SEH **MEMORANDUM**

TO: Jerry Kenny, PE

FROM: Rocky Keehn, PE

DATE: September 14, 2009

RE: Summary of High Flow event Spring 2009
SEH No. APRRIP0701

Current Conclusions and Recommendations from the April 2009 Short Duration High Flows summary report and follow-up discussions.

Phragmites Removal for flow improvements upstream of Highway 83.

Conclusions:

- Velocity measurements in the phragmites indicated the flow is near 0.5 feet/second verses 1 to 3 feet per second in the free flowing section of the river which means that flow capacity in a reach can be more then doubled by just removing the phragmites.
- In areas where the short duration high flows will cause a significant change in flow velocities it appears that spraying, which results in the death of the phragmites, will be sufficient and thus shredding is not required if there is not an immediate need for flow increase.
- Shredding of the phragmites has value in helping prevent flooding since it can provide immediate flow relieve in key areas that are threaten by highwater due to phragmite growth creating "dams" that block key flow channels.
- In diversely vegetated areas with several meandering channels that tend to cause wetland flooding during low flows, shredding becomes more difficult and can have limited impact and thus spraying and natural removal is more cost effective.

Recommendations:

- In large areas use spraying in the fall and indications are that within two growing seasons the phragmites will be removed by the spring short duration high flows which eliminate the need for shredding of large tracks of land
- Use shredding only in areas were there is an immediate need for flow improvement to prevent flooding.

Phragmites Removal for flow improvements downstream of Highway 83.

Conclusions:

- The gage stage has increase by about 1 foot for the 3000 cfs flow rate since 1994 at the Highway 83 Bridge.
- The only major change in the system has been the growth of Phragmites and thus there is a relationship between the growth and changes in flood stage.

- The North Platte FIS model downstream of the Highway 83 bridge was modified to determine if the 1 foot increase in the stage could be directly related to decrease flow due to phragmite growth and it was determined that this can only account for a portion of the stage increase (0.3 to 0.5 feet)
- The model was revised by increasing the bottom of the river (sedimentation) and it showed there is a relationship between an increase in river bottom elevation about 2000 feet downstream of the gage station and stage elevations. sta 26 6/6
- There is a constriction in the river near the east end of Cody Park in the river which may be the cause of the increase in sediment in the bottom of the river.
- Although there is not a 100% direct relationship between the current gage elevation and the phragmites, all indications are that phragmites decrease the velocity in the river and thus increase sediment deposit, which creates natural vegetation and sediment dams in the river and traps sediment that use to flow downstream.

Recommendations:

- Continue phragmite removal of the areas downstream of the Highway 83 Bridge. Based on our experiences upstream, if the phragmites are removed and flow can travel over non-vegetated areas, flows can scour the river as it may have occurred in 1994 prior to the phragmites growth.
- Cross-sections of the river should be taken in key areas to aid in determination how much sediment has built up and monitor whether high flow will begin to scour the river. This can be monitored next year with a base elevation in the fall, spring and next fall after both PRRIP spring high flow event and higher flows during irrigation season.
- Complete the phragmite removal downstream and then the spring high flow can proceed incrementally to determine if the 3000 cfs can be reached by phragmite removal and sediment removal that will occur in old channels as the flow increases (use of the "dam break effect" of vegetated island areas in the river that was observed upstream).

Future Short duration high flows:

Conclusion:

- Based on the new calibrated model, it appears the flows could be increased up to 3000 cfs with no major property damage even if the flow stage is increased. If the flows are increased to 4000 cfs there is a possibility that some structures could be at risk but could be protected if needed.
- It appears the National Weather Service will not adjust the flood elevation from it's current 6.0 flood stage significantly enough to allow for the program to increase the flow to 3000 or 4000 cfs since the reference point it Cody Park which has a high frequency of flooding.
- The channels in the floodplain (i.e. North Channel and State Channel) have limited impact on the overall conveyance of the river. However, the due serve the purpose of reducing localized flooding and groundwater levels which aid in the protection of the property along the North River Road.
- The HEC-RAS model predicts that flood elevation experienced in the Spring 2009 are those that would be observed if flood stage is 6 feet at 3000 cfs.

Recommendations:

- It is recommended that the short duration high flows be increased up to 2500 cfs in 2010 which based on the flood elevation which should prevent any flooding of major structures and again monitor the

river system. This will verify the assumption that was developed based on 2009 short duration high flows. If the assumptions and calibrated model computation are accurate, then the flows could be increased to 3000 cfs in 2011 and reach 4000 cfs by 2012.

