2.4 Floodplain Restoration Principles

Anthropogenic alternation of river corridors and floodplains significantly modified the structure and function of landscapes and led to an extensive loss of wetlands. TWI intends to restore the Hennepin Levee District (HLD) based on conditions before construction of the levee. Is the condition of 1904, however, the best model for restoration of the site in the 21st century? What is restoration? What features are we restoring for? And how do we do it? These are fundamental questions to answer before organizing a restoration plan.

2.4.1 Definition of Restoration

To *re*store, based on the meaning of the word itself, is to bring back to an original condition, which implies that something has been altered. The action of restoration is to *re*turn its previous stage, *re*cover its formal state, *re*gain its processes, and *re*pair its damage. Based on this definition, wetland restoration is to restore a wetland, which has been altered and perhaps destroyed or degraded, to its previous condition.

Questions arise, however, regarding what conditions do we want to restore and how far back in time should we go as a paradigm for restoration?[1] In the report, *Restoration of Aquatic Ecosystems*, the National Research Council (1992) claims that restoration is the "return of an ecosystem to a close approximation of its condition prior to disturbance." The National Research Council further emphasizes that an aquatic ecosystem restoration is aimed to reestablish the "pre-disturbance aquatic functions and related physical, chemical, and biological characteristics. Restoration is …a holistic process not achieved through the isolated manipulation of individual elements…Merely recreating a form without the functions, or the functions in an artificial configuration bearing little resemblance to a natural form, does not constitute restoration."[2]

Therefore, wetland restoration is to *re*turn the wetland ecosystem to a close approximation of its natural condition, *re*cover its hydrological function so as to *re*gain its abiotic environment and biotic communities, and *re*pair its connection to nature.

2.4.2 Design Principles

Humans often guide the restoration process. Whether humans have sufficient knowledge in designing a wetland restoration and the level of human interference in the natural context of a floodplain wetland thus become issues.[3] Mitsch and Gosselink therefore proposed two fundamental concepts for restoring wetlands: understand wetland ecology and minimize artificial input.[4] In addition, ecological restoration in riparian systems should attempt to reconnect the organisms and their environment.[5] In other words, the restored floodplain wetlands should accommodate regional context of landscape and land use development. Finally, to ensure the restored floodplain wetlands in the HLD are functional and self-sustainable, the restoration plan should be integrated with economic, political, and cultural perspectives from local to statewide collaborations.

General restoration design principles are summarized as follows:

1. *Planning on a regional scale.*
   - *Applying landscape ecology theories.* Landscape ecology is a field that assists in analyzing structure, function, and changes in a landscape. It helps to manage a restored floodplain in an ecological and sustainable way by considering the context of regional landscape. Floodplains are ecosystems accordingly interacted with climate change, energy flow, nutrient cycle, and organism movement in adjacent ecosystems (Section 2.1); as a result, how the restored HLD floodplain fits into contiguous landscapes and functions within a regional context is vitally important.
   - *Integrating watershed hydrology.* Floodplain hydrology is connected to streams and rivers in the context of a watershed. Hydrology functions not linearly but weaving like a three dimensional network in a watershed (Section 2.l). As a result, when considering hydrologic function, it must be integrated in the watershed hydrology. Restoring the hydrologic function at the scale of the Illinois River watershed thus becomes a base line for restoring floodplain wetland ecosystems in the HLD.[6]

- *Accommodating land use and development.* Existing and future land use and development plans will influence the viability of the restored floodplain. For example, agricultural and urban activities in the Illinois River watershed cause non-point and point source pollution thereby degrading water quality; human disturbances negatively impact biotic habitats and hydrological functions (Sections 2.2). Thus, a restoration plan should take potential future land uses and trends in development into account to prevent restored floodplain from future degradation.[7]

2. *Establishing a self-sustained ecosystem.*
   - *Designing for function, not structure.* Hydrological function governs wetland ecosystem development. Wetland structure, including soil, vegetation and wildlife communities, and abiotic environment, is determined directly and indirectly by wetland function (Section 2.1). As a result, the success of a restored floodplain should be based on restoring wetland function rather than the form of wetland structure.[8]
   - *Allowing self-design.* Self-design is an innovative concept in ecosystem restoration process. Restoration by means of self-design relies on self-organizing ability of an ecosystem, in which natural processes (wind, rivers, biotic inputs, etc.) contribute to species introduction and selection. In self-design, the presence and survival of species due to their continuous introduction is the essence of the succession and functional development of an ecosystem.[9] Ultimately, sustaining natural energy is the best way to maintain ecological integrity with capacities to adapt to disturbance and changes.[10] TWI plans to allow self-design on the HLD by reintroducing surface water from the Illinois River and the Coffee Creek watershed as an initial stage of the restoration plan. This is a good start for renewing the natural function of the river and regenerating a floodplain wetland ecosystem.
   - *Minimizing engineering techniques.* To minimize artificial input in a restoration plan, it is critical to minimize the need for maintenance and avoid over-engineering to reduce the interference of artificial mechanisms and materials involved in wetland ecosystem natural succession.[11] High maintenance approaches not only

increase the costs, both in construction and management, but also make restored wetland systems dependent on human and financial resources that may not always be available.[12]

- *Planning with time*. Time is an important factor in natural processes and dynamics. A wooded bottomland swamp may take longer to re-establish in terms of structure and function, than a shallow-water, sedge-meadow wetland. Boggs and Weaver (1994) point out that the pattern of change in riparian vegetation and nutrient pools likely developed over more than a century of succession.[13] Therefore, sufficient time should be allowed for natural succession to restore floodplain wetland structure and function.[14] In addition, in floodplain wetlands, particularly, time is a critical factor when hydrology changes seasonally and annually, which in turn affects wetland ecosystems. Consequently, time should be considered fully when establishing stages of goals and objectives in a restoration plan.

