APPENDIX B

HYDRO SCIENCE

WETLANDS • ENVIRONMENTAL HYDROLOGY
WATERSHED MANAGEMENT • CHANNEL DYNAMICS

March 2, 2009

Alex Rabidoux, P.E.
Solano County Water Agency
P.O. Box 349
Elmira, CA 95625

Robert MacArthur, P.E.
Northwest Hydraulic Consultants, Inc.
3950 Industrial Blvd., Suite 100C
West Sacramento, CA 95691-3430

RE: Task 3.1a Deliverable. BMP Evaluation Matrix

Dear Alex:

We are submitting to you via e-mail the BMP Evaluation Matrix spreadsheet. It is more correctly labeled as the "Lateral Sources" Evaluation Matrix as some measures are more properly considered as capital improvements to reduce loading of sediment into the canal from lateral sources at specific locations.

Please consider the evaluation matrix as a tool for your use and in setting priorities in implementing measures to reduce lateral sources of sediment. We fully expect that you will modify and update the spreadsheet where you might have, for example more accurate cost or equipment productivity information. The overall priority for implementation of the measures identified in the June 2008 final **nhc** report is given, based on the evaluation criterion contained in the spreadsheet and our professional judgment regarding the relative magnitude of the sediment sources. In many cases, more than one treatment option is given. You may also have other considerations, operational and budgetary, which could change the initial ranking provided.

Numerous assumptions have been made in the spreadsheet regarding equipment rental and labor rates, and the costs of various materials. The equipment rates are based on specific models of equipment, which may be in excess of what is required for accomplishing specific tasks. In general, CALTRANS equipment rental rates, and Davis-Bacon wage rates were used. Various vendors of erosion control materials were contacted, in addition to local vendors for gravel.

Overall, we attempted to estimate costs conservatively high, and SID's experience may indicate that they can implement BMPs at lower costs. The spreadsheet reports the initial application cost and it also provides the estimated cost for maintaining the BMP over a 20-year period, in those cases where retreatment may be required. In such cases we have typically applied an inflation factor of 1.3 for the total 20-year estimated cost. The spreadsheet includes explanatory notes where additional assumptions are made. In general, those BMPs that entail widespread application, such as toe recovery treatments, are given on a cost per acre basis. In contrast, the total estimated cost is provided for measures designed to treat sediment entering from specific sites, such as direct drains.

Since our current scope of work includes some hours to assist you in the application of BMPs and in the development of pilot tests, we encourage you to quickly decide on a course of action in terms of what items and treatments you wish to advance forward. We can then move forward in advancing your goals prior to the onset of the 2009 field season.

Sincerely,

Toby Hanes

Toby Hanes, P.H.
Hydro Science

PSC Herbicide Review
October 20 & 27, 2008
Field Notes

October 20 participants:
Toby Hanes, Charlotte Kimball, Alex Rabidoux, Stan Walker, Frank Morris, Jeff Null

Canal Reach:
Headworks (MP 0.0) to North Bay Regional WTP (MP 16.85)

Notes:
The first location looked at, was directly behind the Putah Diversion Office (PDO) along the right bank of the PSC. The site had lots of bare soil, and is likely to be a large source of sediment during the winter. A cover or mulch should be placed down at the site to prevent lateral erosion into the canal and Lake Solano. The reason why this site is disturbed is because it is the proposed location for the new PDO. Alex will follow up with Thomas of SCWA to make sure protective measures are put into place. Another issue brought up was, should SID continue bare ground spaying the ditches. Stan felt that spaying the ditches allowed for easier maintenance. Toby and Charlotte indicated that by leaving the vegetation, you would prevent sediment erosion and trap sediment. The overall conclusion was that some of these ditches near the PDO should be left to vegetate. Allowing ditch lines to revegetate is particularily important within areas that drain directly into the canal.

Downstream of the Pleasants Creek overchute (MP 0.5) there was concern about the offside road draining into the PSC. The offside road should be graveled in the near future, as it is a source of sediment and drains directly into the PSC. Stan should include this as a location to gravel. In the other areas that drain directly into the canal, until gravel can be applied, the offside road should not be bladed unless absolutely necessary to allow for vehicle passage or to eliminate deep ruts as the blading produces fine sediment easily washed into the canal. Downstream of Campos Lane, the Corning Soils along the canal banks are quite poor and hard to get vegetated. There are not a lot of options available to revegetate these slopes. Upstream of Allendale Road, Stan and Jeff wanted to know if SCWA needed access to the Deep Water Monitoring Well. Currently Jeff has been applying a bare ground policy in this area. SCWA consultants will need to access this site on a quarterly basis; however revegetating the area will not impact access to the site because the PSC offside road will still be available. The bare ground policy for this area will be discontinued.

Near the rural residential areas along Allendale and north Vacaville, Jeff and Stan indicated that landowners have voiced concern about fire hazards. SID has begun mowing several locations in this area to appease landowners. Stan indicated that in his years of canal experience no fire has ever originated from the PSC. Instead, fire has entered into the PSC from outside locations. Jeff and Stan wanted some clarification on what policy to set in this area. The overall decision was to create an 8 ft buffer along the PSC fence line in these rural residential areas. SID and SCWA will need to address this issue, to make sure both agencies are fine with this level of effort and risk.

Near Paddon Road (1-drain) and the Nut Tree Airport (3-drains), Stan keeps these drains clean. The Paddon Road drain is kept clean because of recent landowner flooding concerns. The USBR also has a written easement for this drain. For the Nut Tree Airport drains, Stan has cleaned these drains based upon historical precedence. SCWA needs to investigate whether the USBR has a drainage easement in these areas similar to the Paddon Road drain and determine what level of maintenance is required. Stan pointed out that there are several drains in Fairfield including Dan Wilson Creek which also fall under this same category.

In Vacaville at the Alaza plant, Jeff pointed out that this is a difficult site to treat because people are at this site 7-days a week. Right next to the fence is landscaping and a break area for Alza employees. The canal slope is also quite steep in this area. To remedy this problem, the edge of the canal to the fence line should be shallowed up and vegetated.

Upstream and downstream of Vaca Valley Parkway the canal banks are bare. The overall conclusion was that this stretch of canal bank should be graveled. Near the Nut Tree airport overchute, the canal banks should also be graveled as well. Within the City of Vacaville the key point of discussion was to (a) gravel the canal banks or (b) vegetate the canal banks. The driving factor was that many of the banks maintained in a bare condition were less than 4 ft in height. Overall, the concensus was that the general policy should be to vegetate the bank unless the canal bank was 1-2 ft in height, at which point the bank should be graveled, since it would would have a sufficiently gentle slope to be able to retain the applied gravel. The other key issue was whether or not to spray the outside canal areas. These are areas between the fenceline and the access roads. The group determined that since these areas are in dense neighborhoods and flat, they should be continued to be kept bare, but gravel should be applied in these reaches. If the level of effort is desired to be reduced SCWA and SID will need to balance the maintenance effort with the risk.

October 27 participants:
Toby Hanes, Charlotte Kimball, Bob MacArthur, Alex Rabidoux, Frank Morris, Jeff Null

Canal Reach:
North Bay Regional WTP (MP 16.85) to Terminal Check (MP 32.33)

Notes:

The first stop was at MP 18.31 at a series of spoil piles. The spoil piles are located upstream of the McCoy Check. The spoil piles are a source of sediment, and should either be taken out or revegetated if they are no longer being used. Alex will check with Thomas of SCWA to determine what will be done with the spoil piles. In this same location there were several terraced roads. The terraced roads might serve as access to the PSC Bypass Pipeline. Jeff currently applies a herbicide to the terraced roads. Alex will need to check with Stan and Thomas to see if there a need for access to these terraced roads. If not the roads should be revegetated.

At Cement Hill Road the canal banks are subsequently all sprayed. The long term plan is to revegetate all of the inside canal banks. Within the City of Fairfield the canal banks are fairly high (at or greater than 4 ft) where gravel would not be a good option.

At MP 20.58 upstream of Dover Road the outer canal banks are quite steep and potentially drain into neighboring landowners. Jeff indicated that it is very hard to treat the ditch along the fenceline. The ditch is also quite plugged up and could present a flooding issue. Downstream of Dover Road, the group recommended placing crushed gravel on the offside access road and the need to stabilize the bank.
Downstream of Dickson Hill Road (MP 20.72) the group noted that the operation road could be taken down in elevation several feet. This would reduce the inside and outside canal banks.

As a long term strategy, there may be a number of opportunities where there are high, steep outside banks that boarder on residential properties where erosion and flooding are possible threats and equipment access is not possible. In such locations, it may be beneficial to simply lower the road elevation to the minimum acceptable freeboard on the inside bank and sell the generated fill. This would result in a shorter outside bank, and since the graded surface would be wider, the outside bank could then be laid back to a much more gentle slope, thereby reducing the erosion rate and allowing for vehicle access for spraying and maintaining ditch lines next to the fence.

Downstream of Mankas Corner Road, Toby pointed out the two largest open drains into the canal. The first drain has a watershed of approximately 20 acres of cultivated land. Frank pointed out that a vegetation strip should be setup along the bordering landowner’s property. The second drain is location at MP 27.23 and drains significant cultivated areas. Frank suggested working with Chris Rose from the Solano RCD to develop good land use practices in this area. NHC’s Draft Sediment Study included the use of conservation easements with landowners to help reduce sediment into the PSC. Follow up should be done by Alex and Frank with the Solano RCD. Within the areas that drain into the canal the offside road should ultimately be graveled. The outside shoulder and ditchline should be revegetated in order to capture some sediment before it enters the drain entrance.

The last issue looked at were two drainage ditches located at MP 28.02 and MP 28.30. SID is not clear if the USBR has a drainage easement to maintain these ditches, and if this should be included in the yearly PSC maintenance. SCWA will need to investigate this and determine what level of maintenance should be done.

Follow Up Items:

1.) Erosion control measures need to be placed at the proposed PDO location. This is likely to be a major source of sediment if nothing is done. (Alex)

2.) Determine what level of fire protection SCWA and SID want. (Alex / Stan)
Current Thinking:
    - Rural Residential: 8 ft buffer along fence line
    - Urban (Vacaville): Keep canal outside banks bare-ground, apply gravel
    - Urban (Fairfield): Keep access and offsite roads clear and canal outside ditches as clear as possible. For steep hill banks along the offsite road, keep offsite road and base of hill clear, but leave hill vegetated.

3.) SCWA needs to determine which drains the USBR has an easement and responsibility to clean. Need to determine the extent of maintenance that SID should do, so that SID can budget accordingly. (Alex)

4.) Need to determine the future of the spoil piles and terraced roads near MP 18.31 near McCoy Check. (Alex / Stan)

5.) Work with Chris Rose from the Solano RCD to improve land use practices in the Suisun Valley, where the PSC open drains exists. (Alex / Frank)

6.) Charlotte and Toby will be testing a number of seed mixes at a number of locations over the winter and spring to determine which mixes provide the best results. The existing spray program for inside ditches will be maintained during the 2008-09 rainy season.

WETLANDS • ENVIRONMENTAL HYDROLOGY
WATERSHED MANAGEMENT • CHANNEL DYNAMICS

August 22, 2008

Alex Rabidoux, P.E.
Solano County Water Agency
P.O. Box 349
Elmira, CA 95625

RE: BMPs Recommended for Implementation, Fall 2008

Dear Alex:

In response to your recent inquiry to Bob MacArthur, we have prepared the following list of recommended BMPs that could be implemented this fall, or sooner. The purpose of this list is to introduce the recommended BMPs and to initiate discussions with SCWA and Solano Project Operators. This activity is part of Task 3.1-a in NHC's scope of work. Unit costs for recommendations discussed below will be developed within the next 10 days. Hydro Science will implement revegetation plot studies this fall to identify the most effective revegetation treatments which are expected to replace the majority of the length of canal currently maintained with bare banks.

Some of the recommendations will require a limited amount of additional analysis and working with Solano Project Operators and SCWA to assess available in-house equipment and labor availability, along with associated costs, and to gain further information regarding the objectives of the current vegetation management practices applied to the canal banks; e.g., is the objective to maintain bare banks for avoid fire hazards, or to only attack invasive plant species, or other objectives?? Jeff Null will provide NHC with information regarding Solano Project Operators' present herbicide embankment vegetation management plan. The GIS database and Solano Project Operator embankment vegetation management plan will be compared. For BMP planning purposes, the GIS database will be used to identify reaches to be treated.

1. <u>Replace Broad-Spectrum Herbicide Use on Canal Banks with Dicot Herbicide.</u> Over 20 miles of canal banks are maintained in a condition void of grass cover. Although plot studies this winter and spring will be used to develop reseeding recommendations for use in the fall of 2009, replacing the current spray program with one just targeting noxious weeds may allow for some recruitment of endemic grasses this winter and would facilitate degradation of any residual broad-sprectrum herbicide that could diminish reseeding efforts the following year. Some further effort will be needed to identify if there are areas where continued use of broad spectrum herbicide may be warranted. For example, on the operational access road, there is frequently a high percentage of gravel mulch on the canal bank and the erosion potential is very low for

for slope lengths under five feet. I recommend that NHC work jointly with Solano Project Operators and SCWA to identify areas that no longer require herbicide treatments and, locate areas where continued application of broad spectrum or dicot-only herbicides is deemed necessary or cost effective.

2. <u>Treat Right Bank Access Road in Areas With Direct Drains in the Vicinity of Horton Road.</u> Approximately 4,000 lineal feet of native surface access road on the right bank drains directly into the canal. Annual blading of this road recruits a fresh supply of fine sediment which is then delivered to the canal during the following winter. The proposed BMP for this site and set of conditions would lower the height of the unstable berms on the canal bank by reestablishing the minimum acceptable outslope. A four-inch thick gravel blanket would then be applied to the road surface and roadside ditch to eliminate sheet erosion from the road surface. This treatment would be applied to those areas tributary to direct drains R1-R4 (see report).

3. <u>Apply Gravel on Right Bank Access Road in Areas Tributary to Direct Drains 5 and 6 in Suisun Valley.</u> Gravel application will eliminate sheet erosion from native surface road segments which drain directly into the canal in the Suisun valley bottom. A 4-inch thick gravel blanket would be applied to the road surface. Approximate distance is 2,200 lineal feet.

4. <u>Eliminate Side Casting.</u> Side casting during access road blading operations can directly introduce sediment into the canal and can lead to excessively high unstable berms on the canal banks which occasionally fail during intense winter storms. Side casting on the operational, left bank road leads to a loss of gravel from the road surface, although in areas where the bank heights are low and broad spectrum herbicide is applied, this side cast gravel has reduced sheet erosion from the canal bank. Implementation of this BMP would consist of working with Solano Project Operators road maintenance personnel. The BMP would be applied universally.

5. <u>Reestablish Minimally-Acceptable Access Road Outslope.</u> This BMP is a companion to #4 above. The cumulative effect of decades of routine road maintenance is the steepening of the cross-section slope and the formation of a side cast berm on the top of the canal bank. Material is also occasionally side cast over the bank and into the canal. The side cast berm is subject to sheet and rill erosion and, occasionally, mass failure. The steepened cross-section, primarily on native surface road segments tends to be subject to increased rates of the sheet erosion and can eventually lead to rill erosion, which begets further aggressive blading and even more subsequent erosion. Annual road blading would be performed with the objective of pulling the inslope berm back onto the road surface, thereby reducing the cross-slope and reducing the height of the inslope berm. An additional benefit of this measure would be the recovery of road gravel that has been bladed off the operational road. This BMP would be applied universally. Its implementation would require the use of a road grader and water

truck. The water truck will moisten the area to be bladed back and assist with the compaction of loose material bladed back onto the road surface. One or two laborers may be needed to remove excessive vegetative debris which can foul the blade.

6. <u>Apply Gravel Mulch or Polyacrylamide To Canal Banks With Low Revegetation Potential.</u> This treatment would be applied in areas where the soils comprising the canal banks are not conducive to revegetation. Our preliminary assessment is that these conditions are limited to exposures of Corning soils with the primary area where treatment may be feasible is limited to the reach between Vaca Valley Parkway and the Nut Tree Airport. Further work is required to identify whether application of gravel mulch which would be a permanent solution, is more cost effective than applications of polyacrylamides, which require re-treatment. Gravel applications may have the disadvantage of being less safe since the material is subject to sloughing by foot traffic.

7. <u>Apply Gravel Mulch or Polyacrylamide to Canal Banks Where Vegetative Stabilization is Undesirable.</u> Pending discussions with Solano Project Operators may indicate that selected reaches should be maintained free of all vegetation. In such reaches, alternate erosion control treatments would be considered; either application of a gravel mulch, or periodic applications of polyacrylamide. There are many miles of left bank (operational side) where gravel comprises a significant portion of the ground cover. Application of additional gravel could eliminate residual sheet erosion and allow for the continued application of broad-spectrum herbicides.

8. <u>Initiate Toe Recovery Program.</u> Use of the GIS database allows for the identification of areas which have an effective toe width of less than 1 foot and where there is low existing groundcover on the toe. In addition, the database could be queried to identify which of these reaches have slope lengths which are sufficiently short so as to utilize existing Solano Project Operator equipment. The accumulated slough materials would be removed to reestablish a 3-foot minimum width horizontal toe. Care would be taken to avoid over steepening the canal bank slope. Treated areas would be seeded with an endemic grass mix and either a mulch applied or a temporary BMP, such as a wattle or “sock” applied along the edge of the canal. Further work is needed to develop the grass seed mix and the one or more temporary BMPs to reduce erosion from the disturbed surfaces during the first winter following treatment.

September 5, 2008

Alex Rabidoux, P.E.
Solano County Water Agency
P.O. Box 349
Elmira, CA 95625

RE: Draft Minutes from BMP meeting, September 2, 2008

Dear Alex:

The following summarizes the results of our meeting today.

Attendees: Thomas Pate and Alex Rabidoux, SCWA; Stan Walker, Frank Morris and Jeff Null; Solano Irrigation District; Bob MacArthur, **nhc;** Toby Hanes, Hydro Science.

Hydro Science's August 22 letter was used as the basis for discussion. Thomas categorized each of the eight recommended BMPs with respect to funding category.

1. Replace Broad-Spectrum Herbicide Use on Canal Banks with Dicot Herbicide. (improved maintenance with accompanying reveg pilot study). Jeff provided an overview of the existing spray program of pre-emergent spraying on the right-of-way during early winter and broadleaf application in the spring. Jeff found no documentation as to why certain banks were maintained in a bare condition. Typically, the bare banks are found within urban areas and in the bottom of Suisun valley where irrigated agriculture is practiced immediately adjacent to the canal right-of-way. Jeff explained that a specific spraying is done to attempt to control oats along the canal banks as these tend to grow over two feet tall and can limit visibility of the canal and thus affect canal inspections. Additionally, a very light herbicide application is sometimes made to limit the height of grasses (Jeff called this "chemical mowing"). These latter practices are quite sensitive to a number of factors and are not always reliable.

Toby explained that this BMP would be a precursor to stabilizing bare banks via grass or other means. Some plot studies will be implemented this fall to develop revegetation specifications. Jeff noted that one of the pilot treatments should be to have a plot where the treatment is simply cessation of existing herbicides to control grass. Toby will incorporate this recommendation.

There was some discussion of the general category of grasses that might be used in revegetating bare banks. Toby explained that the use of native bunch grasses does not provide for the most effective erosion control as there remains substantial bare ground between the bunches which can tend to concentrate overland sheet flow. Bunch grasses also obtain substantial height, although do not present the visibility problem that oats do. Toby stated that the objective of the grass revegetation program would be to concentrate on low stature annual grasses that can provide for a dense uniform ground cover.

Toby suggested that not all slopes maintained in a bare condition may be worthy of conversion to a grass cover. These would likely be slopes of less than 4-5 feet long that already have substantial gravel cover on the slope. Such slopes are predominantly on the operational side of the canal. Conversion to grass may complicate existing spraying programs and the low risk of erosion resulting from the short slope distance and gravel cover might cancel any marginal benefit associated to conversion to grass. If a *di minimus* category were established then the existing GIS database could be used to identify all those bare banks which would be slated to undergo grass stabilization.

There was a discussion of possible methods to control erosion of the banks where grass stabilization may not either be feasible because of soil limitations or not desirable from an operational perspective. Gravel mulch can be easily applied but only on short bank lengths, probably less than 5 feet. Jeff noted that application of gravel does not limit the growth of weeds and that such areas would still need routine treatment to restrict vegetation. Polyacrylamides have a much lower initial cost than gravel mulch, but require re-treatment every 1-2 years, albeit at far reduced application rates. Jeff stated that his experience with polacrylamides is that they performed well but are highly viscous and may require a dedicated piece of spray machinery. The use of jute netting or other types of measures were also briefly discussed. Although they can be highly effective, they have a limited effective life, typically 3-4 years and many of the sites where they might be used already have gravel and often some vegetation. In order for nettings to be effective they must be in immediate contact with the ground which would require substantial hand labor to remove existing gravel and vegetation.

For implementation, it was decided that the first task would be to enter the existing spray plans into the GIS database to determine the extent of agreement between bare banks identified during the erosion inventory versus the existing spray plan. We would then conduct a field trip (Alex, Toby, Jeff and Stan at a minimum) to inspect all areas maintained in a bare condition and make a decision to continue to maintain the bank in its current condition or determine if erosion control BMPs are warranted. If BMPs are determined necessary at some sites, then a further decisions will occur to prescribe appropriate means to either revegetate or control erosion through the applicaton of gravel mulch or through the use of polyacrylamides, which ever is most appropriate for site-specific conditions.

Based upon the results of the field review, Jeff would make a recommendation as to where to eliminate pre-emergent/broad spectrum spraying on those banks maintained in a bare condition. Jeff pointed out that in the Suisun Valley bottom no late season broadleaf spraying is conducted because of the conflict with adjacent agriculture (only the early winter pre-emergent control is used). In such locations, erosion control of bare banks would best be done by using gravel or polyacrylamides since there would be a continued need to continue broadleaf control using pre-emergent herbicides, which are not selective for dicot species.

2. Treat Right Bank Access Road in Areas With Direct Drains in the Vicinity of Holmes Road (repair and betterment). All agreed that this measure should be implemented. At the present time, gravel placement/replacement is routinely done on the access roads such that there is sufficient in-house expertise to implement this measure without further assistance from **nhc.** Toby will place lathe and flagging at the suggested limits. Although not discussed, this area should be evaluated to assess the need and benefit to reestablish the original road template to lower the height of the canal-side berm prior to placement of gravel. As a temporary measure, it was agreed that routine road blading should cease since it leads to the production of a new “crop” of fine sediment which is eroded into the canal the following winter. Toby recommended that routine annual blading of the non-operational access road be reduced (or eliminated) to site specific and as-needed basis.

3. Apply Gravel on Right Bank Access Road in Areas Tributary to Direct Drains 5 and 6 in Suisun Valley (repair and betterment). This measure will be implemented although it has a lower priority than #2 above because of its location below the principal water treatment plants. Although not discussed, the limits of this work coincide with bare banks which require treatment and also with toe recovery. I recommend that implementation of this measure be coordinated such that toe recovery and erosion treatment of the bare banks (likely via application of gravel mulch) be done as part of the same project. As stated for #2 above, Toby recommended that routine blading of this area be eliminated until such time as the gravel is placed. Stan said he is working toward eventually having access roads on both sides of the canal graveled.

4. Eliminate Side Casting (improved operations). Toby provided an explanation of why side casting occurs. Stan pointed out that maintaining a berm along the canal side of the access roads was considered to be a safety requirement. Jeff stated the existence of the berm is also very valuable in using the spray equipment as the operator uses the berm to guide the equipment.

Toby explained that side casting is likely a minor contributor to the overall sediment budget in the canal. Thomas summarized by requesting that Stan direct his operators to minimize side casting. No further involvement of **nhc** is needed for this measure, although Toby is available to work with Stan if needed.

5. Reestablish Minimally-Acceptable Access Road Outslope (repair and betterment or heavy maintenance). Toby explained how routine road blading tends to increases the height/volume of the canal side berm and increase the road outslopes. The greatest berm heights tend to occur within through-cuts where material eroded from the upper slope is not exported. From an erosion perspective all of the canal access roads would benefit by having the outside berm “pulled” back onto the roadway. This would reduce erosion and mass failure of the berms and reduce rilling associated with an oversteepened road cross-

section. In some through-cut locations, material would have to be exported to regain the original road template. In all locations, achieving the objective would require the use of a water truck to allow the material respread on the roadway to be compacted. The last pass of the blade would be used to reestablish the smallest acceptable outside berm.

It was decided that implementation of this measure is currently a low priority with no further action to be performed by **nhc.**

6. Apply Gravel Mulch or Polyacrylamide To Canal Banks With Low Revegetation Potential (repair and betterment with pilot program). Pilot studies are needed to assess the costs and practical limits to using these methods. Toby stated low existing vegetation is largely limited to Corning soils which occur principally north of Allendale road. There was a discussion of other possible methods (see item #1). Toby stated that, in his opinion, remediating the soils through application of various amendments would be cost prohibitive. The principal area where low vegetation density occurs in a reach between Midway road and the Nut Tree airport. Toby will prepare cost and effectiveness comparisons and make recommendations for pilot studies. There was a brief a discussion on the merits of using jute matting or other similar methods (summarized in Item #1, paragraph 5)

7. Apply Gravel Mulch or Polyacrylamide to Canal Banks Where Vegetative Stabilization is Undesirable (repair and betterment with pilot program). Reaches where these treatments will be considered will be identified as a result of the Item #1 field review. Toby will prepare cost and effectiveness comparisons and make recommendations for pilot studies.

8. Initiate Toe Recovery Program (repair and betterment with pilot program). Toby provided an overview and explained that toe recovery, which can reduce erosion rates over the long term, results in temporary site disturbance and increased risks for bank erosion resulting from the generation of bare ground and the risk of oversteepening the canal bank. He also stated that in many cases there appears to be little active erosion even where there is little or no toe as long as the slope and former toe area have a grass cover. The GIS database will be utilized to identify several high priority categories for treatment, and mass wasting site density will be used in the algorithm. Stan recommended that existing scars from previous soil slips could be repaired at the same time in reaches where toe recovery operations are being conducted. There was some limited discussion of the need for both temporary and permanent erosion control after treatment. A pilot project might be needed to evaluate several different methods to prevent sediment delivery to the canal the winter following treatment (wattles, silt fence, etc.) Permanent stabilization would be accomplished by grass stabilization, with recommended methods developed this coming winter as a result of the revegetation plot studies.

HYDRO SCIENCE

WETLANDS • ENVIRONMENTAL HYDROLOGY
WATERSHED MANAGEMENT • CHANNEL DYNAMICS

March 2, 2009

Alex Rabidoux, P.E.
Solano County Water Agency
P.O. Box 349
Elmira, CA 95625

Robert MacArthur, P.E.
Northwest Hydraulic Consultants, Inc.
3950 Industrial Blvd., Suite 100C
West Sacramento, CA 95691-3430

RE: Status of BMPs Recommended for Application in August 22, 2008 Letter

Dear Alex:

You requested that an initial set of Best Management Practices (BMP) recommendations be made available in August, 2008, so that SCWA could consider implementation of some BMPs during the 2008 field season. A letter from Hydro Science was issued on August 22, 2008 in response to this request. It contained a description of eight measures which could be implemented without further investigation. All of the measures were contained in the 2008 **nhc** final report to SCWA. Although not specifically part of the scope of work, this effort fits best under Task 3.1a. Following issuance of the August 22 letter a meeting was held between SCWA, SID, and **nhc** personnel and subcontractors to discuss the recommendations. This letter documents the status of those initial recommendations plus additional measures.