- Work with the property owners to purchase flood easements during the high water events and if needed provide temporary protection of non-critical structures.

- Concentrate phragmite spraying efforts on increasing the channel flow in the main channel of the river verses the floodplain.

- Floodplain area improvements such as additional phragmite removal in the North Channel and State Channel should be done to improve local drainage to improve the groundwater levels.

Future Projects based on what was learned in the Spring High Flow in 2009

Conclusion:

- Based on the results of the monitoring program, it appears that past projects of spraying the phragmites, shredding the phragmites and monitoring the flows have been successful.

- Spraying and shredding of the phragmites can increase the flow in the floodplain in lieu of large construction projects which not only are costly but require special permit issue and thus are difficult to complete.

- All indications are that although there are two channels around the islands in the project area, only one channel appears to be the main conveyance channel and thus the largest percentage of the flow goes through that reach and thus there is a large cross-section area that is underutilizing to aid in reduction of the water surface elevations.

- The connections to the under utilized channels are beginning to be blocked with sand bars and vegetation growth. The best example was the Maxwell site. As these become more blocked they are less utilized and thus measure to keep this area open should be undertaken

Recommendations:

- Increase the width of the North Channel in the backyards of the properties along North River Road through spraying and shredding to aid in improvement of local drainage.
- Support Phragmite spraying in the Platte River flood channel both in this region and downstream past the Highway 83 bridge in large areas along the main channels to improve the capacity of the main river channel.
- Consider in river project such as natural spur dikes to increase flow to underutilized channels around island to not only keep the area open, but aid in the removal of sand bars which promote phragmite growth.
- Based on the results of the island channel on the Marshell property, allow the phragmites to die and dry up and be removed with the annual short duration high flows in lieu of large scale shredding projects.
- A wetland enhancement project should be undertaken to connect the State Channel to the Dishman property.
- Continued monitoring of the site during high summer flows and during the short duration high flows.

Update on the original Recommended Project Modifications from the SEH report from February 2008 which was developed as part of changes that occurred from the original construction project.

In bold are the recommendation in the report and the current status of each::

- **Island Removal per the JFS Report** – Phragmites were sprayed in the Fall of 2007 and appears the vegetation was removed by the spring 2009 high flow events without any mechanical methods. This site will be monitored to determine the impact of non-mechanical removal of the dead phragmites.
- **Phragmite Removal** – About 20 acres were sprayed in Fall of 2007 and about 10 acres shredded in March 2009.
- **Installation of Staff Gages** – 15 gages were installed in August 2008 and two more in April 2009.
- **Monitoring Program Fall 2007 to Fall 2008 Monitor controlled short duration high flows in the Spring of 2008**. System was monitored in August 2008 and April 2009 during high flow events.
- **Develop a Calibrated HEC-RAS Model to Help in Flow Forecast** – completed based on information collected during high flow events.
- **Revise Flood Stage Elevation** – continues to be monitored, some progress has been made but the 1994 flood stage flow of over 3500 cfs has not been obtained.

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April 2009 High Flow Event, Project Update Report

Platte River Restoration and Enhancement Project

Platte River Recovery Implementation Program (PRRIP)

SEH No. A-PRRIP0701.00

May 2010

May 1, 2010

RE: Platte River Restoration and Enhancement Project
April 2009 High Flow Event, Project Update Report
Platte River Recovery Implementation Program (PRRIP)
SEH No. A-PRRIP0701.00

Dear Mr. Kenny:

Attached is a summary report of our monitoring results and observations at North Platte, Nebraska during the High flow event in April, 2009. The project, which started as a $500,000 dollar plus construction project to reduce flooding in the area upstream of the Highway 83 Bridge on the North Platte River is now a project based on vegetation removal and monitoring at a greatly reduced cost.

Based on the information gathered over the last two years, all indications are that the goal of allowing for increased flow through the reach can be achieved with a combination of vegetation removal and hopefully through the purchase of flow easements. Also, the area that was previously identified as the island removal project on the Maxwell property had results that could benefit the PRRIP. It appears after spraying the phragmites, a large spring flow is sufficient to knock down and remove the dead plants and increase the river flow and also create new sandbars in areas that use to be vegetated. If this is the case, then significant savings can be achieved on future channel improvement projects since the shredding may not be needed if there is not an immediate need for flow or vegetation removal.

