

Distributed Storage Alternative Screening Analysis

February 17, 2015

The Draft EIS version of this document was accepted as the Final EIS version. No changes were made to this document.

Executive Summary

The Distributed Storage Alternative (DSA) was conceptualized during the public comment and alternative screening process as part of the State of Minnesota environmental review for the Project. Public comments received suggested that distributed storage in combination with other measures might provide greater environmental benefits than the proposed Project. This screening analysis first evaluates the conceptualized Distributed Storage Alternative (DSA) as an option to meet the need for flood risk reduction for the Fargo-Moorhead Metropolitan Area (Metropolitan Area). Next, this screening analysis evaluates two variations to the DSA to see whether they can provide additional benefits to meet the project purpose, which are: 1) the DSA in combination with a new Sheyenne River Diversion, and 2) the DSA in combination with other non-structural measures (e.g., wetland and grassland restoration).

Evaluation in the screening analysis is based on the following information:

- Water flow models included in the Final DSA Report (Wenck, 2014).
- Relevant literature examining the potential for using upstream storage areas (wetlands, reservoirs, etc.) in major subwatersheds to reduce downstream flows through the Metropolitan area. These storage areas referenced were often built with other structural and non-structural measures for flood risk reduction.

Quantitative and qualitative analysis shows that the DSA would provide the Metropolitan Area substantially greater flood risk reduction benefits than currently exists. The distributed upstream storage would lower flood levels along the Red River through Fargo-Moorhead, as well as potentially reduce flood damage throughout the upper portion of the Red River basin.

While it appears that the DSA by itself would not meet the project purpose as defined by the project proposer, distributed storage is an excellent basin-wide approach to provide flood protection at a local level and should be pursued wherever feasible. Additional upstream storage would greatly benefit many downstream communities in the Red River Basin, including Fargo and Moorhead, but individual communities will still need additional flood protection for large or catastrophic flood events.

The screening analysis of this alternative indicates that the DSA:

- 1) is limited in meeting the project purpose;
 - a. The DSA provides the communities on the Red River mainstem with limited protection from catastrophic events or from peak tributary flows;
- 2) is not a feasible or practical alternative to the proposed project; and
 - a. Roughly 96 impoundment sites would be required to achieve the desired 20 percent flow reduction basin-wide. Since 1997, only 3 impoundment projects have been completed upstream of Halstad.

- b. It would be very challenging for the Diversion Authority or the USACE to work with all interested parties across the basin to implement this number of storage sites within a reasonable time period.
- 3) in combination with other measures, does not substantially improve the performance of the alternative toward meeting the project purpose.
- a. Sheyenne Diversion: The addition of the Sheyenne Diversion has the potential to increase flood flows downstream of the Fargo-Moorhead Area; and the cost of adding the Sheyenne Diversion, while not a prime consideration, would decrease the feasibility of DSA.
 - b. Wetland/Grassland Restoration: it is unlikely that adding wetland/grassland restoration to the DSA measures would have a sufficient impact to allow the DSA to meet the Project purpose as it relates to catastrophic flood events.

Minnesota Rules 4410.2300 subpart G allows for alternatives that were included in the scope of the EIS to be eliminated from further consideration based on information developed as part of the EIS. The DSA screening analysis will be included in the Draft Environmental Impact Statement (EIS) to briefly describe why this alternative is not being carried forward for full analysis in the Draft EIS. Public comments on the DSA screening analysis will be considered during preparation of the Final EIS.

Alternative Description

The Distributed Storage Alternative (DSA) is a combination of distributed Red River basin storage sites upstream of Halstad MN and an in-town levee plan for flood protection of the Fargo-Moorhead Metropolitan Area. The distributed storage component of the DSA relies on the recent Halstad Upstream Retention Study (HUR) completed by the Red River Basin Commission in December 2013. The HUR identified 96 specific retention sites throughout the basin to achieve a 20-percent flow reduction on the Red River. The in-town levee component of the DSA relies on a maximum levee protection plan that was developed by the United States Army Corps of Engineers (USACE). The levee plan includes over 50 miles of levee construction and ties into high ground. As part of analyzing the DSA, the MDNR considered other measures, including the Sheyenne diversion and wetland/grassland restoration that could be combined with the DSA to improve flood risk reduction in the Fargo-Moorhead Metropolitan Area.

