the plant was to be deactivated. For instance, at plant #1 there are some questions as to whether or not it would be wise to take out of service such areas as pumping station #1, or reservoirs #1 and #2. Thus, certain portions of the plant might be retained and these would provide several alternative courses of action branching from the basic assumption. The very early discussions at our next session should revolve around the elementary actions possible.

We also must consider in our analysis the factor of time span. The are many different ways of doing this, and they should be discussed in some detail. For preliminary consideration I suggest it might be appropriate to think of the water treatment plant's future in terms of four basic time phases. These are:

- short term - now to one year
- medium term - one year to three years
- medium long term - three years to ten years
- long term - ten years to perhaps as much as forty or fifty years

Once a time frame and a basic decision tree has been constructed within it, it is necessary to identify the most desirable courses of action. When these are determined the actual decision making process as to which one offers the optimum opportunities can be evaluated. Decision making involves several basic steps including (and to be cautioned, not to be limited to) the following:

1. Narrow the choices available to the lowest number possible without damaging the choice process. This usually is done in the preliminary decision tree analysis.

2. Determine the circumstances, conditions, and factors that impact significantly upon the decisions.

3. Decide what weight each of these factors should carry in making the decisions.

4. Rate each choice of those courses of action selected on its potential to satisfy each of the factors.

5. Identify, where appropriate, alternative futures and assign, to the best of the group's ability, the probabilities of occurrence of each.

6. Identify the cost structure surrounding the various courses of action, if possible, to incorporate the

potential use of present value, future value, or rate of return in making final choices.

7. Apply decision techniques to the elements of the analysis and determine the best decision based upon the factoring process.

In all likelihood, the result of the analysis will provide several choices which may be relatively close in merit standing. These then must be further evaluated based upon the objective and subjective feelings of the various parties who must ultimately make the decision.

Within decision making groups, disagreement is expected and, in most cases, is healthy so long as it does not become disruptive. Healthy disagreement forces the decision making group to consider many more components and ideas than they might normally look at in arriving at their conclusions. Another advantage of treating the analysis in numeric terms is that it provides necessary backup and justification to the ultimate decision makers, and allows them to proceed with confidence in justifying it to those to whom they report. This becomes very important when such analyses are being made in the public sector of today's political environment. A decision about this plant will be a very sensitive matter and must be given the highest degree of good technical, political, and financial thinking.

At our next session we shall plan to address the decision process in detail and to set a timetable for our work so as to clearly identify the objectives of our analysis and determine at about what point decisions from others might be required. I shall be in touch with Mr. Ewing shortly to set the next meeting.

I would like to thank both Mr. Ewing and Mr. Weisenberger for their courtesy and assistance in orienting me to the problems and decisions to be made about the plant. It appears that the competence and desire is fully available by which proper courses of action can be determined.

Ralph J. Stephenson, P.E.

RJS:sps

To:Mr. William C. Ewing

cc: Mr. John W. Weisenberger

Mr. Kenneth Collard

M.

(54) cpy

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June 9, 1984

Subject: Report #1

Flint Water Treatment and Distribution System Futures Analysis

Flint, Michigan

Project: 84:26

Date of Meeting: June 4, 1984

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Ralph J. Stephenson, P.E.

RJS:sps

To:Mr. William C. Ewing

cc: Mr. John W. Weisenberger

Mr. Kenneth Collard

NM

(55)

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August 12, 1984

Subject: Report #2

Flint Water Treatment and Distribution System Futures Analysis

Flint, Michigan

Project: 84:26

Dates of Meetings: July 18, 1984 (working day 140) and August 7, 1984 (working day 154)

(Note: Working day designations refer to two year working day calendar starting January 3, 1984 (working day 1))

Actions taken:

July 18, 1984 (working day 140)

- Met with Mr. William Ewing and Mr. John Weisenberger to review Michigan Department of Public Health requirements for water test
- Prepared network model for test run preparation
- Began decision tree analysis of alternate futures for Flint water plant

August 7, 1984 (working day 154)

- Monitored test run preparation plan with Mr. Weisenberger and Mr. Ewing
- Reviewed general status of work with Mr. Elgar Brown, district engineer Flint area, Michigan Department of Public Health
- Continued preparation of decision tree analysis

General Summary

At our meeting on July 18, 1984 (working day 140) we discussed the request by the Michigan Department of Public Health of the City of Flint to make a test run on the plant to determine its availability as a standby facility. This run has been scheduled for October 1, 1984 (working day 192), and it was decided by Mr. Ewing and Mr. Weisenberger to plan the steps necessary to bring the plant on line for the test run. To do this, we prepared a network model, Issue #1, dated

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July 18, 1984 (working day 140) sheets #1, and #2, showing the major steps required to get the existing plant ready for the run.

