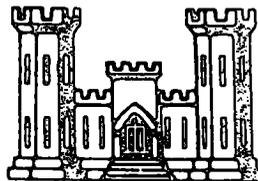


**TEST OF FLOOD PLAIN MANAGEMENT
PLANNING METHODOLOGY AT
PULLMAN, WASHINGTON**

**A Report Submitted to the:
U.S. ARMY ENGINEER INSTITUTE FOR WATER RESOURCES
Kingman Building
Fort Belvoir, Virginia 22060**

**by
Walla Walla District
U.S. Army Corps of Engineers
Walla Walla, Washington**

February 1975



IWR Pamphlet No. 2

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Paul C. Fredericks

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This report is not to be construed as necessarily representing the views of the Federal Government or of the U. S. Army Corps of Engineers.

TABLE OF CONTENTS

	<u>Page</u>
I Introduction	1
II Determination of Community Goals	3
a. Questionnaire approach	4
b. Analysis of Planning Documents	10
c. Past Development Decisions	13
d. Summary of Determination of Community Goals	15
III Plan Formulation and Evaluation of Levels of Objective Achievement	19
a. Units of Measure	19
b. Plan Formulation	21
1. Structural Plans	22
2. Nonstructural Plans	26
3. Alternatives Outside the Flood Plain	30
4. Combinations	31
IV The Selection of the Best Plan	35
a. Trade-off Analysis	36
b. Critical Value Approach	40
c. Decision Analysis	45
V Conclusions and Recommendations	46
VI List of Exhibits	
1 - Picture of January 21, 1972 Flooding in Pullman	48
2 - Index Map, Flood Areas, Pullman	49
3 thru 5 - Plates 6, 7, & 8 from Pullman Flood Plain Information Report, Flood Plain Areas, Pullman	50, 51, 52
6 - Community Influentials Questionnaire	53
7 - Revised Community Influentials Questionnaire	54
8 - Flood Plain Management Questionnaire	55
9 - Revised Flood Plain Management Questionnaire	60
10 - Architects Brochure - Pullman Flood Control Recommended Design Concept.	65
11 - Recreation Benefits	70

I INTRODUCTION

The purpose of this study is to test in Pullman, Washington, the practical application of concepts and methods set forth in earlier studies in flood plain management done for the Institute for Water Resources. These studies are: A Methodology for Flood Plain Development and Management, by TRW Systems Group, and Community Goals - Management Opportunities: An Approach to Flood Plain Management, by the Center for Urban Studies, University of Chicago.

These studies have two common themes. First, that flood plain planning should incorporate other goals in addition to flood damage reduction; second, that a variety of measures should be considered to achieve the goals.

Pullman, Washington, is a small city of about 20,000 people in rural eastern Washington. It is the home of Washington State University and the commercial center for a large surrounding area. In contrast to other communities in the area, its population nearly doubled from 1960 to 1970. Pullman was chosen as the study area to test the methodology suggested in the research for several reasons:

A flood problem exists in Pullman. Most recent flooding was January 1972. A scene from this flood is shown in Exhibit 1. Damage was estimated at about \$350,000. The frequency of this flood was about once in 40 years. A portion of the downtown area, a city park and swimming pool and mobile home court were the areas of major damage. Several other major floods have occurred in the last 75 years. The flood of record was in 1910 and covered an area slightly smaller than the intermediate regional flood shown in Exhibits 3 through 5.

Floods have not been frequent enough to curtail activity in the flood plain and it is in demand for several uses. New buildings are planned for some vacant space in the flood plain in the business district. Also, a heavily used city park occupies part of the flood plain. The city would like to enlarge the park and convert some of the area along the stream to park use. These various demands on the flood plain suggest multiple objectives.

A channel project was authorized for Pullman in the 1940's. In 1963, the Corps recommended a channel enlargement plan that would have provided a high degree of protection through the city. The city declined to sponsor this project primarily because they felt it would be aesthetically displeasing. High local costs were also a factor. The project was placed in a deferred status for eventual deauthorization. However, in 1969, the city asked the Corps to hold open consideration of a flood protection plan for Pullman while studies by local interests were being made. Also, in 1969 the Corps made a Flood Plain Information Report for Pullman. These past studies provide basic information for the pilot study.

Based on the Flood Plain Information Report, Pullman has adopted a land-use ordinance. This ordinance requires that the City Engineer review and approve plans for construction in the flood plain in accordance with guidelines that recognize the flood hazard. These land-use regulations imply that multiple means of achieving objectives would be worth pursuing in Pullman.

II DETERMINATION OF COMMUNITY GOALS

The purpose of this phase of this study was to test the methods for eliciting community goals as suggested in Community Goals - Management Objectives: An Approach to Flood Plain Management, by the University of Chicago (Chicago Report) and in so doing to determine the various objectives of flood plain management planning in Pullman.

The following discussion concerns the application of the methods suggested in the Chicago Report, their efficiency in determining community goals with respect to the flood plain, the apparent community objectives as derived by application of these methods, and recommended changes or improvements in the methods.

This is not a complete test of the Chicago Report in that the methods for determining community goals are only one part of a complete approach to flood plain management presented in that report. However, this aspect of the Chicago Report complements the testing of flood plain management plan formulation and evaluation (TRW Study) that follows. Also, the determination of community goals in relation to flood plain management may be an area of deficiency in past planning and it is a promising aspect of the Chicago Report.

The Chicago Report proposes three ways of determining community objectives: 1. by means of a questionnaire given to the community "influentials," 2. analysis of planning documents, and 3. analysis of past development decisions. This is also the order in which these approaches were applied to the Pullman situation.

A. Questionnaire Approach

The first step in determining community goals via a questionnaire survey of community influentials is to determine who the influentials are. This was done by means of the Issue Specific Reputational Method; a questionnaire suggested in the Chicago Report. (See Exhibit 6.)

This questionnaire was administered by personal interview to the following:

- City Supervisor
- City Engineer
- City Councilman
- President of the Chamber of Commerce
- Manager of a local bank
- Editor of local newspaper
- City Planner
- Chairman of Pullman Flood Protection Committee
- A prominent citizen

The Chicago Report did not suggest a method of evaluating the responses to the questions regarding the ranking of "influentials" in the questionnaire. Therefore, the following procedure was used and is recommended until something better is devised. Three, two, and one points are given for first, second, and third place ranking, respectively. If only two entries were made, the split was four-two. If one choice was made, it got the six points. If more than three entries were made, only the top three were considered. The results of this "point" evaluation are shown below:

Part I - Which interests, considering both public and private, have been most influential in community-wide issues?

<u>Person or Group</u>	<u>Points</u>
Chamber of Commerce	14
City Council	7
Civic Organizations	5
City Administration	4
Landowners and other Citizens	4
Washington State University	2
Department of Parks and Recreation	2

Part IIA - Which groups or persons in local government are most influential in issues affecting the flood plain?

<u>Person or Group</u>	<u>Points</u>
City Administration (Particularly the City Engineer)	18
City Council	10
Pullman Flood Protection Committee	5
City Planning Commission	3
Department of Parks and Recreation	1

Part IIB - Which persons or groups outside local government are most influential in issues affecting the flood plain?

<u>Person or Group</u>	<u>Points</u>
Flood Plain Property Owners	19
Chamber of Commerce	12
Private Citizens (outside flood plain)	8
League of Women Voters	4
Washington State University	4

Overall, the "influentials" questionnaire did a good job of indicating who the influentials in the community are; a better job than one could do based on hearsay. This is particularly true of the relative importance of various groups.

Some problems with the wording of questions were encountered; suggested changes are incorporated in the revised questionnaire attached. (See Exhibit 7) The interviewer should see to it that responses to the questionnaire are explicit enough to allow subsequent administration of the flood plain management questionnaire.

Due to the unstructured nature of the questionnaire, it is important that it be administered in a personal interview. Since it isn't given to a large number of people, the quality of the responses to the questionnaire is very important. No matter how carefully worded, questions are subject to misinterpretation. Also, additional information is sometimes obtained in the interviews that would not be obtained otherwise. (Leaving the questionnaire with the respondent to be completed at his convenience was tried in a couple of instances and did not work well - hasty and inappropriate answers.)

One difficulty with the "influentials" questionnaire, as with the flood plain management questionnaire, is that it is a time-consuming process to get the questionnaire into the hands of the people you want and to administer it satisfactorily. These people are important in the community and, thus, have many demands on their time. One time-saving step that was employed and is recommended is administering the "influentials" questionnaire and the flood plain management questionnaire one after the other at the same session whenever it seems likely that those given the "influentials" questionnaire will themselves be influentials. Another possibility would be to administer a portion of the questionnaires in conjunction with a public meeting or workshop on the flood problem.

The "influentials" identified by the questionnaire are listed below:

City Planner
President of League of Women Voters
City Councilwoman (and flood plain businesswoman)
City Councilman (and Division Manager of Power Company)
President of Chamber of Commerce (and bank manager)
Past President of Chamber of Commerce
County Planner
Vice-President - University Development, Washington State University
Chairman of Pullman Flood Protection Committee
City Engineer
City Supervisor
City Councilman
Two prominent owners of flood plain land

After the "influentials" have been identified, it is possible to administer a questionnaire to them in order to elicit information on perceived problems and flood plain management alternatives. By administration of such a questionnaire it is possible to gain information from those who shape flood plain management policy. This assessment of community goals is essential if one is to develop alternatives which reflect goals and aspirations of local interests and project the future role for the flood plain.

The flood plain management (FPM) questionnaire is straightforward, asking the respondent to identify the goals of his particular interest and the goals of the community. Exhibit 8 is a copy of the questionnaire that was used and a summary of the responses. For questions involving ranking of factors, a point system similar to that used in the "influentials" questionnaire was used. In this case, five points were given for a first place ranking, four for second, and so on for the first five choices.

The questions and responses can be roughly grouped into three categories:

1. Those indicating community goals, especially with respect to the flood plain (Q6, Q21).
2. Those that deal with factors to be considered in land development policies (Q7, Q25).
3. Those dealing with the perception of flood problems and desirable ways of approaching the flood problem (Q14, Q19, Q20C, Q26, Q27).

Concerning the community needs to be met by the development of the flood plain, the questionnaire indicates that there is a desire for a comprehensive plan for the flood plain and that some of the community needs that could be met by the development of the flood plain are the provision of recreation space (playfields, parks, open space), space for parking, and space for commercial development.

Of the factors to be considered in land development policies, the questionnaire indicates that economic efficiency is probably the most important, followed by consideration of the flood hazard and maintenance of the natural environment.

The flood hazard is perceived to be between "slight" and "moderate" and is related to man-made development. The most popular solutions are those ordinarily classified as non-structural (land use regulation, flood-proofing, purchase of flood plain land), although structural-type solutions also have significant support.

Suggested changes in the wording and format of the FPM questionnaire are shown in Exhibit 9.

Another possible supplement to the personal interview administration of the questionnaire that should be pursued is giving the questionnaire at public meetings or workshops held in connection with flood control projects or flood plain information studies.

The flood plain management questionnaire (preceded by the "influentials" questionnaire) was very useful in eliciting community goals, indicating the types of solutions to which the community might be receptive, and indicating what factors the community feels are important in land development policies.

In addition, the use of the questionnaire has the significant fringe benefits of promoting community involvement in Corps planning and providing more personal contact between the Corps and the community.

The tentative community objectives of a flood plain management program based on the FPM questionnaire are: 1/

1. Economic efficiency (maximize net benefits).
2. Reduce flood damages.
3. Provide space for recreation purposes.
4. Provide space for parking.
5. Provide land for commercial development.
6. Maintain the natural environment.

While these objectives could be grouped under the more general headings of economic development and environmental quality, it is desirable to express them in terms such that achievement of objectives can be measured.

1/ Order of presentation does not imply priority of objectives. The objectives as identified by the FPM questionnaire overlap somewhat and will be consolidated after the other approaches to determining community goals have been described.