The DSA would provide the Fargo-Moorhead Metropolitan Area substantially greater flood risk reduction benefits than currently exists. The height of the USACE Phase 2 levee is equivalent to a river profile associated with a 47 foot gage height, compared to the existing levees that have typically been built to an equivalent gage height of 43 to 44 feet. The distributed upstream storage would provide lower flood levels along the Red River through the Fargo-Moorhead Metropolitan Area, as well as provide flood damage reduction throughout the upper portion of the Red River basin.

While the DSA would provide improved flood damage reduction benefits, two key questions remain: 1) would it fully meet the project purpose; and 2) is the DSA a practical alternative considering the construction of dozens of impoundments relies on individual project approval by multiple water management boards and watershed districts?

DSA Analysis

The Minnesota State Environmental Impact Statement (EIS) for the Fargo-Moorhead Flood Risk Management Project (the Project) is evaluating the DSA to determine if it meets the project purpose. If the DSA meets the project purpose, the DSA will be analyzed in the EIS along with the Proposed Project and the No Action Alternatives. If the DSA does not meet the project purpose, the EIS will describe the basis for this determination and the alternative will not be further analyzed.

The project purpose has been defined as:

1. Qualify substantial portions of the metropolitan area for 100-year flood accreditation by the Federal Emergency Management Agency (FEMA) under the National Flood Insurance Program (NFIP);
2. Reduce flood risk potential associated with a long history of frequent flooding on local streams including the Red River of the North, Sheyenne, Wild Rice (in North Dakota) Maple, Rush and Lower Rush Rivers, passing through or into the Metropolitan Area; and
3. Reduce flood risk for floods exceeding the 1 percent event (100-year flood or greater), given the importance of the Metropolitan Area to the region and recent frequencies of potentially catastrophic flood events.

While the first component of the project purpose, FEMA 100-year flood accreditation, is relatively a definitive criteria (i.e., yes/no), the remaining two components do not present a quantitative determination for whether an alternative meets the project purpose. The Minnesota Department of Natural Resources (MDNR) as the Responsible Governmental Unit (RGU) for the preparation of the EIS needs to evaluate how well the DSA meets each of these project purpose components and come to a determination of whether or not the DSA meets the purpose of the Project. The following discussion describes the degree to which the DSA meets each of these project purpose components.

Project Purpose #1: FEMA 100-year Flood Accreditation

As shown in Figure 1, the DSA provides 100-year flood protection to a substantial portion of the Fargo-Moorhead Metropolitan Area. Some areas of existing development with flood risk are not protected by the DSA. For instance, the area to the northwest of Fargo, in the vicinity of the city of Harwood, is a specific area not protected by the DSA. The DSA does not provide as much protection as the proposed project; however, this is not necessarily a requirement for the DSA to meet the project purpose. The MDNR consulted FEMA about the ability of the DSA to provide 100-year flood accreditation. The following are two of FEMA's primary concerns for DSA accreditation:

- Freeboard – FEMA requires levees to have 3-4 feet of freeboard above 100-year flood elevation and that the levees are certified by an engineer. The levees by themselves do not have the required 3-4 feet of freeboard. The levees combined with flood reductions from the 96 distributed storage sites could provide 3 feet of freeboard. Because the project is a joint local-federal project the USACE would likely be tasked with levee certification. Preliminary review by the USACE has indicated that the DSA would not provide 100-year flood protection with a 90-percent confidence that is required for USACE levee certification.
- Distributed storage – FEMA accreditation of the DSA would depend on all 96 distributed storage sites being developed. The RRBC's HUR study assumed an ideal scenario in which maximum storage

is achieved during a 100-year event at all 96 impoundments. It is also unlikely that the distributed storage sites will achieve the 100-percent utilization of storage that was modeled in the HUR. It is more likely that some watersheds will contribute either more or less flow to the Red River, depending on precipitation and weather patterns. The uncertainty of distributed storage sites to achieve the modeled twenty percent reduction in flow contributes to difficulty of the DSA to achieve 100-year flood protection with 90-percent confidence.