SEH appreciates having to opportunity to work on this important project and all indications are that results of the effort can be used on future projects to the benefit of the PRRIP.

Sincerely,

Rocky J. Keehn, PE
Project Manager

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Executive Summary

The report will be broken into five parts. The first is the field observation of the flow paths, secondly the results of the HEC-RAS model calibration effort, the third is the success of the phragmite removals to increase flow, fourth is a discussion on the impact of the pulse flows on surrounding properties and finally recommendations for future actions.

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Part 1 Observed Flow Conditions During the Pulse Flow in April 2009

There appears to be three flow paths in the river at the critical sections behind the property located south of North River Road. The flow paths are the main channel of the North Platte River, the State Channel and the flow channel behind the properties along the North River Road which will be referred to as the North Channel (see Figure 1 located in Appendix A).

1.1 Main Channel of the North Platte River

As was the case in August 2008, portion of the Platte River were observed to flow away from the main channel and into the floodplain. Based on the gage station information, the pulse flow peak was slightly lower then what occurred in August of 2008. This was confirmed based on our ability to navigate the river. We found it was more difficult to travel upstream in April 2009 then in August 2008 due to the lack of water depth over the submerged sandbars.

One of the key observation areas in the main Platte River was the Island removal Channel located at the far upstream end of the project and on Property 1 or Maxwells (see Figure 2). This was the channel that an island removal project was proposed, but since the property owner did provide access the island remained. However, in the fall of 2007 the overflow banks of the channel where phragmite growth had occurred as well as the island were sprayed. During the high flow event in August of 2008, channel flow in this area was limited to about a 10 to 20 foot channel entrance at the west end (see Figure 2). The remaining 100 plus feet was blocked by vegetation growth, primarily phragmites. This area was not conveying water in August 2009 or at the beginning of the pulse flow (as observed by TC Engineering staff taking the gage readings). However, sometime between the April 14 and April 15, the vegetation "dam" broke and the entire channel area was open to flow. Figure 3 shows the flow in August 2008 and during the end of the pulse flow in April 2009.

Flow measurements were taken in the main river channel to aid in the final calibration of the model. It appears the river flow in the main conveyance areas is between 2 and 3 feet/second and most of the time were near 2.5 feet/second. In some cases where the flow goes over the sandbars, the velocity appeared to be closer to 1 foot/second. This could be due to the rougher sand surface of the sandbars since they were not as stable as the main channels in the river.

1.2 State Channel

At the downstream end of the State Channel there was significant water in the floodplain and it was flowing from the State Channel and back into the main river. The channel was tracked upstream and it was discovered that it became dry prior to reaching the discharges from the

ponds west of Properties 3 and 4 (Dishmans and Meads). Thus it was not conveying any water from ponds located west of the house on Property 3. It appears the channel was constructed originally for this purpose, but additional excavation was done behind the Dishman's to intercept the flow and carry it to the North Channel. This was based on the observation there was what appeared to be a narrow channel in the area (see Figure 4). Figure 1 shows the assumed area intercepted by the State channel. Based on flow meter readings, there was limited velocity in the channel primarily due to the vegetation growth.

1.3 North Channel (Along Backyards on North River Road)

As was indicated earlier the State Channel is not connected to the ponds west of the Property 3 (Dishmans). The original assumption that this area was connected to the State Channel was difficult to verify due to the phragmite growth in the area. In March 2009 the phragmites were removed and it appeared that the flow would not go to the State Channel, but was not verifiviable was wether or not it would flow to State Channel during high flows such as those that occur during the pulse flow./ When the pulse flow occurred in April, the flow did not go into the State Channel as was originally assumed but went to to the North Channel.

There were important observations on the impact of phragmites to river flows and groundwater levels during the removal the phragmites. First, the water level of the pond west of Dishman's home drop significantly when the outflow channel was opened up with the removal of the phragmites. One of the major concerns has been the impact of groundwater in this area, which is directly impacted by the elevation of the water in the ponds. As the pond elevation drop, so does the potential impact of high permanent groundwater in the area. Figure 5 shows the location of the gage and area opened up to increase flow from the pond.

During the removal of the phragmites, it was then discovered that the outflow channel still had significantly blockage behind Dishman's and Meads and thus impacted the ponded water elevation in the ponds and the groundwater elevation in the area. Since Property 4 (Mead's) was a critical property due to high ground water, it was determined that it would not benefit the project to pond water in the channel behind Meads. A field decision was made during the shredding of the phragmites to increase the phragmite removal downstream of Meads to open up the channel and eliminate water ponding behind their home. Figure 5 shows the extent of the phragmite removal downstream of the Meads.