The work was divided into several major steps including:

1. Flow redirection
2. Chlorine system, traveling screen, and low lift pump activation
3. Activation of the alum system, and PS #4 valve replacement
4. Obtaining a discharge permit
5. Reconditioning sludge system
6. Repairing or removing the floculator roof
7. Establishing corrective action needed for the clarifier roof
8. Correcting and insuring proper filter valve operation

It was recognized when this network model was prepared that the time frame was very tight, and a detailed analysis was made of how to insure as close compliance to the public health department's requests as possible be maintained.

At our meeting on August 7, 1984 (working day 154) we monitored the project and found that the work as planned leading to a target start up plant and conduct water test on October 1, 1984 (working day 192) was in fairly good condition.

Relocation of the stop gates to redirect flow is currently meeting targets between early and late starts and finishes. The chlorine system has been activated, and activating the traveling screens and low lift pumps can be done in a matter of a few days. Thus, this work is in good condition.

Installation of the alum system and replacement of PS #4 valve may pose some problems. The verbal order to proceed for the installation of alum and valve work has been issued, and preparation of shop drawings for the alum system tank is currently in work. The preparation of these shop drawings lags late starts by about five working days. However, there is some thought that for the test run the alum could be fed directly out of tank trucks.

The three butterfly valves needed for PS #4 are in the procurement process. There is no current authentic word on their status, but this is being checked presently by Mr. Weisenberger. In order to bring these valves on line according to our network model it will require about five working days once the valves are on the site. Thus, the late delivery on the valves is presently set for September 24, 1984 (working day 187). However, it would be desirable to get them there if at all possible to insure they can be in place on time.

As with alum tanks the new valves might not be essential to the test run. However, they would certainly be desirable to have on hand and available. Mr. Weisenberger has requisitioned the liquid alum but apparently the requisition has not yet cleared official channels. The matter will be checked in the near future.

To discuss the discharge permit Mr. Ewing initiated preliminary discussions with the DNR and the Department of Public Health. Presently it is expected that the matter will be considered by the required agencies sometime in mid-August, 1984. This will be an important matter since a discharge permit is necessary in order for the test to proceed. Mr. Ewing will follow this task.

Work on the sludge system reconditioning has started and the primary clarifier sludge system motor is being rebuilt. Work has not yet started on reconditioning and lubricating the primary clarifier drive mechanism However, this activity has not yet passed its late start.

The work order for sludge line repairs is being readied and should be issued shortly. These repairs are not expected to take more than five working days so there is still some time available for this to be done.

Presently in work is the floculator roof removal specification and necessary drawings. It is intended to solicit and receive roof removal proposals in the very near future, and work must start there just as quickly as possible. This will probably be a difficult project because of the difficulty of access to the roof. We reviewed various schemes that have been proposed, and this matter will be given ongoing study. Present plans are to encourage the roof removal contractor to move on the site by an early start of September 5, 1984 (working day 174) or sooner if at all possible.

The clarifier roof analysis is not a critical item, but it would be desirable to get a report on this roof structure and establish the corrective actions required sometime in the near future. A change order has been issued to the structural engineer for a study of the floculator roof and the clarifier roof. Thus, work at the clarifier should proceed soon.

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Work on the filter valves has started with one valve already rebuilt and delivery of leather packings being awaited for work on others. Thus, it appears as of August 7, 1984 (working day 154) this work is slightly ahead of target early and late starts and finishes.

We shall plan to monitor the ongoing progress of the test run preparations at each of our sessions in the future. Meanwhile, Mr. Weisenberger is tracking the project carefully and I reviewed with him some of the basic monitoring techniques that might be helpful in establishing current status.