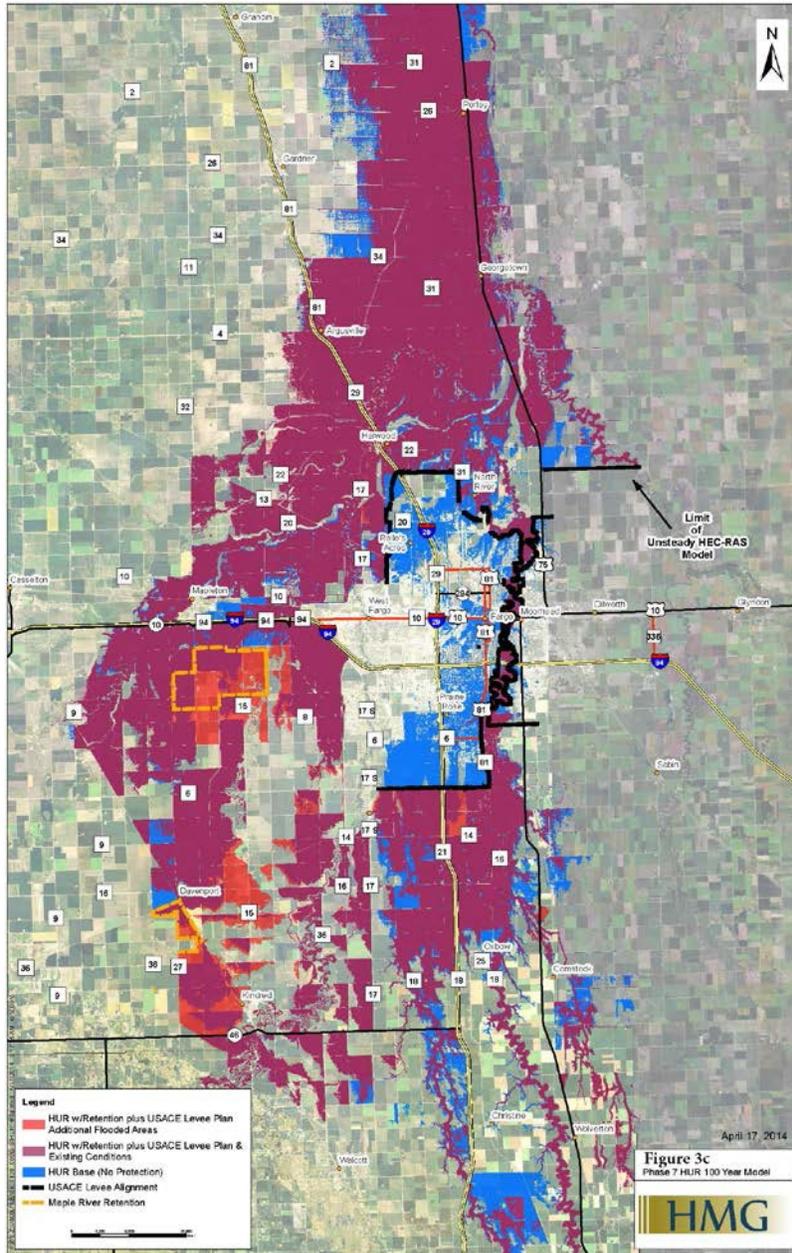


Figure 1. DSA 100-year Flood Protection

The DSA includes increased staging of flood water upstream of the levee system (this stage increase is similar to the No Action with Emergency Measures Alternative). This is a consideration for flood protection provided by the DSA, because higher peak flood flows and stage would occur if this staging area was filled by development and/or blocked by road construction. This would result in less free board for the levees and increased flows downstream of Fargo-Moorhead.

Although the DSA would provide 100-year protection for a substantial portion of the F-M metropolitan area, the ability to actually receive FEMA accreditation for this protection is limited by the feasibility of all of the distributed storage sites to be constructed and the uncertainty associated with protection provided by the levee system.

Project Purpose #2: Reduce Flood Risk from North Dakota Tributaries

The DSA provides some flood risk reduction from the Sheyenne, Maple and Rush Rivers. The levee component of the DSA would provide protection to the north end of Fargo from Sheyenne River overflow. The distributed storage component would reduce flooding from events centered on the Maple and Rush Rivers and the lower portion of the Sheyenne River.

However, the highest flows on the Sheyenne River are associated with the runoff from the upper portion of its watershed (i.e., above the Baldhill Dam). Since none of the 96 impoundments are located in the upper portion of the Sheyenne River, the DSA would provide limited benefit to reducing peak flows on the Sheyenne River. As shown on Figure 1, the existing Sheyenne River diversion/West Fargo diversion provides flood protection from the Sheyenne River for the cities of Fargo and West Fargo. There is no protection from overflow to areas southwest and northwest of the metropolitan area, including the city of Harwood.