The other important observation was made when velocity measurements were taken in the North Channel behind Property 4 (Mead's) in both the open water area and the phragmite areas adjacent to areas shredded in the channel. The channel flow was just over 1 foot/second in the open channel. Based on the cross-sectional area in this location it was carry only about 50 cfs. Since the full river flow was near 1500 cfs, the flow in the North Channel thus represent a very small portion of the total flow. Based on the small amount of water in the channel, it appears to have a limited function as a major conveyance system and thus acts more as a drainage channel to remove water from the floodplain and backyards and to reduce the pond elevations in properties 2 and 3 and more then likely 6. One of the modeling results in the early stages of the projects was it appeared the main channel had the capacity to convey the larger flows and the floodplain had limited impact in increasing the ability to convey additional flow in the river. Based on what was observed in the North Channel this appears to be the case and the floodplain channels act more to prevent localized flooding then increase the main flows in the river.

Part 2 HEC-RAS Calibration Model.

A flow meter was taken to the river to aid in calibration of the model. It was discovered that the main river channel velocity would range from 2 to 3 feet per second but were near 2.5 feet. The best guess for flow through the phragmites was 0.5 to 1 foot per second. A typical cross-section was used to estimate the Mannings n-value to determine based on these velocities. It was concluded that the main river channel n-value appears to be near 0.025 and the phragmite and heavily vegetated areas 0.10. The previous model used a main channel n-value of 0.20 and in these areas the values were modified. The previous assumption of flow in phragmite areas was 0.10 and thus there was not need for change. Based on the gage reading and rating curve obtained from the NWS the peak gage reading was 6.08 during the pulse flow which equates to a flow rate of 1675 cfs. This flow rate was used to calibrate the model.

The model was ran with the new values and results were compared against the field measured values obtained during the pulse flow. The model calibrated very well for the upstream of the bridge to the first set of islands and also very well at far upsteam end of the Marshell Island where again there were no islands. However, the cross-sections where the flow split into two distinct reaches, the model tended to predict elevations that were about 1 foot lower then those measured in April during the pulse flow.

In model calibration the n-value of the channel or overbanks areas tends to be the main variable altered to obtain matching results. Since there was so little percentage of the flow in the overbank areas, the main focus of n-value changes would need to be in the main channel The result of the first calibration model using an n-value of 0.020 for the channel and the revised model which used 0.025 were compared to see how much an n-value could be anticipated to calibrate the model. These initial comparisons indicated that the n-value would need to change significantly to impact the water surface by the one foot which was needed to calibrate the model.

During the large flows it was noticed that the south channel downstream of the Maxwell island and corresponding north flow channel appeared to convey limited flow since the river flow moved from the south channel which conveys most of the water at the Maxwell property to the north channel until the two branches converge downstream of the island (see Figure x). One of the concerns was that the connection between these two flow paths would eventual be blocked by vegetation growth due to the limited flow going to the south channel. The current primary function of the south channel is to convey water from an irrigation system that discharge back into the North Platte River at this location, but this discharge point is downstream of the main channel split. Since the pulse flow did not incorporate flows from the irrigation channel, most all of the flow would be going on the north side of the island and thus the model should reflect this. The model had assumed equal flow distribution on both sides of the island.

To simulate limited flow in the south channel, the n-value was modified from 0.025 to 0.10 which would push most all the flow into the north channel and thus requires a higher water surface elevation to convey the water in this reach of the river. This assumption was successful since the model calibration was within 0.10 feet in all cases. It appears that in this section of the river, the north channel is the main conveyor of water and thus projects to improve flow will need to focus on this channel and also those that force more water into the south channel through spur dikes or other methods. This will allow for more flow to the south channel and thus utilize more of the available flow area in this section of the river. This will have the effect of reducing the water surface by more then 1 foot in these key locations.

The final step was to run to the calibrated model for 3000 cfs and 4000 cfs to determine if the model would predict the same river stage increase as those that would occur at the gage station for these flow events. The anticipated stage increase from the pulse flow in April 2009 to 3000 cfs and 4000 cfs would be 0.73 and 1.23 respectively (more discussion on these values in Part 4 of this report). The model predicted similar results.