1. Replace Broad-Spectrum Herbicide Use on Canal Banks with Dicot Herbicide.
A general field review of herbicide use was conducted on October 20 and 27 (see summary notes prepared by Alex Rabidoux). The issue of allowing the canal banks that are currently maintained in a bare condition to be converted to a grass cover was discussed. The principal objection to allowing revegetation is the potential for the grass along the road edge to become excessively tall to the point of constraining the ability to inspect the canal. With the exception of oats, the grasses currently occupying the canal banks were not considered to be excessively tall.

Most banks currently maintained bare are generally within the city limits of Vacaville and Fairfield and on the valley floor in Suisun valley. The vast majority of these banks have slope lengths of between 2 and 10 feet. There are also considerable reaches of bare banks on those sections of the canal elevated off the valley floor, such as within the Cement Hill area, the west side of Suisun Valley upstream of the Rockville check, and the remainder of the canal from that point to the terminal check. In these reaches the canal cross section has a 1-3 foot rocky canal bank on the operational side which is kept bare. Slope lengths on the non-operational side are typically far longer and have a grass cover. No change from the existing situation is proposed in these areas.

Bare banks in excess of 2-3 feet would be revegetated. For banks less that 2-3 feet long there are some practical considerations in that those banks often have considerable gravel cover on the operational side of the canal (from side-casting of road gravel over the road edge) such that the existing erosion rates, because of the short slope lengths and existing rock mulch are probably already low. In such areas, the application of additional gravel could be readily accomplished without special equipment (simply sidecast it) and it would allow for more straight-forward weed management through the use of broad spectrum herbicide use, rather than a selective herbicide for broad-leaf weeds only.

The situation is somewhat different on the non-operational side, since there is no existing gravel mulch. In these areas, the maximum slope length that would continue to be treated with herbicide could be less than 2-3 feet.

Currently, a pilot study is being conducted by Hydro Science and **nhc** to assess which of five grass mixes gives the best results. Nine test sites have been seeded. Each site consists of five 10 foot-wide plots, each seeded to a different grass mix. Because of the severely dry winter, the germination rates have been lower than normal. Pending the outcome of the trials, some consideration for extending the trials another year might be advantageous if it appears that the results are biased by the early dry conditions which may have suppressed germination of species that might otherwise offer good results. The plots were briefly watered by pumping out of the canal the on February 2. Current results and some selected photographs are attached.

Next Steps

1. Continue current plot studies and report results this May.
2. Continue monitoring plots during winter/spring 2010.
3. Provide recommendations on seed mix(s).
4. Provide canal bank revegetation cost estimates.
5. Develop final recommendations on locations where bare banks will be maintained.

2. Treat Right Bank Access Road in Areas with Direct Drains in the Vicinity of Holmes Road. IMPLEMENTED.

3. Apply Gravel on Right Bank Access Road in Areas Tributary to Direct Drains 5 and 6 in Suisun Valley Alex and Stan performed a reconnaissance to accomplish this measure.

Next Steps

1. Program funds for accomplishment and schedule for accomplishment.

4. Eliminate Side Casting This BMP was judged to be incompatible with safety considerations and is being implemented where feasible through improved operations. No further need for **nhc** involvement.

5. Reestablish Minimally-Acceptable Road Outslope This measure has been judged to be a low priority. No further need for **nhc** involvement.

6. Apply Gravel Mulch or Polyacrylamide To Canal Banks With Low Revegetation Potential No action has been taken. SCWA needs to consider the BMP evaluation matrix and decide if it wishes to move forward on this measure. If so, the next step would be development of a pilot study. For gravel application the principal issues are whether gravel can be uniformly applied over the slope and have it resist sloughing to the toe of the slope. For polyacrylamides, the principal issues are 1) longevity of the treatment, 2) needs for a dedicated piece of spray equipment, and 3) assessing any ancillary benefits associated with the sealing of the soil which might reduce herbicide application costs. An additional issue is verification that polyacrylamide applications do not pose a water quality concern. This issue should be resolved during the further investigations for its use in removing the black organic floc in the canal bottom.

Next Steps

1. Issue BMP evaluation matrix.
2. Develop pilot studies for gravel and polyacrylamide application

7. Apply Gravel Mulch or Polyacrylamide to Canal Banks Where Vegetative Stabilization is Undesirable SCWA needs to adopt a policy on the minimum bare bank height that will be converted to a grass cover. For those banks less than the *di minimus,* application of gravel may be limited to the operational side. On short banks, gravel application may be more cost effective over long time periods as none, or extremely infrequent retreatment is required. However, the BMP evaluation matrix indicates that polyacrylamide treatments may be very cost effective, even over 20-30 year periods in comparison to gravel. A pilot study for item #6 should provide guidance on any potential benefit in reducing herbicide costs.

Next Steps

1. Adopt policy on maximum bare bank height on operational and non-operational access roads.
2. Use GIS database in conjunction with existing herbicide spray program to identify banks where gravel will be applied.
3. Program funds and schedule implementation.
4. Use results of polyacrylamide pilot test for Item #6 to decide on implementation of that technique on low banks to be maintained as bare.

8. Initiate Toe Recovery Program This item will be coordinated with the GIS database delivery and training task to have SCWA and SID staff use the database to develop high priority treatment areas and use the GIS database to identify those locations. Toe recovery cost estimates will be developed as a result of the BMP comparison matrix. The

principal uncertainty is the whether temporary erosion control measures are needed to prevent sediment delivery from the disturbed toe. A pilot test may be needed to assess the costs and benefits of such additional measures.

Next Steps

1. Schedule GIS database delivery and training.
2. Identify priority tiers and locate highest priority sites using GIS database.
3. Use BMP evaluation matrix to decide on which toe treatments to apply
4. Decide if pilot test of erosion control measures are needed. If yes, design and implement a pilot study in fall, 2009.
5. Schedule 2009 field season treatments (assuming no pilot study).

High Priority Measures Identified in Final Report But Not Discussed in August 22 Memo

The following measures were considered to be of lower priority than those previously recommended for immediate implementation or were recognized to be complex and not ready for immediate implementation at the close of the 2008 field season.

A. Development of Land Owner Agreements for Cover Crop or No-Till on Direct Drains in Suisun Valley Bottom Status unknown

B. Application of Gravel Mulch on Non-operational Access Road For Direct Drains 7-11 This measure was implemented in the fall, 2008.

New Recommendations

The following items have been identified since the June, 2008 final report was issued.

C. Examine Cost Effectiveness of Erosion Control Nettings On Canal Banks These measures will be considered in the BMP evaluation matrix. Their principal disadvantage for large scale canal bank stabilization is the high unit cost. However, these materials may be the most effective technique in areas such as in the vicinity of the Sweeny check where overtopping occurs, or where some structural stabilization may be desirable, such as at locations where there have been landslides.

Next Steps

1. SCWA to evaluate the BMP matrix.
2. Identify a test site and implement it vendor assistance.

D. Eliminate Routine Blading of the Non-Operational Access Road This measure was identified during the October, 2008 herbicide review. While blading the road eliminates concentrated flow which can cause rill erosion, it also disturbs the surface and generates a new crop of fine sediment which is then discharged during the subsequent rainy season. The highest priority for implementation here would be the watersheds for direct drains 5-6 until these reaches can be overlaid with gravel. For the other portions of the canal this measure has no direct bearing on sediment delivery into the canal, although it could substantially reduce non-point source sediment delivery into local drainages and should, therefore, be considered for universal application. In conjunction with this measure, it may be worthwhile to consider polyacrylamide applications on the access roads as these could further reduce erosion and sediment delivery and may also reduce herbicde costs.

Next Steps

1. SID to document adoption of policy.
2. SCWA/SID to decide on test application of polyacrylamide.

Sincerely,

Toby Hanes

Toby Hanes, P.H.
Senior Hydrologist

Dover North, February 2, 2009.

Mankas Drain (east side of Suisun Valley), February 2, 2009.
Preliminary Results of Seed Mix Trials. February 2, 2009.

SITE	SEED MIX A Germination Rate - 2 / 2 / 09	B	C	D	E
Vaca Valley Parkway Eastern exposure	45%	45%	40%	50%	n/a
Elmira Road Eastern exposure very shady in afternoon	0%	5%	10%	10%	0%
Youngsdale Drive Eastern exposure	10%	20% *	20%* *	30%	n/a
Cement Hill Road Southwest exposure	10%	25% ^	5% ^	20% ^	n/a
Dover - South Northern exposure	30%	20%	30%	50%	n/a
Dover - North Southern exposure	75%	10%	25%	50%	n/a
Mankas Drain Sothern exposure	50%	n/a	35%	70%	0%
Suisun Valley Road - South Northern exposure	15% #	n/a	30%	40%	5% #
Suisun Valley Road - North Southern exposure	0%	n/a	10%	0%	0%
TOTAL GERMINATION PERCENTAGE	26%	21%	23%	36%	1%

* - germinated seed beginning to dry out. ^ - germinated seed is dried out.
\# - New germination began after watering

draft

PUTAH SOUTH CANAL

BMP PILOT PROJECT PLAN:

GRAVEL BLANKET APPLICATION ON LOW GROUND COVER SITES WITH LOW REVEGETATION POTENTIAL

Introduction

The objective of this project is to determine if a 0.2 foot thick gravel blanket can be efficiently placed on the canal banks in areas where the soil conditions are such that revegetation measures are judged to have a low potential for success. Application of the gravel blanket will cover the bare soil and protect the slope from erosion. This technique may be difficult to implement because of the tendancy of the gravel to roll down to the toe of the slope. The technique may be more efficient when applied to the operations side, since there is frequently already a berm of gravel at the road edge next to the canal bank. In contrast, on the non-operations side, the side-cast berm is composed of native soil, which must be first bladed back across the road surface prior to gravel delivery. The delivered gravel, which will be delivered via "belly" dump trucks will form a gravel berm in the center of the road, which must then be bladed acoss the road and then side-cast over the road edge. This operation may result in a substantial portion of the gravel remaining on the roadway.

Treatment Reaches

Operations side:	L57	Length = 1,060 feet,	Slope Length = 10 ft.
Non-Operations side:	R47	Length = 1,362 feet,	Slope Length = 13 ft.

SID Equipment and Personnel Required

Motor Grader
Water Truck
Piece of chain link fence
w/ wood beam or other device

Foreman
Equipment operators (2)
Laborers (2)

Materials/ Contracted Services

¾" crushed gravel, delivered at job sites with belly dumps
Assume one cu. yd. = 1.5 tons

Reach L57: 82 cu. yds. + 15% waste (residual left on road) = 94 cu. yds., = 140 tons

Reach R47: 131 cu. yds. + 25% waste (residual left on road) = 164 cu. yds., = 246 tons

Estimated Time Requirements

Reach L57 – one day
Reach R47 – one day

Preferred Implementation Window

July- August, 2009, prior to annual road maintenance or canal clean-out

Estimated Cost

Reach L57

Equipment w/operator	Hours	Rate	Cost
Motor Grader	5	$210	$1,050
Water Truck	5	$85	$425
Transport	2	$90	$180
Labor			
Foreman w/truck	7	$70	$490
Laborers	14	$45	$630
Materials	Tons		
3/4" Crushed gravel, delivered	140	$24	$3,360
		Project Total =	$6,135

Reach R47

Equipment w/operator	Hours	Rate	Cost
Motor Grader	8	$210	$1,680
Water Truck	8	$85	$680
Transport	2	$90	$180
Labor			
Foreman w/truck	8	$70	$560
Laborers	16	$45	$720
Materials	Tons		
3/4" Crushed gravel, delivered	246	$24	$5,904
		Project Total =	$9,724

Procedures

1. Locate and flag reach end points using GPS coordinates from GIS database.

2. Fabricate a section of chain link fence with weighted end (timber post) or other device which could be used to control the rate of gravel movement down the slope and to assist in the uniform spread of the gravel. This operation would be performed by the laborers and may require some on-the-job modifications to achieve the desired result.

3. For R47 (non-operations side), motor grader shall pull the road edge berm back onto the roadway and spread. Water shall be applied both for dust abatement and to compact the material so that mixing with the subsequently delivered gravel is minimized.

4. For L57 (operations side), the existing berm on the road edge shall be checked to determine that at least 70 percent of the material down to the elevation of the road bed is composed of gravel. If not, the material shall be pulled back onto the road as described in #3, above.

5. Gravel shall be delivered beginning 10 feet prior to the start of the reach. Gravel shall be delivered in belly dumps as close to the road edge as is safe. For L57, delivered gravel should be approximately 2.4 cubic feet of gravel per lineal foot of dumped material. For R47, delivered gravel should be approximately 3.4 cubic feet per lineal foot. The objective is to side cast the gravel such that there is a uniform 0.2 foot thick blacket of gravel on the slope. Slope length changes within the reaches and the gravel dumping must be carefully managed in order to achieve uniform results.

6. Water truck applies water to the delivered gravel to determine if the added water renders the gravel less prone to sliding down the slope.

7. Motor grader blades off the delivered gravel berm over the road edge.

8. Laborers use the weighted chain link fence to control the side-cast gravel to prevent it from rolling down to the toe of the slope and to, the extent practical, achieve a uniform coverage of 0.2 feet thick.

9. Motor grader makes a second pass to reestablish, to the extent needed, the road-edge berm. For R47, no native material should be side cast over onto the canal bank, which would contaiminate the newly applied gravel blanket.

Bidders/Suppliers

The following are sources of gravel and associated trucking. SID may have a preferred supplier. For this project, it is important that the majority of the material is indeed crushed, as it will better adhere to the slope. "River-run" material should be avoided.

****

****

****

Project Documentation

The purpose of limiting the size of the pilot projects is to gain knowledge that can be used when the BMP is subsequently applied that will improve the techniques and reduce the cost. The following information shall be collected.

1. Equipment and labor hours. How did the labor and equipment hours deviated from those estimated. For cost estimating, how much time was devoted to set up and "working out the kinks" Once the operation was going, what was a reasonable production rate in lineal feet/hour.
2. What part of the operation seemed to limit the production rate?
3. Did the operation achieve the objective of laying down a uniform 0.2 foot gavel blanket on the slope?
4. Did water application aid or hinder the spreading process.
5. Would you recommend that this BMP continue to be implemented or should other approaches be considered.
6. Were the waste estimates accurate?
7. Were any deviations made in the Procedures?
8. What modifications are recommended to improve the reliability and consistancy of applying the gravel blanket?
9. What modifications could be made to improve the efficiency of the work.
10. What modifications should be made in the Procedures for future work.

11. Update the GIS database to indicate the date, type of treatment applied to the treated reaches, and cost.
12. Prepare a schematic showing any zones within the reaches that received less than 0.2 feet of gravel.

APPENDIX C

Appendix C-6.1

Putah South Canal Turbidity and Sediment Management Project
May 20, 2008

ADCP Measurement Results from Lake Solano & Headworks, May 20, 2008.

A series of ADCP measurements were conducted within Lake Solano, upstream of the PSC Diversion Dam on May 20, 2008. The measurements consisted of continuous profiles along 9 transects (6 within the lake and 3 within the forebay and stilling basin upstream of the diversion channel). In addition, stationary readings were performed at a number of locations on each of the 6 transects within the lake.

The following data presentations have been extracted from the continuous profiles:

- Velocity Magnitude Plots (contours) showing the variation in velocities along the transects
- A plan view of the depth averaged velocity and direction (velocity field)
- A contour map of the depth averaged velocity

From the stationary measurements, vertical velocity profiles have been generated.

A RDI “Rio Grande 1200 kHz” model ADCP was deployed for the measurements. The ADCP was supported within an Oceanscience RiverBoat with wireless communications between the unit and a recording computer on the bank.
For each of the transects, a wire rope static line was established across the lake at the elevation of the top of the dam (approximately 10 ft above the water level). The RiverBoat was attached to the static line via a block and tether line.

Raw Data Files
The following is a description of the contents of the raw data files

Files PSC_000 to PSC_017, PSC_019, PSC_028 can be deleted from the project

PSC_018: Transect 1; complete loop starting on right bank.
PSC_020: Transect 1 with stationary readings from right to left bank
PSC_021: Transect 2 with stationary readings
PSC_022: Transect 3
PSC_023: Transect 3 with stationary readings.
PSC_024: Transect 4
PSC_025: Transect 4 with stationary readings.
PSC_026: Transect 5
PSC_027: Transect 5 with stationary readings
PSC_029: Transect 5 with stationary readings and Bay 12 open passing 125 cfs
PSC_030: Transect 6 with stationary readings and Bay 12 open passing 125 cfs

PSC_031: Transect 6 –loop with continuous readings and back with stationary readings
Bay 12 closed
PSC_032: Transect 7 – In stilling basin downstream side of trash racks
PSC_033: Transect 8 – In middle of stilling basin
PSC_034: Transect 9 – Downstream end of stilling basin

The following drawings have been generated:

1. **Transect_locations.dwg** - A plan view of site with transect alignment (static line) and numbering. The actual locations of the measurements were approximately 12-14 feet downstream of the indicated alignments except near the structures were the distance was in the order of 4 ft.
2. **vel-aln.dwg** - depth average velocity vectors measured along the transects. In essence this shows the velocity field.
3. **gate_open.dwg** - depth average vectors on transects 5 and 6 with the gate being operated.
4. **contour.dwg** - contour map generated from the velocity magnitude along the transects. Shows the variation in intensity within the lake and trash racks at the Headworks. Use this data file with caution, “smoothing” was required in order to generate the display contours.
5. **stationary.dwg** - plan view showing positions of stationary measurements.

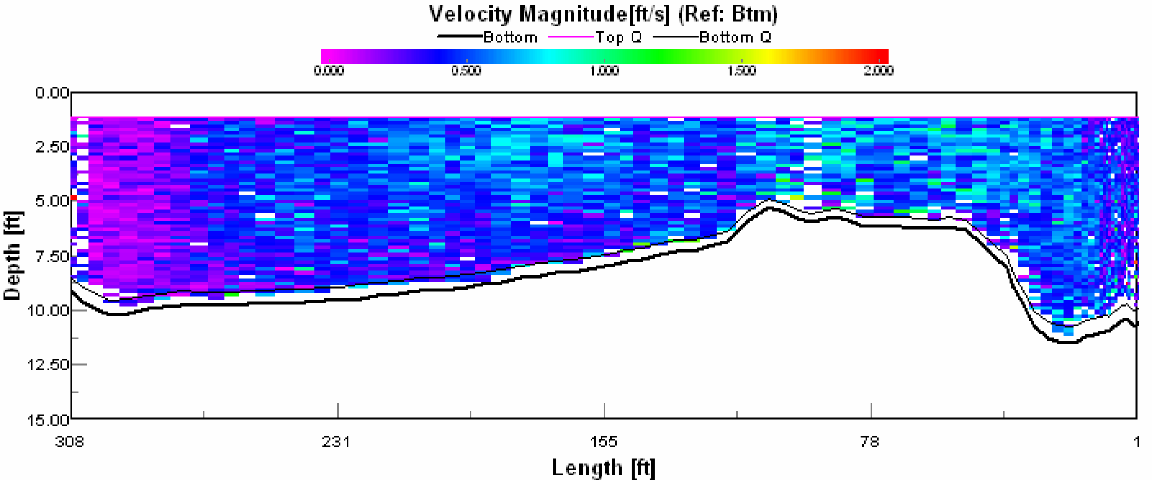
The spreadsheet **Velocity Profile.xls** contains the data for the vertical velocity distribution plots. I was not able to extract the nice profile plots generated from the program ADCXP so I created the spreadsheet. There are other spreadsheets used to extract the transect depth average values. I will include these on a CD with all of the extracted data.

The following pages contain plots, for each transect, the velocity magnitude profiles extracted from the collection software (WinRiver) and the vertical distribution plots. The profiles have been generated with 3 Ensembles averaged.

Figure C-6.1.1 showing locations along the six in-lake transects where stationary velocity profile measurements were measured with the ADCP.

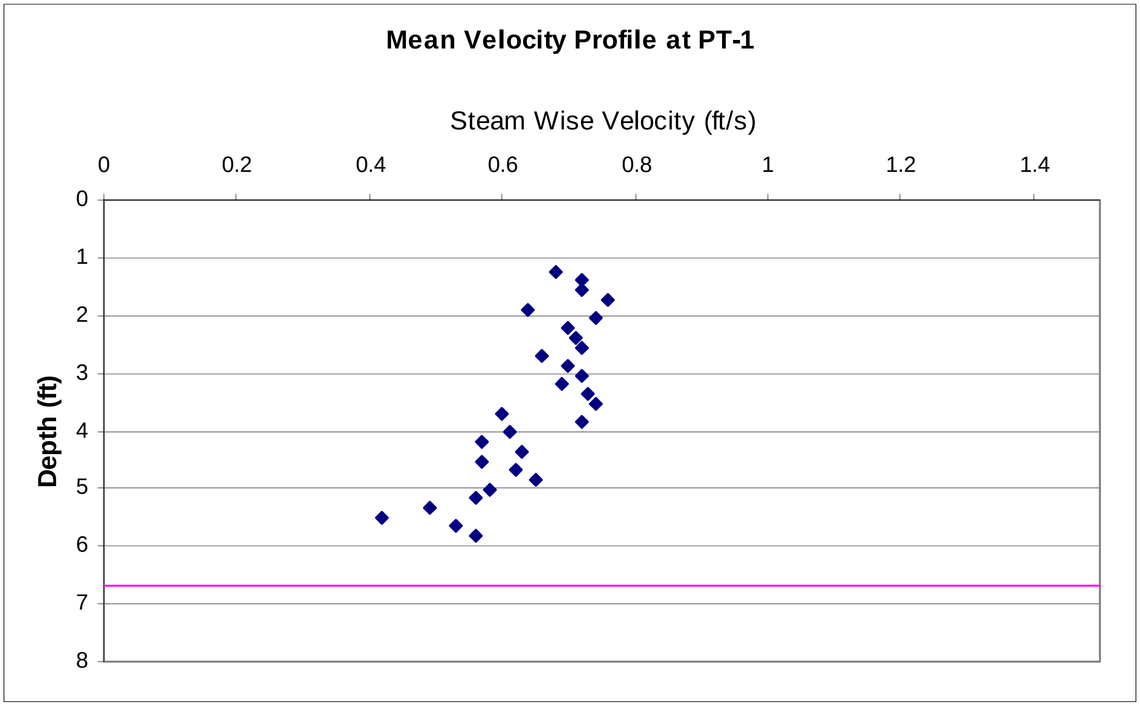
Transect 1: File 018
Running upstream of dam from upstream end of diversion structure/intake to "guide bank structure on left side of channel.

Velocity magnitudes

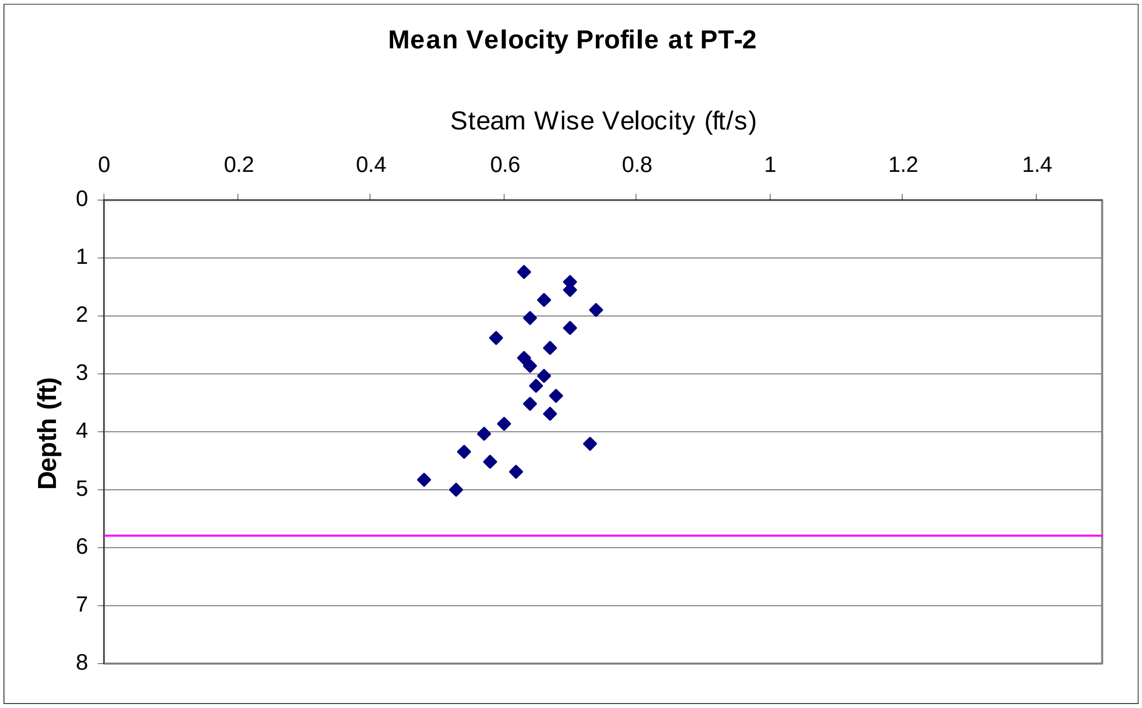


Vertical Velocity Distributions (File 020)