B. Analysis of Planning Documents

Another method suggested by the Chicago Report for identifying community influentials and determining community goals is the analysis of local planning documents.

All available planning documents relating to Pullman were collected during the administration of the "influentials" and the FPM questionnaires. The Check List of Probable Plans in Appendix A of the Chicago Report was very helpful in this regard.

Most of the planning documents collected for Pullman originated in the public sector. However, a considerable part of their input came from citizens' committees representing a cross section of the community.

The following is a list of the planning documents analyzed.

1. Report of Planning Studies, Pullman, Washington, Harlan Nelson and Associates, 1960.
2. Comprehensive Outdoor Recreation and Openspace Plan, Orland Ward, Pullman Superintendent of Recreation, 1965.
3. Goals and Objectives for the City of Pullman, Pullman Planning Commission, 1970.
4. Report of Pullman Planning Commission, Subcommittee on Parks and Recreation, 1970.
5. Report of Pullman Planning Commission, Subcommittee on Transportation and Circulation, 1970.
6. City of Pullman, Sewage System Plan, Gregory Wilder, Pullman Assistant Planner, 1969.

The more recent planning documents noted above are part of an updating of the 1960 Comprehensive Plan being undertaken by the Pullman Planning Commission.

A review of these planning documents leads to the following conclusions which are pertinent to flood plain planning:

1. Interest in structural flood control improvements, particularly for the downtown area as expressed in the 1960 comprehensive plan, has apparently shifted to sentiment for planning appropriate land use and land use regulation as a means of reducing flood damage.

2. Traffic circulation and the need for parking space in the downtown area are persistent problems.

3. There is a desire to locate sites for industry (warehousing and research-oriented light industry). A suggested area is near the Pullman-Moscow airport. Such a development outside the flood plain might eventually draw some of these activities now located there.

4. There is growing emphasis on environmental and aesthetic considerations in planning, particularly for the downtown area.

5. A shopping center is recommended near the proposed bypass highway interchange at the northern edge of town. Plans for the bypass and the shopping center are both proceeding. These developments would relieve congestion in the downtown area and may also lessen the demand for commercial space downtown.

6. The need for space for recreation areas possibly including bicycle and horseback riding trails was expressed. It was recommended that flood plain areas be used for these purposes.

The planning documents review indicates that there is no need to add to or delete from the list of community objectives to be used in proposing flood plain management plans as derived from the FPM questionnaire.

Several conclusions can be drawn from the experience of using planning documents as a means for identifying community "influentials" and determining community goals in Pullman.

Concerning identification of community "influentials," the planning documents were not very helpful. It was implied in the planning reports that various groups, including city officials, business leaders, the university, were influential in the community, but this is no more than what would have been assumed without the planning documents. The Issue Specific Reputational Method (ISRM questionnaire) was much more effective with regard to determining community "influentials."

With respect to determination of community goals, much useful information is contained in the planning documents as described above. However, the community objectives are primarily expressed in general terms or implied, thus making it difficult to relate them to possible flood plain management plans.

Also, community objectives are slowly but continuously being modified and adjusted in the light of physical changes in the community and changes in the attitude of citizens. Any assessment of community goals, therefore, begins to be outdated as soon as it is made. The expression of community goals through planning documents suffers more from this than a questionnaire survey of goals simply because of the time lags involved in expressing goals in planning reports and printing and disseminating these documents. In addition, questions can be directed in a questionnaire (toward flood plain management, for example) and responses may yield specific information that would ordinarily not be put in planning documents.

It appears that the analysis of planning documents will be most useful in indicating how flood plain management plans might fit into overall community plans (for example, transportation plans, park plans, central business district development plans, etc.). It is worthwhile for the Corps planner to acquire the principal planning documents and become generally familiar with them, but the ISRM and the FPM questionnaires seem to be a better means of determining community goals.

C. Past Development Decisions

The third method suggested by the Chicago Report for determining community goals is the analysis of past development decisions.

This avenue was not pursued as far as the questionnaire approach or the analysis of planning documents because it did not appear to be as rewarding. The relevance of past development decisions to current goals may be questioned, since needs and attitudes change and future decisions will be made in a different context than past development decisions. Also, it is difficult to dig out information on the sequence of past development and the circumstances of the decisions. Therefore, the analysis of past development decisions was essentially a survey of current land use with some background on how it evolved.

Industrial type functions, especially the warehousing of agricultural products (grain and peas) occupy more of the land area in the flood plain than any other category of use. The high flood damage susceptibility of these industrial warehousing-type buildings and their contents is obvious.

Transportation uses also take up a relatively large amount of land, nearly 30 percent throughout the whole flood plain. The railroads are a

major factor in land use patterns. They occupy nearly on-fourth of the total flood plain area in the downtown section. In fact, probably no past development has had as much impact on the use of the flood plain as the location of the railroads, not only for the area they occupy, but also because industrial activities, particularly warehousing, were drawn to the flood plain in order to be served by them.

This combination is no longer as imperative as it once was because improved highway transport makes location of industrial sites more flexible. Also, one set of railroad tracks through downtown Pullman instead of the present two should be sufficient. Because the river is bordered on one or both sides by railroads through the downtown reach, the railroads have an important role in any future changes of flood plain land use (e.g., riverside park development).

Residential use within the flood plain is not dominant, but neither is it insignificant. Approximately one-eighth of the land area and one-fourth of the building area in the flood plain is in residential use. Naturally, most of the residential development decisions have been made piecemeal. The notable exception, however, is two large trailer parks in the flood plain in the upstream portion of Pullman. These account for approximately one-third of all residential housing in the flood plain area. It is assumed that the decision to locate these trailer parks in the flood plain was based on easy access and the availability of a sizeable plot of flat ground.

Access to higher areas has been improved and there is enough level ground at higher elevations for trailer parks, as evidenced by the recent

development of an area for mobile units for student housing by the university. It is noteworthy that the past decision to locate trailer homes in the flood plain is less irrevocable than most past development decisions.

As noted previously, a good share of Pullman's commercial facilities are located in the flood plains of the South Fork of the Palouse River and Missouri Flat Creek. This development evolved over a long period of time and couldn't be characterized as a deliberate or conscious decision to develop the flood plain. The prime factors considered were the traditional ones for settling along a water course: relatively flat building sites and closeness to transportation routes.

Recent and pending decisions concerning the bypass loop highway, shopping center, downtown beautification, and flood plain regulation will all have a considerable impact on commercial interests. These developments are indicative of a break with the factors forming past development and are more compatible with sound flood plain management.

D. Summary of Determination of Community Goals

The experience in Pullman leads to the conclusion that the questionnaire approach (use of the ISRM and FPM questionnaires) is a better method for eliciting community goals than the analysis of planning documents or past development decisions. This method has the virtue of getting to the decision makers with explicit questions. It also promotes the involvement of community leaders and rapport between community leaders and the Corps.

Minor changes in the questionnaire are suggested (Exhibit 9), consisting principally of the addition of two questions concerning community goals and changes in wording.

The determination of community objectives via the questionnaire method should not cause a major disruption in present planning procedures.^{2/}

It would be best if the questionnaire were administered by the engineers, hydrologists, and economists who would be involved in the full study because of the relationship established with "influentials" and the familiarity gained with community objectives.

Inclusion of community objectives should result in greater public involvement and acceptability of proposed plans.

Based on the preceding analysis of community objectives, primarily the FPM questionnaire, the community goals of a flood plain management program for Pullman appears to be:

1. Economic efficiency (maximize net benefits)
2. Reduce flood damages.
3. Provide space for recreation purposes.
4. Provide space for parking.
5. Provide land for commercial development.
6. Maintain the natural environment.

^{2/} Using the interview approach and an unstructured questionnaire makes it possible to avoid the requirement that a structured questionnaire, to be administered by a Federal agency to more than ten people, must be submitted to the Office of Management and Budget for review, a procedure which can take as long as three years.

Another objective needs to be added to this list. It is the reduction in the risk of catastrophic loss from flooding. This was not identified as a community goal, although question number 19 on the questionnaire, concerning the risk of floods, alluded to it. It is added to the list of goals because reduction in risk of catastrophic loss is a common objective of Corps' flood control studies and should be made explicit. The rationale for including it is that while laymen may overlook the risk associated with rare floods, the Corps as a professional in this field, has a responsibility to recognize and plan for the possibility of catastrophic loss. If such an objective were not included, a plan might be formulated which provided a low degree of flood protection which if instituted might promote a false sense of security and magnify losses from a catastrophic flood.

One might take issue with this rationale but it is clear that reducing risk of catastrophic flood loss has been and probably will continue to be an objective of any flood plain planning in which the Corps participates.

For the next step in this study, the formulation and evaluation of plans, the objectives were consolidated as follows:

1. Maximize net benefits (this includes all dollar costs and flood damage reduction benefits)
2. Provide space for recreation purposes.
3. Provide land for commercial development (includes providing space for parking).
4. Reduce the risk of catastrophic loss.
5. Maintain the natural environment.

With the establishment of community goals, the portion of this study devoted to testing the application of methods suggested in the Chicago Report was complete.

III PLAN FORMULATION & EVALUATION OF OBJECTIVE ACHIEVEMENTS

The remainder of this study involved the use of concepts and methods presented in A Methodology for Flood Plain Development and Management by TRW Systems Group (TRW Report).

A. Units of Measure

Before proposing plans and evaluating the levels of objective achievement of each, it was first necessary to establish non-dollar units to measure achievement of various plans for those objectives other than the maximization of net benefits. Several criteria need be considered in seeking an adequate unit of measure. It should be clearly correlated with the objective being measured. It should be easily understood. It should be economical to use in the sense that data required must not be unduly expensive to acquire. The units of measure chosen are discussed below.

For the objective of maximizing net benefits the measure to be used is the traditional one; the maximization of the difference between average annual dollar benefits and average annual dollar costs.

The achievement of the objective of provision of space for recreation is to be measured in visitor days. This also is the traditional measure. Originally in this study the measure was acres of land projected to be used for recreation purposes. This was felt to be unsatisfactory for several reasons including its failure to reflect the quality of the recreation space and intensity of use. Visitor days as a measure incorporates these elements although it is, of course, a less precise measure than acres.

The objective of provision of space for commercial development and parking will be measured in acres of land projected to be used for this purpose. This measure is open to the same criticism as acres of space recreation purposes. However, in the plans considered for Pullman this is not a serious shortcoming, as the space provided by the plans has similar attributes of access to transportation, suitability for development, etc., and the major difference is size. The traditional measure for this objective is market value of land and this is probably superior to the acreage measure but for purposes of demonstrating the methodology, non-dollar measures were used wherever possible.

Reduction in risk of catastrophic loss is measured as the reciprocal of the ratio of residual residential and commercial damages to residential and commercial damage resulting from the standard project flood. That is:

$$1.00 - \frac{RD}{SPFD} \text{ where}$$

RD = residual residential and commercial damages from a standard project flood and

SPFD = residential and commercial damages from a standard project flood.

This measure suffers from a serious shortcoming in that it only applies to plans that reduce physical damage. Therefore, it does not measure the reduction in risk of catastrophic loss from a plan of flood insurance which doesn't change physical damage but spreads the cost of damage over a period of time. Also this is only a measure of catastrophic financial loss and does not reflect the potential for bodily injury or loss of life. In spite of the shortcomings, measurement of reduction in risk

of catastrophic loss makes explicit an objective which is present in almost all flood plain planning.

The objective of maintaining the environment was not measured directly due to the difficulty of defining a unit of measure and making quantitative measurements of objective achievement of what is essentially a matter of aesthetics. For those plans to be considered that involve physical changes to the stream setting, that is, those that directly impact on the natural environment, modifications in design will be made to enhance the streamside environment. Also, the aesthetics or environmental quality are included, to some extent, in the visitor day measure of the recreation space objective.

Some promising techniques have been developed to measure levels of aesthetic appeal. These might be employed in future studies of this type.