Table 1 – Highwater Comparison for calibration

Gage No.	HEC-RAS ID	Pulse flow	Calibrated n=0.02	Calibrated n=0.25	Calibrated south channel n=0.10	3000 cfs Calibrated south channel n=0.10	4000 cfs Calibrated south channel n=0.10
16 (Old Bridge)	29688	2798.6	N/A	N/A	2898.6	2899.4	2899.8
1 & 11	31018	2800.4	2800.2	N/A	2800.2	2800.9	2801.4
2 & 10	32306	2802.2	2801.3	2801.6	2802.0	2802.7	2803.1
3 & 9	33038	2803.0	2802.3	2802.5	2803.0	2803.9	2804.3
4 & 8	34288	2804.7	2803.6	2803.8	2804.3	2005.0	2005.4
5 & 7	35993	2806.5	2805.3	2805.5	2806.1	2806.8	2807.3
6 (upstream)	37270	2807.7	2806.8	N/A	2807.3	2808.3	2808.8

Part 3 Phragmite Removals.

When the initial phragmite spraying was completed in the fall of 2007, what was not known was whether or not the phragmites would need to be mechanically removed after the spraying to facilitate an increase in flow or would be removed by natural forces (plants dying due to spraying and increased flows knocking them over or flows uprooting them). Because of the wet site conditions, not all areas that were sprayed in 2007 (Figure 6) could be mechanically removed in the spring of 2009 (Figure 5) and thus the results of both of these methods could be observed.

There were two areas of Phragmite removals by mechanical methods that were completed in the May 2009 (see Figure 5). The first was the planned shredding areas near the Dishman Ponds (6.04 acres) and along the State Channel (2.46 acres). The second area was field determined to be beneficial to the flow paths even though it was not part of the area sprayed in 2007. An additional 1.5 acres of unsprayed areas along the North Cannel behind the houses along North River Road was shredded beginning at the west end of Property 4 and ending near Washborn Road. As is shown in Figure 5, approximately 10 acres of phragmites were shredded of the 20 acres sprayed in 2007.

During the mechanical removal process, it was observed that the pond south of the Dishman home was reduced in elevation by about 1 foot by removing the phragmites. This effectively

reduced the potential for high groundwater elevations in the area. As the area was opened up water from the ponds was able to travel downstream instead of effectively being damned up by the phragmites. This effort does demonstrate that mechanical removal of phragmite can have an immediate impact on the flows. One of the historical concerns in the area has been the high ground water elevations in the area which are close to the pond levels. Removal of the blockage to channel showed there was significant improvements to the flow from the ponds and thus provide groundwater relieve.

Based on historical map and an attempt to observe the flow patterns in the phragmites, the original thought was that the Dishman ponds flowed into the state channel and away from the backyards of the homes along North River road. This assumption could not be confirmed due the dense growth of phragmites in the area from the ponds to the backyard channel and/or to the state channel. Upon removal of the phragmites, it was discovered that the overflow elevation from the ponds to the State channel was significant enough that the flow would not naturally flow in that direction and thus would flow to the backyard channel. This was the main reason for the removal area of 1.5 acres to increase the flow in the backyard channel. The location of the high area separating the North Channel and State Channel is shown in Figure 1. This area has a sand bottom with little to no vegetation which supports that it remains dry and is not impacted by the waters in the floodplain. A potential future project would be to convert this area to a wetland and thus connect the Dishman's ponds to the State Channel. A wetland option which could provide more benefits then a ditch would be preferred over a ditch project which would be difficult to permit.

Due to the wet site conditions and lack of landowner cooperation, the additional 10 acres of phragmites sprayed in the fall of 2007 next to the river could not be mechanically removed. However, during the pulse flow a significant change occurred the flow patterns in the next to the Maxwell property which is the location of the island removal project that needed to be abandoned due to lack of cooperation of the property owner. During all site visits beginning in the summer of 2007, the bypass channel there was blockage due to the phragmites and thus created a dam at the entrance. However, on April 15 during the last few days of the pulse flow, it was observed the phragmite "dam" broke and this entrance and the flow width went from about 10 feet to the full 150 feet. This had a significant change in the flow area and also causes a surge of flow to go down this channel and knocked down and or remove the phragmites that had died as a result of the 2007 spraying. Figures 3 shows the flow change from the Fall of 2008 to the Spring of 2009 when the phragmites and other growth failed to block the flow. Based on the field observation, it was apparent that there was a clear boundary on the banks where the phragmites had been sprayed and not sprayed in 2007. The area that had been sprayed the phragmites was knocked down or had been removed by the flows.