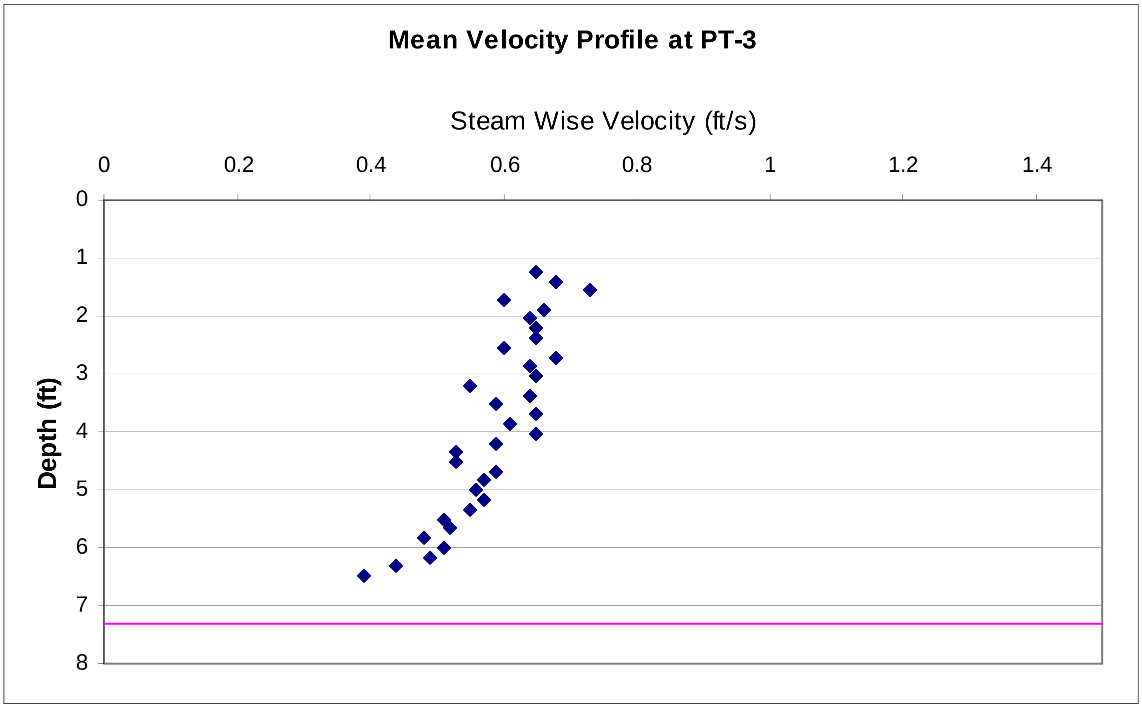
PT-1



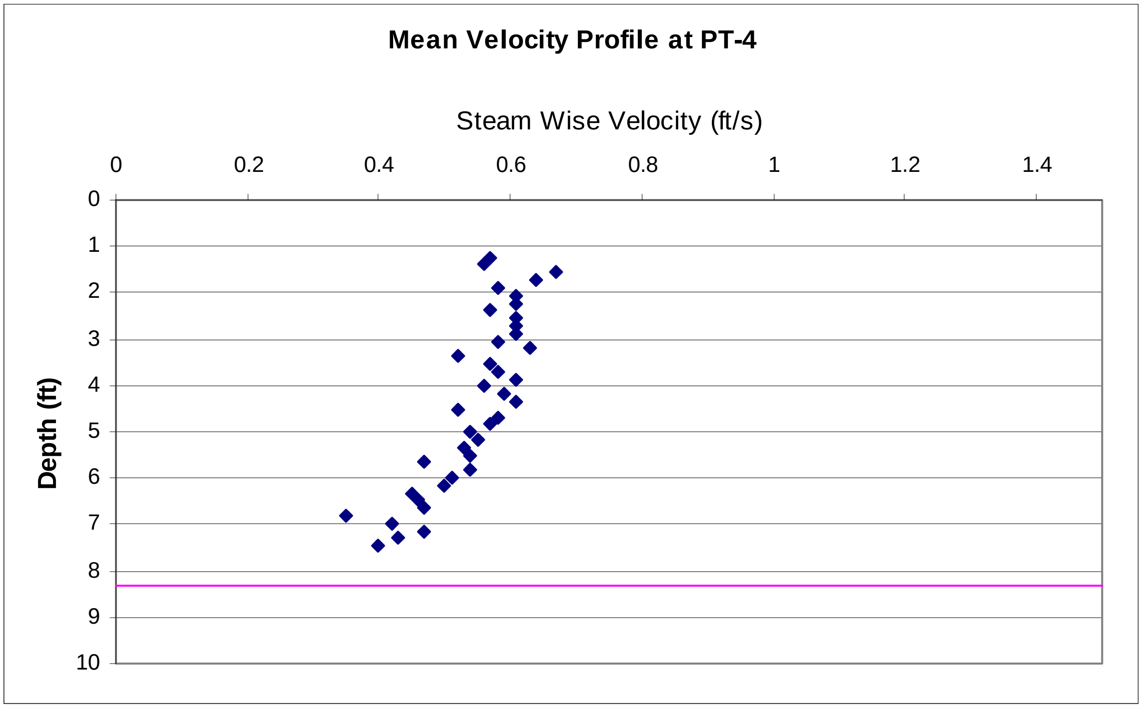
PT-2


Mean Velocity Profile at PT-2
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8

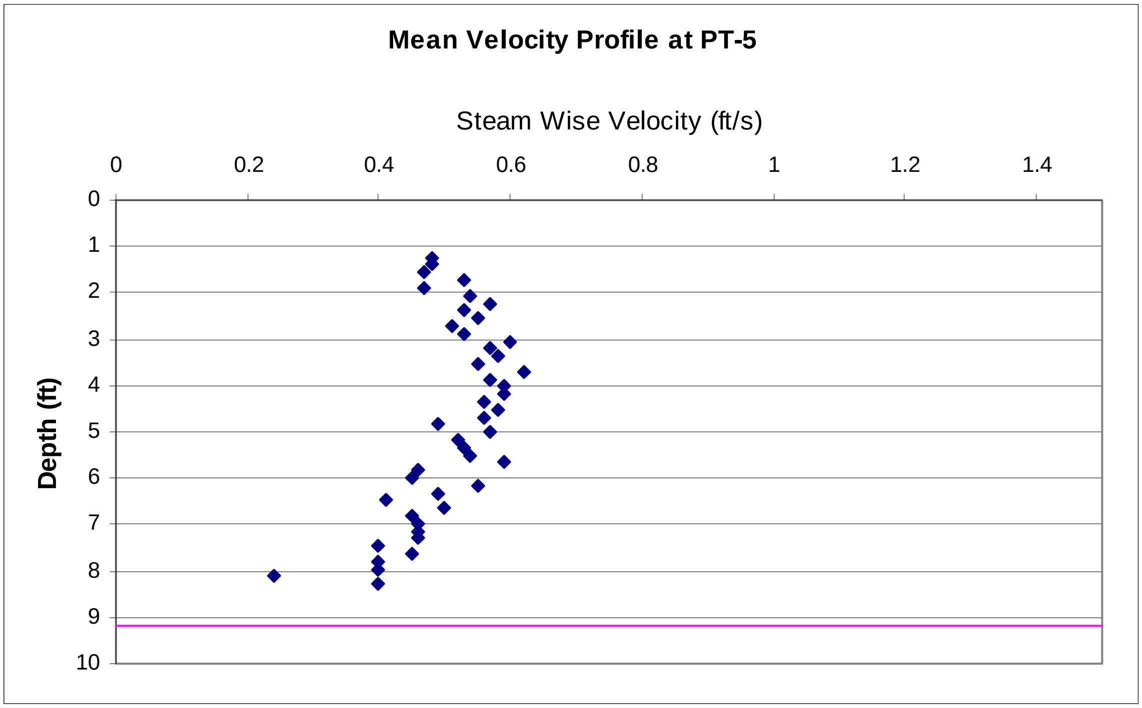
PT-3


Mean Velocity Profile at PT-3
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8

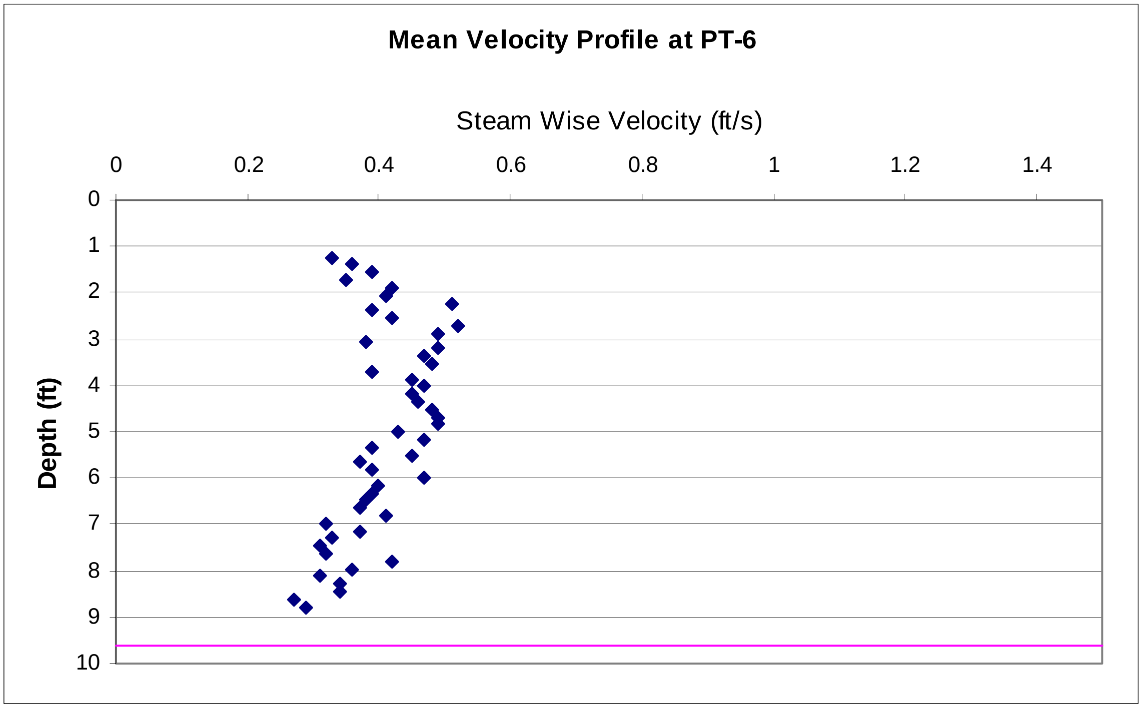
PT-4


Mean Velocity Profile at PT-4
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

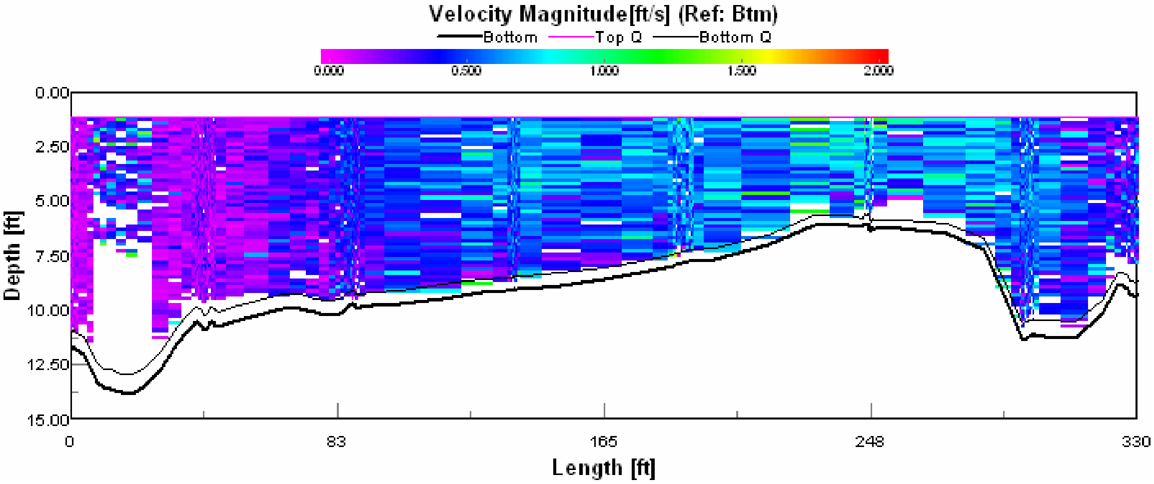
PT-5


Mean Velocity Profile at PT-5
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

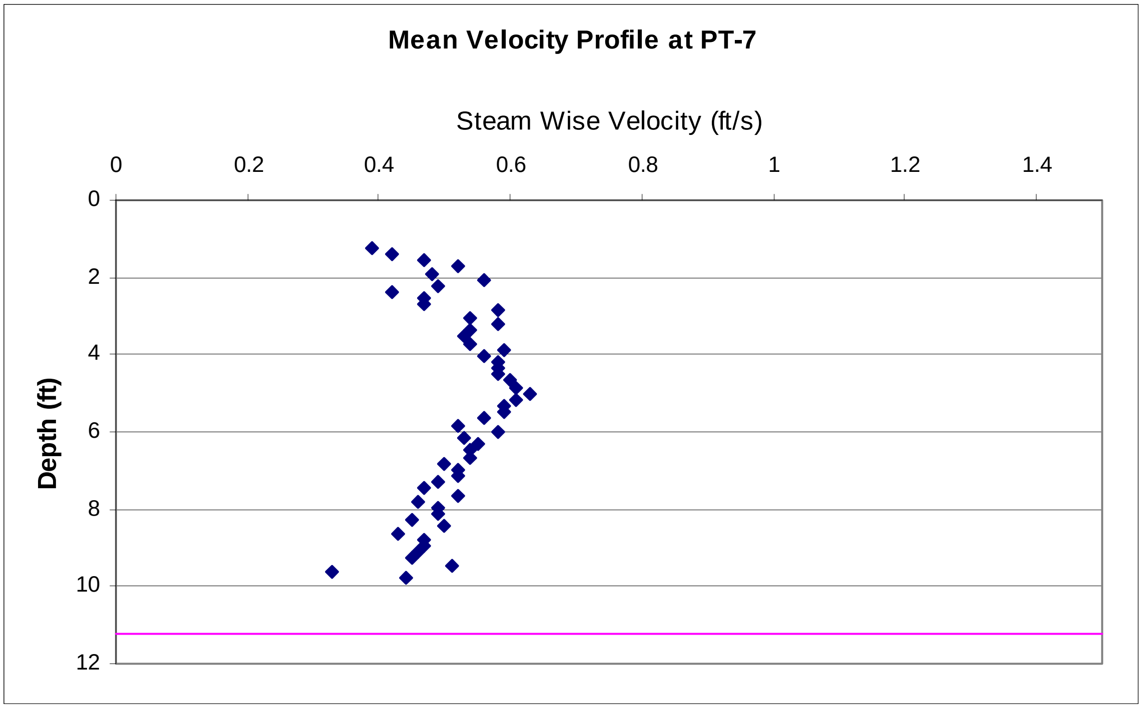
PT-6


Mean Velocity Profile at PT-6
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

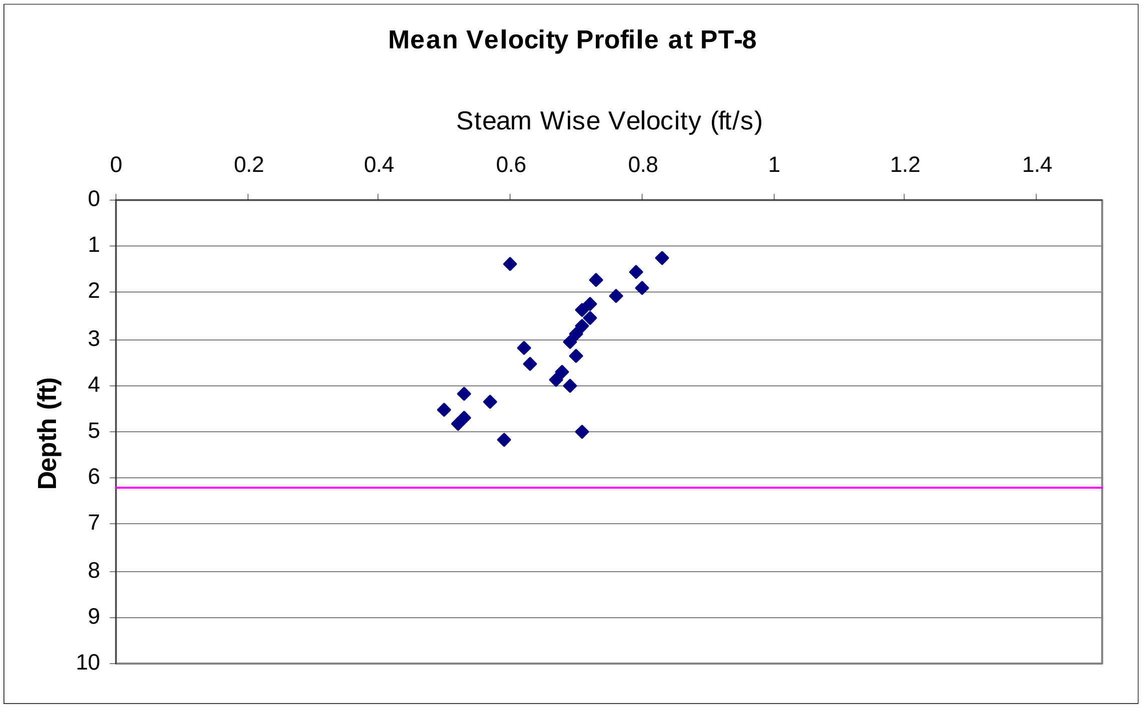
Transect 2: File 021
Running from upstream end of diversion structure/intake to end of dam structure on left side of channel.
Velocity magnitudes – includes stationary measurements



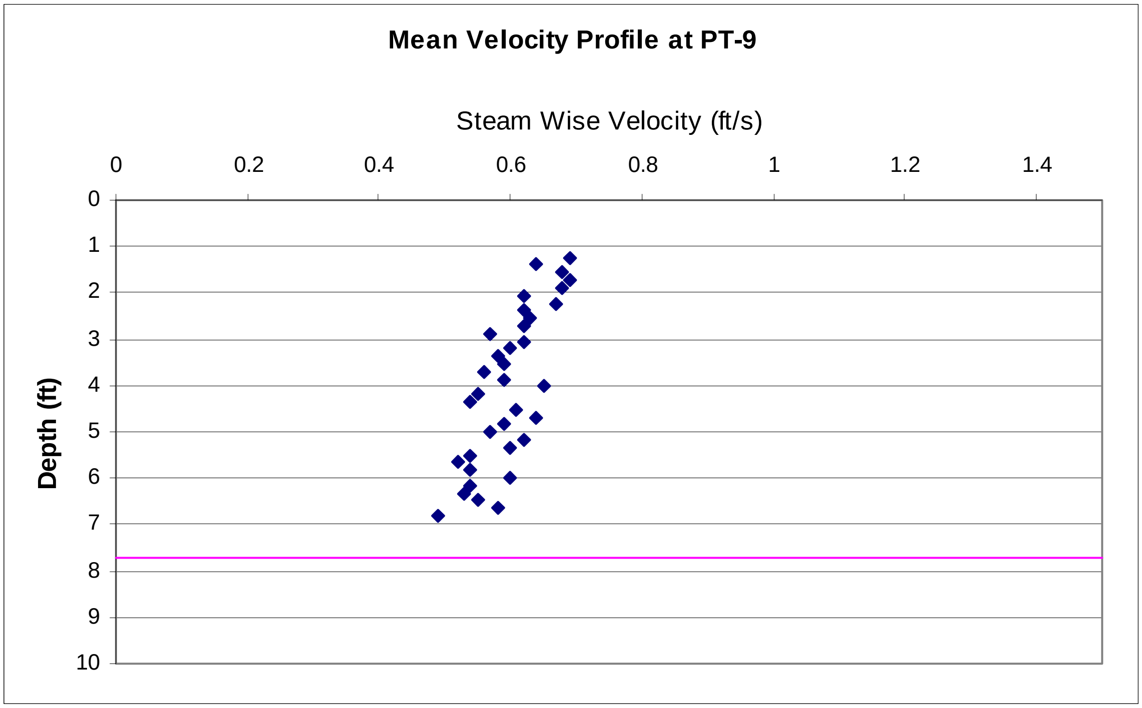
Vertical Velocity Distribution (File 021)
PT-7



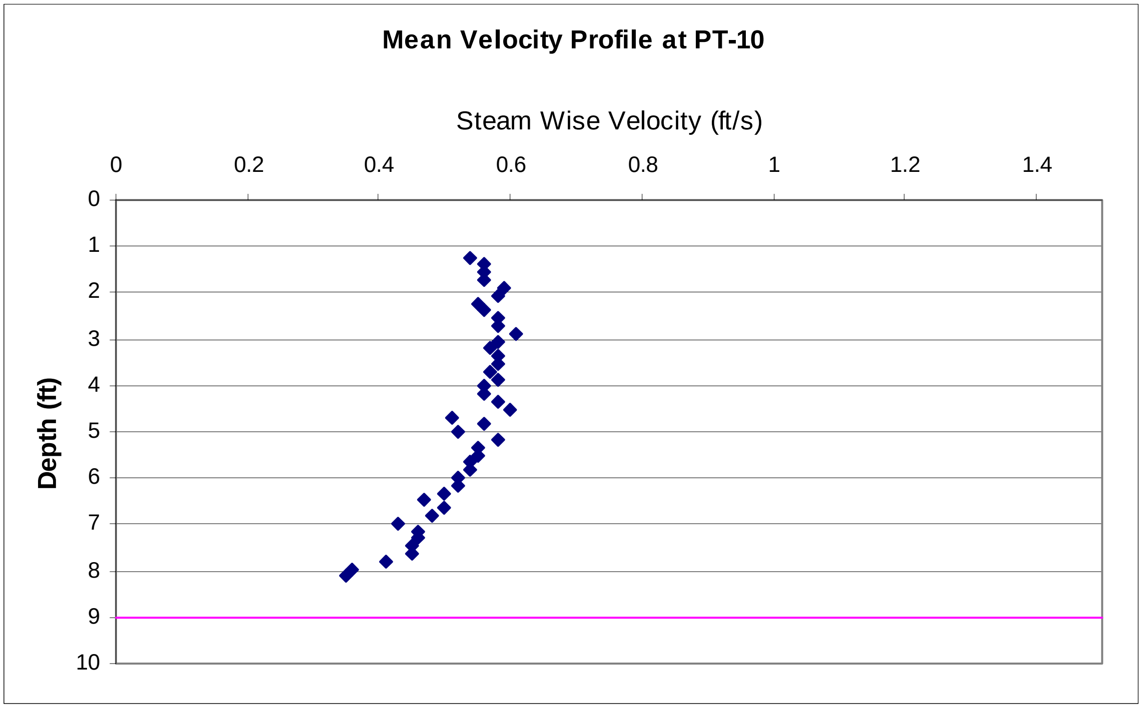
PT-8


Mean Velocity Profile at PT-8
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

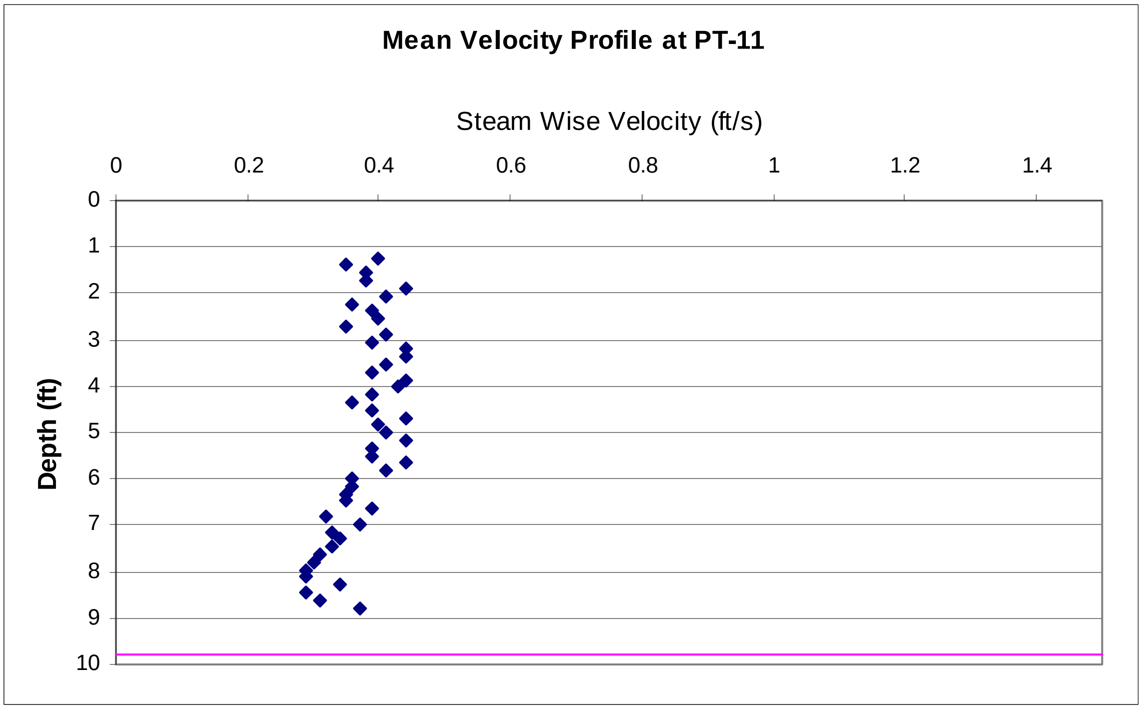
PT-9


Mean Velocity Profile at PT-9
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

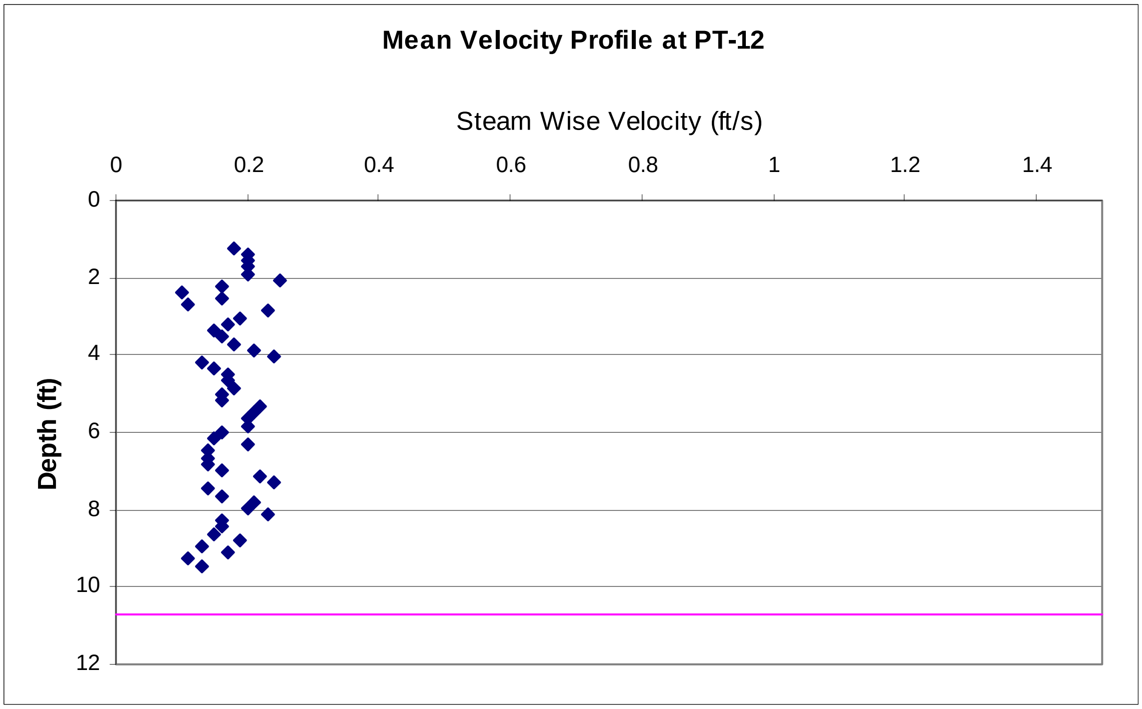
PT-10


Mean Velocity Profile at PT-10
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