For the above objectives to be measured in non-monetary terms research needs to be done on improving the units of measure, particularly for those objectives likely to occur frequently like the reduction in risk of catastrophic loss.

B. Plan Formulation

Generally, the procedure followed for this stage of the study was that suggested by TRW. That is:

1. Consider the status quo or the situation without an explicit flood plain management plan.
2. Consider various structural plans; for instance, channel enlargement.
3. Consider nonstructural measures; for example, land-use regulations.

4. Consider alternatives outside the flood plain; for example, relocation of damageable property outside the flood plain.
5. Consider combinations of structural, nonstructural, and alternatives outside the flood plain.

Although land-use regulations have been adopted in Pullman, these regulations were not considered part of the status quo but were analyzed separately and in combination with other measures. This was done because it appears that land-use regulations, particularly in combination with other measures, can achieve several objectives. On the other hand, regulations by themselves may preclude other measures. Another reason for handling land-use regulations separately is the possibility that in the absence of some structural flood control the city will relax the enforcement of the land-use ordinance, reducing its effectiveness.

1. Structural Plans

First, the level of objective achievement with the status quo was measured then various structural plans were evaluated. The structural measures considered were three channel plans and a plan of modification of the railroads that run through the flood plain.

Flood detention reservoir storage might have been considered but past studies by the Corps and others indicates that such a plan is not likely to have economic feasibility. Problems are lack of sites that provide control of runoff from a significant portion of the basin, relocation costs, sedimentation and water quality.

The largest of the channel plans is one that would carry approximately the 100-year flood. This size project, in the form of a rectangular,

concrete-lined channel through the downtown area with riprapped sections above and below town was proposed to the city in 1963 and rejected as mentioned earlier. At the time that interest in a project was renewed, 1969, it was understood that the city would inform the Corps of what type of project would be acceptable. As time passed it became apparent that the Corps would have to make the restudy and present alternatives to the city. As part of the restudy, the Corps contracted with an architect to develop an aesthetically acceptable design concept.

The consultant recommended concealing the flood channel underground in a closed conduit (100-year flood capacity) and over it developing a lineal arboretum with a small stream, paths, and other attractive features. The concept is portrayed graphically in a brochure prepared by the consultant attached as Exhibit 10. The costs shown in the brochure do not include the full cost of the arboretum or advanced engineering and design and supervision and administration cost. Addition of these costs and conversion to average annual results in average annual costs of \$83,200 for flood control work (open rectangular concrete channel) and \$39,700 for facilities associated with recreation and aesthetics (channel cover and arboretum) for a total of \$122,900.

Reduction in flood damages to existing and projected future damageable property in the flood plain were estimated at \$84,400. Recreation benefits provided by this plan are also considerable. The type of recreational experience would range from the passerby enroute through the arboretum to or from downtown businesses to the student visiting the arboretum for an educational experience. Exhibit 11 shows an estimate of

visitors by various types. Total visitor days are estimated at 479,500.

This plan, with its capacity for the 100-year flow, reduces the risk of catastrophic loss considerably. Also, some space for commercial development and parking can be provided by this plan.

Table 1 summarizes the extent to which this plan, and others to be discussed below, achieve the various objectives.

The 50-year channel plan would be identical to the 100-year channel plan described above except that the closed conduit flood channel would be of lesser dimension. Average annual cost for the flood control features were estimated at \$53,100 and average annual cost of the recreation features \$35,600 for a total cost of \$88,700. Flood damage reduction benefits were estimated at \$58,700. Recreation benefits of this plan are the same as the preceding plan, 479,500 visitor days annually.

The levels of objective achievement of this plan are also summarized in Table 1.

A fair reduction in risk would result from this plan. In this regard it should be noted that channel enlargement to provide capacity for a particular size flood would provide increased capacity for all size floods and thereby reduce the risk of catastrophic loss. Additional commercial development space would be provided in the downstream channel reach.

The 25-year channel plan is based on a proposal submitted by the Pullman City Engineer in 1969. It has been revised slightly and its cost update. The plan involves use of grass-lined, set-back levees with a

small concrete channel lining which would handle relatively low flows. Average annual cost was estimated at \$50,000 and average annual flood damage reduction benefits at \$52,000.

It was not possible to fully evaluate the recreation benefits of this plan because recreation features of the plan have not been specified. However, it seems that with proper landscape treatment this plan would be attractive enough to draw an appreciable number of visitors. Annual visitor days of recreation that might be provided by this plan are estimated at 162,000. A breakdown of this is shown in Exhibit 11. Commercial space and parking provided by this plan is somewhat less than provided by other plans. The reduction in risk of catastrophic loss is minor.

Table 1 also summarizes the levels of objective achievement of this plan.

The railroad modification plan involves combining the two sets of railroad tracks that run parallel to each other on both sides of the river. This would eliminate two bridges and a section of track. While this plan reduces flood damage somewhat its primary attraction is the amount of recreation space it would make available. Not quantified is the favorable impact this plan would have on aesthetics. Railroads on both banks of the river and the right-of-way they occupy is somewhat unsightly. Objective achievement values from this plan are shown in Table 1 below:

TABLE 1

	<u>Benefits - Costs (\$)</u>	<u>Recreation Visitor-Days</u>	<u>Reduction in Risk of Catastrophic Loss (% Decrease In Probability)</u>	<u>Commercial & Park. Space (Acres)</u>
Status Quo	0	52,000	0	47.5
100-yr Flood Channel	-38,500	479,500	56	53.5
50-yr Flood Channel	-30,000	479,500	42	51.3
25-yr Flood Channel	2,000	162,000	37	50.3
Railroad Modification	-1,200	90,000	0	47.5

Table 1 is next reviewed to see if any plans are dominated. This means that if one plan is superior to another with respect to every objective, the first plan is to be preferred to the second and the second is said to be dominated. Inspection of Table 1 shows no plans dominated. It should be noted that the large negative net benefits of the 100-year and 50-year channel plans are due to the comparison of all dollar costs to dollar benefits for flood damage reduction. If just the costs and benefits of flood damage reduction were compared the net benefits of the 100-year channel plan would be \$1,200 and net benefits of the 50-year channel plan would \$5,600. The latter then would dominate the 25-year channel plan.

2. Nonstructural Plans

The next step in the investigation was to propose and analyze nonstructural plans. Nonstructural plans may be characterized as measures to modify flood damage susceptibility as opposed to structural plans which are measures to modify the flood flows.

The nonstructural measures considered in this study were land-use regulations, flood insurance, and flood proofing. Other nonstructural measures in addition to those shown above might have been considered, such as early warning and evacuation or flood plain land acquisition. However, the measures chosen for consideration were those felt to be most applicable to Pullman. The effectiveness of early flood warning and evacuation would be limited in Pullman because of the flashy nature of flooding and the fact that floods occur relatively infrequently. With respect to land acquisition, a portion of the flood plain is now publicly owned and land-use regulations can probably achieve most of the objectives of acquisition.

The land-use regulations plan consists of an ordinance which, in essence, requires that new or replacement buildings be built with their first floor above the level of the Standard Project Flood. This plan provides a large amount of net benefits, largely because it is not an expensive plan to implement. Costs were computed consisting of: (a) the cost of drafting the ordinance, (b) the cost of administering it, (c) the added cost of constructing buildings to comply with the ordinance. This would be limited by the difference in cost between building in the flood plain and outside of it giving due consideration to factors like location, access, etc. Benefits from a plan of land-use regulations consist of damage prevented to residential and commercial structures and contents projected to be built in the flood plain in the future as well as prevention of damage to existing buildings as they are replaced by new buildings complying with the regulations. Annual costs were estimated at \$15,400 and annual benefits at \$42,400 for net benefits of \$27,000.

The reduction in risk of catastrophic loss provided by land-use regulations is quite low. This is because damage to existing property would only gradually be reduced over time as replacement buildings come under the ordinance.

A small amount of recreation over the status quo is provided by the land-use regulations. This results from land that would have been developed for residential and commercial uses that becomes available because regulations cause some of these activities to locate elsewhere. Annual visitor-days were estimated at 82,000. The achievements of a plan of land-use regulations are shown in Table 2

The levels of objective achievement of a plan of flood insurance are also shown in Table 2. This plan would reimburse policy holders for damage to residential and commercial structures and contents.

The cost (insurance premium) would consist of an amount equal to average annual damage plus an annual administration charge. The benefit of a flood insurance plan is the reimbursement for damages sustained. Therefore, the net dollar cost is the administration charge. The administration charge was computed as 80 percent of the average annual damage to insurable property.

It should be noted that some damage such as damage to streets, utilities, and debris cleanup would not be covered by insurance.

The main purpose and primary benefit of the flood insurance plan is the reduction in risk of catastrophic loss. This is what people are willing to pay the cost above average annual damage to obtain. The reason that reduction in risk is not 100 percent is because of the element of

catastrophic loss associated with those items of damageable property mentioned above not covered by insurance. As noted previously the unit of measure for reduction in risk of catastrophic loss is not applicable to plans like flood insurance. Therefore, the 90 percent reduction in risk of catastrophic loss is a judgment figure.

A small amount of recreation is provided by the flood insurance plan based on the same rationale as in the land-use regulations plan. That is, premiums add enough to development costs to discourage some construction that would otherwise take place in the flood plain.

As is evident from the range of levels of objective achievement of the various objectives shown for flood insurance, this is not a particularly good plan to use by itself but it does combine well with other plans. For example, the National Flood Insurance program administered by HUD requires land-use regulations for eligibility for flood insurance.

The third nonstructural plan studied was floodproofing of individual facilities. The floodproofing plan considered here was selective in the sense that the economic feasibility of protecting individual structures or facilities was analyzed for the floodproofing measure most applicable to that facility (raising, sealing walls, shut-off valves, pumps, etc.). If costs were found to exceed damages prevented, that facility was omitted from the floodproofing plan. Because each facility was considered separately, the overall floodproofing plan was guaranteed to have economic feasibility. However, residual damages after implementing the plan would be substantial due to those facilities not protected.

The reduction in risk of catastrophic loss from a plan of floodproofing as shown in Table 2 is not particularly large because of the amount of residual damage as discussed above.

The floodproofing plan would not provide any additional space for recreation or space for commercial development or parking.

TABLE 2

<u>Plan</u>	<u>Net Benefits (\$)</u>	<u>Recreation Visitor-Days</u>	<u>Objective Reduced Risk of Catastrophic Loss %Decrease in Prob.</u>	<u>Commercial & Parking Space (Acres)</u>
Land-Use Regulations	27,000	82,000	25	47.5
Flood Ins.	-22,000	82,000	90	47.5
Floodproofing	16,800	52,000	39	47.5

A review of Table 2 reveals that none of the nonstructural plans are dominated and to be set aside at this point.

3. Alternatives Outside the Flood Plain

In addition to structural and nonstructural measures which concern actions taken on the flood plain, another possibility is measures which have their focus outside the flood plain. That is, to meet the objectives identified, proposed solutions would consider possible actions outside the flood plain. In Pullman several possibilities suggest themselves.

(1) relocation of a mobile home park now in the flood plain, (2) relocation of warehouses (primarily grain elevators) now in the flood plain, (3) identification of recreation and commercial development space outside the flood plain.

To illustrate this concept of alternatives outside the flood plain, a plan of relocating the mobile home park was analyzed. This plan was studied because it could partially achieve several objectives and it has a good chance of being implemented.

The benefits of this plan in terms of flood damages prevented exceed the cost of developing a new site and relocating mobile homes to it. Average annual benefits were estimated at \$15,000 and average annual costs at \$6,600 for net benefits of \$8,400. It should be noted that the cost estimates at this level of refinement are necessarily rough.

The reduction in risk from this plan is relatively minor because the prevention of damage at the mobile home park is not a large share of overall damage.