At both the July 18, 1984 (working day 140) meeting and the August 7, 1984 (working day 154) meeting we worked on the decision tree analysis for alternative futures of the Flint water treatment plant. Resulting from this analysis is a drawing #1 Issue #1 dated August 7, 1984 (working day 154) showing one branch of the decision tree for the Flint water treatment plant. This preliminary analysis starts out with seven basic courses of action that might be appropriate. It should be cautioned here that these courses of action have been put down with no regard whatsoever to their desirability or feasibility. They have merely been articulated as a potential method of proceeding. The determination as to which of the seven represents the best starting point is to be made as the analysis proceeds. The seven basic steps include:

1.1 - Do nothing.

1.2 - Demolish the 1917 chemical addition elevator bridge and shaft, and remove chemical hoppers at 1936 softening addition.

1.3 - Demolish all of plants #1 and #2 and the reservoirs except engine room, Dort reservoir and pump station #4.

1.4 - Demolish all of plants #1 and #2 except reservoirs, engine rooms, and PS #4

1.5 - Demolish all of plants #1 and #2 except Dort reservoir and pump station #4

1.6 - Rehabilitate all of plants #1 and #2

1.7 - Take legal action against appropriate agencies for not providing second source

These seven alternatives are shown on the sheet #1 decision tree at the left starting from a point designated as now. Each of the branches moves to the right and from them are derived alternative courses of action at each major decision point.

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Today we were able to evaluate the branch for 1-1, Flint Water, Do Nothing. However, in evaluating that course of action it also required us to establish decision trees following actions 1.2 and 1.7. These can be seen in the decision tree as branches stemming from column #5 for 1.2 and column #3 for 1.7. On the decision tree the description of the course of action is given above the arrow. Below the line is shown a number consisting of first the drawing sheet number, next the column number, and third, the number of the item reading from the top to the bottom of the drawings. Thus, item 1-8.2 is an item shown on sheet #1, colunn #8, second down from the top of the tree. In some cases where time did not permit writing in the full description, we merely used the identification code number to indicate what appeared on that branching. As the analysis proceeds and is refined we will run out those branches selected and put in the full identify so the tree can be read directly.

Although the decision tree looks complex it actually is a fairly sophisticated analysis method. It is relatively simple to read and should permit full and fair comparison of all of the possible alternatives. It also will help prove to those agencies who govern the operation of the plant that different alternatives have been reviewed and considered without bias.

I have printed the sheet #1 decision tree and sent copies of to Mr. Weisenberger and Mr. Ewing for their use.

Mr. Ewing is to meet with members of the city staff soon to discuss the project, and I believe the sheet #1 analysis should be adequate to illustrate the approach presently being made in our work. In the near future, however, I shall continue to put the remaining initial branches 1.3 through 1.6 into similar form to that shown on sheet #1. These will be issued as they are prepared.

During our sessions Mr. Elgar Brown, district engineer for the Michigan Department of Public Health Flint area, visited and we discussed our various activities and techniques with him. He is reasonably well up to date on what the current status is of the test run preparation and forward planning analysis. It was a help to have him at our session, and it would be well if in the future on a selective basis representatives of regulatory agencies could be present to help guide the work we are doing.

During our session we also again inspected portions of the plant primarily the roof system at the floculator area. Pictures were taken of this failing roof system for reference purposes.

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Our next session will probably be sometime in late August preferably after meetings have been held to discuss preparations for the test run. It is also desirable that discussions of the alternative courses of action be held and a review made by the Water Department staff of the decision tree work. I shall be in touch with Mr. William Ewing to set the next session.

Ralph J. Stephenson, P.E.

RJS:sps

To: Mr. William Ewing

cc: Mr. John Weisenberger
Mr. Kenneth Collard

bc: Mr. Ray Vyvyan

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September 27, 1984

Subject: Report #3

Flint Water Treatment and Distribution System Futures Analysis

Flint, Michigan

Project: 84:26

Date of Meeting: September 19, 1984 (working day 184)

Actions taken:

- Reviewed status of water plant test run preparation
- Began analysis of alternate courses of action for water plant future

Water Plant Test Run Preparation - Monitored from Issue #1 dated July 18, 1984 (working day 140) sheets #1 and #2

Work is proceeding well toward making the plant ready for a water test to be conducted in early October, 1984. There is some potential problem with valve delivery, but it is expected that this matter can be worked around for the test.