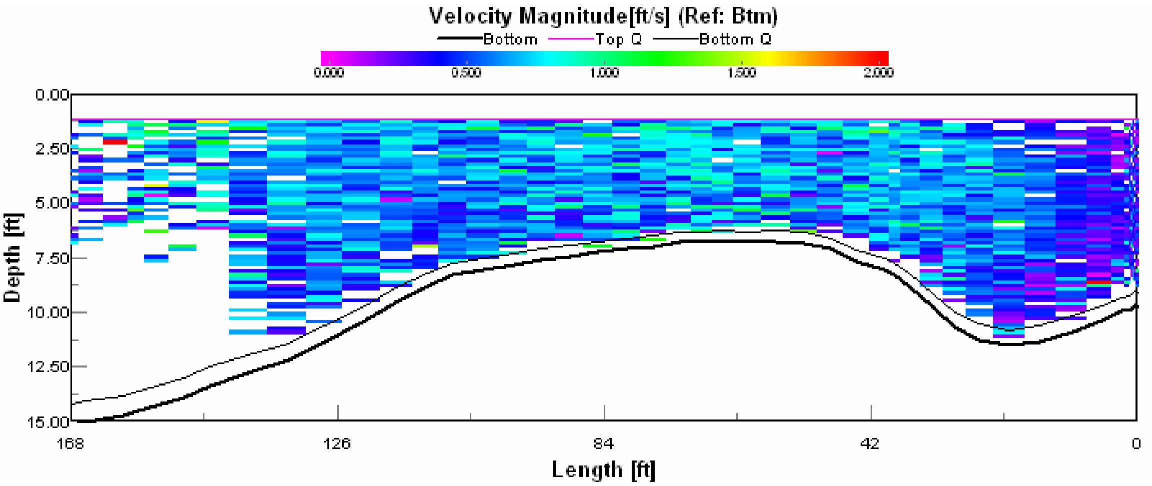
PT-11


Mean Velocity Profile at PT-11
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

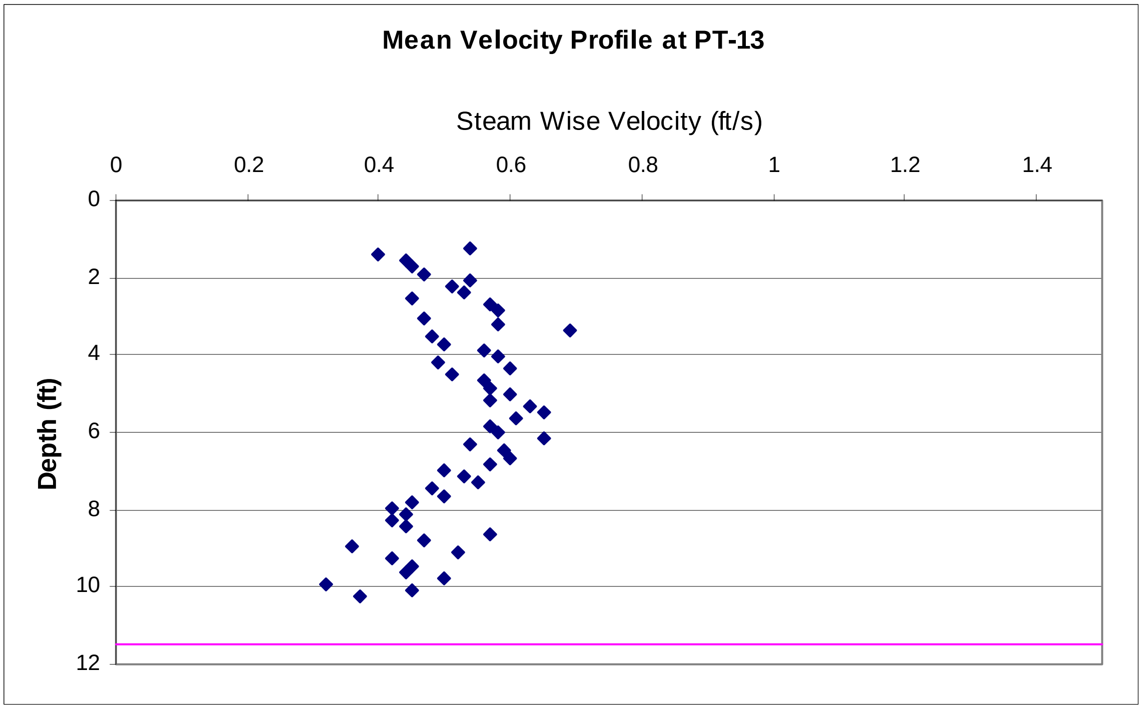
PT-12


Mean Velocity Profile at PT-12
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12

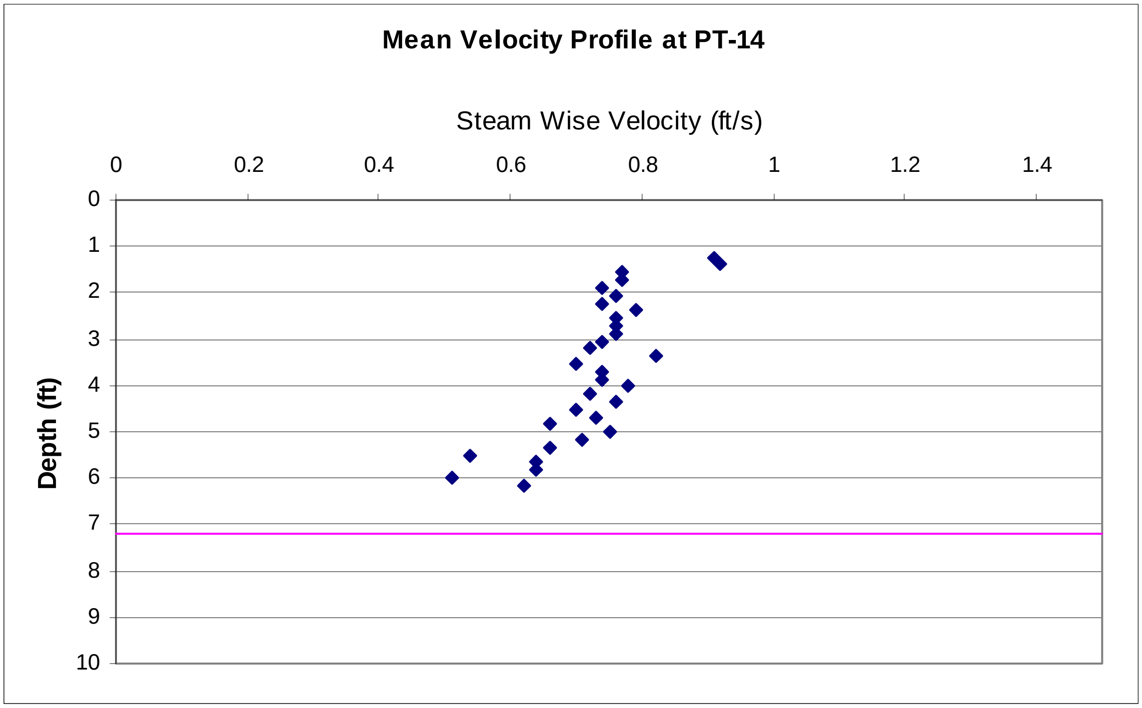
Transect 3: File 022
Running from upstream end of diversion structure/intake to middle of dam (pier between bays 6 and 7)
Velocity magnitudes - Lost of data near the dam due to water mode being used.



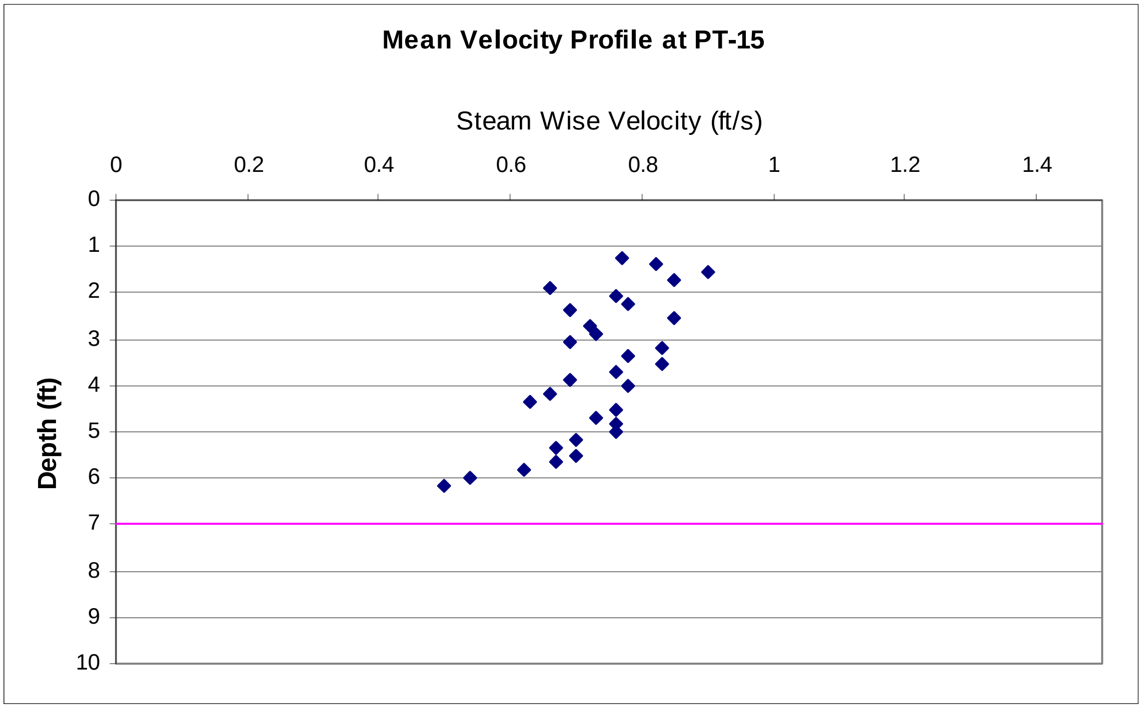
Vertical Velocity Distribution (File 023)
PT-13



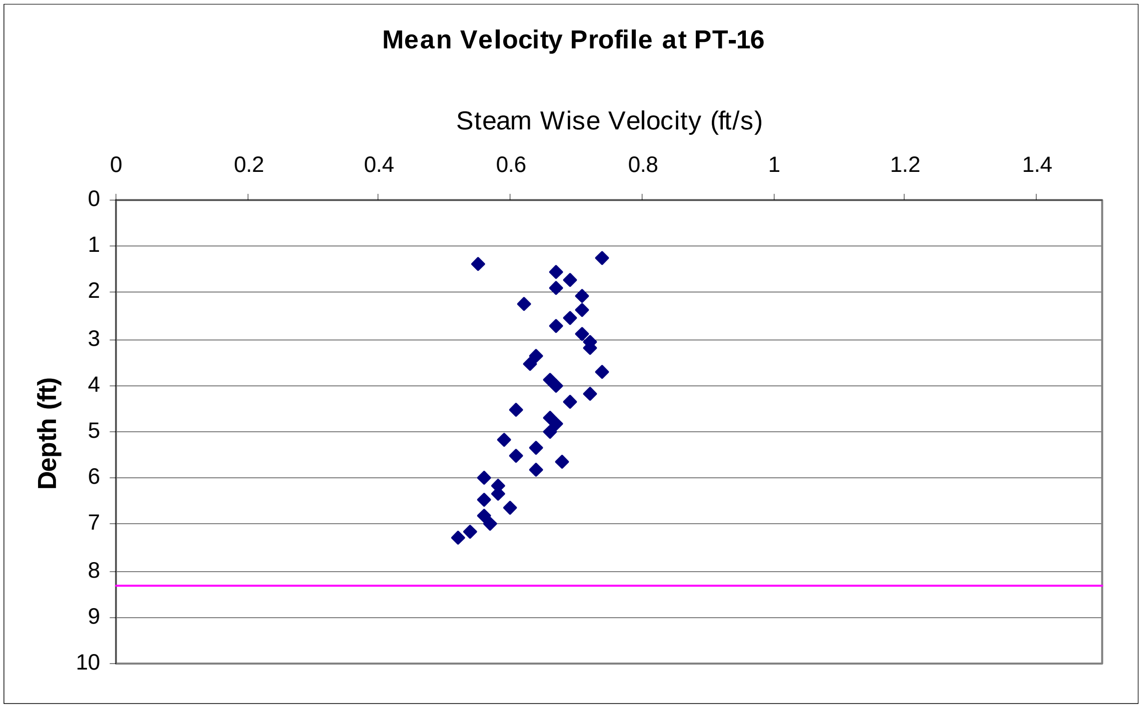
PT-14


Mean Velocity Profile at PT-14
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

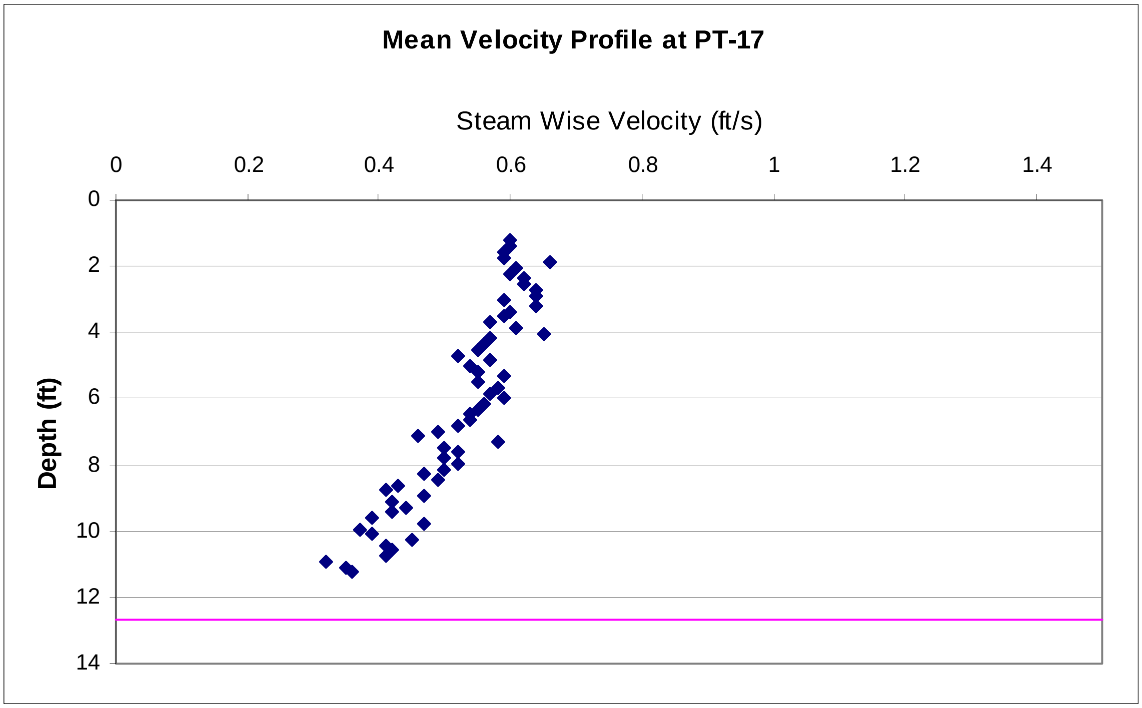
PT-15


Mean Velocity Profile at PT-15
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

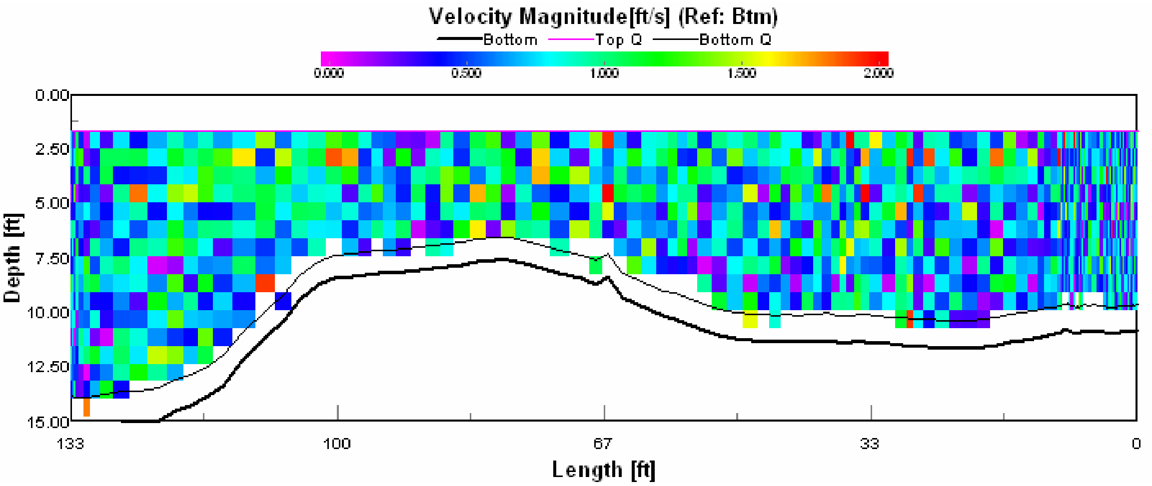
PT-16


Mean Velocity Profile at PT-16
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10

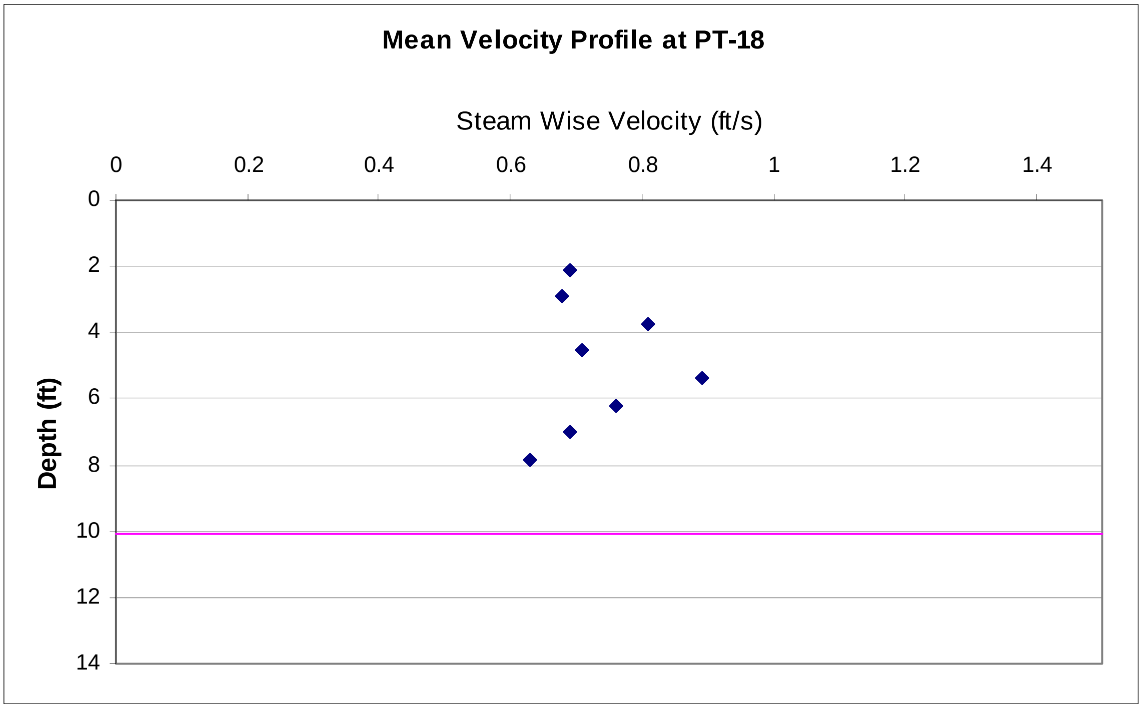
PT-17


Mean Velocity Profile at PT-17
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14

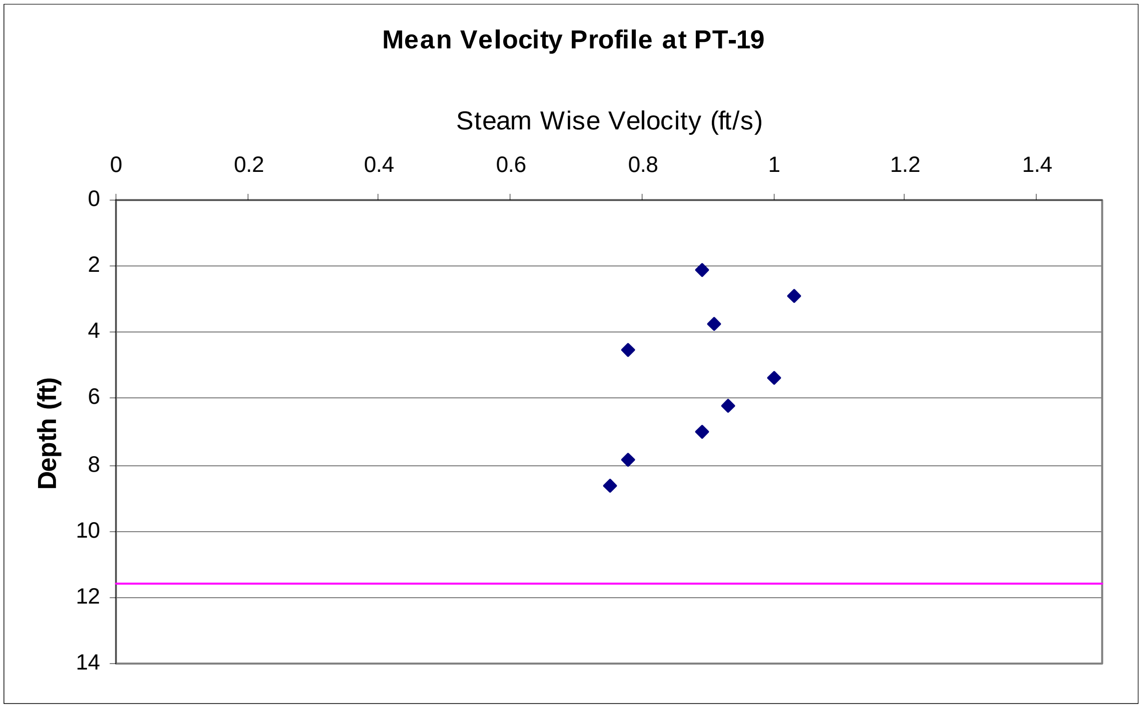
Transect 4: File 024
Running from upstream end of diversion structure/intake to pier between Bays 9and 10
Velocity magnitudes - Water mode reset to 1 due to expected depths near dam.



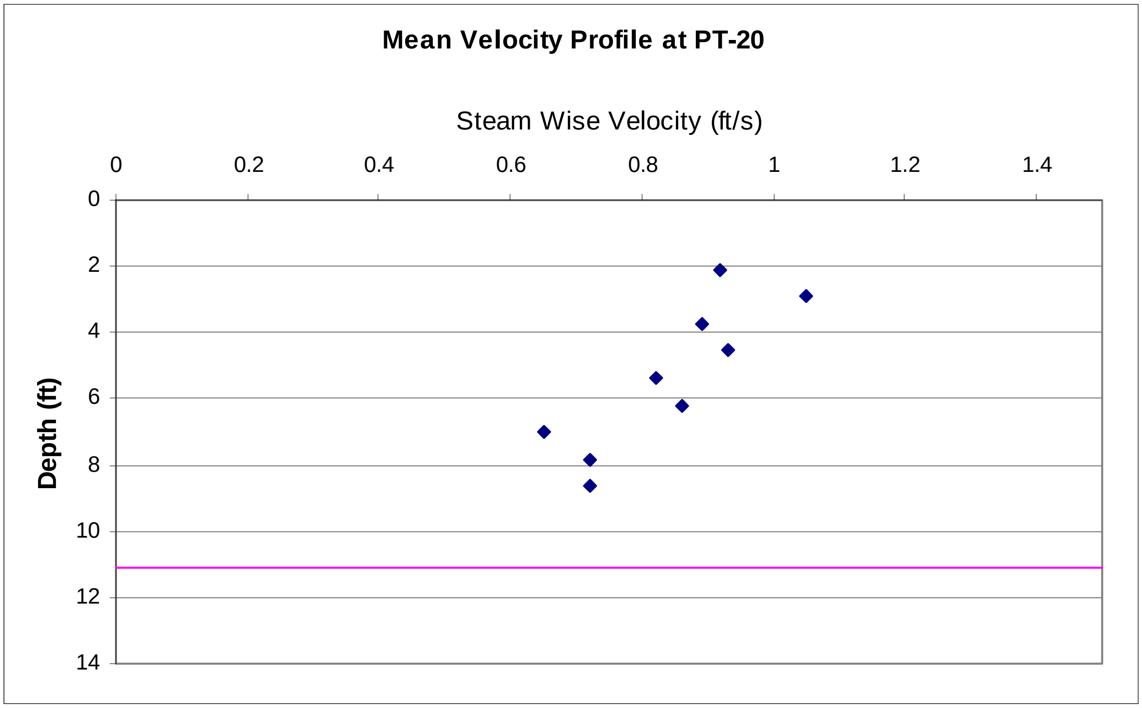
Vertical Velocity Distribution (File 025)
PT-18



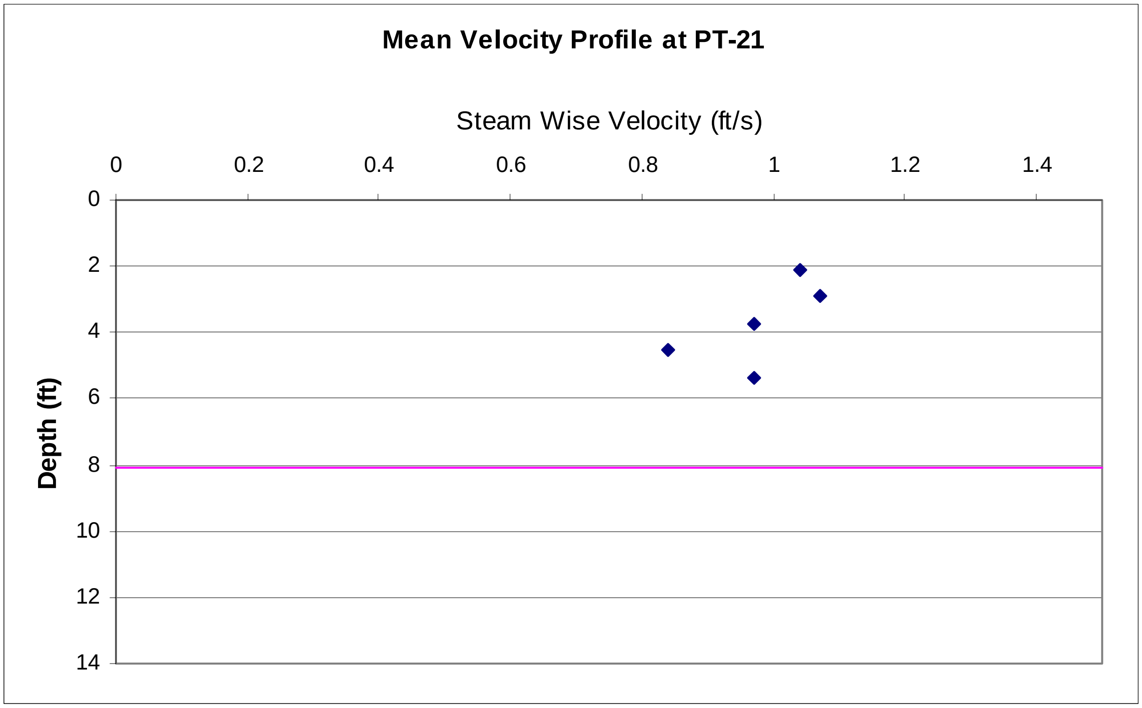
PT-19


Mean Velocity Profile at PT-19
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14