The relocation of the mobile homes would provide a significant parcel of recreation land. The site is adjacent to the existing city playfield and its logical use, compatible with flooding, would be for open space recreation. Recreation benefit of 72,000 visitor-days were estimated. The levels of objective achievement of this plan are shown below:

TABLE 3

<u>Plan</u>	<u>Net Benefits (\$)</u>	<u>Recreation Visitor-Days</u>	<u>Objective Reduced Risk of Catastrophic Loss % Decrease in Prob.</u>	<u>Commercial & Parking Space (Acres)</u>
Relocate Mobile Home Park	8,400	72,000	9	47.5

4. Combinations

The final step in proposing plans is to consider combinations of structural measures, nonstructural measures and alternatives outside

the flood plain. As one can imagine, the possibilities are numerous. The planner must exercise judgment in putting together the most promising combinations. A complication in analyzing combinations is the overlap among single-type solutions. One has to be careful to avoid double counting of costs or benefits. For example, one of the costs of a plan of land-use regulations is the expense involved in building the first floor above the 100-year flood level. If a structural plan of channel enlargement is combined with land-use regulations the enlargement reduces the 100-year flood level and lowers the elevation to which first floors must be constructed. If the cost of the two measures, land-use regulations and channel enlargement were added together, there would be an overstatement. The same is true of benefits in various situations. Two combinations plans were considered for Pullman. They are described below. These by no means exhaust the possibilities. They were chosen because they appear to combine the best elements of single-type solutions and because they would seem to have a reasonable chance for acceptance and implementation.

Combination A would consist of the 50-year flood channel, land-use regulations, and flood insurance. These plans have been discussed separately above. The most noteworthy aspect of these plans in combination, as with all combinations, is the improvement in net benefits, achieved primarily by land-use regulations. The 50-year channel improves the plan by reducing damage to existing property. The channel enlargement also reduces the stage of the 100-year flood thereby reduces the cost of building to comply with the land-use regulations. The 50-year

channel greatly reduces the inconvenience associated with land-use regulations by decreasing the height to which first floors must be built above ground from the range of 5 to 6 feet to 2 to 3 feet. This is not insignificant in this flood plain where a good share of structures are, and will be, retail and service establishments. The cost of this plan, including all dollar costs, was estimated at \$116,500 while benefits consisting of flood damage reduction benefits were estimated at \$121,700 for net annual benefits of \$5,200. The inclusion of the 50-year channel in the combination makes available the recreation space and hence the recreation benefit provided by that plan singly. The amount of space for commercial and parking space would also be the amount provided by the 50-year channel. A large reduction in risk of catastrophic loss is provided by including flood insurance in the combination.

The second combination considered, Combination B, would add the plan of relocating the mobile home park to the elements of Combination A described above. This addition increases net benefits by \$6,900 because damages prevented by relocation exceed cost and this area would not have been protected by the 50-year channel. Another attractive aspect of this combination is the parcel of recreation space provided by the relocation. The reduction in risk and the amount of commercial and parking space would be the same as in Combination A.

The achievements of the combination plans are summarized in Table 4 below:

TABLE 4

<u>Plan</u>	<u>Benefit (\$)</u>	<u>Recreation Visitor-Days</u>	<u>Reduced Risk of Catastrophic Loss (Decrease in Prob.)</u>	<u>Commerical & Parking Space (Acres)</u>
Combination A 50-yr Flood channels + Land-Use Regs + Flood Insurance	\$ 5,200	479,500	90	51.3
Combination B Combination A + Relocate Mobile Homes	12,100	499,500	90	51.3

It is clearly evident from Tables 1 through 4 that the combinations dominate the single type solutions for almost all plans considered in Pullman. This does not seem to be an unusual result. The apparent superiority of the combinations make one wonder why it is necessary to go through the trouble of analyzing the single-type solutions. The reasons seem to be that analysis of single-type solutions shows what the best combinations are likely to be and provides the basic data on benefits and costs, although adjustments are needed as noted above.

IV THE SELECTION OF THE BEST PLAN

The purpose of this step is to evaluate the relative merits of the various plans. In order to better visualize the alternatives, all plans considered are shown together below:

TABLE 5

<u>Plan</u>	<u>Net Benefits (\$)</u>	<u>Recreation Recreation Visitor-Days</u>	<u>Reduced Risk of Catastrophic Loss (%Decrease in Prob.)</u>	<u>Commercial & Parking Space (Acres)</u>
Status Quo	0	52,000	0	47.5
100-Year Flood Channel	-38,500	479,500	56	53.5
50-Year Flood Channel	-30,000	479,500	42	51.3
25-Year Flood Channel	2,000	162,000	37	50.3
R.R. Modification	-1,200	90,000	0	47.5
Land-Use Regulations	27,000	82,000	25	47.5
Flood Insurance	-22,000	82,000	90	47.5
Floodproofing	16,800	52,000	39	47.5
Relocate Mobile Home Park	8,400	72,000	9	47.5
Combination A	5,200	479,500	90	51.3
Combination B	12,100	499,500	90	51.3

It can be seen from this table that the combination plans are better than most of the other alternatives. The nondominated plans are the 100-year channel plan which provides more commercial and parking space than any other plan, the land-use regulations plan which provides the highest net benefits, and combination B which provides the most visitor-days of recreation and as much reduction in risk of catastrophic loss as any other plan. The fact that all but a few plans are dominated greatly simplifies the evaluation process.

The TRW study suggests several methods of evaluation. These are Trade-Off Analysis, the Critical Value Approach, and Decision Analysis.

A. Trade-Off Analysis

In looking at the suggested evaluation methods, the first, Trade-Off Analysis, endeavors to present the choices between plans in a format that decision makers can quickly comprehend without attaching values to the nondollar objectives. This procedure is discussed in the following paragraphs.

The nondominated plans are shown below with objectives ranked in order of importance from left to right and plans ranked in order of net benefits from top to bottom. This arrangement is arbitrary and is only made for convenience purposes. It does not prejudice the outcome of the evaluation process in any way.

TABLE 6

<u>Plan</u>	<u>Objective</u>			
	<u>Net Benefits</u>	<u>Recreation Visitor-Days</u>	<u>Reduced Risk</u>	<u>Commercial Space</u>
Land-Use Regulations	\$27,000	82,000	25 %	47.5 A
Combination B	12,100	499,500	90 %	51.3 A
100-Year Flood Channel	-38,500	479,500	56 %	53.5 A

Trade-Off Analysis is made between pairs of alternatives. One of the alternatives is chosen as a base plan. The base plan will be compared with each of the remaining plans to determine the conditions which will permit making a trade-off decision as each pair of plans is examined. The first step is to "normalize" the table (or matrix) of plans and objectives. This is done by subtracting the values in the base plan from the values of each of the other plans. The results of this using Combination B as the base plan are shown below.

TABLE 7

<u>Plan</u>	<u>Objective</u>			
	<u>Net Benefits</u>	<u>Recreation Visitor-Days</u>	<u>Reduced Risk</u>	<u>Commercial Space</u>
Land-Use Regulation	\$14,900	-417,500	-65	-3.8
100-Year Flood Channel	-50,600	-20,000	-34 %	2.2 A

An inequality can now be set up to compare the relative merits of the land-use regulations plan and the 100-year channel to the base plan in this instance, combination B. This inequality is formed by assembling

negative levels of achievement for a plan to the left and positive values to the right. The result is:

417,500 Annual Visitor-Day + 65 % reduction in risk + 3.8 acres of commercial space is greater than \$14,500 annual net benefits

If this statement is true, then the base plan, B, is better than the land-use regulation plan. Most would agree that the inequality apparently is true.

The inequality formed by comparing the 100-year flood channel plan with the base plan, combination B, leads to a similar conclusion.

\$50,600 annual net benefits + 20,000 annual visitor days + 34 % reduction in risk is greater than 2.2 acres of commercial space.

Most would agree that this inequality is true, that is, the added net benefits, recreation, and reduced risk from Combination B are of greater value than the additional commercial space from the 100-year flood channel.

This process can be repeated using the land-use regulations as the base plan as follows:

TABLE 8

<u>Plan</u>	<u>Benefits</u>	<u>Recreation Visitor-Days</u>	<u>Objective Reduced Risk</u>	<u>Commercial Space</u>
Combination B	-\$14,900	417,500	65 %	3.8 A
100-Year Flood Channel	- 65,500	397,500	31 %	6.0 A

\$65,500 annual net benefits is greater than 397,500 annual visitor-days recreation + 31 % reduced risk + 6.0 A commercial space

This comparison of the 100-year flood channel to the base plan, yields results that are not immediately conclusive.

The relationship of combination B to land-use regulations is, of course, the same as in the first trade-off comparison and land-use regulations indicates that Combination B is superior.

The process can be repeated again with the 100-year flood channel as the base plan.

TABLE 9

<u>Plan</u>	<u>Benefits</u>	<u>Objective</u>		
		<u>Recreation Visitor-Days</u>	<u>Reduced Risk</u>	<u>Commercial Space</u>
Combination B	\$50,600	20,000	+ 34 %	- 2.2 A
Land-Use Regulations	65,500	-397,500	- 31 %	- 6.0 A

2.2 A commercial space is greater than \$50,600 net benefits + 20,000 annual visitor-days recreation + 34 % reduced risk

397,500 annual visitor-days recreation + 31 % reduced risk -- 6.0 A commercial space is greater than \$65,500 annual net benefits.

As one would expect from the trade-off comparison already made, using the 100-year flood channel as the base indicates that Combination B is superior to it while the choice between land-use regulations and the 100-year channel plan is somewhat inconclusive.

The value of the Trade-Off Analysis is evident. It makes the opportunity cost of one plan in relation to another explicit thereby clarifying the decision making process.

As illustrated, Trade-Off Analysis shows how much more net benefits, recreation, and reduced risk would be obtained and how much commercial space would be foregone in choosing combination B over the 100-year flood channel or land-use regulations. The advantage of the combination plan in this comparison is clear enough to indicate a decision in favor of it. In the other comparison, between the 100-year channel and land-use regulations, the choice is not as clear cut but this is immaterial since combination B is apparently superior to both. Trade-Off Analysis is very valuable in that it portrays explicitly what one would give up from one plan to achieve the results of another plan.

B. Critical Value Approach

The Critical Value Approach applies dollar values for levels of objective achievement that have, to this point, been measured in non-dollar terms. The dollar values used, however, are not precise but are estimated ranges of willingness-to-pay values for each objective. Using ranges, that is, setting upper and lower limits, has several attributes:

- a. Where the benefits of some objectives can't be measured with sufficient precision to incorporate in the standard Benefit-Cost framework but where enough is known to approximate values.
- b. Where there may be general agreement on a range of values but where it may be difficult or impossible to reach unanimity.
- c. Where precise measurement of values might be theoretically possible but costly and time consuming to achieve.

The Critical Value Approach may enable one to reach a decision despite the constraints presented by each of these circumstances. An outline of the steps in the Critical Value Method is as follows:

First, set upper and lower limits on willingness-to-pay values for the nondollar objectives. Next, make pariwise comparisons, assuming willingness-to-pay values most favorable to one plan and least favorable to the other. If the plan with the most favorable assumptions is inferior to its counterpart, it can be eliminated from consideration. If the plan with favorable assumptions is superior, no conclusion can be made and the procedure is reversed. That is, the most favorable assumptions are applied to the other plan. If the first one is still superior, under the most unfavorable assumptions, its counterpart can be eliminated. This process continues until every pair of plans has been compared.

The first step, setting limits of willingness-to-pay, could be quite simple or quite involved, depending on such things as the objective, i.e., if it has a close proxy that has established market values, and the sensitivity of decisions to the limits chosen. A questionnaire to influentials could be quite useful here, as would a review of past spending in the area to achieve the objectives under consideration. In this pilot study of Pullman the limits of willingness-to-pay values were established by a review of those used in the test cases in the TRW report, values used in similiar circumstances elsewhere, information at hand, and judgement of experienced personnel. The limits of willingness-to-pay values used is shown below:

<u>Objective</u>	<u>Willingness-to-Pay Values</u>
Net Benefits	\$/
Recreation	Varies by type, See Exhibit 11
Reduction in Risk of Catastrophic Loss	\$8,450 to \$14,800/ (\$300 to \$530/% annually)
Provision of Space for Commercial Use	\$30,000 to \$40,000/Acre (\$1,070 to \$1,430/% annually)

In the calculations that follow the upper limit will be designated H and the lower limit L.