The Sheyenne River is a major contributor to flooding in the greater Fargo-Moorhead Area; thus, the inability for distributed storage to reduce peak flows on the Sheyenne River limits the ability of the DSA to meet this component of the project purpose. An additional levee system is not feasible for the Sheyenne River in the Fargo-Moorhead Area due to the perched nature of the river in this area.

Project Purpose #3: Protection from Floods Greater than the 100-year Event

The HUR study did not evaluate any event greater than the 100-year flood. Although it is expected that the 96 impoundments (66 of which are upstream of Fargo-Moorhead) would provide some benefit during a 500-year event, the peak flow reduction at Fargo-Moorhead would likely be less than the HUR study's idealized 20-percent reduction calculated for the 100-year event. Each of these storage sites will have a finite amount of storage capacity and when that capacity is reached the additional runoff will be contributing to downstream flooding. There would be some variability from site to site, but it is not reliable to assume these sites will have capacity for catastrophic runoff in the range of a 500-year event.

Any system of levees through the Fargo-Moorhead metropolitan area would confine the flow of the Red River to a relatively narrow floodway. Confining flood flows up to the 100-year event would cause a minor flood stage surcharge at the upstream reach of the levee system (< 2 feet). For floods greater than the 100-year event, a greater amount of flow would be confined between the same levee system causing increased flood level surcharge – as much as six feet for the 500-year event.

The levees and floodwalls recently constructed in Fargo and Moorhead are generally at an equivalent stage of 43 to 44 feet gage height. The two cities are therefore now in a much stronger position to fight a flood of similar magnitude of the 2009 which reach a peak stage of 40.7 feet. The computed 500-year flood profile on the Red River with the proposed project is equivalent to a gage height of 40.0 feet. With the combined effect of the recently constructed levees and the proposed project, it is reasonable to envision a successful flood fight during a future 500-year flood.

By contrast, the computed 500-year flood stage for existing conditions is 46.3 feet. A flood of that magnitude is essentially at the top of the USACE Phase2 maximum levee height and over two feet higher than the existing levees. A successful 500-year flood fight with the DSA would therefore require emergency measures to raise portions of the “maximum” levees to provide adequate freeboard. The feasibility of adding that extra level of protection throughout the metropolitan area is unknown. There would be an ever-increasing risk of catastrophic failure with floods exceeding the design capacity of any system of levees.

Implementability of the DSA

Levees by themselves would not meet FEMA’s three-foot freeboard requirement for accreditation. Therefore, the distributed upstream storage is a critical component of the DSA. Throughout the scoping process and the analysis in this EIS, it has been recognized that the feasibility and practicality of constructing dozens of impoundments within a reasonable period of time is a key consideration to a finding that the DSA is a practical alternative to meet the project purpose. While impossible to accurately predict how many impoundments could or would be constructed during the next 20- or 30 years, it may be instructive to look at the recent past.

Since the 1997 flood, only three impoundment projects have been completed upstream of Halstad: Baldhill Dam (5 foot rise adding 31,500 acre feet of storage); Maple River dam (60,000 acre feet); and the North Ottawa impoundment (18,200 acre feet). The Maple River and Baldhill dam are large on-channel impoundments, and not likely replicated in too many other locations due to the environmental consequences and feasibility of on-channel impoundments. The North Ottawa impoundment was the only project constructed since the 1997 flood that is representative of the types of projects anticipated by the HUR.

On the Minnesota side, there are two additional projects– Red Path (22,200 acre feet in the Bois De Sioux) and Manston Slough (5,320 acre feet in the Buffalo-Red). The Manston Slough project will likely be completed in 2014. The Red Path project is still a concept, but it could begin in the foreseeable future. The Bois de Sioux watershed district has a couple more projects at various planning stages, and the Buffalo-Red watershed district has a concept plan for an additional project on the South Branch that could move forward.