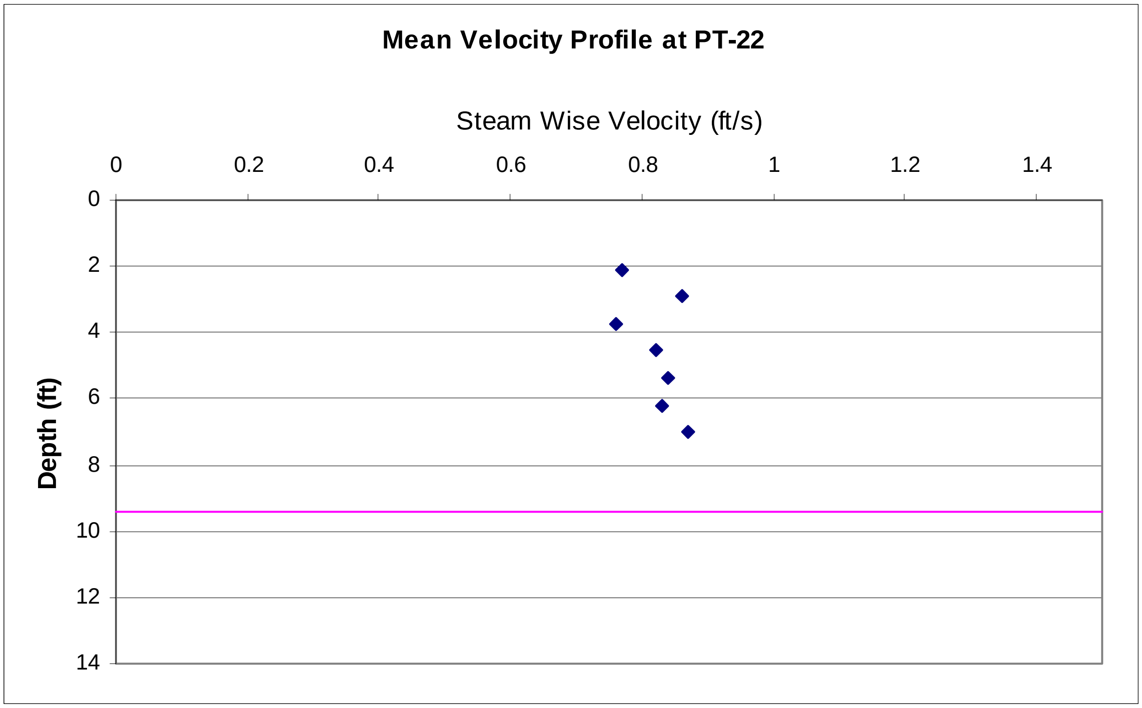
PT-20


Mean Velocity Profile at PT-20
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14

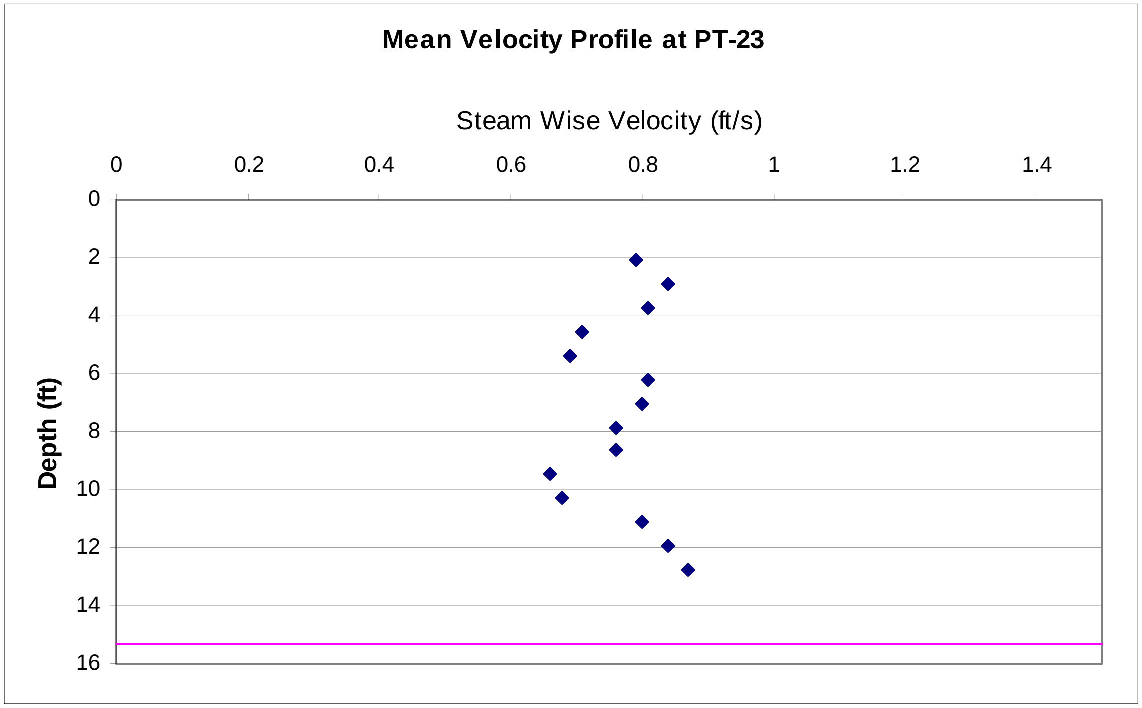
PT-21


Mean Velocity Profile at PT-21
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14

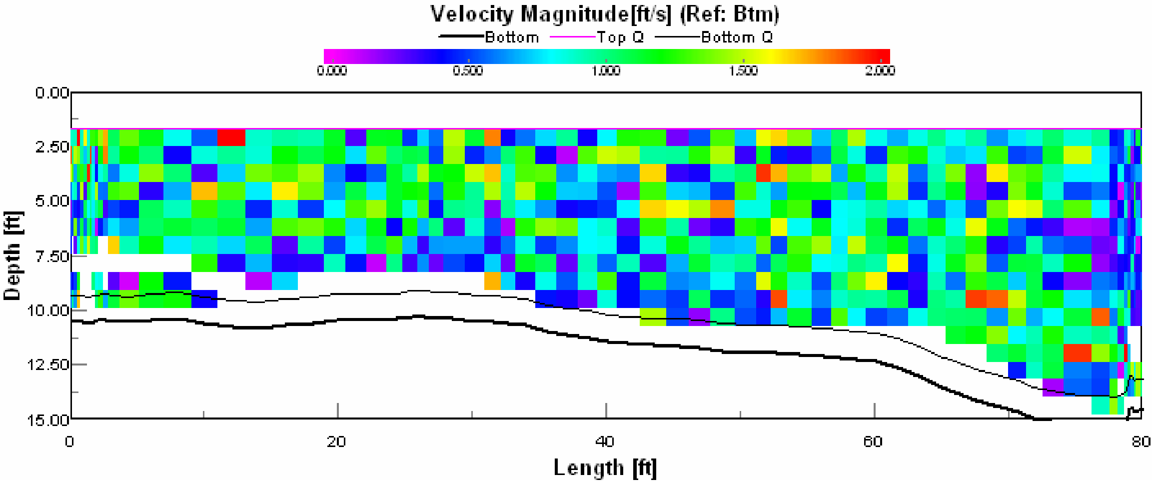
PT-22


Mean Velocity Profile at PT-22
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14

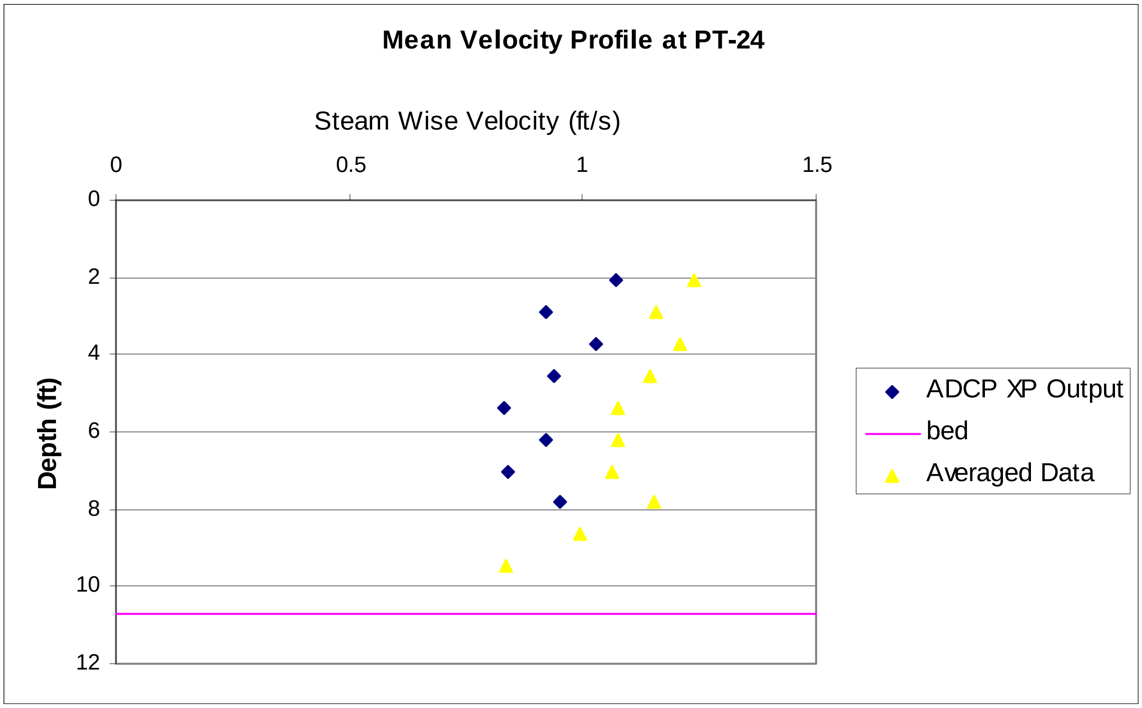
PT-23


Mean Velocity Profile at PT-23
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14
16

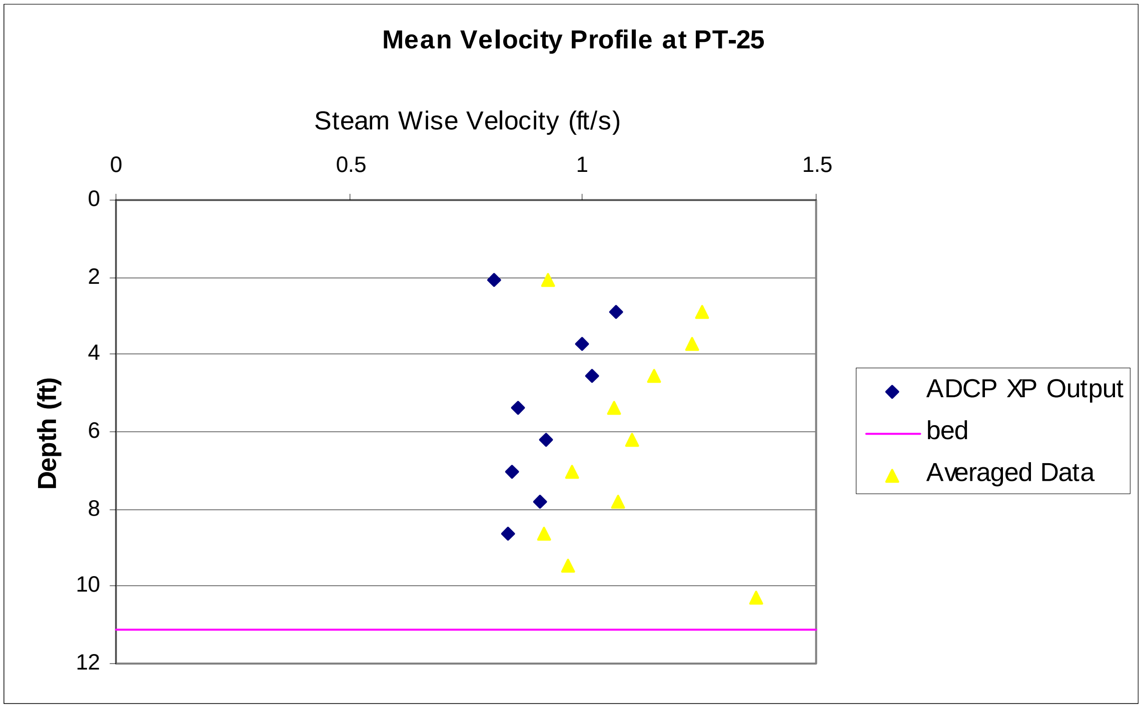
Transect 5: File 026
Running in front of trash racks
Velocity magnitudes - from upstream to downstream



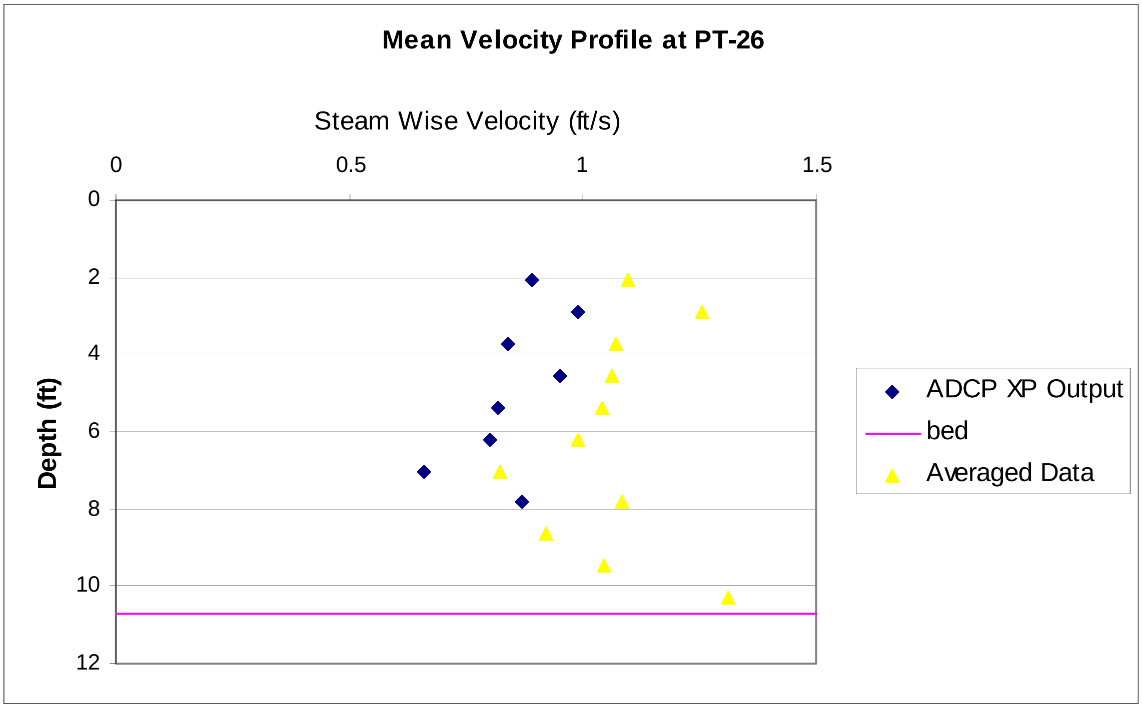
Vertical Velocity Distribution (File 027)
PT-24



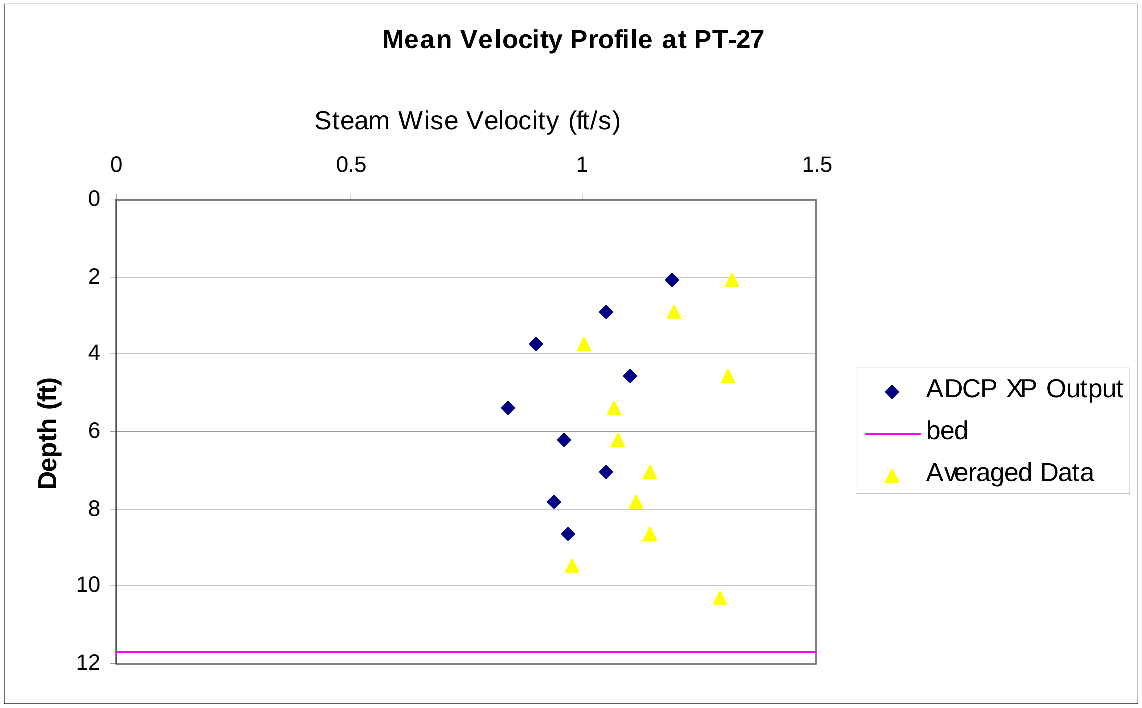
PT-25


Mean Velocity Profile at PT-25
Steam Wise Velocity (ft/s)
0
0.5
1
1.5
Depth (ft)
0
2
4
6
8
10
12
ADCP XP Output
bed
Averaged Data

PT-26


Mean Velocity Profile at PT-26
Steam Wise Velocity (ft/s)
0
0.5
1
1.5
Depth (ft)
0
2
4
6
8
10
12
ADCP XP Output
bed
Averaged Data

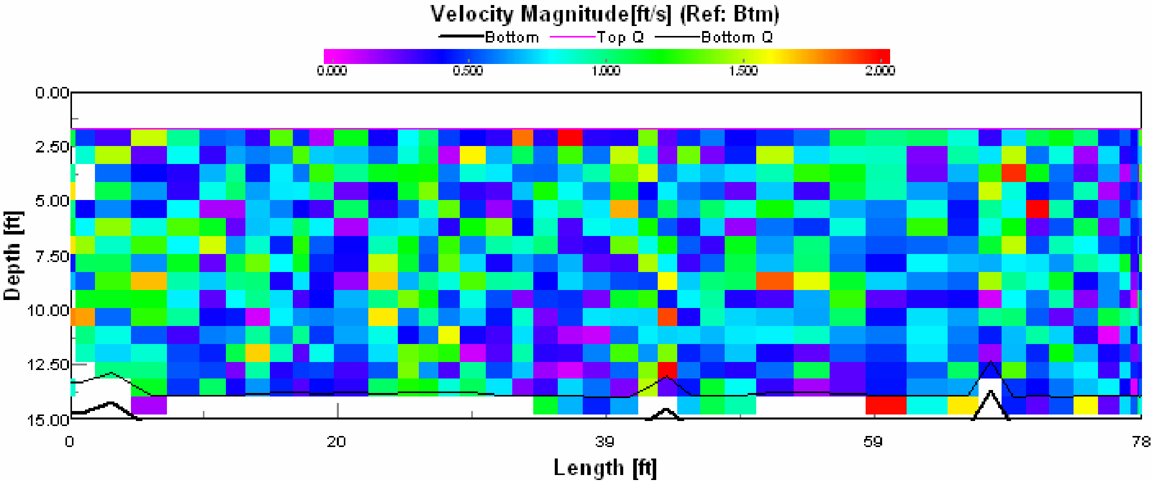
PT-27


Mean Velocity Profile at PT-27
Steam Wise Velocity (ft/s)
0
0.5
1
1.5
Depth (ft)
0
2
4
6
8
10
12
ADCP XP Output
bed
Averaged Data

Transect 6: FILE 031

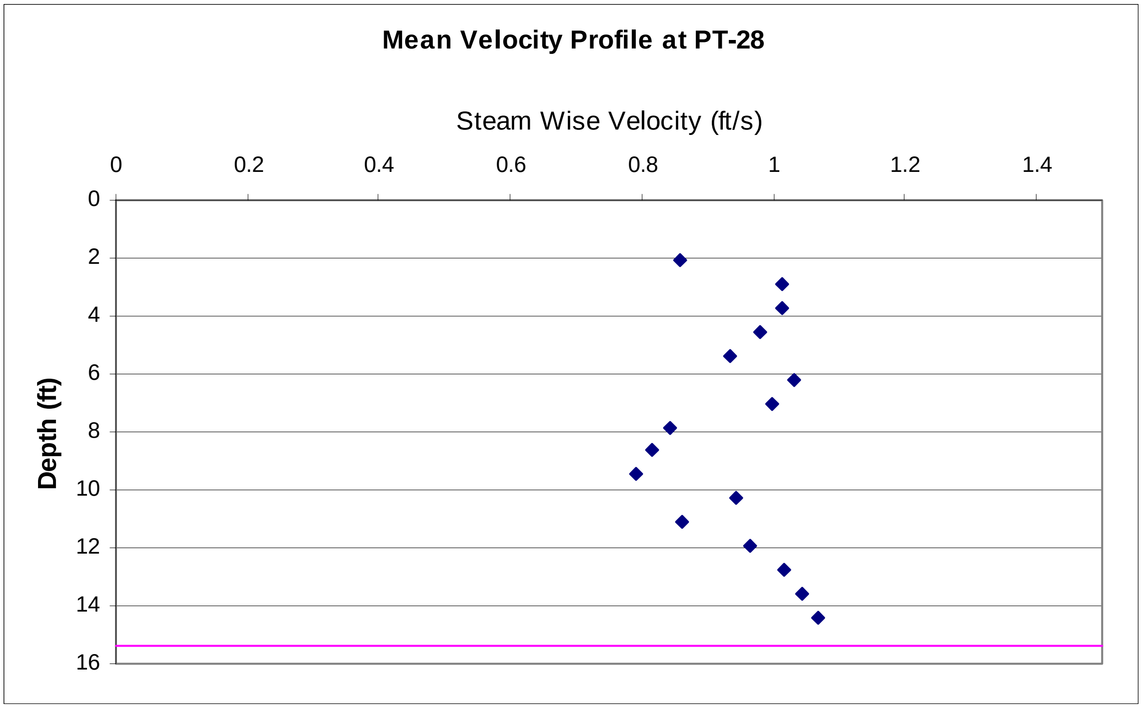
In front of Bay 12 (no discharge)

Velocity magnitudes - viewed looking downstream

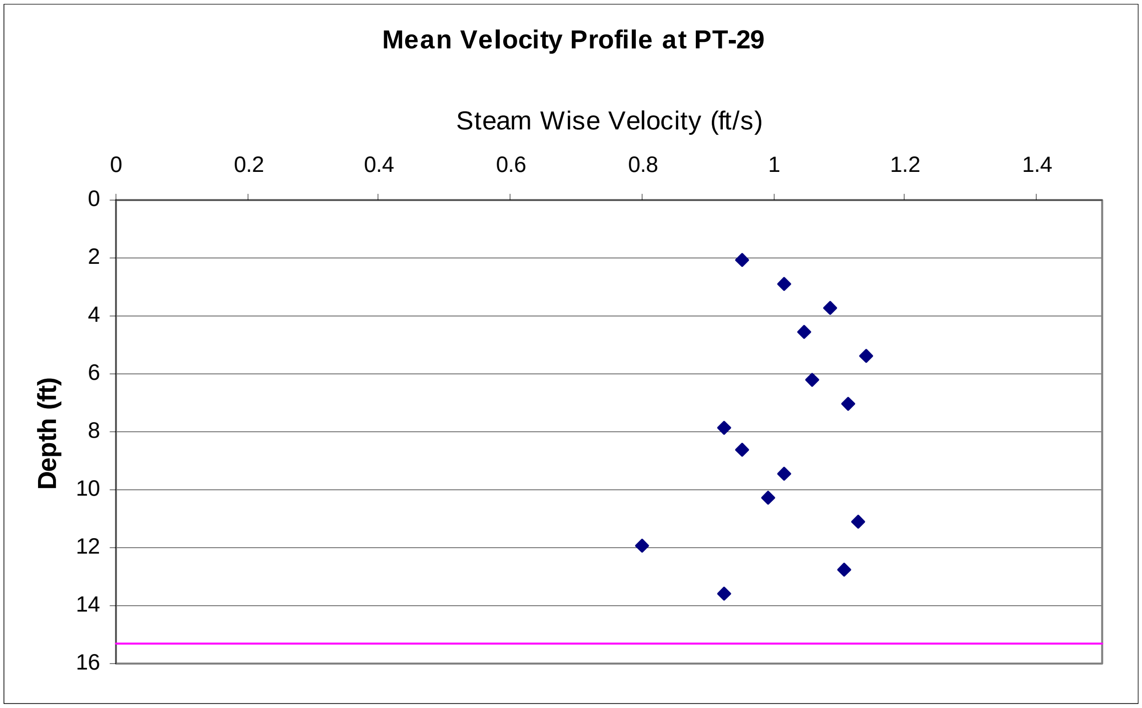


Vertical Velocity Distribution (File 031)