The next step in the procedure is to compare every alternative with every other one in a pair-wise manner. Initially, a comparison matrix is set up as in the Trade-Off Analysis. This is shown below. The position of each entry in the matrix is indexed by the number in parenthesis.

TABLE 10
Comparison Matrix

<u>Plan</u>	<u>Objective</u>			
	Annual Net Benefits <u>01</u>	Annual Recreation <u>02</u>	Reduction in Risk <u>03</u>	Commercial Space <u>04</u>
Land-Use Regulations (1)	\$27,000 (11)	82,000 (12)	25 (13)	47.5 (14)
Combination B (2)	12,100 (21)	499,500 (22)	90 (23)	51.3 (24)
100-Year Flood Channel (3)	-38,500 (31)	479,500 (32)	56 (33)	53.5 (34)

An excerpt from the TRW report gives a conceptual description of the process involved in the Critical Value Approach. "When comparing alternative n to alternative i, the upper limit of willingness-to-pay is used to evaluate all objective attainment levels better met by alternative n than by alternative i. The lower limit is used to evaluate objective attainment levels better met by alternative i than by alternative n. If under these assumptions, which are most favorable to alternative n, alternative i is shown to be superior, alternative n is eliminated as a candidate for the best plan. Next, the plans are evaluated under the circumstances most favorable to alternative i. If n is shown to be superior to i under these conditions, alternative i is eliminated as a candidate for the best plan.

This procedure is followed for all pairs of alternatives for which n does not equal i. That is, no plan is compared to itself."

Comparing Plan (1) (Land-Use Regulations) to Plan (2) (Combination B) shows the following:

$$O_{11} - O_{21} = \$27,000 - \$12,100 = \$14,900$$

$$O_{12} - O_{22} = \$82,000 - \$499,500 = -\$417,500$$

$$O_{13} - O_{23} = 25 - 90 = -65$$

$$O_{14} - O_{24} = 47.5 - 51.3 = -3.8$$

Making assumptions most favorable to Plan (1) (Land-Use Regulations) and calculating the difference in total willingness to pay between the two plans: 1/

$$\begin{aligned} S_{12} &= (O_{11} - O_{21})H_1 + (O_{12} - O_{22})L_2 + (O_{13} - O_{23})L_3 + (O_{14} - O_{24})L_4 \\ &= \$14,900 (1) + (-\$63,800) + (-65)(\$300) + (-3.8)(\$1,070) \\ &= \$14,900 - \$63,800 - \$19,500 - \$4,066 \\ &= \$-72,466 \end{aligned}$$

Since S_{12} is less than zero under the assumptions most favorable to Plan (1) it can be concluded that Plan (2) (Combination B) is superior to Plan (1) (Land-Use Regulations) and the latter can be set aside.

1/ Annual values used. Recreation (Column 2) is a composite figure derived from the number of visitors of various types times the appropriate value (high or low)(See Exhibit 11).

A similar comparison is now made between Plan (2) (Combination B) and Plan (3) (100-Year Flood Channel). The differences between these two plans is as follows:

$$O_{21} - O_{31} = \$12,100 - (-38,500) = 50,600$$

$$O_{22} - O_{32} = \$499,500 - \$479,500 = \$20,000$$

$$O_{23} - O_{33} = 90 - 56 = 34$$

$$O_{24} - O_{34} = 51.3 - 53.5 = -2.2$$

Assuming values least favorable to Plan (2) (Combination B), is most favorable to Plan (3) (100-Year Channel). ^{1/}

$$\begin{aligned} S_{23} &= (O_{21} - O_{31}) L_1 + (O_{22} - O_{32}) L_2 + (O_{23} - O_{33}) L_3 + (O_{24} - O_{34}) H_4 \\ &= \$50,600 (1) + \$20,000 + (34) (\$300) + (-2.2) (-\$1,430) \\ &= \$50,600 + \$20,000 + \$10,200 + \$3,146 \\ &= \$77,654 \end{aligned}$$

S_{23} is greater than zero even with values least favorable to Plan (2). That is Plan (2) is superior to Plan (3) even under assumption most favorable to Plan (3). Therefore Plan 3 can be set aside.

In summary, the application of the Critical Value Approach shows that Plan (2) (Combination B) is superior to Plan (1) (Land-Use Regulation) and Plan (3) (100,Year Channel). Therefore, Combination B is the best plan.

It can be concluded from the application of the Critical Value Approach in Pullman that this method is an effective way of determining the best plan (or plans) without forcing the decision maker to derive single values for the achievement of objectives more easily measured in nondollar terms. The Critical Value Approach is amenable to computer

adaptation as described in Appendix A of the TRW Report. This allows varying the limits of willingness-to-pay values to determine the sensitivity of results to those values and provides the flexibility to handle a number of nondominated plans should that circumstance arise.

C. Decision Analysis

The third method of evaluating plans suggested by TRW, Decision Analysis, was not used in the Pullman case, due to the small number of nondominated plans and the satisfactory results of the Trade-Off Analysis and the Critical Value Approach. Also, no basis was available for determining probability distributions to be assigned to willingness-to-pay values for non-dollar objectives. A uniform distribution might have been applied but there was no reason to assume that a uniform distribution is more correct than any other distribution. While it seems likely that Decision Analysis will aid in evaluating plans in many instances, it did not appear that it would add much in the Pullman case, particularly in the absence of information on which to base a probability distribution to be applied to willingness-to-pay values.

V. Conclusions and Recommendations

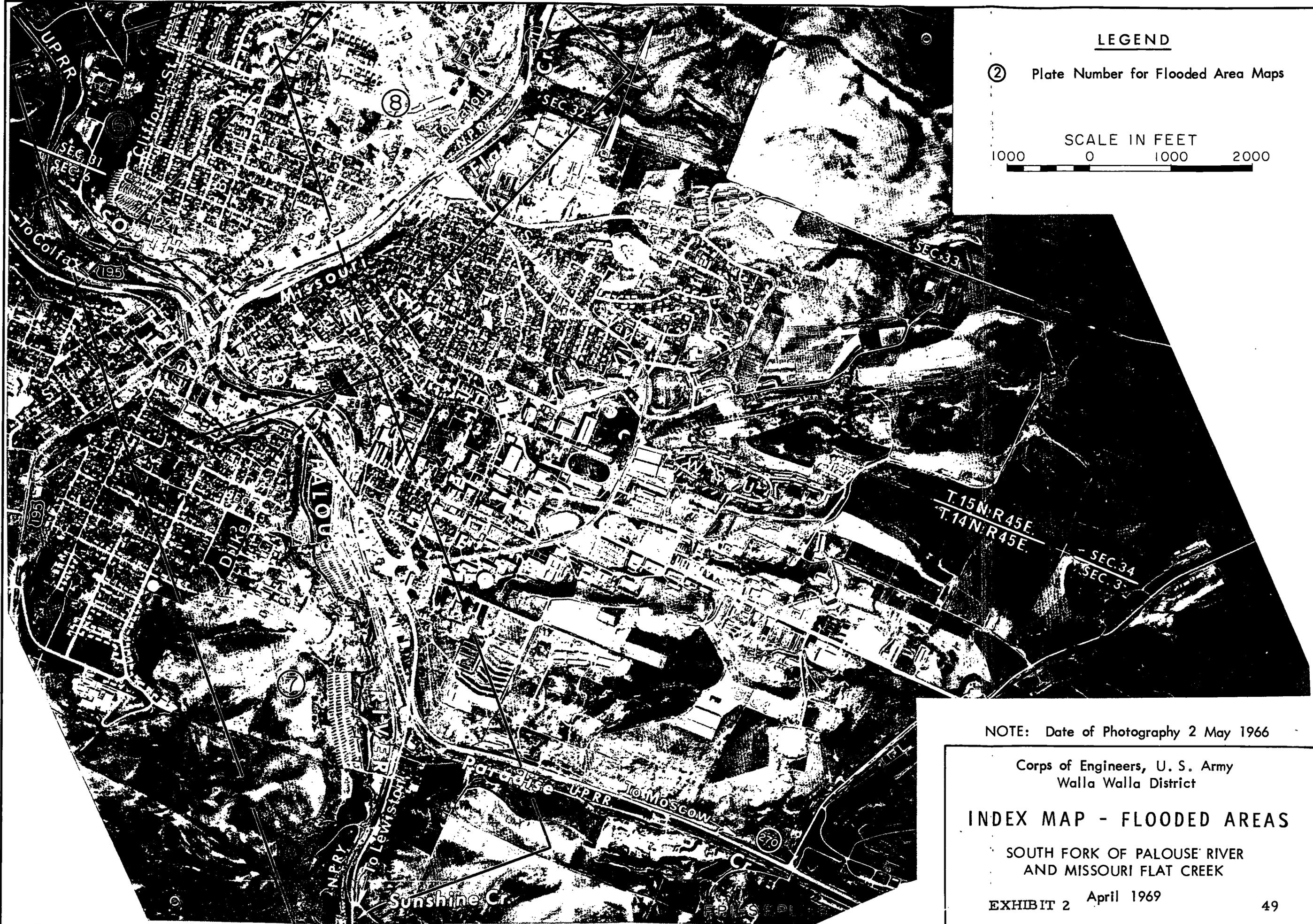
1. Concepts for eliciting community goals, suggested in the Chicago Report, particularly the Institutional Specific Reputational Method questionnaire and the Flood Plain Management questionnaire, are effective and should be employed with the minor changes that have been suggested. The possibility of using followup questionnaires should be explored.
2. The sequence for formulating plans suggested in the TRW Report might be altered slightly so that first structural, then nonstructural, then alternatives outside the flood plain, and finally combinations of the three are considered. This would avoid the necessity of formulating combinations twice.
3. The methods for evaluating plans, particularly the Critical Value Approach, that make possible plan selection without assigning specific dollar values to objectives measured in non-dollar terms are a significant improvement in plan evaluation techniques and should be implemented.
4. The implementation of the methodology tested will improve Corps planning. The process of determining community goals will produce greater public involvement and the inclusion of these goals and the formulation and evaluation of plans to meet them will enhance public acceptability.

5. There are several problem areas not specifically addressed in the methodology tested but which require additional research. These are:

1. short-cut methods for formulating and evaluating a wide range of alternatives on a preliminary basis, 2. better units of measure for non-dollar objectives, and 3. methods for setting limits for willingness-to-pay values in the Critical Value Approach.