Impediments to constructing 96 storage projects include funding, regulatory issues and land owner consent. Of the three, buy-in by multiple land owners affected by a given project would likely be the largest hurdle because the Diversion Authority or the USACE would have to coordinate work with all interested parties across the basin to implement this number of storage sites within a reasonable time period. That being said, all entities within the basin have a responsibility to participate in basin wide

efforts for flood risk reduction. This participation in basin wide efforts does not alleviate the need for communities on the main stem Red River from pursuing community based flood risk reduction efforts.

Past studies and reports on basin wide impoundments also provide examples and conclusions that are informative.

- 1996 Federal Tier I EIS/State Generic EIS: This EIS was prepared jointly by the USACE and the DNR. The EIS discusses the potential cumulative environmental effects of 33 proposed surface water impoundments in the Red River of the North watershed that have flood damage reduction as a project purpose. The EIS determined a number of conclusions about impoundments:
 - The estimated cumulative downstream flood flow effect of all of the proposed impoundments would be a less than 1-inch reduction for the 100-year flood event.
 - The proposed and existing impoundment projects are estimated to provide reduction in average monthly runoff volume and low flow of 0-2 percent.
 - In general, on-channel gated impoundments on the tributaries have the greatest potential to reduce flood flows on the main stem.
 - In general, the types of impoundments with the most potential for cumulative flood flow reduction also have the most potential for adverse environmental effects on natural resources.
 - Most state and federal agencies support a comprehensive approach to flood damage reduction, which includes both structural and nonstructural components. Controlled impoundments need to be considered, but may not be the most effective way to reduce damages at a specific location.
- 2004 Red River Basin Flood Damage Reduction Framework, Technical Paper No. 11: This report was developed by the Red River Basin Flood Damage Reduction Work Group (Technical and Scientific Advisory Committee) and presents concepts, facts, alternative flood damage reduction measures, and Red River Basin storage example. In summary, this report found the following:
 - For this report's example, it was estimated that the collective effects could reduce the 100-year peak flood flow at the U.S./Canada border by approximately 20%.
 - The types of upstream local solutions that have the best potential for also providing watershed and main stem benefits are flood volume reduction and increased temporary storage.
 - However, because flood volume reduction and increased temporary storage alone cannot achieve the flood damage reduction and natural resource goals of the Basin, a multi-measure approach is needed.
 - Multiple measures can be implemented to reduce flood damages. These include structural measures such as levees, channel modifications, and various types of floodwater impoundments, as well as nonstructural measures, such as limiting floodplain development, changing floodplain use, and changing upstream land use to reduce runoff volumes and rates.
- 2005 Fargo-Moorhead and Upstream Feasibility Study, Phase 1 Summary: This report was written by the USACE in cooperation with the North Dakota State Water Commission and the City of Moorhead. The report studied ways to reduce flood stages, restore aquatic ecosystems in the Red River Basin, and alternatives, including a system of water storage sites. This study determined the following conclusions:

- A system of multi-purpose impoundments has the potential to reduce the 100-year flood elevations in Fargo-Moorhead by as much as 1.6 feet.
- In general, impoundments would provide the greatest stage reductions for floods of the 10- to 20-year magnitude.
- Agricultural flood damage reduction benefits and urban benefits outside of Fargo-Moorhead have not been quantified but would probably be significant.
- With careful design, it is likely that a system of impoundments could be justified largely by ecosystem restoration benefits.

These previous studies and the HUR report have similar findings about the ability for distributed storages sites to reduce flood levels on the Red River. It is clear that these types of projects can reduce flood elevations on the Red River, but the magnitude of the potential reductions is such that additional flood risk reduction measures are still warranted for large flood events. The distributed storage sites have much greater benefits near the storage sites and at smaller flood events.

Additional Concerns

Several additional concerns with the DSA were articulated throughout the analysis, including:

- Reliability and residual risk of the DSA: This is of concern because of the high elevations of flood waters that could be held back by the levee system. The project proposes to take areas out of the 100-year flood plain; an action, which in turn, has the potential to attract building and development in those areas. The potential for constrictions or catastrophic floods to overtop the levee has a high residual risk.
- The likelihood of reducing environmental and social impacts: This is a concern because of the need to impact existing structures as part of constructing the levee. In addition, the area needed by the 96 distributed storage sites is greater than the area needed by the proposed Project for upstream staging. Each of the 96 storage sites would have their own environmental and social impacts.
- Uneven snowmelt volume and timing: The HUR analyses assumed that the entire Red River basin would generate 100-year flood runoff volumes during the 100-year event. During an actual large flood event, individual watersheds within the basin will, in all likelihood, generate more or less runoff than the design volumes. Runoff will exceed impoundment design capacities in watersheds having relatively greater runoff volumes. Conversely, the full storage volume in impoundments in watersheds having relatively smaller runoff amounts will be underutilized. The net effect is that the 20% peak flow reduction goal may not be realized during an actual major flood event.