3. *Designing for cultural-natural sustainability*. Political, economic and cultural issues are not discussed in most wetland restoration literature reviews. A sustainable restoration plan, however, should include these perspectives. Since humans manipulate the land greatly, focusing solely on the ecological aspect of restoration and not accounting for regional anthropogenic influences will likely result in failure of the restoration. Therefore, collaborating with government and local communities so as to make the floodplain restoration successful is an effective way to design restoration for sustainability.

2.4.3 Design Process

Since humans guide restoration, a design process has been developed in order to organize a restoration plan. The design of an effective restoration project should include clear goals and objectives, sufficient baseline data and historical information, integrated planning and comprehensive design, and long-term monitoring.

1. *Goals*. Floodplain restoration is defined by restoring functions; as a result, restoration of specific functions becomes the goals. Subject to the influence of various human values, a restoration may be planned to achieve multiple goals in terms of wetland function and values (Section 2.3). Mixed goals, however, may be difficult to achieve and difficult to quantify for monitoring.[15] Therefore, one primary goal must be identified for the project.[16]
2. *Site Selection*. Criteria for site selection should be established based on restoration principles and project goals and objectives. According to the principle of establishing a self-sustaining ecosystem, a restoration with natural succession potential is better than newly created wetlands.[17] As a result, criteria for selecting an adequate site include several elements: (1) historical wetlands, (2) potential to reconnect the natural hydrological regime, (3) hydric soils, and (4) possible wetland species or seedbank. Other components related to planning within a regional scale and designing for sustainability include existing and future land use, land availability, geomorphic setting (e.g., steepness of river channel and topography gradients), climate, and regulations (e.g., Clean Water Act and Endangered Species Act). TWI chose the HLD for restoration based on historical information of the Hennepin and Hooper Lakes in late 1800's and early 1900's. This provides a baseline for evaluating the restoration plan.
3. *Site analysis*.
   - *Site inventory*. Onsite and offsite inventories provide a baseline for the restoration plan. Onsite inventory includes investigating local hydrology, soil properties, native and non-native flora and fauna communities, accessibility, land use and human activities. Other data needs include water quantity and quality, flood frequency and duration, climatic and geomorphic data, nature and cultural history, land use and development pattern, regulations, and financial and stewardship support.[18]
   - *Site evaluation*. Based on knowledge of floodplain ecosystems, site evaluation is a process used to assess the suitability of a selected site and the feasibility of restoration according to information collected from the site inventory. Criteria for evaluation include reconnecting the original hydrologic regime, soil properties

for water capacity and wetland vegetation, control of invasive species, potential seedbank, availability of land acquisition, appropriateness of landscape and land use setting, accessibility to the site, wetland restoration and land use development regulations, and opportunities for financial and community support.

4. *Site Plan*. Based on the result of the site analysis, an effective site plan should amplify opportunities and minimize the constraints onsite in order to achieve the project goals.
5. *Site Design*. Specific design should be addressed after the site plan is developed. Details include hydrologic engineering, topographic grading details, planting design, construction details, and facilities to accommodate specific human needs.
6. *Management*. A restoration project should have a long-term management plan to ensure the wetland function is restored and the goals are achieved. A management plan includes monitoring and evaluation programs to investigate the conditions of the restored wetland and evaluate the successfulness of the restoration plan through a set of assessment procedures. Finally, a critical object is to establish stewardship, by promoting collaboration between TWI, local communities, and Federal and State agencies to sustain the restored floodplain.

The design process is not always straightforward (Figure 2.4.3-1). Site evaluation and site planning is a systematic, iterative process of collecting and analyzing information followed by modifying the plans, then repeating the cycle until the initial concept is polished into a preliminary plan that becomes the basis for the design. The process summarizes information on topographical, geological, hydrological, soils, land ownership, land use, climatic, biological, and regularity factors that may influence construction, operation, management, and possible impacts of the proposed system. It provides a baseline for evaluating alternative sites, choosing compatible designs, assessing important components, drafting concept drawings, and outlining construction details.[19] Once the plan and design is accomplished, a monitoring and evaluation program should be conducted to ensure that the restored wetlands are functional and the goals are achieved. Assessment of the success of the restoration project and recommendations for the next restoration plan are parts of the management plan. The HLD restoration project intends to provide a floodplain restoration model that is applicable to similar sites around Illinois and other states.