FLOODING IN PULLMAN, WASHINGTON - JANUARY 21, 1972





LEGEND

② Plate Number for Flooded Area Maps

SCALE IN FEET

1000 0 1000 2000

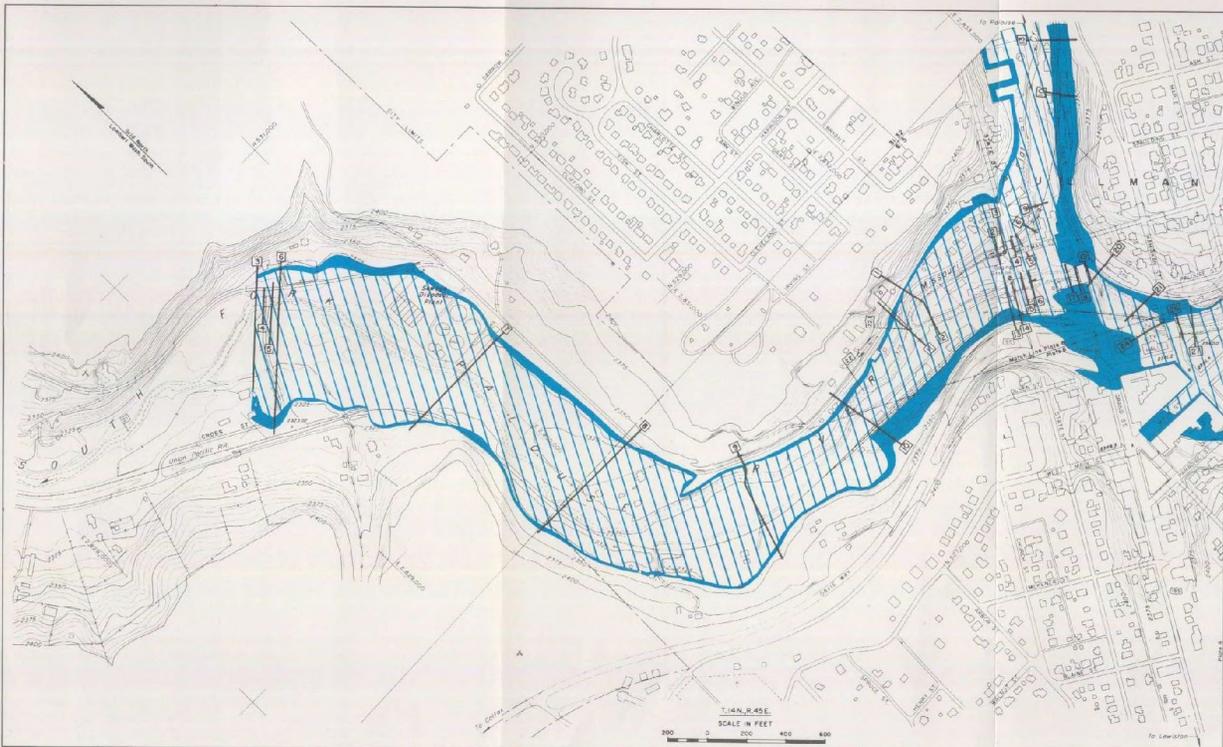
NOTE: Date of Photography 2 May 1966

Corps of Engineers, U. S. Army
Walla Walla District

INDEX MAP - FLOODED AREAS

SOUTH FORK OF PALOUSE RIVER
AND MISSOURI FLAT CREEK

EXHIBIT 2 April 1969



LEGEND

OVERFLOW LIMITS

- INTERMEDIATE REGIONAL FLOOD
- STANDARD PROJECT FLOOD

MILES ABOVE MOUTH

CROSS SECTION

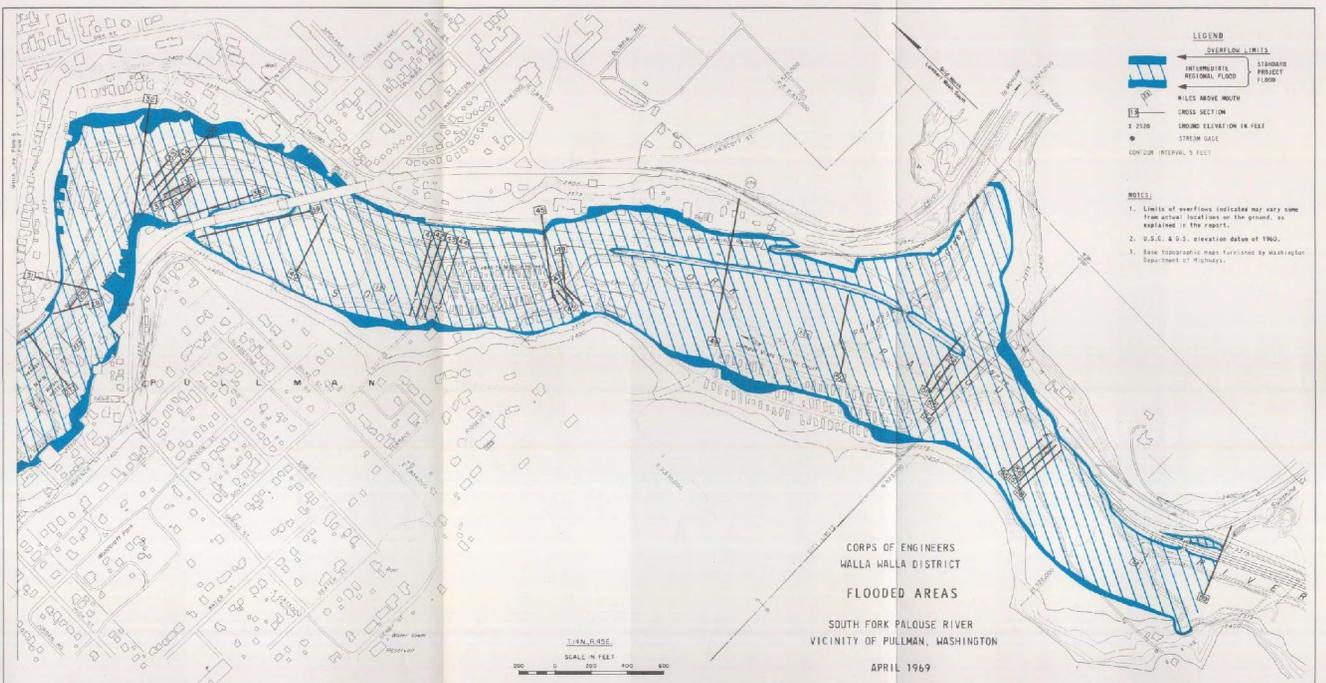
X 2320 GROUND ELEVATION IN FEET

● STREAM GAGE

CONTOUR INTERVAL 5 FEET

- NOTES:**
1. Limits of overflows indicated may vary some from actual location on the ground, as explained in the report.
 2. U.S.C. & G.S. elevation datum of 1960.
 3. Basic topographic map furnished by Washington Department of Highways.

CORPS OF ENGINEERS
 WALLA WALLA DISTRICT
FLOODED AREAS
 SOUTH FORK PALOUSE RIVER
 VICINITY OF PULLMAN, WASHINGTON
 APRIL 1969



COMMUNITY INFLUENTIALS QUESTIONNAIRE

We are conducting interviews with a group of community leaders as part of our interest in community decision making and land use planning. We have prepared a brief set of questions in order to identify public and private interests involved in the initiation, support, or opposition of local decisions.

PART I

The first group of questions concerns both the public officials, agencies, and organizations within local government and the individuals and organizations outside the government which you would regard as important in issues and policy-making in your community.

1. Among both public and private interests in your community, whose support would be essential if public policy changes were to be effectuated?
2. Which of these interests have been most influential in local issues? Please rank.

PART II

The next group of questions refer to the public and private interests whose activities relate to the flood plain, the area of special concern in our research.

A. Public

1. Which, if any, are the persons or agencies within local government involved in activities affecting the use and development of the flood plain.
2. Which are most influential in decisions affecting this area?

B. Private

3. Which, if any, are the persons or organizations outside local government involved in activities affecting the flood plain?
4. Which are most influential in decisions affecting this area? Please rank.

REVISED COMMUNITY INFLUENTIALS QUESTIONNAIRE

1. Name _____ Title _____

2. Name of Organization _____

We are conducting interviews with community leaders and have prepared the following questions in order to determine the individuals and groups that are influential in community decision making. Our purpose in this is to make our planning more responsive to the needs and desires of the community.

1. Considering both public officials and organizations within local government and individuals and organizations outside local government, whose support or opposition is influential in community-wide issues and policy changes? (Please list in order of importance)

The next questions refer to the public and private interests whose activities relate to the flood plain, the area of special concern in our studies (map attached).

2. Who are the persons or agencies within local government that, through their actions or their support or opposition to the actions of others, affect the use and development of the flood plain? (Please list in order of importance)
3. Who are the persons or organizations outside local government that, through their actions or their support or opposition to the actions of others, affect the use and development of the flood plain? (Please list in order of importance)

FLOOD PLAIN MANAGEMENT QUESTIONNAIRE ¹

SUMMARY

INSTITUTIONAL CHARACTERISTICS

1. Name of organization _____
2. Name _____ Title _____
3. Does your organization have a stated set of goals or objectives? (If no, go on to Question 6.) (If so, explain.)

6. What specific problems is your agency focusing on at the present time?

Most frequently mentioned problem was the need for a comprehensive plan for the use of the flood plain. Other problems were housing, traffic circulation, and parking. It should be kept in mind that most respondents to this question were formal organizations.

LAND DEVELOPMENT AND USE

7. Many factors are considered in the planning and for execution of land development policies. Which of these are important to you? (Check.)

Total Points

- (27) Flood hazards
- (16) Drainage
- (10) Geological factors
- (6) Sociological effect
- (12) Effects on water quality
- (3) Effects on air quality
- (42) Economic effects
- (18) Recreation
- (16) Visual pollution
- (15) Political implications
- (7) Protection of wildlife and natural vegetation

8. (List those checked in order of importance.)

See 7.

¹ Questions not analyzed have not been included.

GENERAL PLANNING FUNCTIONS

11. Do you have any responsibilities for planning? (If no, skip to question 14.) If yes, are these planning responsibilities your main activities?

Of the 14 respondents, 10 said they had responsibilities for planning. Of these, 3 said planning was their main activity.

EVALUATION OF FLOOD HAZARDS

14. What in your opinion constitutes a flood hazard? (Example, extent of damage.)

This is a useful question but it is difficult to analyze the responses. Generally, most respondents perceive the flood hazard as related to man-made development. Also, most related the hazard to property damage and bodily harm. Minor themes of significance were the frequency of flooding, obstructions to nature flow, and lack of planned control.

15. Are you or your organization involved in evaluating flood hazards? If so, how?

Six respondents answered this in the affirmative. Most were involved in the problem through city government.

16. There are many types of data used to determine existing flood hazards. Which of the following do you use?

Total Points

- (8) Soils maps and interpretation
- (7) Drainage and storm sewerage plans
- (20) Topography (shapes of the land)
- (40) Map of flood plain areas
- (14) Vegetation

(List those checked in order of importance.)

See 16.

17. Did you use the flood information reports prepared by the Corps of Engineers? (If no, skip to question 19.) If so, how were they useful?

Seven respondents answered "yes" to this question. Predominant use was in setting up and administering the local ordinances dealing with construction in the flood plain.

18. What additional data or features would have been useful to you if they were included in the reports?

Only three respondents felt additional data or features would be useful. These asked for more policy alternatives or choices to reduce flood hazards, more geographic area covered, and an explanation of how flood magnitudes were derived.

19. Evaluate the risk presented by floods in your area.

<u> </u>	<u> 1 </u>	<u> 1111 </u>	<u> 11111 </u>	<u> </u>
no hazard	negligible hazard	slight hazard	moderate hazard	great hazard

20. A. What methods or adjustments have been taken in your area to reduce the flood hazard?

Eleven of the fourteen respondents mentioned the ordinances regulating building in the flood plain. Six mentioned the periodic channel maintenance to remove silt. Four mentioned both. Two also mentioned on-going studies concerning the flood plain.

- C. If you had completely free reign in formulating a flood policy, what type of policy would you implement? (Elaborate, giving reasons.)

Seven respondents preferred a nonstructural-type flood policy (restrictive building codes, modification or removal of some existing development, open space). Four preferred a structural type policy (clearing and snagging, moderate protection channel improvement, retention reservoirs, concrete channel). Two preferred some combination of the above.

21. What community needs could be met by development of the flood plain?

There were a variety of responses to this question, but most could be categorized as follows: Commercial and warehousing space - 5 responses, parking - 4 responses, open space - 5 responses, parks and playfields - 6 responses. The last two might be combined in which case recreation type is most popular. Most respondents mentioned two or more of the above needs.