After the pulse flow had receded, the Island removal project area was revisited since the flow over the entrance had such a significant increase. It appears some significant changes to the flow occurred as the result of the high flows. Several sets of photographs are provided in Appendix B showing some of the key changes to the area. The following changes were observed:

- Phragmites that had been sprayed in 2007 had died were removed and/or knocked down by the flow.
- Phragmites in some areas appeared to have "sheered off" by the flow.
- New un-vegetated sand bars formed in the areas that had previously been vegetated
- Main channel width increased due to the increase volume of water which help erode the banks to a wider width

- There was a distinct "line" where the phragmites had been sprayed and were they had not since the sprayed areas were removed or knocked down and the unsprayed areas remained.
- There was evidence of four wheel traffic in the phragmite area and thus the spraying does allow for secondary use of the area and thus property owners activities (recreation or active removal) which can aid in the removal process.

Part 4 Property Impacts

The critical properties west of North River Road were surveyed on the north side of the river to determine how much freeboard was available between the recorded elevation in the river during the pulse flow and any critical building elevations. Table 1 summarizes the results of the survey. Since House elevation and garage elevation are more critical then outbuildings they are highlighted in the Table. The highest gage station reading during surge flows was on April 16, 2009 and was read as 6.08 feet. Based on the revised flow chart provided by the NWS, this would correlate to a peak flow of 1675 cfs. The flow chart indicates that the gage reading would be 6.81 at 3000 cfs and 7.23 at 4000 cfs. This would correlate to a 0.73 feet depth increase at the gage station to increase the flow to 3000 cfs and 1.23 feet of depth increase at the gage station for a flow 4000 cfs.

During the pulse flow there appeared that no buildings or structures were in danger of flooding since all the flows were contained within existing drainage ways in the floodplain. The information can be reviewed to determine what the potential flooding issues are if the flow rate is increased to 3000 cfs and 4000 cfs. If the depth increase is translated fully upstream then, a check can be made on which structures have the potential of being flooded.

Based on these values a few sheds would be flooded during the 3000 cfs and the only major structure that appears to be threaten is the garage for Property 5. For the 4000 cfs several more sheds are threatened and major structures beside the Property 5 garage, the Property 5 house is threaten as well as the Jenson home and Rupp garage. The impact of 3000 cfs and 4000 cfs flows are summarized in Table 1 as either being "OK" or showing the structure "Floods".

This is the worst case scenario and there is evidence as you go upstream of the gage station and the influence of the Highway 83 bridge the flow depths will decrease for the same flow rate that is shown at the gage station. This is due to the wider floodplain available. There is thus a possibility that the property that showing flooding would actually be safe during the 3000 and 4000 cfs flows or there is more freeboard available then shown in Table 1.

Houses on the east side of Washborn Road, based on past flooding history, appear to be safe from River flows. The focus of the phragmite project was homes west of Washborn Road and not east. A gage was place at the end of the old Highway 83 right away on the Property 12. The river elevation was shown to be 2798.6 feet which based on the topography maps is 3-4 feet below any critical homes north of this location. If there is a concern, it may require additional surveys of the homes to verify the contour maps accuracy.

Table 2 – Critical Property Surveys

Nearest Gage	Elevation	Property	Structure	FF	Freeboard	3K cfs	4K cfs
#13 Pond	2803.45	3 - Dishman	House	2808.62	**5.17**	**OK**	**OK**
#13 Pond	2803.45	3 - Dishman	Garage	2805.33	**1.88**	**OK**	**OK**
#13 Pond	2803.45	3 - Dishman	Shed	2805.22	1.77	OK	OK
#3 River	2803.02	3 - Dishman	House	2808.62	**5.60**	**OK**	**OK**