Critical is the obtaining of a discharge permit. The Water Resources Commission will consider a conditional permit at their meeting on September 20, 1984 (working day 185). If there is no adverse public comment by September 27, 1984 (working day 190) the permit will be issued. There is some possibility, of course, of adverse comment or other problems, but presently we are assuming that a discharge permit will be available and the test can proceed as planned. Mr. John Weisenberger is monitoring and managing this project closely, and it has moved extremely well.

Courses of Action for the Water Plant Future

Our analysis used the decision tree prepared at our meeting on August 7, 1984 (working day 154) sheet #1 as a base for selecting the various courses of action possible. Today we concentrated on several steps in the decision process. These were:

- Determining the factors of importance that will influence selection of a course of action. These factors describe the circumstances or events that must be considered in

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making a decision.

- Weighting the factors relative to their importance in deciding the future of the water treatment facilities. This element is called a factor weight.

- Selecting a sample set of decisions for testing the procedure. Today we used course of action 1-1.1 to 1-8.8, 1-1.1 to 1-8.2, and 1-1.1 to 1-9.1. These courses of action can be seen on the decision tree sheet #1 Issue #1 dated August 7, 1984 (working day 154). The designations refer to the starting activity at the left and end at the activity mentioned at the right. For example, 1-1.1 to 1-8.1 is the topmost path of activity from the far left on across to the end of the 8th column. For convenience in this report only we shall refer to these paths as A, B, and C. As the evaluation continues, we shall revise the designations for ease of reference.

- Selecting a set of possible futures for testing the courses of action. Several alternate futures are possible but for this example we said that future demand would be used as the variable. We selected three future demands, the same as present, a lower demand in the future than at present, and a higher demand in the future than at present. We further said the probabilities of these occurring were for staying the same, 70%; being lower, 10%; being higher, 20%.

With this raw material we then made a preliminary evaluation of the three courses of action and reached a numerical rating for each path based upon the weighted analysis or the weighted analysis in conjunction with an evaluation of future consideration. A brief description of the procedure followed and some of the details considered are given below. Twenty-seven factors were initially identified that were to influence the selection of a final course of action. These are lsited at random below. Once the factors were selected a factor weight was assigned to each as shown in parenthesis. The weight represents the group's judgement as to how important that factor is in establishing what is to be done with the water plant. A low rating indicates the factors is of little importance, and a high rating indicates it is of great importance. Ratings used ranged from 1 to 9 with the most important of all factors being given the 9 and the rest arrayed equal to or lower.

Factors were:

A. Reliability of treated water supply (9)

B. Quality of treated water (5)

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C. Total capital investment required (6)

D. Flint capital investment required (9)

E. Total operating and maintenance costs (6)

F. Flint's share of operating and maintenance costs (9)

G. Available capital funding (8)

H. Available operating and maintenance funds (8)

I. Political considerations (9)

J. Flint public relations (6)

K. Time required to implement (8)

L. Susceptibility legal action (9)

M. Regional public relations (4)

N. Internal management staff time demands (3)

O. Operating personnel demands (1)

P. Public agency demands (such as from the Department of Public Health, EPA, and DNR) (2)

Q. Cost recovery potential (3)

R. Contract renegotiation requirements (5)

S. Useful life (7)

T. Land acquisition needs (legal considerations) (2)

U. Detroit contract conflicts (5)

V. Condition of retained facilities

W. Meeting regulatory standards (These are assumed constants but must be met by any plan) (9)

X. Raw water quantity (3)

Y. Raw water quality (4)

Z. Cost of treated water per unit (7)

AA. Cost of land acquisition (2)

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Once we had listed the various factors we then began assembling them in groups. The preliminary decision was that the twenty-seven factors above could be combined into ten major factors and further weighted. The combinations and weights are given in the list below:

Factor	Factor Name	Items Included (from above)	Weight
1	Initial capital cost	C, D, AA	5
2	Funding	G, H	7
3	O & M costs per unit of water	E, F, N, O, Z	7
4	Total capital investment per year of useful life	Q, S, V	4 Change to 6 - 1/25/87
5	Public relations	J, M, P	4
6	Political considerations	I	9
7	Having all the water we want where and when we want it	A, X	9
8	Legal considerations	L,R, U, T	6
9	Implementation time	K	4
10	Quality of potable water	B,Y	5

(Note that factor W dropped out of the final list)

Once this combined list was completed we began to think about possible futures. As noted above, there are several major possible future scenarious including:

- future revenue expectation
- future demand
- future city physical condition
- future regulatory standards
- future line failures

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This is merely a starter list and from it we selected for our testing future demand. The three conditions for future demands and their probability of occurrence as selected were low (10%), same as present (70%), high (20%). These were basically for testing purposes and the percentage probably will have to be more explicitly defined as we refine the system.