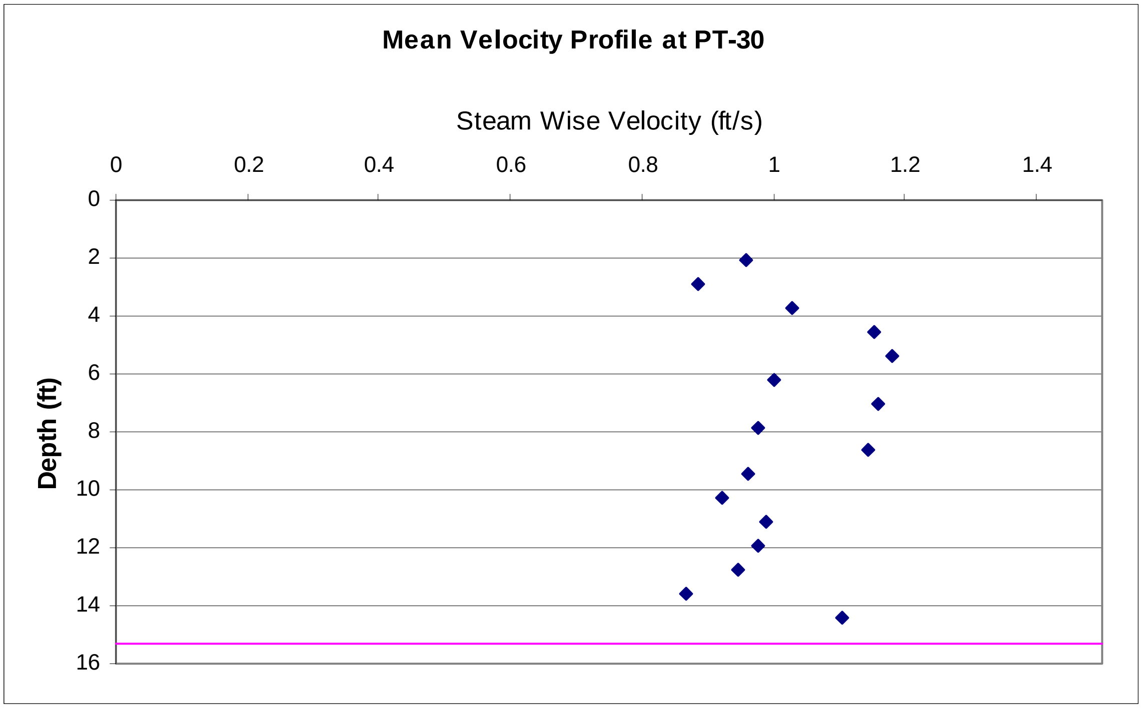
PT-28



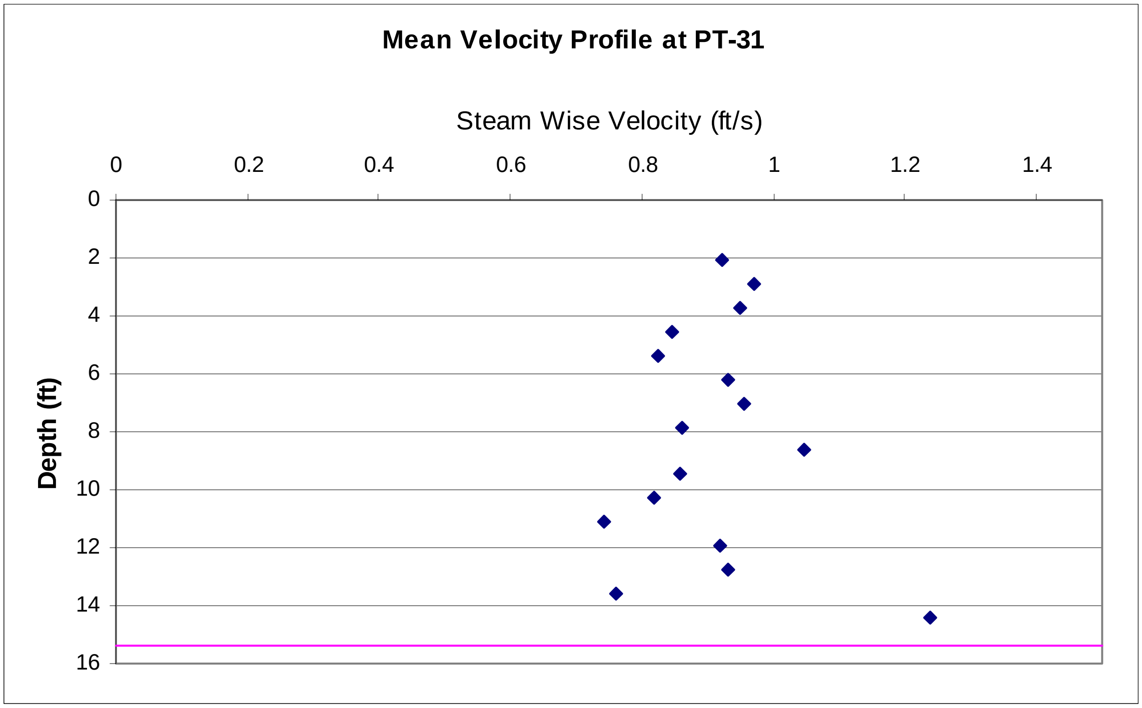
PT-29


Mean Velocity Profile at PT-29
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14
16

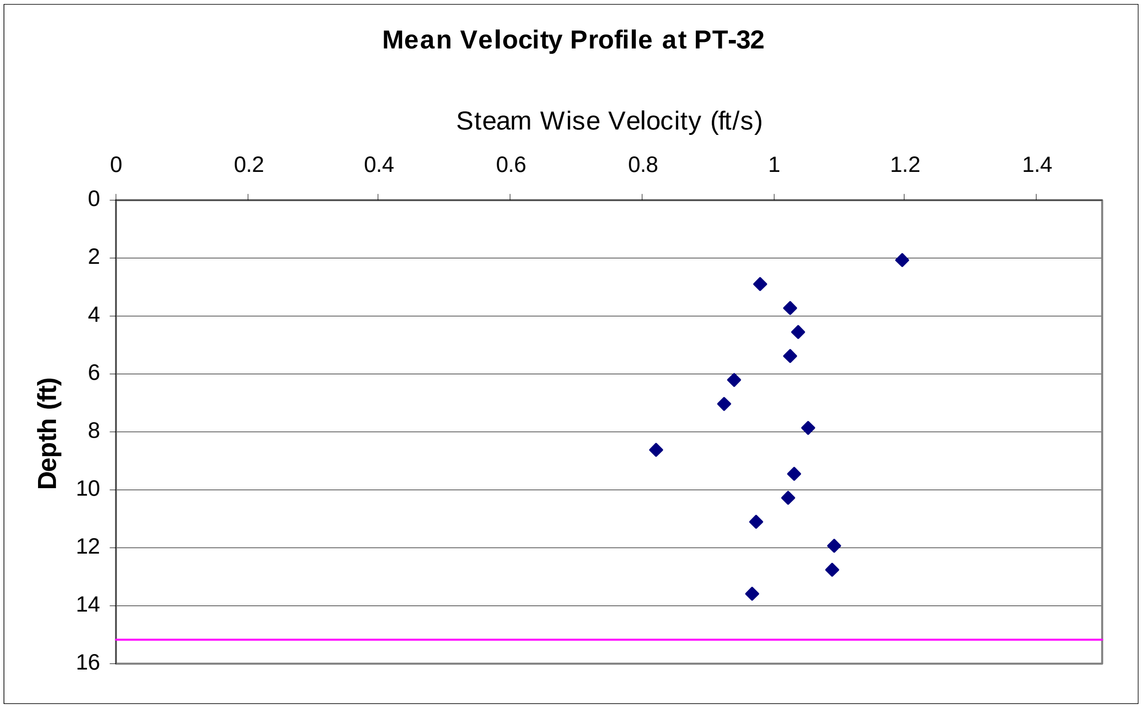
PT-30


Mean Velocity Profile at PT-30
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14
16

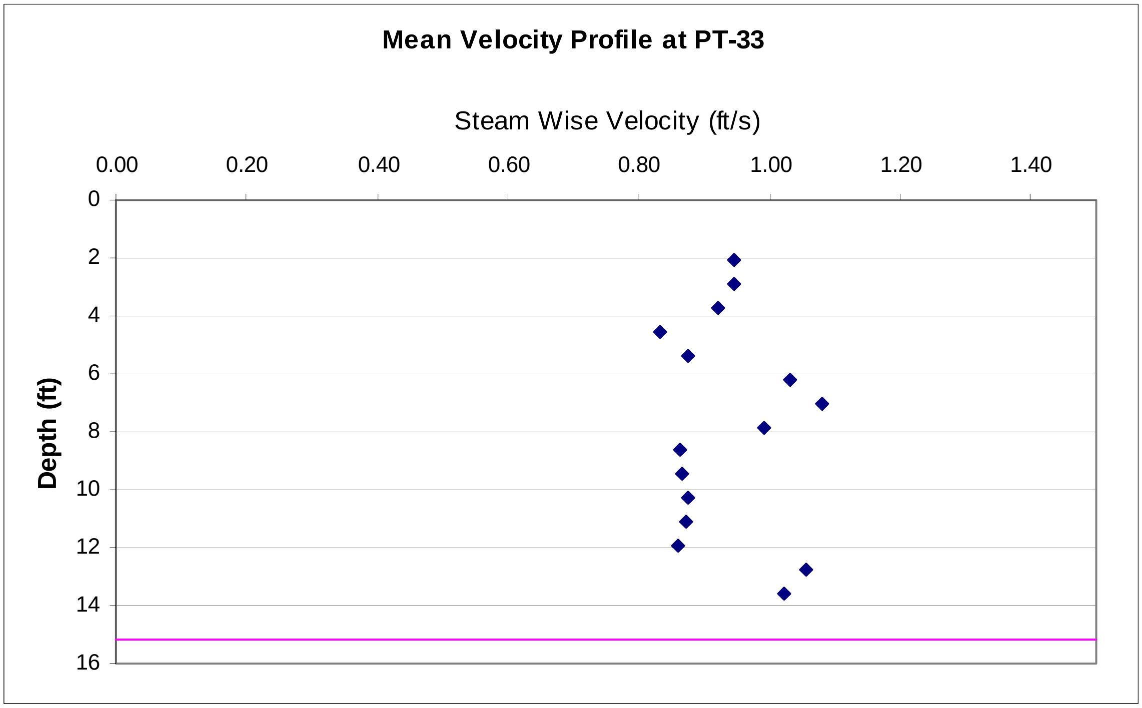
PT-31


Mean Velocity Profile at PT-31
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14
16

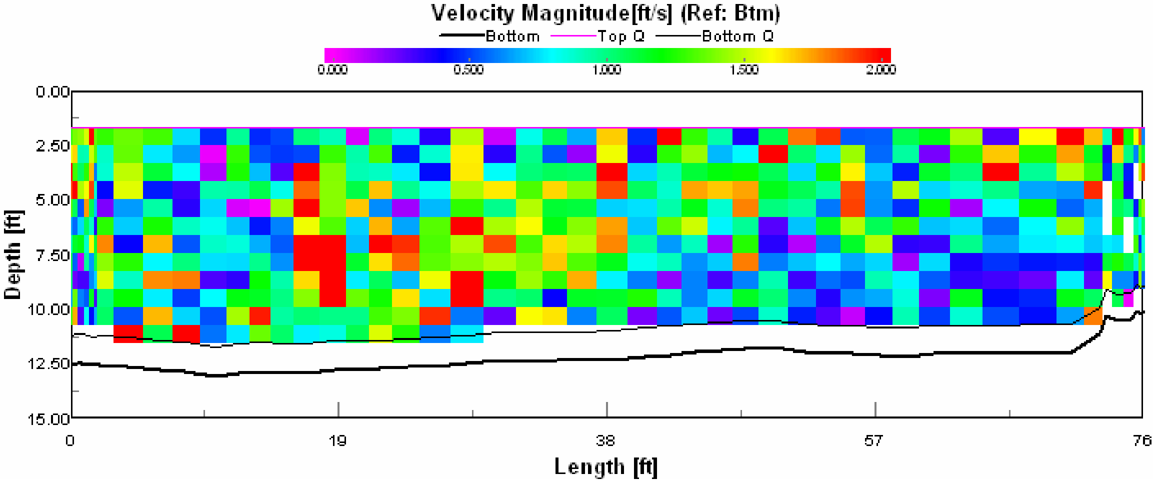
PT-32


Mean Velocity Profile at PT-32
Steam Wise Velocity (ft/s)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Depth (ft)
0
2
4
6
8
10
12
14
16

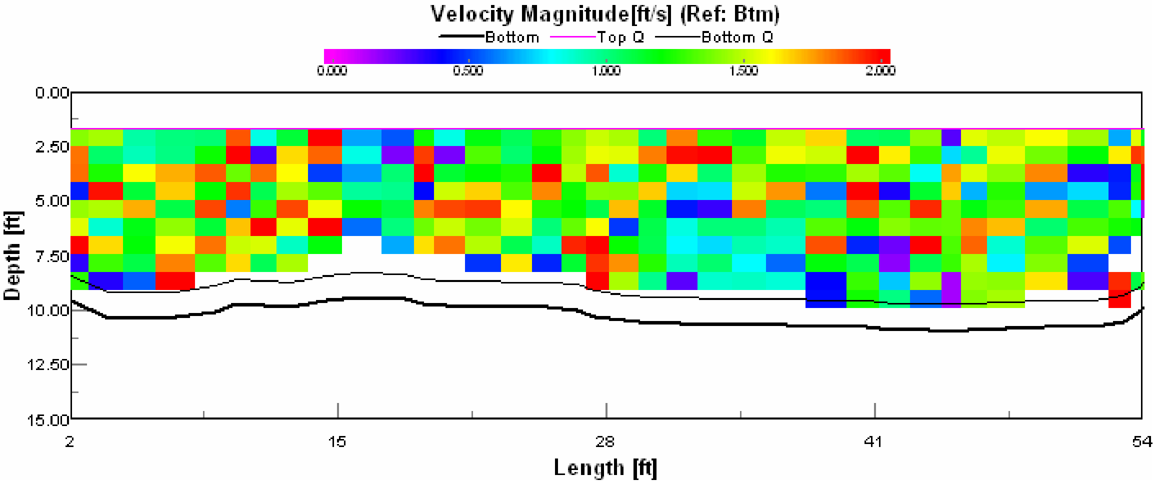
PT-33



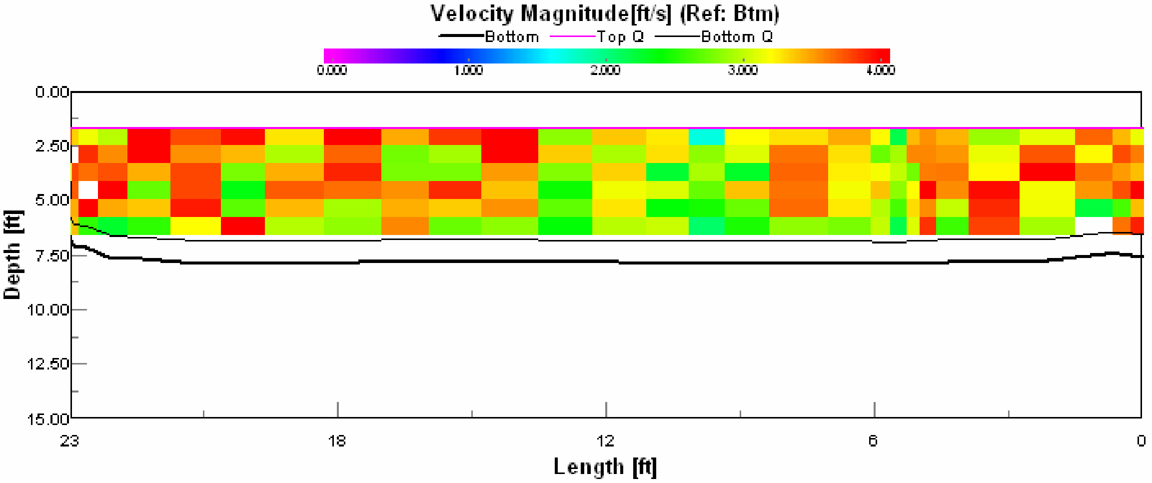
Transect 7: FILE 032
In stilling basin downstream of trash racks
Velocity magnitudes - viewed looking downstream



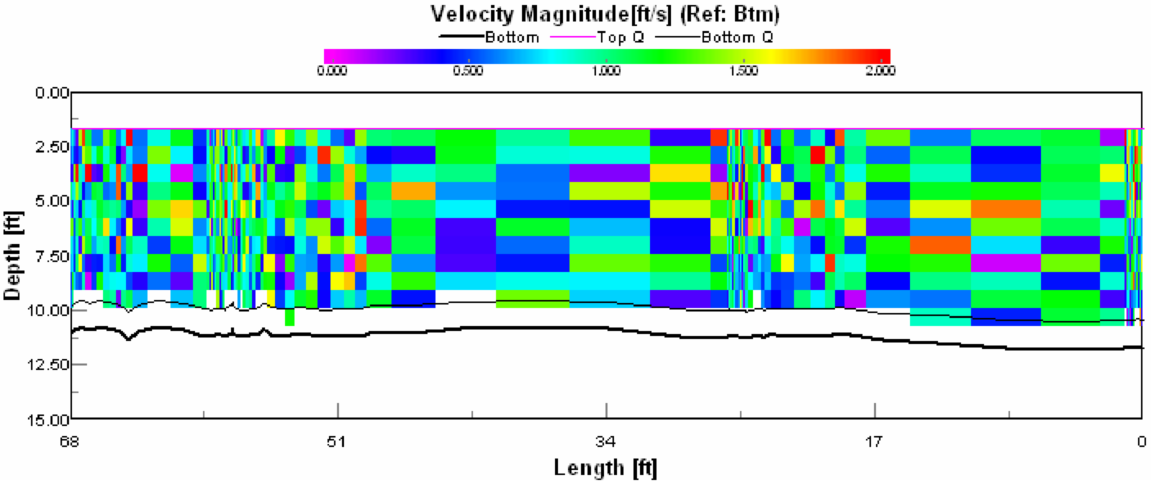
Transect 8: FILE 033
In middle of stilling basin
Velocity magnitudes - viewed looking downstream



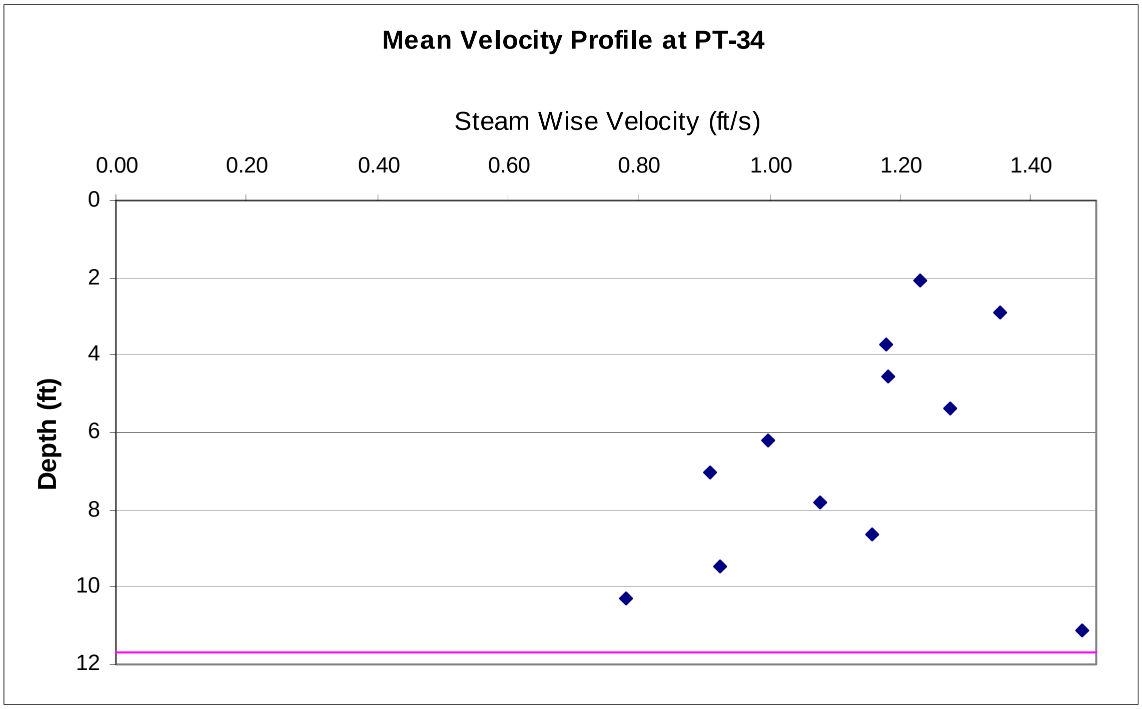
Transect 9: FILE 034
Downstream end of stilling basin
Velocity magnitudes - viewed looking downstream (NOTE: Velocity scale has been doubled)



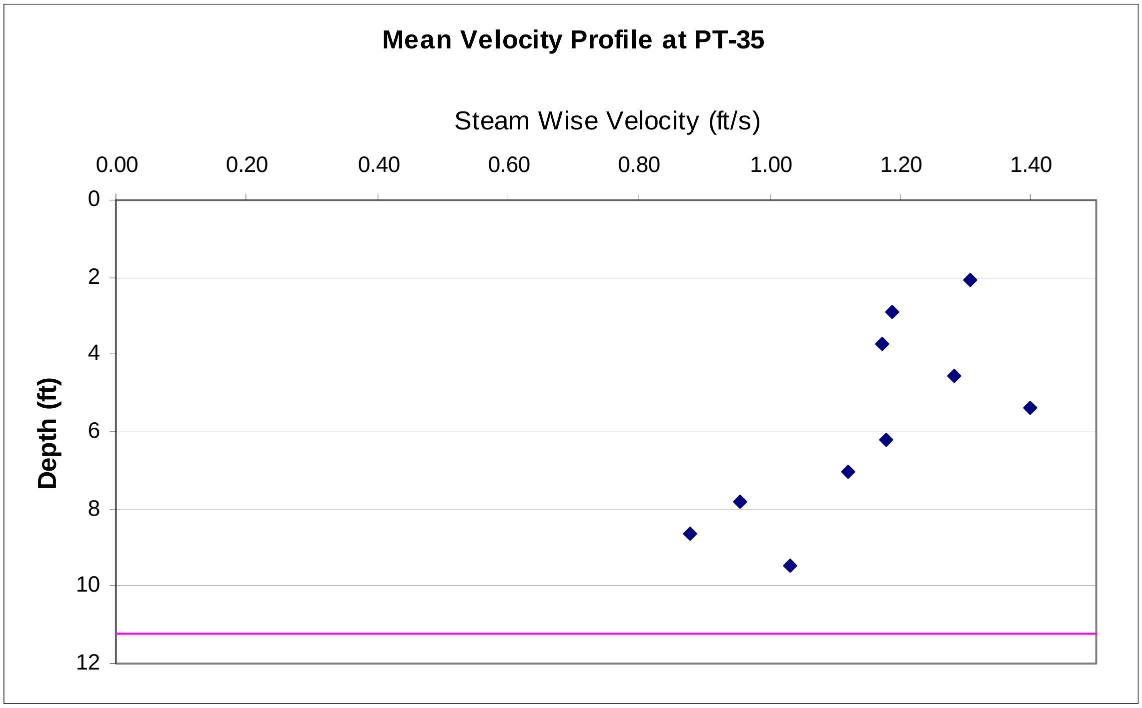
Transect 5: File 029
In front of trash racks with Bay 12 passing 125 cfs – includes stationary readings
Velocity magnitudes - viewed from upstream to downstream



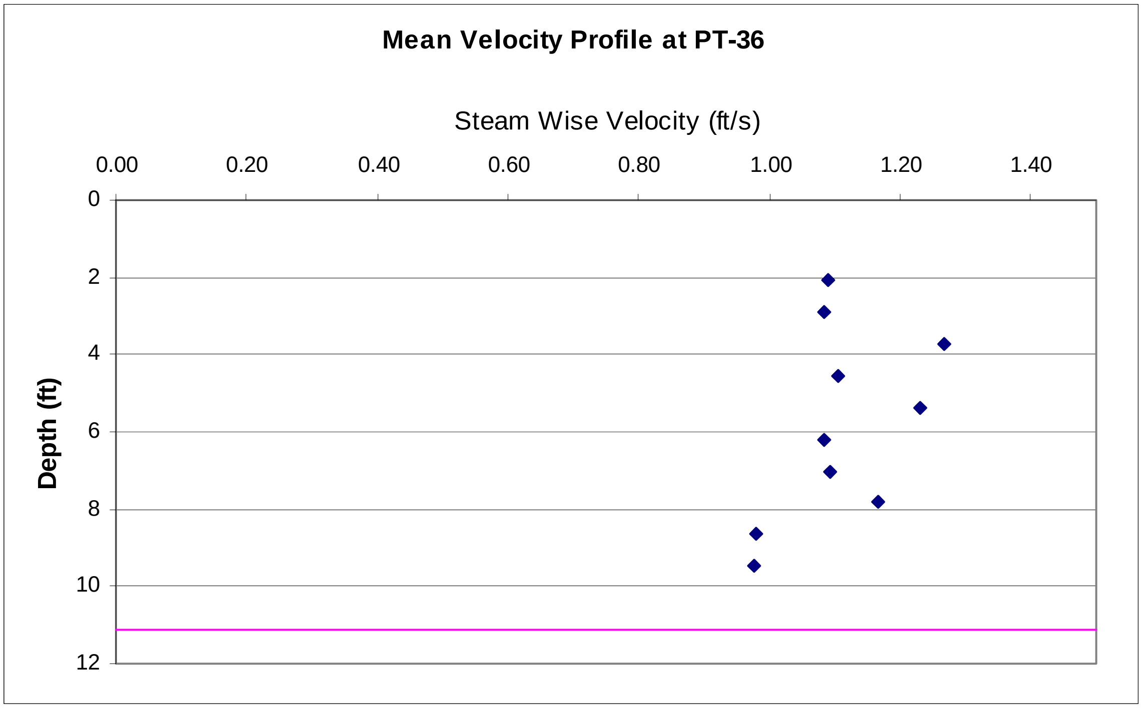
Vertical Velocity Distribution (File 029)
PT-34



PT-35


Mean Velocity Profile at PT-35
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12

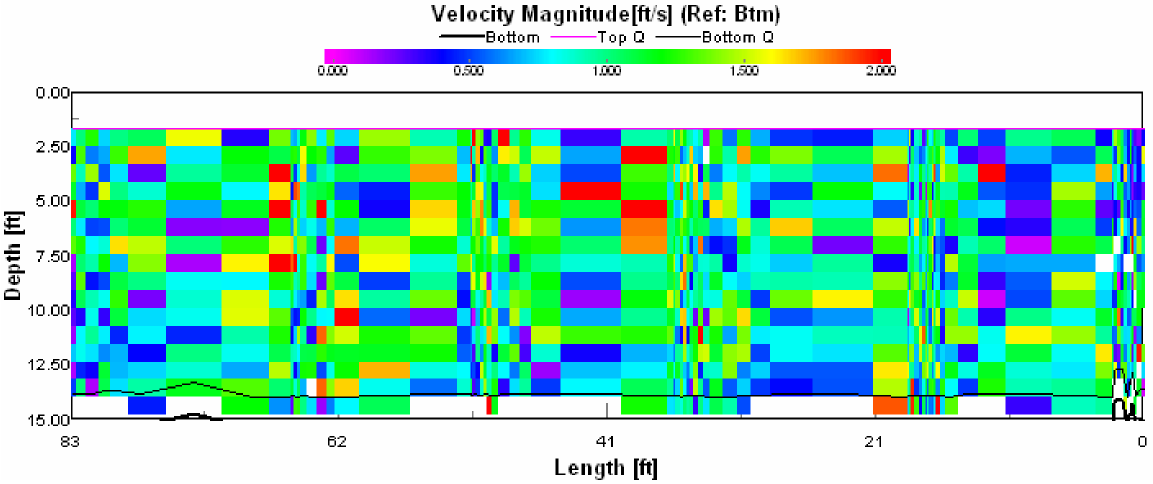
PT-36


Mean Velocity Profile at PT-36
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12