Table 2 – Critical Property Surveys

Nearest Gage	Elevation	Property	Structure	FF	Freeboard	3K cfs	4K cfs
#3 River	**2803.02**	**3 - Dishman**	**Garage**	**2805.33**	**2.31**	**OK**	**OK**
#3 River	2803.02	3 - Dishman	Shed	2805.22	2.20	OK	OK
#15 Channel	**2802.50**	**4 - Mead**	**W. Garage**	**2805.21**	**2.71**	**OK**	**OK**
#15 Channel	**2802.50**	**4 - Mead**	**E. Garage**	**2804.25**	**1.75**	**OK**	**OK**
#15 Channel	2802.50	4 - Mead	Shed	2803.82	1.32	**OK**	**OK**
#15 Channel	**2802.50**	**4 - Mead**	**House Gar.**	**2805.25**	**2.75**	**OK**	**OK**
#15 Channel	**2802.50**	**4 - Mead**	**House**	**2806.49**	**3.99**	**OK**	**OK**
#3 River	**2803.02**	**4 - Mead**	**W. Garage**	**2805.21**	**2.19**	**OK**	**OK**
#3 River	**2803.02**	**4 - Mead**	**E. Garage**	**2804.25**	**1.23**	**OK**	**OK**
#3 River	2803.02	4 - Mead	Shed	2803.82	0.80	OK	Floods
#3 River	**2803.02**	**4 - Mead**	**House Gar.**	**2805.25**	**2.23**	**OK**	**OK**
#3 River	**2803.02**	**4 - Mead**	**House**	**2806.49**	**3.47**	**OK**	**OK**
#15 Channel*	2802.50	Giesenhagen	W Shed	2804.16	1.66	OK	OK
#15 Channel*	2802.50	Giesenhagen	SW Shed	2804.86	2.36	OK	OK
#15 Channel*	2802.50	Giesenhagen	Central Shed	2804.08	1.58	OK	OK
#15 Channel*	**2802.50**	**Giesenhagen**	**W. House**	**2805.04**	**2.54**	**OK**	**OK**
#15 Channel*	**2802.50**	**Giesenhagen**	**W. Garage**	**2804.68**	**2.18**	**OK**	**OK**
#2/#3 Ave. Riv.	2802.59	Giesenhagen	W Shed	2804.16	1.57	OK	OK
#2/#3 Ave. Riv.	2802.59	Giesenhagen	SW Shed	2804.86	2.27	OK	OK
#2/#3 Ave. Riv.	2802.59	Giesenhagen	Central Shed	2804.08	1.49	OK	OK
#2/#3 Ave. Riv.	**2802.59**	**Giesenhagen**	**W. House**	**2805.04**	**2.45**	**OK**	**OK**
#2/#3 Ave. Riv.	**2802.59**	**Giesenhagen**	**W. Garage**	**2804.68**	**2.09**	**OK**	**OK**
#2/#3 Ave. Riv.	2802.59	Giesenhagen	S Shed	2804.90	2.31	OK	OK
#2/#3 Ave. Riv.	2802.59	Giesenhagen	E Shed	2803.44	0.85	OK	Floods
#2/#3 Ave. Riv.	**2802.59**	**Giesenhagen**	**E Garage**	**2803.07**	**0.48**	**Floods**	**Floods**
#2/#3 Ave. Riv.	**2802.59**	**Giesenhagen**	**E House**	**2803.59**	**1.00**	**OK**	**Floods**
#2&10 Hi. Riv.	2802.16	Jenson	N. Shed	2803.07	0.91	OK	Floods
#2&10 Hi. Riv.	2802.16	Jenson	W. Shed	2802.60	0.44	Floods	Floods
#2&10 Hi. Riv.	2802.16	Jenson	S. Shed	2802.87	0.71	Floods	Floods
#2&10 Hi. Riv.	2802.16	Jenson	Central Shed	2802.26	0.10	Floods	Floods
#2&10 Hi. Riv.	**2802.16**	**Jenson**	**Garage**	**2803.61**	**1.45**	**OK**	**OK**
#2&10 Hi. Riv.	**2802.16**	**Jenson**	**House**	**2803.10**	**0.94**	**OK**	**Floods**
#1 & 11 River	2800.36	Rupp	SW Shed	2801.32	0.96	OK	Floods
#1 & 11 River	2800.36	Rupp	W. Shed	2801.78	1.42	OK	OK
#1 & 11 River	2800.36	Rupp	NW Shed	2800.99	0.63	Floods	Floods
#1 & 11 River	**2800.36**	**Rupp**	**House Gar.**	**2801.97**	**1.61**	**OK**	**OK**
#1 & 11 River	**2800.36**	**Rupp**	**House**	**2803.18**	**2.82**	**OK**	**OK**
#1 & 11 River	2800.36	Rupp	NE. Shed	2803.27	2.91	OK	OK
#1 & 11 River	**2800.36**	**Rupp**	**N Garage**	**2801.28**	**0.92**	**OK**	**Floods**
#1 & 11 River	**2800.36**	**Favinger**	**House**	**2804.92**	**4.56**	**OK**	**OK**
#1 & 11 River	**2800.36**	**Favinger**	**Garage**	**2803.83**	**3.47**	**OK**	**OK**
#1 & 11 River	2800.36	Favinger	SW Shed	2801.12	0.76	OK	Floods
#1 & 11 River	2800.36	Favinger	W. Shed	2800.73	0.37	Floods	Floods
#1 & 11 River	2800.36	Favinger	NW Shed	2801.21	0.85	OK	Floods