The next step in the evaluation required us to take each course of action - A, B, and C- and for each factor and for each future assign a value for each course of action and for each of the factors. This value indicates how well the course of action being considered fulfills the needs of the factor. It is important here to understand that for each future the value of a course of action in meeting each factor can vary considerably. Early in our meeting this procedure was not clearly defined but during our later work Mr. Weisenberger and I reviewed the method in detail, and we were satisfied that the technique described above was valid relative to inclusion of futures.

Thus, at the completion of an evaluation for one course of action we have established a weight for each factor, a probability of each of three futures and the value that that course of action has in relation to each of the factors.

Next the factor weight was multiplied by the value for each of the courses of action and the products totaled for all of the factors for each future. For the courses of action under consideration here, for intance, course of action A had a sum of 355 under the low future, 364 under the same future, and 367 under the high future. If we were to consider the same or normal future only, then we would compare the other two courses of action with A and make a selection from these three. However, if the analysis is to use futures consideration we must adjust each of the factor weight times value totals by the probability of each future occurring; for the low, same, and high, respectively 10%, 70%, and 20%. Making this adjustment to each of the factor weight times value sums for A gives the following:

Lower future demand -	355 x .10 =	35.5
Same future demand -	364 x .70 =	254.8
High future demand -	367 x .20 =	73.4
Total weight for expected futures		363.7

See note below

The value 363.7 is the total factor weight times value for each decision, further weighted according to the probability of the futures.

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It is generally suggested in decision theory that the futures weighted number be used to make the final evaluation. This methodology is called the Bayes analysis.

In the evaluation of A, B, and C it was found that using the figures assumed for each of the three elements that the Bayes analysis gave us a set of relative values as follows:

A, 363.7

B, 353.2

C, 355.7

This indicates a fairly close choice between the three but that weighting the factors for future considerations gives course of action A a slight edge over the other two.

Now that we have a methodology it should become easier to make these evaluations as we proceed on through the various courses of action available. We should select those courses that at first appear most desirable and work on down through those that are apparently less desirable. It is to be stressed, as Mr. Ewing pointed out, that we should not overlook or neglect a course of action that has at first glance a low desirability appearance since it may prove upon objective analysis to be a better course of action than those that at first appear to be more desirable. Since there are many courses of action to be evaluated this process probably will require some intensive and time consuming thought. Therefore, we will defer any further detailed evaluation until after the plant test has been completed and we can focus our full attention on it.

Meanwhile, Mr. Weisenberger has a good understanding of the process, and will be doing some additional thinking as he evaluates the various alternatives available.

As we proceed we should establish for each capital investment and each O & M requirement in the decision tree an estimated cost so that we can further add to the decision analysis the element of expense and income.

I appreciate very much the patience and understanding that was evident in our rather complex analysis today and am looking forward to continuing with this work in the near future. I shall be in touch with Mr. Ewing soon to set the next planning session.

Ralph J. Stephenson, P.E.

RJS:sps

To: Mr. William C. Ewing

cc: Mr. John W. Weisenberger

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11/13/84

(58)

RALPH J. STEPHENSON, P. E., P. C.
CONSULTING ENGINEER

November 10, 1984

Subject: Report #4

Flint Water Treatment and Distribution System Futures Analysis

Flint, Michigan

Project: 84:26

Date of Meeting: October 25, 1984 (working day 210)

Actions taken:

- Briefly discussed water plant test run
- Continued analysis of alternate courses of action for water plant future

Water Plant Test Run Preparation

The water plant test run has been made and the reports are being prepared and forwarded to the Health Department for evaluation. Presently it appears that aside from some quality problems the run was generally successful and did make target start dates.