DSA with Sheyenne Diversion

The Sheyenne River is a major contributor to flooding in the greater Fargo-Moorhead Metropolitan Area. Increasing protection from Sheyenne River flood flows would increase the Alternative's ability to meet the project purpose. Consideration was given to whether the cumulative benefit of additional flood reduction measures on the Sheyenne River could help the DSA meet the project purpose. The MDNR revisited an alternative (i.e., DSA with Sheyenne Diversion, or Northwestern Diversion) that was suggested in the Alternatives Screening Report to see if there was a modification that would increase the Alternative's ability to meet the project purpose. The addition of a diversion channel to the DSA would be needed to provide this additional protection. Figure 2 provides a concept for such a diversion.

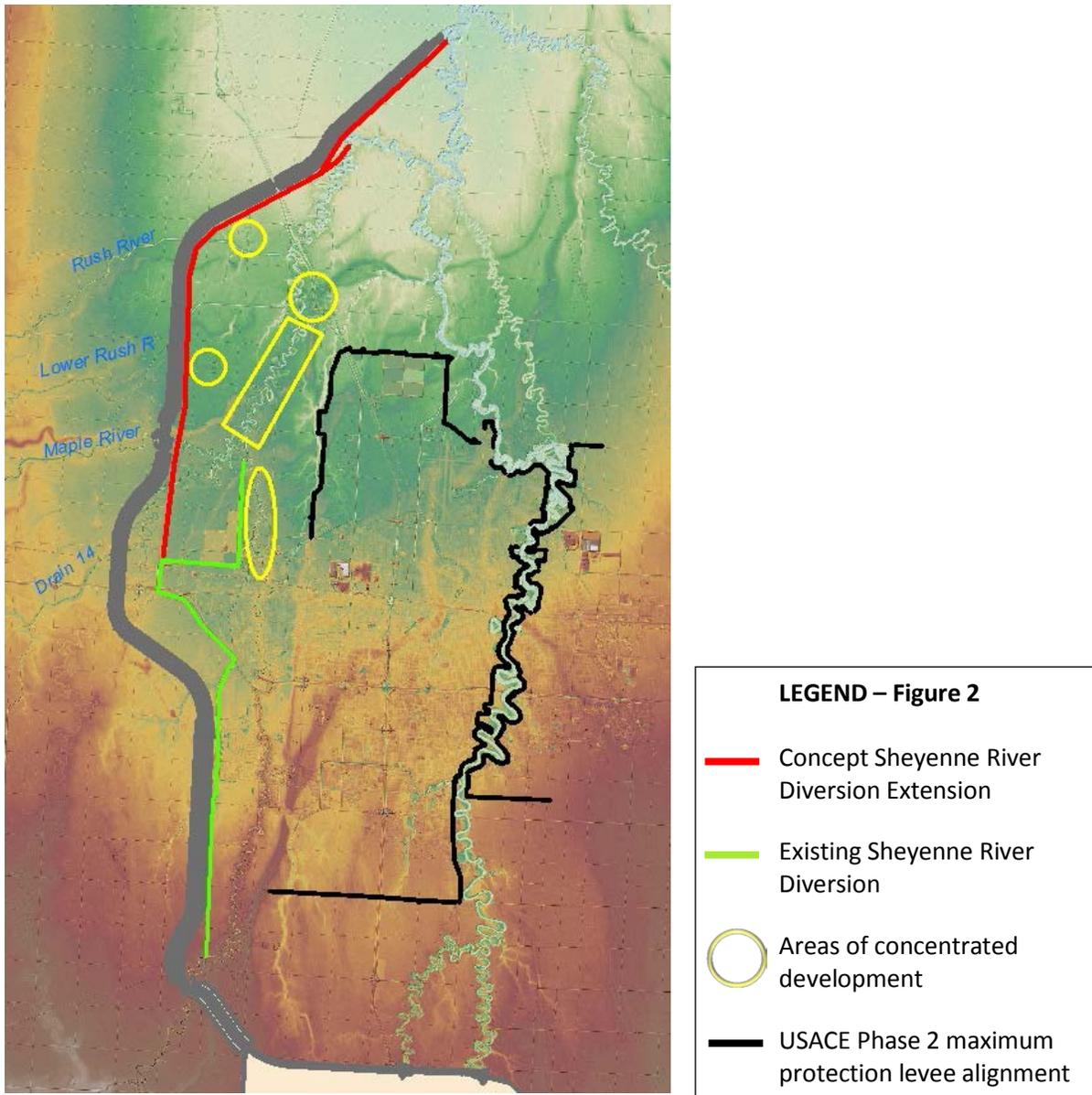


Figure 2: Sheyenne River Diversion

The red line in Figure 2 represents a new Sheyenne River diversion that would be added as a third component to the DSA. The concept assumes the Sheyenne River diversion would extend the existing Sheyenne River Diversion(s) (green line) along a similar alignment of the proposed diversion project. This diversion channel would be smaller than the proposed channel and at least one third as long. The channel would intersect the Maple, Lower Rush and Rush Rivers. Similar to the proposed project, hydraulic structures would be needed to divert some/all of the Maple River and the Lower Rush and Rush River flow into the diversion channel.

This addition to the DSA would capture flood flows from the Sheyenne River and improve the DSA performance in meeting the North Dakota tributary component of the project purpose. It would not

include a high hazard dam on the Red River, nor will it require a permit from the DNR. Due to the timing of Sheyenne River flooding, the DSA with a Sheyenne Diversion does not address any of the issues with FEMA 100-year accreditation nor the flood events greater than the 100-year event that have been identified above. The addition of the Sheyenne Diversion also has the potential to increase flood flows downstream of the Fargo-Moorhead Area. The cost of adding the Sheyenne Diversion, while not a prime consideration, would decrease the feasibility of DSA.

DSA with Additional Non-Structural Measures: Wetland/Grassland Restoration