Transect 6: FILE 030

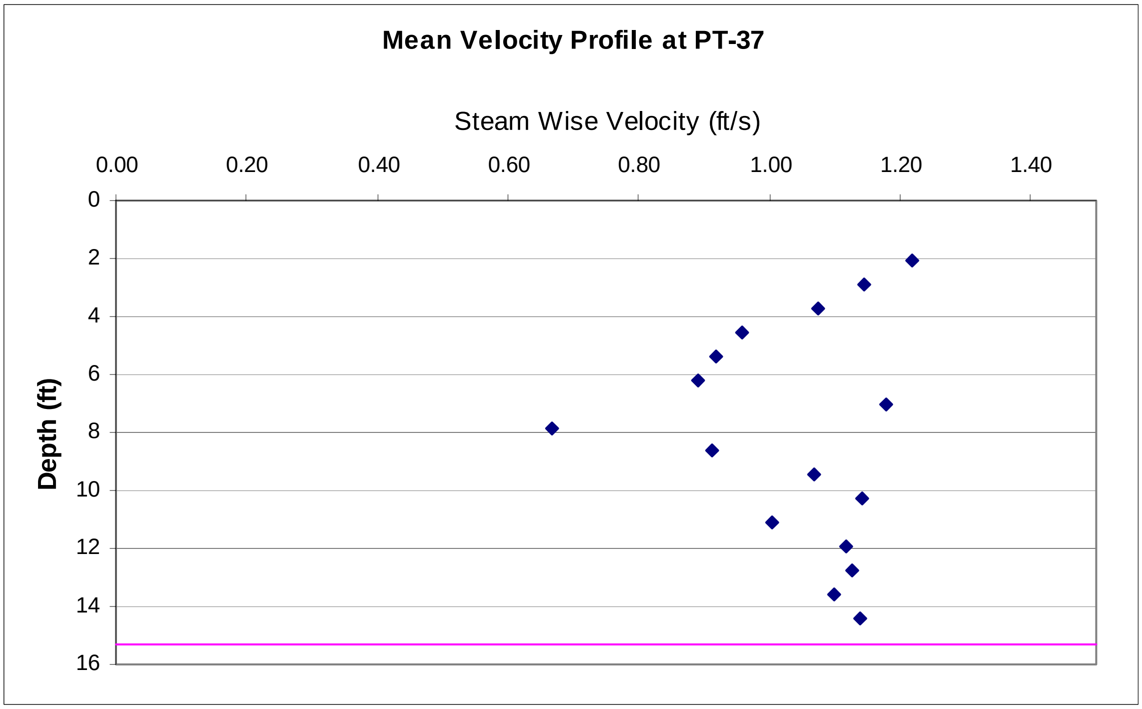
In front of Bay 12passing 125 cfs – includes stationary readings

Velocity magnitudes - viewed looking downstream

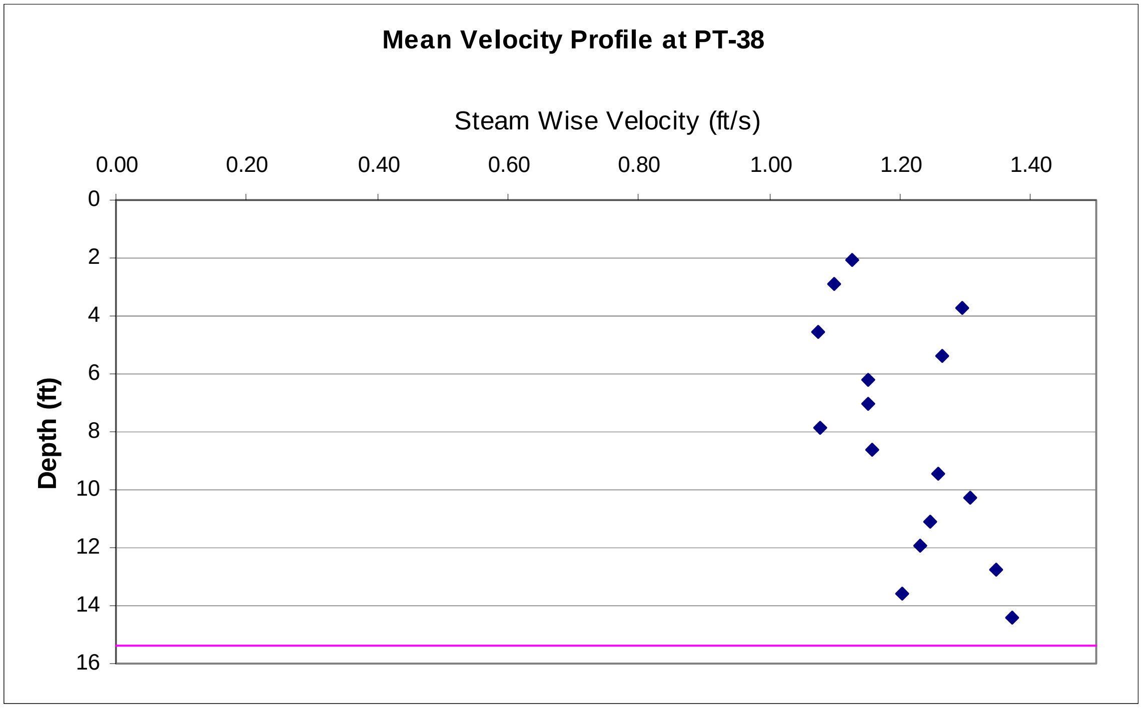


Vertical Velocity Distribution (File 030)

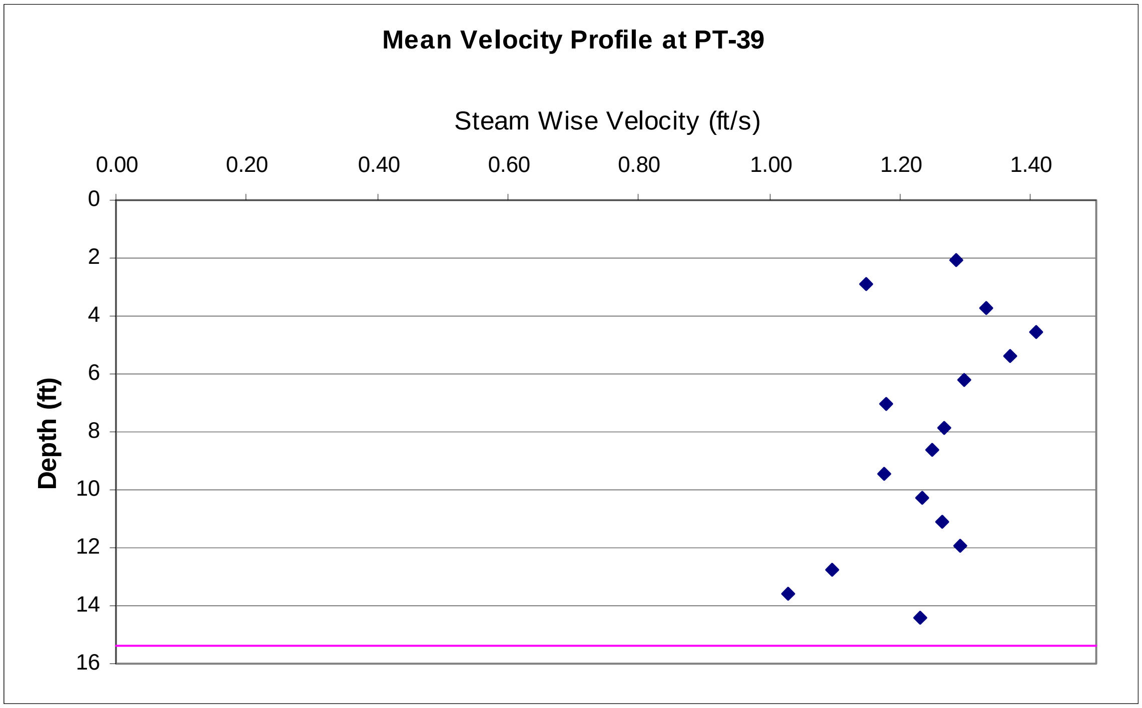
PT-37



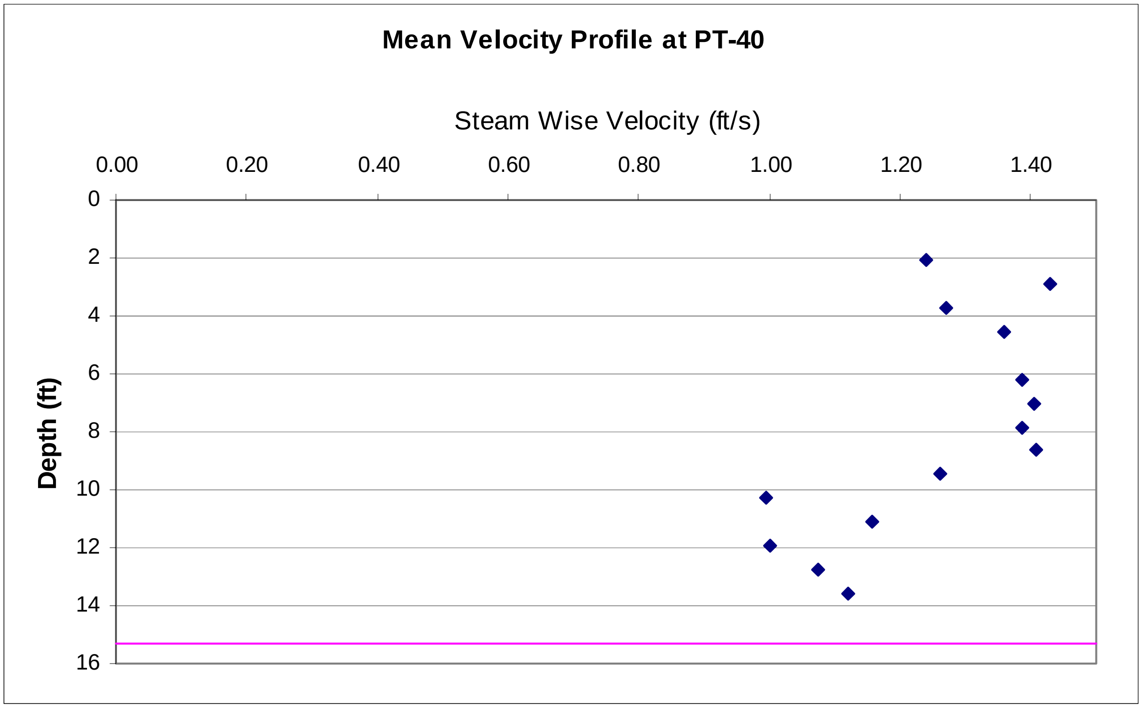
PT-38


Mean Velocity Profile at PT-38
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12
14
16

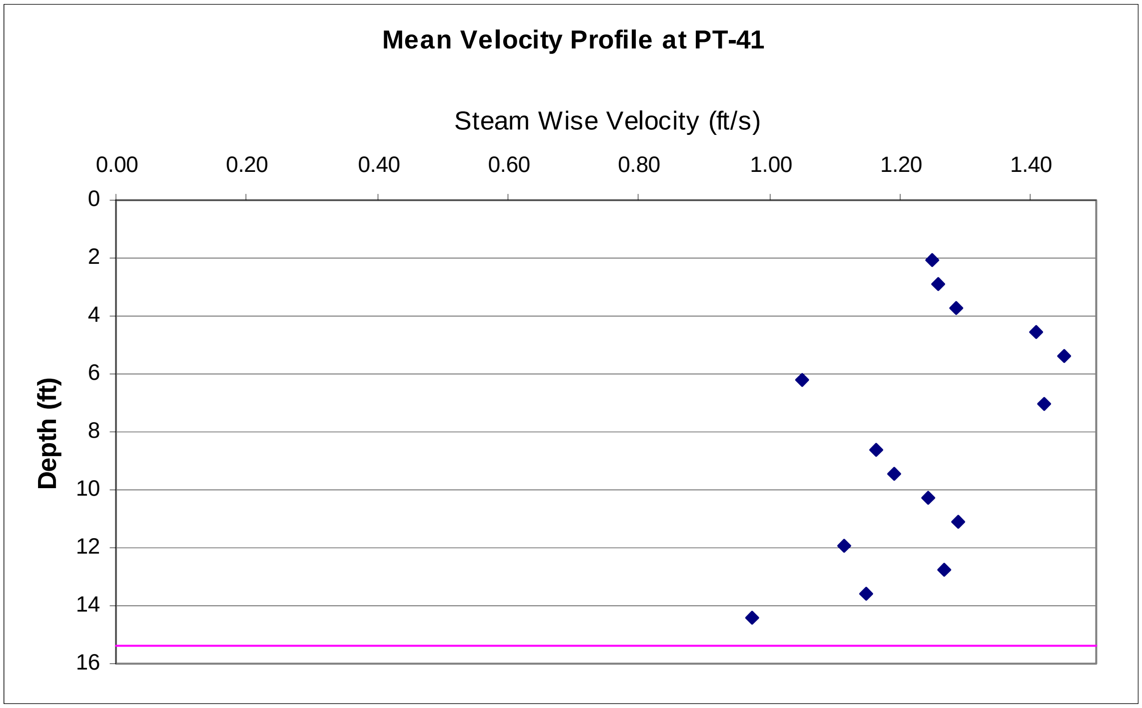
PT-39


Mean Velocity Profile at PT-39
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12
14
16

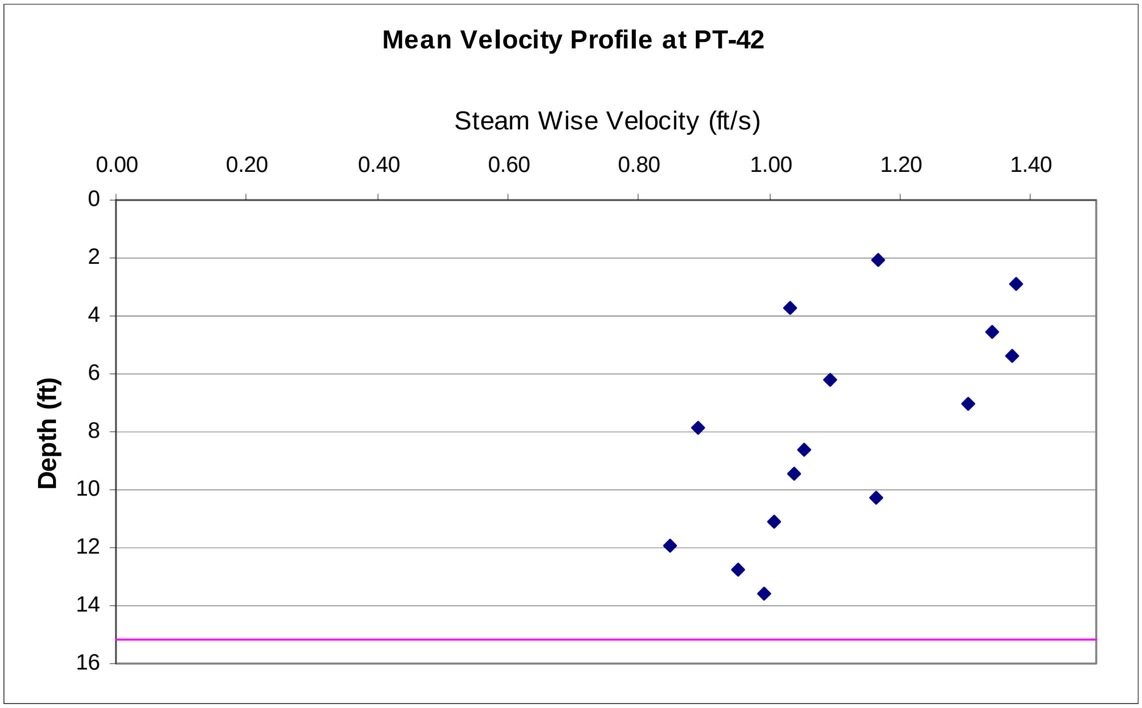
PT-40


Mean Velocity Profile at PT-40
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12
14
16

PT-41


Mean Velocity Profile at PT-41
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12
14
16

PT-42


Mean Velocity Profile at PT-42
Steam Wise Velocity (ft/s)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
Depth (ft)
0
2
4
6
8
10
12
14
16

Appendix C-6.2.

Interim Protocol for Reducing Suspended Sediment into the PSC from the Headworks during Large Storm Events

---

The protocols and recommendations have been compiled from SID, NHC, and SCWA and are designed to be flexible until all agencies are satisfied with the final results of the protocol.

1.) SID and SCWA will need to collectively watch daily weather forecasts and identify when a large storm(s) is likely to occur. Wet weather monitoring should occur from October 1st - May 1st and be composed of two alert levels:

- Level 1 (Low Risk) – This level will consist of daily monitoring of weather forecasts.
- Level 2 (High Risk) – This level will initiate the Interim Protocol and be triggered by the following:
  - Total precipitation from October 1 to current date is greater than 5.0 inches *(All storms occurring before this are considered to be low risk events)*
  - A single storm event producing greater than 0.75 inches of rain in a 24-hr period
  - Back-to-back storm events producing greater than 0.5 inches / day

2.) SCWA will provide a 24-48 hr notice to Stan Walker the Senior Operator of the Solano Project at SID, of the approximate day and time the event will arrive. The accuracy of the timing is probably within a 12-hr window. If weather forecasts are unpredictable, this should be clearly stated to the Solano Project operators so they are aware of the uncertainty.

3.) The Solano Project operators should avoid draining the PSC checks too much, in case the Headworks will need to be shut down. Traditionally during storm events, Solano Project operators lower the PSC to avoid spills. The purpose of this is to minimize flood spills at the Sweeney, Union, McCoy, and Terminal Checks which minimizes the impact of the PSC to local drainages. However larger volumes of water remaining in the PSC will allow the Headworks to be shut down longer. In practice Solano Project operators will have to rely on their experience on lowering down the canal, to both maximize water storage and minimize flood spills.

4.) Prior to the event SCWA staff should check reliability of telemetered turbidity and rain gage sensors. Sensors should be cleaned, checked, and calibrated if necessary. The stations of concern are:

- Pleasants Valley Creek at Putah Creek Road (Turbidity)
- Lake Solano at the Headworks (Turbidity)
- Putah Diversion Office (Precipitation)
- Sweeney Check (Precipitation)

5.) As the storm event approaches, Solano Project operators should closely watch the rain gage and turbidity stations. A PSC Operators Page will be setup showing (a) rain intensities and 24-hr totals for the Putah Diversion Office and Sweeney Check and (b) real-time turbidity at Pleasants Valley Creek and at the Headworks. This data will need to be real-time so that Solano Project operators can make quick and informed decisions.

6.) When turbidity at the Headworks exceeds 200 NTUs Solano Project operators should close the PSC gates at the Headworks. The PSC gates should remain closed until the turbidity levels decrease back to 200 NTU. If after 48-hrs the turbidity levels are still high, Solano Project operators will need to open up the PSC gates to meet demands and operational constraints.

7.) If a large turbidity plume enters into the PSC (Headworks turbidity ≥ 400 NTU), SCWA staff will watch the plume and determine if grab sampling is necessary. For winter time releases it will take approximately 1 day to reach Sweeney Check and 3 ½ days for the plume to reach NBR. If turbidities are in excess of 300 NTU at the Sweeney Check, SCWA should begin PSC grab sampling and notify WTP staff of the incoming plume and arrival time. PSC sampling should begin 24-36 hrs after the event has occurred at the Headworks. Grab samples will be collected at:

- PSC at the Headworks
- PSC at the Sweeney Check
- PSC at the Eldridge Pumping Plant
- PSC at Youngsdale Road

SCWA staff will work with the NBR laboratory to analyze the samples. The samples should be analyzed for turbidity, alkalinity, and any other constituents of concern for the WTPs. The sample results will be electronically distributed to Vacaville, Fairfield, Vallejo, SID and SCWA. Grab samples will be collected daily until (a) the plume reaches the NBR plant or (b) NBR and SCWA staff determine that the plume is no longer of concern.

8.) After the event has passed, SCWA will need to document the results of the Interim Protocol. SCWA and SID staff should periodically discuss the Interim Protocol to determine what problems still exist and how the protocol can be improved.

APPENDIX D

Appendix D-9.1

Filed Data Sheets for PSC Vegetation Presence Identification

Prepared by

Dr. Lars Anderson

October 2007

SID Canal- Macrophyte Presence Page 1 of 10 pages

Date: 10/3/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus Density Ranking: 1 = Low dens. 2 = mod. density 3 = High dens.

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
1.1	1								✓ 1	✓ BACOPA ? + GRASS
1.2	Mile 0.48								✓ 1	
1.3									✓ 1	
2.1	2								✓ 2	
.2	(Bridge)								✓ 2	BACOPA
.3									✓ 2	✓
	3 —									
4.1	4								✓ 2	✓ BACOPA
4.2									✓ 2	✓ MOSS
4.3									✓ 2	✓ Eleocharis sp.
5.1	5	Fragment only							✓ 1	
.2	0.74 miles								✓ 1	
.3									✓ 1	
6.1	6								✓ 1	
.2									✓ 1	
.3									✓ 1	
7.1	7								✓ 1	
.2									✓ 1	
.3									✓ 1 →	NOSTOC
8.1	8								✓ 2	
.2									✓ 2	
.3									✓ 2	✓ NOSTOC
9.1	9.								✓ 1	
.2									✓ 1	
.3									✓ 1	
10.1	10									✓ Horned pondweed
.2										
3										
11.1	11								✓ 1	
.3									✓ 1	
.3									✓ 1	

Wide Turn

SID Canal- Macrophyte Presence **Page** 2 **of** 10 **pages**

Date: 10/3/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
12.1	12								✓ 1	
.2									✓ 2	
.3									✓ 1	
13.1	13								✓	
.2	3.74 miles								✓	
.3									✓	
14.1	14								✓ 3	
.2	~4.0 miles								✓ 3	✓ Horned pondweed
.3									✓ 3	
15.1	15	—	✓ 1						✓ 3	
.2									✓ 3	
.3									✓ 3	
.1	14.25	-	✓ 1						✓ 3	
.2									✓ 3	
.3									✓ 3	
.1	14.5		✓ 1						✓ 3	
.2									✓ 3	
.3									✓ 3	
.1	16								✓	✓
.2									✓	Tetraspora 2
.3									✓	
.1	17		✓ 1						✓ 3	
.2									✓ 3	
.3									✓ 3	
.1	18		✓ 1							✓ Tetraspora
.2										
.3									✓ 1	
.1	19		✓ 3						✓ 1	
.2			✓ 3						✓ 1	
.3			✓ 3							
.1	20									✓ Horned pondweed 1
.2	7.5 miles									✓
.3										✓

SID Canal- Macrophyte Presence **Page** 3 **of** 10 **pages**

Date: 10/3/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-	
.1	21									✓	} 2 Horned pondweed leaches
.2										✓	
.3										✓	
.1	22									✓ 2	} Horned pondweed
.2										✓ 2	
.3										✓ 2	
.1	23									✓ 2	} Horned pondweed
.2										✓ 2	
.3										✓	
.1	24		✓ 1								
.2	8.84 miles									✓ 2	} Horned pondweed
.3			MS on grate							✓ 2	
.1	25	✓ 1 ←									
.2	9.7 miles		✓ 1							✓ 2	} Horned pondweed
.3										✓ 2	
.1	26	NB: no milfoil downstream from Tunnel								✓	
.2										✓ 2	} Horned pondweed
.3										✓ 3	
.1	27	✓	} 1st milfoil attached to							✓ 1	} Horned pondweed
.2			side of canal							✓ 1	
.3		✓ 1	✓ 1							✓ 1	
.1	28	✓ 1	✓ 1							✓ 1	} Horned pondweed
.2		✓ 1	✓ 1							✓ 1	
.3		✓ 1	✓ 1							✓ 1	
.1	29	✓ 1								✓ 1	} Horned pondweed
.2		✓ 1								✓ 1	
.3		✓ 1								✓ 1	
* .1	30	✓ 1	✓	} Tubers on							
.2			✓	Sago pondweed (SP)							
.3			✓								
.1	31									✓ 1	} Horned pondweed
.2										✓ 1	
.3										✓ 1	

→ Sago & Horned pondweed in middle
MS on inside turn only

SID Canal- Macrophyte Presence

Page 4 of 10 pages

Date: 10/3/07 & 10/9/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

/9/07.