22. Based on your judgment, evaluate the effects of developing the flood plains for urban uses. (Check your preference.)

<u> 111 </u>	<u> 111 </u>	<u> </u>	<u> </u>	<u> 11 </u>	<u> 11 </u>	<u> 111 </u>
very disadvan- tageous	disadvan- tageous	not worthy of effort	no effect	worthwhile	advan- tageous	very advan- tageous

23. Based on your judgment, evaluate the political feasibility of this type of development. (Check your preference.)

<u>11111</u>	<u>111111</u>	<u> </u>	<u> 11</u>	<u> 1</u>
very likely	likely	no effect	not likely	very unlikely

There was confusion over the meaning of the term "urban uses" (park type urban uses or commercial type?), thus detracting from the value of the responses to questions 22 and 23.

25. Many different factors may be used for selection of development plans. Which in your opinion should be used in formulating plans for development in your area? (Number in order of importance.)

Total Points

- (30) Maintenance of the natural environment
- (4) Maintenance of ethnic distribution
- (22) Neighborhood development
- (51) Economic efficiency
- (39) Difference between benefits to be derived from given development policy and the costs for accomplishing this policy
- (5) Political repercussions/likelihood of acceptance
- (8) Housing opportunities
- (26) Health standards
- (17) Regional development
- (0) National development
- (7) Psychological distress of the individual

26. Several alternatives or combinations thereof may be considered in an economically objective manner in the planning of flood plain development. Which of the following are important to you? (Number in order of importance.)

Total Points

- (44) Flood control and/or abatement (structural)
- (14) Bearing of flood losses
- (15) Emergency evacuation
- (63) Regulation of flood plain use
- (10) Flood insurance
- (27) Flood proofing
- (35) Purchase of flood plains for open space

27. Using this scale, rate all the alternatives (checked or not) in question 26, in terms of community acceptability. (from 1 to 7: 1 = totally unacceptable, 2 = moderately unacceptable, 3 = barely unacceptable, 4 = neither unacceptable nor acceptable, 5 = barely acceptable, 6 = moderately acceptable, 7 = very acceptable.)

27. (Cont'd)

Total Points

- (54) Flood control and/or abatement (structural)
- (52) Bearing of flood losses
- (70) Emergency evacuation
- (83) Regulation of flood plain use
- (66) Flood insurance
- (78) Flood proofing
- (59) Purchase of flood plains for open space

MAJOR INSTITUTIONAL ROLES IN FLOOD PLAIN MANAGEMENT (FPM)

28. Many roles are available for organizations to take in flood plain management programs. Which of the following roles do you feel you or your organization could play? (Number in order of importance.)

Total Points

- (10) Sponsorship and funding
- (11) Technical analysis and design
- (11) Technical review
- (61) Policy review
- (22) Advisory capacity
- (17) Overall management and FPM decision making
- (41) Enabling legislation
- (24) Implementation

30. What do you feel should be the role of the Corps of Engineers in flood plain management?

The majority felt that the role of the Corps should be to furnish technical information and advice. Many also felt that the Corps should also assist in funding and implementation of solutions.

31. In your opinion what other organizations should participate in a flood plain management program? (Rank in order of priority.)

Based on a 3-place ranking (3 points for first priority, 2 for second, and 1 for third), ranking is as follows:

Local government (City and County)	26 points
State Water Resource Agency	11 points
WSU Hydraulics Lab.	6 points
HUD, HEW, WRC, SCS, Bu. Rec.	1 point each

REVISED FLOOD PLAIN MANAGEMENT QUESTIONNAIRE

INSTITUTIONAL CHARACTERISTICS

1. Name _____ Title _____
2. Name of Organization _____
3. Does your organization have a stated set of goals or objectives?
(If no, go on to Question 4) (If so, explain.)

4. What specific problems is your agency focusing on at the present time?

LAND DEVELOPMENT AND USE

5. If a substantial sum of money were to be invested in your community, on which community projects do you feel the money would best be spent? Please rank in order of importance.

6. Many factors are considered in the planning and for execution of land development policies. Which of these are important to you? Number the five most important in order of importance.
 - () Flood hazards
 - () Drainage
 - () Geological factors
 - () Sociological effect
 - () Effects on water quality
 - () Effects on air quality
 - () Economic effects
 - () Recreation
 - () Visual pollution
 - () Political implications
 - () Protection of wildlife and natural vegetation

7. In your opinion what should a flood plain management program attempt to accomplish in addition to flood damage reduction?

- Maintenance of the natural environment
- Space for commercial and industrial development
- Recreational opportunities
- Urban renewal (housing)
- Other - specify

(Number the above in order of importance)

GENERAL PLANNING FUNCTIONS

8. Do you have any responsibilities for planning? If yes, are these planning responsibilities your main activities?

EVALUATION OF FLOOD HAZARDS

9. What in your opinion constitutes a flood hazard?

10. Are you or your organization involved in evaluating flood hazards? If so, how?

11. There are many types of data used to determine existing flood hazards. Which of the following do you use?

- Soils maps and interpretation
- Drainage and storm sewerage plans
- Topography (shapes of the land)
- Map of flood plain areas
- Vegetation

(Number those checked in order of importance)

12. Did you use the flood information reports prepared by the Corps of Engineers? (if no, skip to question 15) If so, how were they useful?

13. What additional data or features would have been useful to you if they were included in the reports?

14. Evaluate the risk presented by floods in your area.

no hazard negligible hazard slight hazard moderate hazard great hazard

15. What methods or adjustments have been taken in your area to reduce the flood hazard?

16. If you had completely free reign in formulating a flood policy, what type of policy would you implement? (Elaborate, giving reasons.)

17. What community needs could be met by development of the flood plain?

22. Using this scale, rate all the alternatives (checked or not) in question 21, in terms of community acceptability. (from 1 to 7: 1=totally unacceptable, 2=moderately unacceptable, 3=barely unacceptable, 4=neither unacceptable nor acceptable, 5=barely acceptable, 6=moderately acceptable, 7=very acceptable.)

- Flood control and/or abatement (structural)
- Bearing of flood losses
- Emergency evacuation
- Regulation of flood plain use
- Flood insurance
- Flood proofing
- Purchase of flood plains for open space

MAJOR INSTITUTIONAL ROLES IN FLOOD PLAIN MANAGEMENT (FPM)

23. Many roles are available for organizations to take in flood plain management programs. Which of the following roles do you feel you or your organization could play? (Number the five most important in order of importance.)

- Sponsorship and funding
- Technical analysis and design
- Technical review
- Policy review
- Advisory capacity
- Overall management and FPM decision making
- Enabling legislation
- Implementation

24. What do you feel should be the role of the Corps of Engineers in flood plain management?

25. In your opinion, what other organizations should participate in a flood plain management program? (Rank in order of priority)



**PULLMAN
FLOOD
CONTROL**

**RECOMMENDED
DESIGN
CONCEPT**

I. HISTORY OF PROJECT

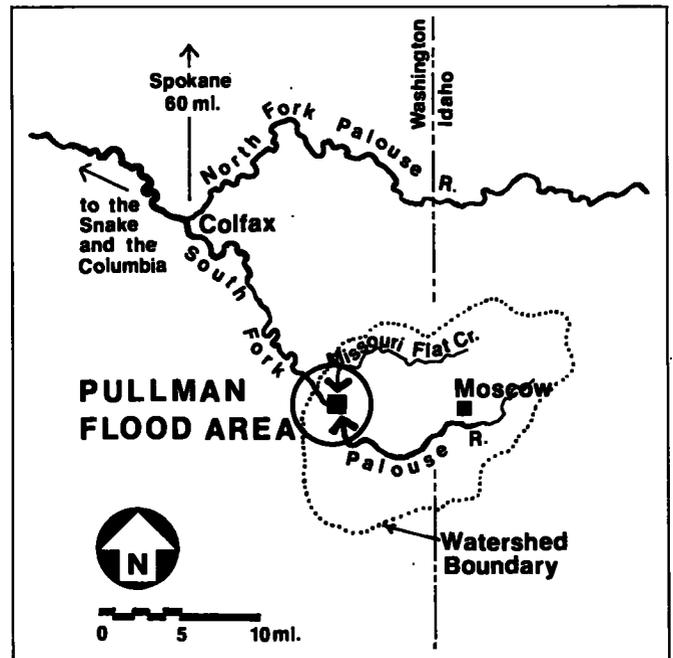
Major flooding of the South fork of the Palouse River has occurred in 1884, 1910, 1933, 1948, and most recently in January, 1972. These floods have inundated major areas of the Central Business District causing extensive damage. Following the 1948 flood, joint discussions between the City of Pullman and the U. S. Army Corps of Engineers resulted in authorization of a flood control project which included an open, high-velocity concrete channel through the center of the Central Business District. ■ This project has been held in abeyance since 1963, due to an environmental concern regarding detrimental effects of an open concrete channel. ■

CONCRETE CHANNELS PROBLEMS-ALTERNATIVES

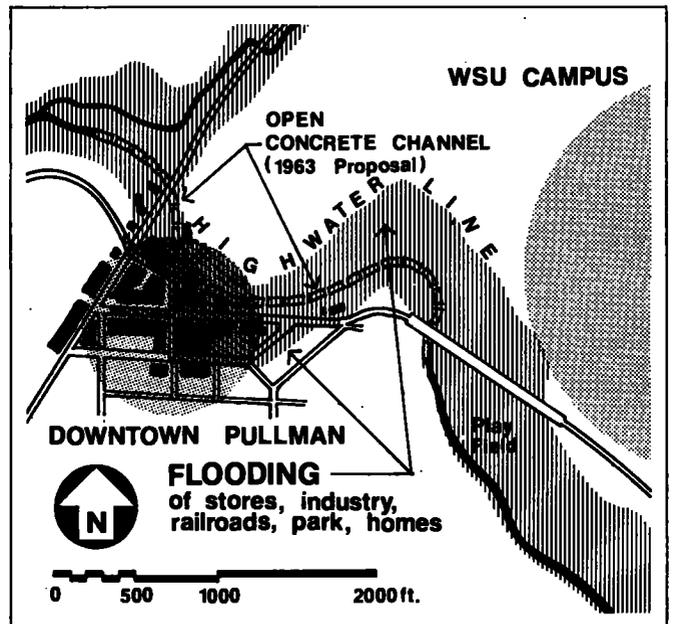
The Pullman Task Force on Flood Plain Management, working with the assistance of the Washington State Department of Ecology and the U. S. Army Corps of Engineers has developed a flood plain zoning ordinance and a flood protection building code intended to minimize the damage due to floods. In addition, a Palouse River Park has been proposed adjacent to the open channel, from the National Guard Armory to South Street. ■ More comprehensive and environmentally sensitive flood abatement alternatives exist—these include changes in agricultural practice to reduce water and silt run-off, and upstream impoundment of seasonal run-off. These methods provide ancillary benefits such as water-oriented recreation, soil reclamation, and environmentally functional land use zoning. This ideally reserves the flood plain as a seasonal park, eliminating flood-vulnerable structures. However, these options are beyond the purview of the project. ■ The open channel plus the Union Pacific and Burlington Northern tracks dissect this potential green belt of property to the degree of destroying its potential as a park. ■ Removal of the tracks would be expensive. However, track removal or consolidation is considered necessary if an open channel is to be used. ■ Removal of commercial and industrial buildings within the flood plain would be difficult and expensive. ■

OBSERVATION:

The Open Channel with protective fencing is hostile to urban living. Parts of the city are isolated from one another. Attractive land is put into disuse. Remaining land is severed. The Open Channel creates a tempting hazard.



REGIONAL MAP



CITY MAP



TRADITIONAL OPEN CHANNEL IS A BARRIER

II. GUIDELINES FOR DESIGN

Corps of Engineers

The recommended design concept follows the guide lines established by the Corps:

1. Affords required degree of flood protection.
2. Comprises visually pleasing waterway corridor.
3. Logically integrates with the developed community.
4. Provides multiple uses, particularly circulation and recreation.
5. Does not impair flood carrying capacity of channel.
6. Does not create attractive hazards.