An alteration to the DSA that could provide additional benefits was the addition of using wetland and grassland restoration in combination with the DSA to meet the project purpose. Available sources of relevant literature were reviewed, including Appendix O from the Final Feasibility Report and Environmental Impact Statement (FFREIS) 2011; *The Impact of Wetlands on Flood Control in the Red River Valley of Manitoba*, September 1999 (Manitoba Study); and *Improving and Testing the Prairie Hydrologic Model at Smith Creek Research Basin*, May 2014 (PHM Study).

Effectiveness of wetland/grassland restoration benefits in combination with the DSA

The evaluation measuring the effectiveness of wetland and grassland restorations when they are used with the DSA included three factors. These factors were: 1) a literature-based assessment of the effectiveness of wetland and grassland restorations, 2) how functioning wetlands relate to runoff volume; and 3) whether the DSA can meet the project purpose.

Scientific literature has shown that wetland restorations typically provide more ecosystem and habitat benefits than flood damage reduction. Instead, surface runoff generally flows directly into and through restored wetlands with limited retention, therefore providing limited runoff reduction (Manitoba 1999). However, the Manitoba Study found that wetlands are effective in reducing total flow volume during low flow events which are more common. During large, less common, flood events, wetlands' capacity to reduce flow volume decreases. The PHM study indicates that under certain topography, wetland types and watershed conditions, water storage provided by wetlands that are sequential can have an impact on the total flow rate and volume generated from the watershed.

The typical behavior of wetlands as discussed above shows that wetlands most likely will have a low impact on the runoff volume and peak flow rates for the flood levels that are applicable to the Project. The PHM study shows different results as the model assumed a cascade effect of wetlands while other parameters included in the model, such as wetland area and excess runoff, were kept consistent across the modeled watershed. These modeled conditions are not directly applicable to the watershed for this project, though it shows that wetlands can support flood control under certain conditions.