Currently, the HLD project is in the transitional stage between site analysis and site planning. TWI has already gone through the extensive process of site selection and analysis of the elements that are essential for beginning the restoration process. With the questions outlined in the introduction, this report offers another level of analysis and site planning to augment TWI's work.

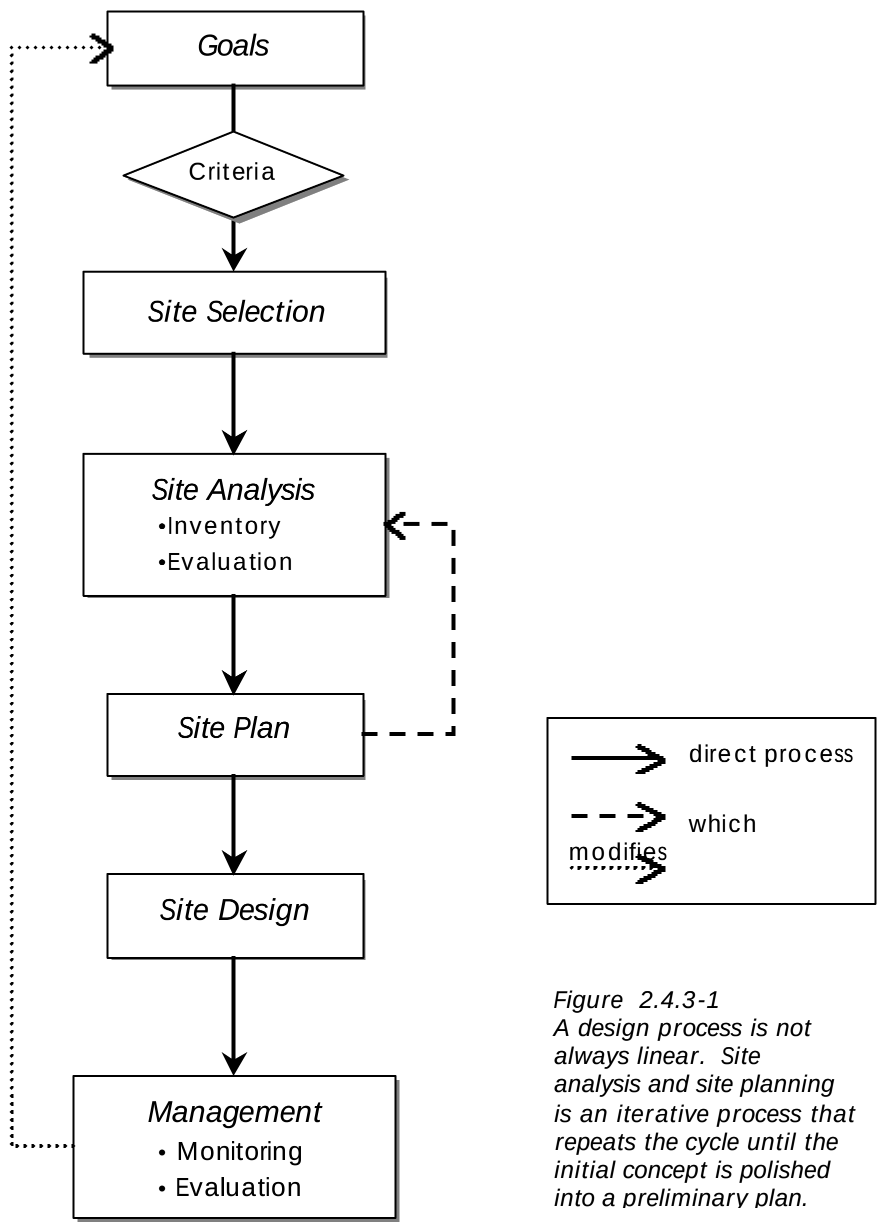

Figure 2.4.3-1
A design process is not always linear. Site analysis and site planning is an iterative process that repeats the cycle until the initial concept is polished into a preliminary plan.

[1] USEPA. 2000. Office of Water.
[2] Mitsch, W. J. and J. G. Gosselink. 2000. p654.
[3] USEPA. 2000. Office of Water.
[4] Mitsch, W. J. and J. G. Gosselink. 2000. p669.
[5] Wissmar, R. C. and R. L. Beschta. 1998.
[6] USEPA. 2000. Office of Water., and Zedler, J. B. 2000.
[7] USEPA. 2000. Office of Water.
[8] Mitsch, W. J. and J. G. Gosselink. 2000. p669.
[9] Ibid. p254-255., and Mitsch, W. J. et al., 1998.
[10] USEPA, 2000, Office of Water.
[11] Mitsch, W. J. and J. G. Gosselink. 2000. p668-669., and National Research Council, 1991.
[12] USEPA. 2000. Office of Water.
[13] Kentula, M. E. 2000.
[14] Ibid., and Wissmar, R. C. and R. L. Beschta. 1998.
[15] Hammer, D. A. 1996. p151-152.
[16] Mitsch, W. J. and J. G. Gosselink. 2000. p669-670.
[17] Ibid. p672.
[18] Hammer, D. A. 1996. p164-165.
[19] Ibid. p151