City of Pullman

The design concept concurs with the spirit of the city's desire for park utilization of the river area.

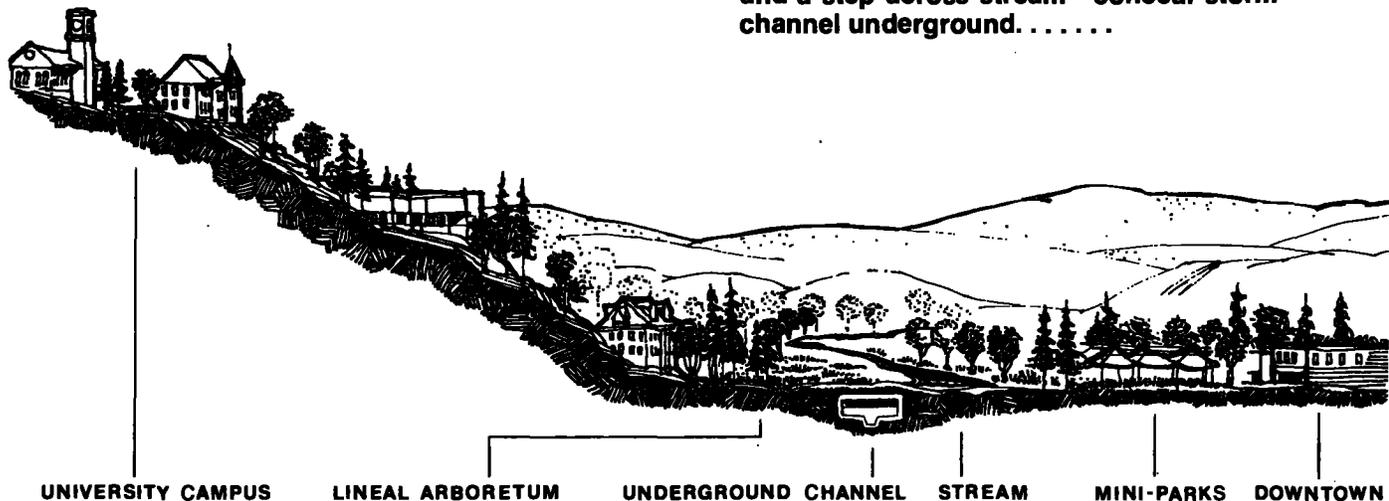
Other Benefits of Recommended Design Concept

1. Eliminates the river as a barrier between the campus and downtown Pullman.
2. Provides a larger park.
3. Encourages business—restaurants, stores, etc.—to face the park, thus helping to re-vitalize downtown Pullman.
4. Avoids relocation cost of Railroad tracks.
5. Eliminates open flow of sewage effluent in stream from Moscow.

III. RECOMMENDED DESIGN CONCEPT

Provide an underground storm channel through the heart of the city, cover with top soil, and develop as a lineal arboretum—use as a common ground central park—for community and campus, summer and winter. Use as an open air museum of plant species for educational purposes. ■ The underground channel eliminates any engineering compromises that may be thought necessary for aesthetic enhancement of an open channel. No specialized textures or "natural materials simulation" involving additional cost and complication would be involved (the value of such cosmetic treatment is open to question in any event). Freedom from such imposed concessions would allow an engineering solution of maximum efficiency in design and materials. ■ Protective barriers such as chain-link fencing required with an open channel are unnecessary with a underground channel. Whereas fence-type barriers are a "stay away" situation, particularly for children, the arboretum invites use and participation. The underground channel eliminates the river as a circulation barrier and allows access across the arboretum between the central business district and College Hill at nearly any point. Tree-lined access paths down the south slopes of College Hill could be developed as "finger extensions" of the arboretum. ■ The concept encourages "mini-parks" in the central business district adjacent to the arboretum park. These mini-parks would provide entry and egress from the park, and create small scale tree-planted relaxation spaces for shoppers and business people to enjoy a few moments of rest or a quiet lunch hour. ■

Join downtown Pullman to Washington State University campus with a lineal arboretum and a step-across stream—conceal storm channel underground.



IV. COMPARATIVE COSTS

1. Maximum Underground Box Culvert Flood Design 8,400 cu. ft./sec.

Conduit Construction	\$2,336,000
Top Soil Cover	<u>\$ 51,000</u>
Total	<u>\$2,387,000</u>

Credit for benefits—Major:

Arboretum educational and research potential, "central park" potential for campus and community, the recreation features, and the potential as a unique and magnetic feature needed to insure a prosperous downtown business district.

vs. Traditional Open Channel

Channel Construction	\$1,597,000
Railroad relocation*	<u>\$1,100,000</u>
Total	<u>\$2,697,000</u>

*Requires a new connection of the tracks one mile east of Pullman, a connection and a new R.R. bridge east of Grand Street, removal of U.P. tracks and a signaling system modification.

Credit for benefits—Minor:

Open channel with chain link fence barrier destroys the park potential and produces a negative factor for Pullman's downtown shopping area.

2. Minimum Underground Box Culvert Flood Design 5,200 cu. ft./sec.

Conduit Construction	\$1,470,000
Top Soil Cover	<u>\$ 27,000</u>
Total	<u>\$1,497,000</u>

Credit for benefits—Major:

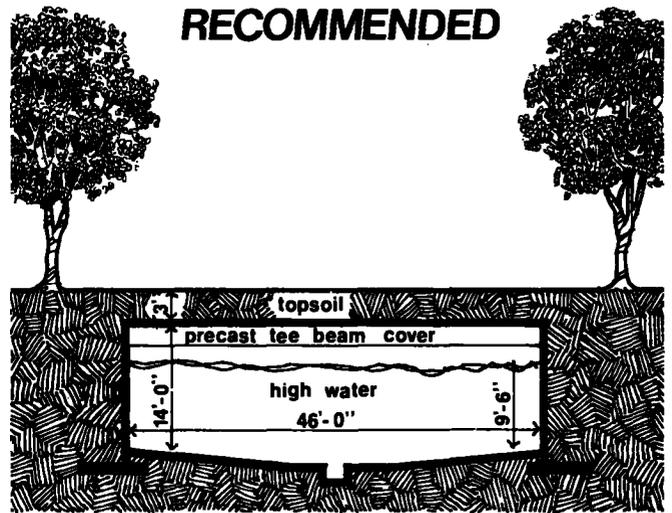
See above.

vs. Traditional Open Channel

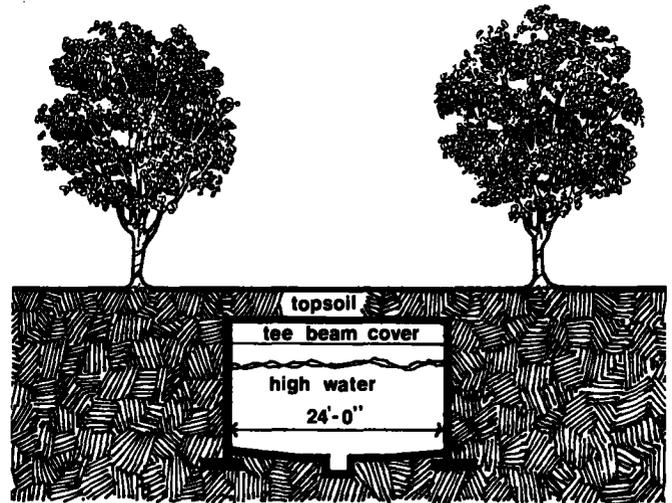
Channel Construction	\$ 995,000
Railroad relocation	<u>\$1,100,000</u>
Total	<u>\$2,095,000</u>

Credit for benefits—Minor:

See above.



MAXIMUM UNDERGROUND CONDUIT



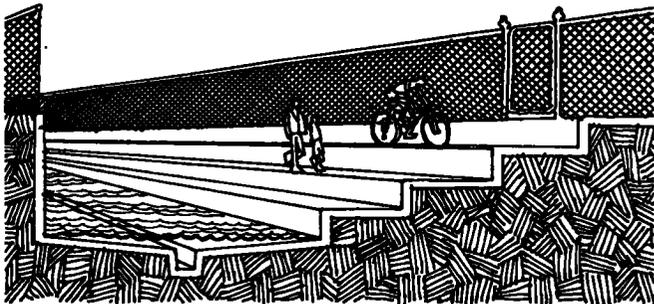
MINIMUM UNDERGROUND CONDUIT

3. Modified vs. Traditional Open Channel

This design would be 15% more costly than traditional open channels due to increased width and more complex design.

Maximum Flood Design \$2,986,550
Minimum Flood Design \$2,294,250

Not recommended—massive strip of hot, dry concrete through the center of the city in summer produces a negative environmental condition. Maintenance is high in keeping flood water mud off terraces. As a bike or pedestrian path, its accessibility is limited, its use awkward. Numerous security gates would be required.



TERRACED CHANNEL X

CENTRAL PARK— AN ARBORETUM

PROVIDES PURE WATER STREAM: A step-across stream is fed by small amount of water from city main. It is shallow, with pebbly sand bottom for wading and dabbling. Stream converts to "down-on-the-creek" ice skating in winter.

INTEGRATES WITH THE COMMUNITY: Private and Public property adjacent to Pullman Central Park is enhanced for either aesthetic or indoor-outdoor commercial use (vs. open channel which reduces value of adjacent property). Mini-parks form linkage to business district. Bike and walking paths through park are free from automobile routes. Links WSU campus with downtown Pullman.

SCHOOL CHILDREN'S ROUTE: Provides a safe circulation route between the athletic field, Reaney Park, Swimming Pool, Neill Public Library and the residential areas of Sunnyside Hill and Military Hill.

RECOMMENDED IMPLEMENTATION

1. Consolidate land by easement or purchase to allow a single total design to be executed.
2. Extend the present Urban Design Consultation to include landscape and engineering input. Work closely with the Corps of Engineers, the City of Pullman and Washington State University to produce the final design phase drawings. The Corps of Engineers produce the working drawings and specifications for the flood control engineering. Consultant firms produce the working drawings and specifications for the park and urban design improvements. Let either joint or separate construction contracts, all at one time, for the entire Central City Renewal Project.

Urban Design Consultation by Architects
BROOKS • HENSLEY • CREAGER SPOKANE
for
DEPARTMENT OF ARMY
WALLA WALLA DISTRICT
CORPS OF ENGINEERS

August 1, 1973

ANNUAL RECREATION BENEFITS TO PULLMAN
COVERED CHANNEL AND ARBORETUM

Population of Pullman - 20,500 (12,500 students, 8,000 residents)

100-Year Channel Plan and 50-Channel Plan

<u>Item</u>	<u>Number of Visitors</u>	<u>Times Visited</u>	<u>Annual Visitor Days</u>	<u>Range of Willingness- to-pay-Values</u>
Student				
Visit enroute to and from town	12,500	1 time/wk for 20 wks	\$250,000	\$.15 to .30
Resident				
Housewife, employee at lunch stop or rest stop	8,000	2 times/yr	16,000	.25 to .50
Passerby on street, shopper, businessman, employee, student	20,500	10 times/yr	210,000	.05 to .10
Bicyclist	2,000	1 time/yr	2,000	.50 to 1.00
Out-of-town visitor	1,000	1 time/yr	1,000	.25 to .50
Educational experience	500	1 time/yr	<u>500</u>	1.00 to 2.00
Total Annual Visitor-Days			479,500	

25-Year Channel Plan

<u>Item</u>	<u>Number of Visitors</u>	<u>Times Visited</u>	<u>Annual Visitor Days</u>	<u>Range of Willingness- to-pay-Values</u>
Student				
Visit enroute to and from town	6,000	1 time/wk for 10 wks	60,000	\$.15 to .30
Resident				
Housewife, employee at lunch stop or rest stop	1,000	2 times/yr	2,000	.25 to .50
Passerby on street, shopper, business, employee, student	10,000	10 times/yr	<u>100,000</u>	.05 to .10
Total Annual Visitor-Days			162,000	