The DSA included 96 new storage areas with a total volume (559,200 acre feet) of distributed storage added within the watersheds upstream from the cities of Fargo and Moorhead. All together, these resulted in a 20-percent reduction in flow for a snowmelt runoff event. The Final DSA Report shows that even with all of the storage added to the upper watersheds, the overall impact is that Phase 2 levees

only marginally meet the freeboard requirements to provide adequate protection during the 100-year event. The Final DSA Report showed that storage in the lower Sheyenne River watershed had minimal to no effect on flood risk reduction from the Sheyenne River. The USACE estimated that wetland and grassland restoration has a smaller effect on reducing flood volume when compared to the effectiveness of storage on flood volume reduction. Therefore it can be logically assumed that adding wetlands restoration to storage already considered in the DSA would have an incremental benefit in reducing flow rate and volume at Fargo-Moorhead Metropolitan Area.

Given these considerations, it is unlikely that adding wetland and grassland restoration to the list of measures used in the DSA would have enough of an impact to make the DSA adequately meet FEMA accreditations and levee certification requirements.

Conclusions

During the EIS scoping process, many comments were received recommending the DSA, or a similar approach. As a result, the DNR included the DSA alternative in the Final Scoping Decision Document for further evaluation in the EIS. An alternative may subsequently be excluded from analysis in the EIS if it is determined that the alternative would not meet the underlying purpose of the project or offer significantly less environmental or social impacts. If a scoped alternative is excluded from the EIS analysis, it must be discussed briefly and the reasons for its elimination shall be stated (*MR 4410.2300*).

For these reasons, the DNR evaluation of the DSA as an alternative to the proposed project was warranted. Evaluating the DSA against the project purpose, it becomes clear that distributed storage is a viable and important approach for flood damage reduction basin-wide. There are many local benefits and flow reductions on the Red River from distributed storage; however, potential flow reductions from large events on the Red River are not great enough to alleviate the specific flood damage reduction efforts within communities near the Red River. The use of in-town levees combined with the distributed storage does provide additional flood risk reductions, but this combined approach still does not meet the project purpose as identified in the Final Scoping Decision Document.

One of the project purpose components is to qualify substantial portions of the metro area for 100-year FEMA accreditation. While the DSA does provide some protection, it faces challenges to meeting freeboard requirement for 100-year FEMA accreditation. Additionally, FEMA accreditation would require that all 96 sites identified in the HUR study be constructed. Compounding these challenges are the factors of time, funding, land acquisition, and regulatory issues. While it is possible that this component could be met, the feasibility of getting FEMA accreditation is questionable.

The second component of the project purpose is to reduce flood risk from the North Dakota tributaries. The DSA does provide some flood risk reduction, but it does not protect from break out flows on the Sheyenne River. Large portions of the Fargo-Moorhead metro area will continue to have flood risk from the Sheyenne, particularly the north and west. Therefore, the DSA does not meet this component of the project purpose.

Protection from floods greater than the 100-year event is the third component of the project purpose. The HUR study limited the evaluation to a 100-year event; while there is potential for storage above this

event, it is likely limited. The levee system will contain flows greater than the 100-year event, but it would do so without the additional freeboard that would typically be required for a larger event. Flood events greater than the 100-year event significantly increase the probability of overtopping the levee, which would result in catastrophic flood damages. Thus, the DSA does not present a reasonable or prudent alternative from flood events greater than the 100-year event.

Consideration was given as to whether the cumulative benefit of additional flood reduction measures could help the DSA meet the project purpose. The MDNR revisited an alternative (i.e., DSA with Sheyenne Diversion, or Northwestern Diversion) that was suggested in the Alternatives Screening Report to see if there was a modification that would increase the alternative's ability to meet the project purpose. While this addition does provide additional protection from the North Dakota tributaries and removes the need for a dam on the Red River, there are still problems with getting 100-year FEMA accreditation and with flood flows greater than the 100-year event. Similarly, adding wetland restoration to storage already considered in the DSA would have minimal impact on reducing flow rate and volume for the metropolitan area. It was, therefore, determined that these additions do not present a feasible and prudent alternative, and are still not likely to meet the project purpose.

Distributed Storage is an excellent basin-wide approach to provide local flood protection and should be pursued wherever feasible. Many communities in the Red River Basin, including Fargo and Moorhead, would greatly benefit from the implementation of additional upstream storage. That said, basin-wide flood protection was not the goal of the proposed project—the goal is to protect the Fargo-Moorhead metropolitan area. It is determined that the DSA does not provide the communities on the Red River mainstem with protection from catastrophic events or from peak tributary flows. The analysis of this alternative determines that the DSA: 1) does not fully meet the project purpose; and 2) is not a feasible or practical alternative to the proposed project.