Courses of Action for Water Plant Future

Mr. Ewing, Mr. Weisenberger, and I spent the remaining portion of our session making additional detailed analyses of selected courses of action.These were taken from the decision tree shown on sheet #1, Issue #1 dated August 7, 1984 (working day 154). The courses of action analyzed included:

- A. 1-1.1 to 1-8.1 Use plant #2 as standby
- B. 1-1.1 to 1-8.2 Use plant #2 for limited production and renegotiate present contract with DWSD
- C. 1-1.1 to 1-9.1 DWSD construct second pipeline from Detroit after failure to renegotiate contract
- D. 1-1.1 to 1-10.9 Fail to renegotiate contract and construct new plant at Lake Huron using existing pipeline owned by City of Flint for supply. Use existing plant for standby.

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84:25

- F. - 1-1.5 to 2-2.5 Demolish all of plant 1 and 2 except Dort Reservoir and pump station #4. Construct wells to aquifers as backup.

It is recognized that some of these courses of action may not be as good as others and, of course, the purpose of the analysis is to establish the best course of action possible. At this session our objective was to gain a range of values for various courses of action to see if significant differences in the rating on those that intuitively were felt not as desirable as others was great enough to warrant use of a numeric system. It was found there is considerable range in the evaluation based on the present factors being used. Therefore, at our next session we shall continue to use the present factor content and weight in determining the merits of each of the major approaches. Meanwhile, I shall redo the decision tree based upon the changes to it that have been discussed, and put it in a form where it can be more easily read and used as an evaluation tool.

In the analysis today, we used the ten major factors set in our session of September 10, 1984 (working day 184) and described in Report #3 dated September 27, 1984. In summary, these were:

1. Initial capital cost - weight = 5
2. Funding - weight = 7
3. O & M costs per unit of water - weight = 7
4. Total capital investment per year of useful life - weight revised from 4 to 6
5. Public relations - weight = 4
6. Political considerations - weight = 9
7. Having all the water we want where and when we want it- weight = 9
8. Legal considerations - weight = 6
9. Implementation time - weight = 4
10. Quality of potable water - weight = 5

As we went through the evaluation, it was decided to eliminate alternate futures and to base the analysis upon a condition for a general level future demand with some slight increase possible. If future evaluations justify adding alternate possibilities we shall add these into the analysis later. For the five courses of action analyzed today all were based upon the level futures assumption.

It was found as we prepared our evaluations that it will be necessary to further evaluate initial capital costs,expected

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operating and maintenance costs, and expected income. The three factors which influenced by this financial data are 1, 2, and 4:

1. Initial capital costs

2. O & M costs per unit of water

4. Total capital cost of investment per year of useful life

As this financial data is obtained, it will be evaluated on a cash flow basis and the factors more accurately determined from what the return on investment indicates. In our current analysis, however, we did assign a value to these three factors based upon what it appears their value will be.

The backup information for each course of action is contained in the data sheets which are available as required.A summary of the preliminary analysis ratings is as follows:

Course of Action	Description	Rating
A. 1-1.1 to 1-8.1	Use plant #2 as standby	395
B. 1-1.1 to 1-8.2	Use plant #2 for limited production. Renegotiate contract.	350
C. 1-1.1 to 1-9.1	Detroit construct second pipeline due to failure to renegotiate contract	388
D. 1-1.1 to 1-10.9	Fail to renegotiate contract City of Flint construct new plant at Lake Huron using existing pipeline owned by City of Flint. Existing plant to be used for standby.	331
F. 1-1.5 to 2-2.5	Demolish plants #1 and #2 except for Dort Reservoir and pump station #4 Construct wells as backup to to existing Detroit supply	211

We made some very rough estimates of capital cost for the courses of action,but these must be refined as the work proceeds. Without making any major commitment as to the accuracy of the figures, it appears presently that the following costs might be starting points from which further evaluations will be made.

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Course of Action	Approximate rough cost in 1984 dollars
A	$3.2 million
B	$3.2 million
C	$20.4 million
D	$141 million
F	$9.2 million

Again, it is emphasized that these are rough approximations to gain a relative insight into the methodology that might be used for our ongoing analysis. I shall be in touch with Mr. Ewing shortly to set the next meeting.

Ralph J.Stephenson,P.E.

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To: Mr. William C. Ewing
cc: Mr. John W. Weisenberger

bc: Mr. Ray Vyvyan