Part 5 Conclusions and Recommendations

5.1 Phragmites Removal.

5.1.1 Conclusions:

- Velocity measurements in the phragmites indicated the flow is near 0.5 feet/second verses 1 to 3 feet per second in the free flowing section of the river which means that flow capacity in a reach can be more then doubled by just removing the phragmites.
- In areas where the pulse flow will cause a significant change in flow velocities it appears that spraying, which results in the death of the phragmites, will be sufficient and thus shredding is not required if there is not an immediate need for flow increase.
- Shredding of the phragmites has value in helping prevent flooding since it can provide immediate flow relieve in key areas that are threaten by highwater due to phragmite growth creating "dams" that block key flow channels.
- In diversely vegetated areas with several meandering channels that tend to cause wetland flooding during low flows, shredding becomes more difficult and can have limited impact and thus spraying and natural removal is more cost effective.

5.1.2 Recommendations:

- In large areas use spraying in the fall and indications are that within two growing seasons the phragmites will be removed by the spring pulse flow which eliminate the need for shredding of large tracks of land
- Use shredding only in areas were there is an immediate need for flow improvement to prevent flooding.

5.2 Future Pulse Flows:

5.2.1 Conclusion:

- It appears the flows could be increased up to 3000 cfs with no major property damage. If the flows are increased to 4000 cfs there is a possibility that some structures could be at risk but could be protected if needed.

- It appears the National Weather Service will not adjust the flood elevation from it's current 6.0 flood stage significantly enough to allow for the program to increase the flow to 3000 or 4000 cfs since the reference point it Cody Park which has a high frequency of flooding.

- The channels in the floodplain (i.e. North Channel and State Channel) have limited impact on the overall conveyance of the river. However, the due serve the purpose of reducing localized flooding and groundwater levels which aid in the protection of the property along the North River Road.

5.2.2 Recommendations:

- It is recommended that the pulse flow be increased up to 2500 cfs in 2010 which based on the flood elevation which should prevent any flooding of major structures and again monitor the river system. This will verify the assumption that was developed based on 2009 pulse flow. If the assumptions and calibrated model computation are accurate, then the flows could be increased to 3000 cfs in 2011 and reach 4000 cfs by 2012.
- Work with the property owners to purchase flood easements during the high water events and if needed provide temporary protection of non-critical structures.

- Concentrate phragmite spraying efforts on increasing the channel flow in the main channel of the river verses the floodplain.

- Floodplain area improvements such as additional phragmite removal in the North Channel and State Channel should be done to improve local drainage to improve the groundwater levels.

5.3 Future Projects

5.3.1 Conclusion:

- Based on the results of the monitoring program, it appears that past projects of spraying the phragmites, shredding the phragmites and monitoring the flows have been successful.
- Spraying and shredding of the phragmites can increase the flow in the floodplain in lieu of large construction projects which not only are costly but require special permit issue and thus are difficult to complete.

- All indications are that although there are two channels around the islands in the project area, only one channel appears to be the main conveyance channel and thus the largest percentage of the flow goes through that reach and thus there is a large cross-section area that is underutilizing to aid in reduction of the water surface elevations.

- The connections to the under utilized channels are beginning to be blocked with sand bars and vegetation growth. The best example was the Maxwell site. As these become more blocked they are less utilized and thus measure to keep this area open should be undertaken

5.3.2 Recommendations:

- Increase the width of the North Channel in the backyards of the properties along North River Road through spraying and shredding to aid in improvement of local drainage.
- Support Phragmite spraying in the Platte River flood channel both in this region and downstream past the Highway 83 bridge in large areas along the main channels to improve the capacity of the main river channel.
- Consider in river project such as natural spur dikes to increase flow to underutilzed channels around island to not only keep the area open, but aid in the removal of sand bars which promote phragmite growth.
- Based on the results of the island channel on the Marshell property, allow the phragmites to die and dry up and be removed with the annual pulse flows in lieu of large scale shredding projects.
- A wetland enhancement project should be undertaken to connect the State Channel to the Dishman property.
- Continued monitoring of the site during high summer flows and during the pulse flows.