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
	32		(ElNiño Rd)						✓ 1	✓ 1 Hornd pondweed
									✓ 1	✓ 1
									✓ 1	✓ 1
.1	1		✓ 3						✓ 1	
.2	13.2 miles		✓ 3	Tubers					✓ 1	+ Tetraspora
.3			✓ 3						✓ 1	
.1	2		✓ 3						✓ 1	
.2	13.6 miles	Frag.	✓ 3	(1 to 2 meters long)					✓ 1	Tetraspora
.3			✓ 3						✓ 1	
.1	3		✓ 1	very sparse					✓ 1	
.2			✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	4		✓ 2	(Decomposing Anoxic sediment)					✓ 1	
.2			✓ 3						✓ 1	
.3			✓ 3						✓ 1	
.1	5		✓ 3	(inside Turn)					✓ 1	
.2	14.66 miles		✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	6	✓ 1 2 plants	✓ 3	(inside turn)					✓ 1	
.2			✓ 3						✓ 1	
.3			✓ 3						✓ 1	
.1	7	✓ 3	✓ 1						✓ 1	
.2	Dense	✓ 3	✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	8	✓ 2	✓ 1							
.2	Dense	✓ 2	✓ 1						✓ 1	
.3									✓ 1	
.1	9		✓ 1						✓ 1	✓ Hornd 1 pondweed
.2	16.1 miles		✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	10		✓ 1	inside Turn only					✓ 1	
.2			✓ 1						✓ 1	
.3			✓ 1						✓ 1	

SID Canal- Macrophyte Presence Page 5 of 10 pages

Date: 10/9/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)

Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

1. BAY rt. plant

already 2and

S = [illegible]

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
.1	11		✓ 1	inside Turn only					✓ 1	
.2	16.41 miles		✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	12		✓ 1	inside Turn only					✓ 1	
.2			✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	13		✓ 1						✓	
.2			✓ 1						✓ 1	
.3			✓ 1						✓ 1	
.1	14								✓	
.2		✓ 1							✓ 1	
.3		✓ 1							✓ 1	
.1	15	✓ 3	✓ 3						✓ 1	
.2		✓ 3	✓ 3							
.3		✓ 3	✓ 3							
.1	16	✓ 3	✓ 3							
.2		✓ 1	✓ 3							
.3			✓ 3							
.1	17		NO PLANTS → narrow, fast flow? Cleaned?							
.1										
.2										
.1	18		NO PLANTS							
.2										
.3										
.1	19		✓ 2							
.2			✓ 2							
.3			✓ 2							
.1	20		✓ 3							
.2	19.56	✓ 1	✓ 3							
.3	miles		✓ 3							

SID Canal- Macrophyte Presence

Page 6 **of** 10 **pages**

Date: 10/9/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
.1	21	✓ 3	✓ 3							
.2	19.9 miles	✓ 3	✓ 3							
.3		✓ 3	✓ 3							
.1	22	✓ 2	✓ 2	} patchy						
.2		✓ 2	✓ 2							
.3		✓ 2	✓ 2							
.1	23		✓ 1							
.2	20.35		✓ 1	} + Tubers						
.3	Miles		✓ 1							
.1	24	✓ 1	✓ 1							
.2		✓ 1	✓ 1	} Mixed species						
.3		✓ 1	✓ 1	but in Separate colonies						
.1	25		✓ 1							
.2	20.11		✓ 1	} Tubers						
.3	Miles		✓ 2							
.1	26		✓ 2							
.2			✓ 2	} Tubers						
.3			✓ 2							

SID Canal- Macrophyte Presence **Page** 7 **of** 10 **pages**

Date: 10/17/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
1 .1	21.66	✓ 1	✓ 2						sparse	✓ Horned 2
(I-80) .2	mile			} Across entire bottom						
.3										
2 .1										
.2										
.3										
.1	3	✓ 1	✓ 2							✓ Horned
.2	21.81	✓ 1	✓ 2	) Tubers						1
.3	mile		✓ 1							✓ 1 Horned
.1	4	✓ 1	✓ 2	) Tubers						
.2			✓ 2	1° inside town						
.3			✓ 2							
.1	5	✓ 3	✓ 1							
.2	22.1 mi	✓ 3								
.3		✓ 3	✓ 1							
.1	6	✓ 3								
.2		✓ 3		) across entire bottom						
.3		✓ 0								
.1	7	✓ 3		) center of canal						
.2		✓ 3								
.3		✓ 3								
.1	8	✓ 3	✓ 1							
.2	23.25	✓ 3	✓ 1							
.3		✓ 3	✓ 1							
.1	9	✓ 2	✓ 1	) immediate upstream of Treatment Plant						
.2		✓ 2	✓ 1							
.3		✓ 2	✓ 1							
.1	10	✓ 3								
.2		✓ 3		) Pictures						
.3		✓ 3								
.1	11	✓ 3	✓ 1							
.2		✓ 3	✓ 1	) Across all bottom						✓
.3		✓ 3	✓ 1							

8.
12
,9, 11
,13,4

Nostoc
Tetraspora

SID Canal- Macrophyte Presence Page 8 of 10 pages

Date: 10/17/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
12.1	~24.1	✓2	✓1						✓	
.2	miles	✓1	✓1						✓	Nostoc
.3		✓2	✓1						✓	
.1	13	✓2	✓1						✓	
.2	~24.26	✓2	✓1						✓	✓ Horned small patch
.3		✓2							✓	
.1	14	✓3	✓1							
.2	24.48	✓3	✓1	Tubers					✓	
.3		✓3	✓1						✓	Notoc
.1	15	✓2	✓1						✓	
.2	24.67	✓2	✓1	Tubers					✓	Nostoc
.3		✓2	✓1						✓	
.1	16	✓2	✓1						✓	
.2		✓2	✓1	Tubers					✓	Nostoc
.3		✓3	✓1						✓	
.1	17	✓3	✓1						✓	
.2		✓3	✓1	Tubers					✓	Notoc
.3		✓3	✓1							
.1	18	✓3	✓1						✓	
.2	25.49	✓3	✓1	Tubers					✓	Nostoc
.3		✓3	✓2						✓	
.1	19	✓3+		very					✓	Nostoc
.2		✓3+	✓1	sparse sago					✓	
.3		✓3+							✓	
.1	20	✓1	✓1						✓	Typha? shoots
.2	26.20	✓1	✓1	very sparse					✓	
.3		✓2	✓1	sago						
.1	21	✓1							✓	
.2		✓1	✓1						✓	✓ Horned pondweed
.3		✓1							✓	1 (trace)
	22	✓3-							✓	
	27.45	✓3+							✓	
	miles	✓3+							✓	Nostoc/? other

→ some flowering

SID Canal- Macrophyte Presence

Page 9 **of** 10 **pages**

Date: 10/17/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
.1	23	✓ 1							✓	
.2	27.54	✓ 2							✓	Nostoc?
.3		✓ 1							✓	
	24	✓ 2								
	28 mile	✓ 3	> dense colony in							
	miles	✓ 2	center of canal only							
25	28.28	✓ 3								
	miles	✓ 2								
		✓ 2								
26	28.59	✓ 1								
	miles	✓ 2	> center only							
#		✓ 2								
Sample 27		✓ 1								
	28.75	✓ 2	> center of canal							
		✓ 2	~~[illegible]~~ + inside turn							
#28	28.97	✓ 1								
	miles	✓ 1								
	~~#29~~	✓ 1								
29		✓ 1	✓ ① — few plants						✓	
		✓ 1							✓	
		✓ 1							✓	
30	29.86	✓ 1	> dense patches							
	miles	✓ 2	+ bare areas							
		✓ 1								
31.1	30.45	✓ 1								✓ horned pondweed
.2		✓ 2								✓ P. foliosa
.3		✓ 1								leafy pondweed
#32	30.58	✓ 3								
	miles	✓ 3								
		✓ 3								
33.1		✓ 3								✓ leafy pond
.2		✓ 3	✓ — few plants							sago?
.3		✓ 3								

ct.

0.2 mi
= mi
(grate)

pict.

SID Canal- Macrophyte Presence **Page** 10 **of** 10 **pages**

Date: 10/17/07

Sample Method: (Thatch Rake/polyprop. Line; 3x throws per site across the width of the canal)
Species Key: MS=Myriophyllum spicatum; SP= Stuckenia pectinatus; PN=Potamogeton nodosus; PC= Potamogeton crispus; ED=Egeria densa; EC= Elodea canadensis; PG=Potamogeton gramineus

d of
st
pha

Sample Number	GPS ref. # (Waypoint) (mile marker)	MS	SP	PN	PC	PG	EC	ED	Fil. Algae	Other-
34.1		✓ 3								
.2		✓ 3	}	Flowering (Picture of flower.)						
.3		✓ 3								
35.1	31.48	✓ 3+								
.2		✓ 3+	}	Flowering						✓ Hornwort couple plants
.3		✓ 3+								
36	31.53	✓ 2								
		✓ 3								
		✓ 3	}							
37	31.75	✓ 3+								
		✓ 3+		Flowering						
		✓ 3+								
38	32 miles	✓ 3+								
		✓ 3+								
		✓ 3+								
39		✓ 3+							✓	
		✓ 3+	}	All flowering					✓	
		✓ 3+							✓	

APPENDIX E

Appendix E-10.1

FINDINGS: WATER QUALITY ISSUES
PUTAH SOUTH CANAL MUNICIPAL WATER USERS

June 30, 2007

nhc first realized the importance of water quality issues in December 2006 after discussions with a few municipal water users. Later in February 2007, **nhc** submitted a questionnaire to Putah South Canal (PSC) municipal water users that posed a number of questions regarding water quality or canal operation concerns related to water provided by the PSC. That questionnaire also included initial responses to the questions developed from earlier interviews and correspondence with personnel from the Waterman Water Treatment Plant (WTP) and the North Bay Regional (NBR) WTP.

Since December 2006, correspondence and interviews were conducted with operators from the following WTPs.

- *Waterman:* Denise Drumm, Scott Leland, and Dale McClintock
- *North Bay Regional (NBR):* Doug Rodgers and Laura Albidress
- *Cement Hill:* Carol Rameriz
- *Vacaville:* Rich MacLean
- *Green Valley:* Milos Teply
- *Fleming Hill:* Joe Abitong
- *Travis:* Roger Casper
- *Benicia:* Scott Hickman

Summaries for each plant:

The level of detail provided in response to the questionnaire varied depending on the particular WTP's dependence on water from the PSC in relationship to the plant's water needs, capacity and availability of alternate sources of water. Following are summaries from each WTP with respect to their dependency on PSC water, their plant's capability to bypass PSC water when it is of unacceptable quality or during canal cleanout operations, and the threshold at which high turbidity becomes problematic.

Waterman: PSC is the only water source for this treatment plant. The plant intake is located at milepost 23.50 on the north bank approximately 20 feet upstream from the Serpas Check (Figure 1). Water supply and water quality may periodically be affected by the close proximity of the plant's intake to the Serpas check. Occasional 24 hour bypass requirements can be tolerated. A 36 hour bypass may be feasible during an emergency (but it significantly stresses plant operations and jeopardizes water supply). Turbidities in excess of 200 NTUs affect plant operations and begin to make them difficult.

North Bay Regional (NBR): The plant uses both PSC and the North Bay Aqueduct (NBA) as water sources. The water intake is located at milepost 16.85 on the east bank (Figure 2). The plant typically has the capacity to bypass PSC water during periods of high turbidity and during canal cleanout in the fall. During the spring DWR cleans the NBA and the plant is then totally dependent on PSC water. Turbidity levels over 400-800 NTUs become problematic for the plant. During rare storm events, it is possible that high turbidity may occur at both raw water intakes simultaneously, especially during large storms in the winter. Such rare high turbidity events may require the plant to bypass water from both sources for a period of time. However, for most conditions NBR has the ability to draw, blend or bypass water from either the PSC or NBA. The ability to bypass or blend from these sources provides the plant with ample flexibility to handle most episodes of lower quality water from either source.

Cement Hill: The plant intake is located at milepost 19.61 on the south bank (Figure 3). PSC is the only water source for this plant. It can tolerate an 18 hour shut down and may have the capacity to bypass PSC flows for 24 hours during an emergency. Turbidities of up to 1,800 NTUs can be treated without substantial operational constraints.

Vacaville: The plant intake is located at milepost 12.84 on the west bank of the canal (Figure 4). PSC is used only during the high urban water use months (April-October) to meet peak water demands. The plant, when in use, is typically run 8-10 hours/day. The City's primary water sources are 10 City of Vacaville wells and some water from NBR. The April-October high use months typically correspond to the period when water quality in the PSC is the best. The Vacaville Plant discontinues (shuts down) its usage of PSC water for the season in the late fall, just prior to the commencement of canal cleanout operations which typically occurs in mid- to late October. The plant consists only of low-head filtration using diatomaceous earth, with chlorination. As a result, they cannot operate if turbidity in the canal exceeds 10 NTUs. The Vacaville Plant's important reliance on the PSC as a supplemental water source is expected to grow as the City's population increases. Their low tolerance for turbidity may be a significant constraint at times.

Green Valley: Water is taken from the Green Valley Conduit at milepost 32.33 (Figure 5), prior to the Terminal Reservoir. The plant has two lakes that also serve as water sources. However, they prefer to maximize PSC use because it has a much higher alkalinity than their lake sources. Their present 0.3 mgd allotment during the summer is a considerable constraint because it limits their access to preferred higher alkalinity water form the PSC. Turbidity of up to 300 NTUs can be tolerated and since they have the capacity to blend water, low water quality in the PSC during major winter storms and cleanout does not pose large operational problems for the plant.

Fleming Hill: Fleming Hill draws PSC water from the Terminal Reservoir at milepost 33.53 (Figure 6). The plant also has access to NBA water and has a storage reservoir. The combination of the two water sources and stored water give the plant considerable flexibility to blend water. PSC water is relied on primarily during winter months when NBA water can have high Total Organic Carbon (TOC) levels. The plant can tolerate turbidities up to 200 NTUs. Since water is drawn from the terminous reservoir instead of the canal, the effects of turbidity spikes are considerably dampened. Further operational flexibility is provided by having alternate water sources such that winter turbidity spikes and low water quality during PSC cleanout does not pose major operational constraints on the plant.

__Travis__: Travis draws PSC water during the winter from the Terminal Reservoir (Figure 6). Travis' principal water source is from the NBA. They tend to only use PSC water during the winter when TOC levels in the NBA rise to the level where trihalomethane (THM) formation and chlorine consumption becomes a problem. They can tolerate turbid inflows but since they draw water from the terminal reservoir they benefit from the dilution and settling effects of the reservoir such that turbidity from the PSC tends not to be an acute issue. Although there can be instances where both water sources are of lower quality, the PSC water is still the preferred source when NBA is experiencing high TOC levels because treating elevated turbidity is a more manageable constituent than is the THM/chlorine consumption issue and the higher alkalinity levels of the PSC make treating more turbid water from the PSC easier since alkalinity is consumed in the coagulation process.

__Benicia__: Benicia's primary water source is form the NBA; however, Benicia draws some PSC water from the Terminal Reservoir (Figure 6). PSC water is only used occasionally as a contingency to blend with NBA water during periods when water from the NBA has a high TOC levels. Last year, PSC water was only used for a period of two weeks.

Discussion:

Only the Waterman and Cement Hill WTPs rely exclusively on the PSC as their primary water source. As a result, low water quality events, such as the canal cleanout in the fall and winter turbidity spikes associated with severe storms directly affect the operation of these plants. Also, with no alternative source of water supply, periodic applications of copper sulfate in the PSC to control aquatic weed growth during summer months requires that these two plants shut down for short periods of time. They restart once copper levels have diminished to acceptable levels. The Waterman WTP is most directly affected by high turbidity in the PSC. Although both Waterman and Cement Hill have the capacity to treat highly turbid water using conventional approaches, the Cement Hill plant is less affected by turbidity spikes because they use clarifiers and different chemicals which result in fewer operational difficulties than Waterman during these relatively rare episodes of high turbidity.

The remainder of the WTPs have alternate water supplies, most commonly from the NBA. A common theme during interviews with the operators of these plants is that they typically prefer PSC water because it has higher levels of alkalinity (the addition of alum, which is used for coagulation forms hydrogen ions which can lower the pH to the point where aluminum and iron species remain in solution. There must be sufficient alkalinity present in order maintain the pH at levels that allow for effective coagulation to occur). Therefore, if both the NBA and PSC have the same turbidity, PSC is the preferred water source. The preference for PSC water extends even further since NBA water can have considerably higher TOC levels. Overall, high levels of TOC pose a greater problem for the WTPs than turbidity because of the resultant formation of THM as a by-product of chlorination. High TOC water often requires higher levels of chlorination, may result in greater consumption of chlorine residual within the distribution system, and may lead to unpredictable levels of THM formation, all of which can lead to risks to the public's water supply. In contrast, treating turbid water may be a more manageable and reliable process, even though operational costs to remove turbidity may be high at times. Thus, even during large winter storms when water from both NBA and PSC is turbid, PSC water is typically viewed as the preferred water source because of its higher alkalinity and lower TOC levels.

Another commonality among the interviews was the expressed benefit of the high level of communication and cooperation between the Solano Irrigation District (SID) and the WTPs and among the WTPs themselves. By necessity, the WTPs operate in real-time, i.e., their dosing and operations must change when source water quality changes. Rapidly changing water quality in their water supply poses real operational problems. Communication and coordination between the plant operators and SID alerts them as to when they can expect lower quality water to reach their intakes. SID's individual ditch tenders often give the operators detailed information as to when they can expect turbid water to reach them. Operators also rely on SCWA's web site to show them "real-time turbidity readings" at each of the SCWA monitoring sites so operators can assess if and when turbidity pulses will reach them. Therefore, it is very important to regularly maintain and calibrate the turbidity monitoring devises. This high level of operational communication and cooperation during canal clean-out and during major storms greatly ameliorates the difficulty of dealing with pulses of lower quality water.

Following is a summary of responses received from the water users that were interviewed. This summary may be slightly biased to reflect the perspective of the Waterman and Cement Hill WTPs, because they rely exclusively on PSC as their sole source for water supply.

Summary of Primary Water User Issues:

Water quality issues of concern vary seasonally as shown in Table 1. A general characterization, especially for those treatment plants that rely exclusively on the PSC for their source for water supply, is that water quality is acceptable for 9-10 months out of the year, and that the highest levels of turbidity (and low water quality) are associated with periodic short-duration events, such as intense storm events, or during or immediately after canal cleanout operations in the fall. Most reported water quality issues occur after high irrigation demands subside during the fall season and flows in the canal are reduced. Problems occurring in the fall are usually associated with some aspect of the annual canal cleanout operation and are usually short in duration. In all other respects water quality is typically the highest when irrigation flows in the canal are high.

Not all of the water quality issues listed in Table 1 can be practically addressed since they reflect normal, large-scale watershed processes involving the geology, soils, topography and vegetation within the Berryessa watershed which are beyond SCWA or SID's control. Examples include high Dissolved Organic Carbon (DOC) levels at the start of the runoff season, low alkalinity during spring following high runoff years, or problems associated with source switching or blending with other raw water sources having different water quality characteristics.

Remaining water quality issues relate to the two primary sources of sediments entering the canal (upper watershed sediments and localized lateral drainage sediment sources) and problems associated with growth, treatment and removal of higher aquatic vegetation and sediment deposits from the canal. High suspended sediment concentrations associated with runoff from the intervening watersheds between Lake Berryessa and Lake Solano during large storm events can enter the PSC unless the entrance gates at the headworks are closed. Sediment that enters the PSC through the headworks, works its way along the canal throughout the winter and irrigation seasons and deposits in locations where currents are low. Watershed-source sediments deposit in front of the canal forebay during and after the large storm events. These deposits provide a large annual source of sediment and viable aquatic vegetation materials in very close proximity to the PSC intake that may work its way into the canal during the ramp-up of spring irrigation flows following the winter low-flow period. Additional fine sediments can enter and deposit in the canal from localized lateral runoff sources and from earthen embankment sloughing or erosion during winter rains.

Deposited sediments encourage the growth of aquatic vegetation, particularly aquatic macrophytes that rapidly colonize sediment deposits on the canal bottom as well as in panel cracks and seams. Thick mature patches of aquatic macrophytes encourage further capture and settling of fine sediments from the water column and provide a location where inorganic sediments combine with vegetation and other organic detrital materials. These thick mats of sediment and organic materials often become anaerobic during the summer and fall and become sources of hydrogen sulfide and other odor-causing and water quality treatment problems, especially during annual canal cleanout operations. Thick “forests of aquatic vegetation” can reduce water treatment plant intake efficiency and lead to increased maintenance needs. This situation occurs frequently at the Waterman WTP’s intake that is located just upstream from the Serpas Check structure (Figure 1).

These watershed and in-canal processes give rise to the two principal water quality issues that PSC water users have to deal with: (1) high turbidity during major storms, along with the occurrence of turbidity spikes at the start of the irrigation season; and (2) the generation of exceptionally low quality water within the canal during the short period while canal cleanout operations are underway. A minor water quality issue occurs periodically when copper sulfate is applied in some of the checks to control the growth of aquatic weeds which necessitates temporary shut down of WTPs until levels of copper subside. These issues are discussed in detail below.

Water Quality Impacts Associated With Cleanout Activities:

Of the two primary water quality issues discussed above, the fall cleanout operations generate the greatest concern for Waterman and Cement Hill WTPs that rely exclusively on PSC water for their supply. Cleanout activities create water with high turbidity, high levels of objectionable odor, black color, low dissolved oxygen, and high levels of dissolved iron (Fe) and manganese (Mn). Following are the primary challenges for treatment plant operators during the fall: (1) they have to periodically treat for poor water quality; (2) they have to meet increasing public demands for PSC water especially during warm weather periods; and (3) they need to manage supply and demand during period of interrupted supply during cleanout. SID’s primary challenges relate to increasing regulatory constraints on how canal cleanout and vegetation management operations can be performed: (1) there is now a prohibition against using wasteways along the PSC to sluice residual sediment deposits from the canal during cleanout operations; (2) extremely low canal gradients severely limit SID’s ability to drain and clean the canal rapidly; (3) and limited storage and increasing demand for urban water supply limits the amount of time treatment plants can be off-line during canal cleanout; (4) options for the chemical treatment of aquatic vegetation is becoming more limited. This gives rise to the need to re-water sections being cleaned or drained in order to supply downstream water users, such that cleaning can be done only for short periods of time between individual checks. This, in turn, can make the logistics of both the canal cleanout and WTP operations especially complicated. SID and the WTPs work well together to coordinate canal cleanout operations; however, more increasingly difficult operational and time constraints are being placed on both parties.

During cleanout, 3 sections (checks) of the canal are drained (partially drained) at a time to allow equipment access into the canal to mechanically remove accumulated sediments and organic detritus from the canal. Very low density, thick fluid-like canal deposits and sludge (Figure 7) prevents it from being entirely removed by tractors or excavation equipment. These materials are easily disturbed by mechanical equipment and once these materials are disturbed, the remaining residual sludge easily comes into contact and mixes with clean water as the canal is refilled.

Therefore, elevated levels of turbidity during and after cleanout are more problematic than elevated turbidity levels associated with winter storms, but this is more because of the nature of the material and its association with other difficult-to-treat water quality constituents. During cleanout, turbidity can vary between 5-80 NTUs over a 12 hour period but elevated levels of turbidity tend to abate quickly once cleanout activities are complete.

In general, intake water immediately after cleanout requires very high levels of chlorine, which is itself an issue as a precursor to the formation of THMs. For example, at the Waterman WTP, THMs reached levels approaching 50 µg/l after cleanout, as opposed to typical concentrations of 4-6 µg/l. At Waterman WTP, it was also found that the chlorine residual of treated water leaving the plant was rapidly consumed, which is a potential public health issue. The bacteriological quality of intake water during and immediately after cleanout is typically very poor. Levels of DOC are not exceptionally high, but the levels of chlorine required to obtain the mandated residual are often very high and are disproportionate to the levels of DOC in the influent water.

Another key issue is that the canal sludge contains a very high load of decomposing organic material which apparently creates anoxic conditions. After cleanout, influent water can have a black color, strong odor and elevated levels of hydrogen sulfide. It is also possible that anaerobic conditions within the canal bottom sediments results in the reduction and dissolution of metals which are then mixed into the water column once the canal is refilled. For example, a sample of the canal water taken on November 9, 2006 at the NBR intake by Laura Albidress had concentrations of 72.4 mg/l of iron, 1.6 mg/l of manganese, and 0.43 mg/l of copper. These levels exceed the secondary drinking water MCLs for iron and manganese. Typical PSC concentrations are less than 1.0 mg/l for iron and are non-detectable for manganese and copper. High levels of soluble multivalent cations of Fe and Mn, which are in reduced form, are highly effective at combining with reactive chlorine species. Weekly laboratory sheets provided by the Waterman WTP showed a significant jump in chlorine doses when manganese concentrations increased over one mg/l.

Water quality during and immediately following cleanout is becoming progressively worse. NBR WTP reports that prior to 2004, there was no need for high levels of chlorination at NBR and Waterman WTPs. Waterman, Cement Hill and NBR WTPs all report a very serious upward trend in THMs during cleanout without any commensurate upward trend in DOC. Upward trends in dissolved iron and manganese have been noted, and increased black color, hydrogen sulfide and odor also appear to be taking place.

Cement Hill and Waterman, which rely exclusively on PSC water, are having the greatest difficulties in dealing with high levels of black color, turbidity, high objectionable odor, and high THM formation.

There may be a relationship between a trend in increasing duration and severity of anoxic residual water conditions and increasing levels of THMs during the cleanout period that is associated with the mandated inability to use the wasteways and the possibility of a “carryover” load of organic detritus that now remains in sections of the canal. The fact that DOC levels have not been increasing may be associated with different forms/species of carbon associated with anaerobic decomposition that have a greater affinity for THM formation than does the typical DOC species (associated with aerobic decomposition) entering the canal at the headworks. Specific effects of organic loading resulting from the growth and management of aquatic vegetation in the PSC is unknown at this time, but may be an important factor.

While water quality immediately after localized cleanout operations may be very poor, it fortunately tends to be unacceptable for only about 24 hours after the check is refilled. However, treatment plants with takeout structures located just upstream from canal check structures may experience more severe and longer periods of poor water quality then those located further away from checks.

In summary, cleanout operations pose the largest annual canal operation and water quality treatment problems because of the inavailability of continuous water supply during cleanout (especially for those plants wholly dependent on the PSC) and the very poor water quality that can occur immediately after a check is refilled. Cleanout operations are also difficult for SID to manage and coordination with all affected parties relying on PSC water. Cleanout activities result in the need to bypass the flow at WTPs, requiring higher water treatment production rates prior to shut down to ensure all available storage capacity is filled. Cleanout activities yield a large number of constituents at unacceptable levels (bacteria, organics, color, and high metals). Very poor water quality during restart results in greatly increased treatment costs (ozone, chlorine, alum, etc.). Variable PSC water quality during cleanout may also decrease plants reliability and increase risks of unacceptably high levels of THMs and unacceptably low levels of chlorine residual in the distribution system.

High Turbidity Levels During Major Winter Storms and Spikes During Start Up of Irrigation Season:

During the winter and spring, the primary constituent of concern is fine suspended sediment that causes turbidity spikes during intense or prolonged storms. In general, short term turbidity spikes of less than 200 NTUs do not pose a problem for the WTPs. However, turbidity levels significantly greater than 500 to 1,500 NTUs have been observed. The WTPs have varying capacities to treat highly turbid water because of different treatment processes. For example, turbidities in excess of 200 NTUs begin to pose difficulties at the Waterman WTP, whereas turbidities of up to 1,800 NTUs can be accommodated at the Cement Hill WTP. However, in both cases, treatment costs increase significantly.

During typical winter and spring runoff conditions, the occurrence of turbidity spikes does not result in the need to shut down inflows from PSC. Even if exceptionally high turbidities necessitated a shut down, water demand during the winter is at its cyclic low point such that the finished water in storage is usually able to meet demand for a much longer period of time than during fall cleanout.

The WTPs have the capacity to “look ahead” to discern if a turbidity spike is approaching their intakes in the canal. Both the real-time SCWA turbidimeters and communication between SID canal tenders and WTP operators provides a warning of when high turbidities may reach a given WTP. At the Waterman WTP, the typical lag time between entry of highly turbid water at the headworks and its appearance at the plant is typically 3-4 days. In general, locally generated turbidity from lateral inflows during storms tends to be minor, up to 20 NTUs (unless the storm is extreme) in comparison with the turbidity of influent water into the canal at the headworks.

With the obvious exception of the rare December 31, 2005 event, there have been no discernable negative trends in winter turbidity over the past several years. Overall, there seems to be less of a turbidity problem now than there has been in the past. This is likely due to a series of years following 2000 that resulted in flooding on Sweeny Creek and inflows of Sweeny Creek flood waters into the canal through a back-siphon. SID subsequently installed a flap gate that eliminated the problem.

Storm related turbidity spikes have little correlation with other constituents, except possibly bacteria and declines in pH and alkalinity during periods of high runoff from the watersheds. At the startup of the irrigation season (when flows in the PSC increase by an order of magnitude) regular turbidity spikes (typically within 200-500 NTUs) are often recorded at the SCWA's turbidimeter installed at the canal headworks. The cause of these turbidity spikes is uncertain. Possible causes could be re-entrainment of sediment deposited in the Lake Solano in front of the canal forebay (Figure 8) and entrainment of aquatic vegetation and sediment deposited on the trash screens (seen in Figure 9) by the increased canal inflows and disturbed by trash screen cleaning operations. These turbidity spikes are observed only at the headworks, do not propagate below Sweeny Check, and therefore do not seem to pose a problem for the WTPs. The cause and magnitude of this phenomenon merits further investigation and will be monitored next spring.

Copper Sulfate Dosing to Control Aquatic Vegetation:

Slow velocities and the entrainment of fine sediment and aquatic vegetation into the canal at the headworks gives rise to a propensity for the canal to produce large volumes of algae and aquatic macrophytes. Growth of these materials, in turn can foul take-outs and check structures and reduce the flow capacity in the canal itself. Control of aquatic vegetation is presently accomplished through periodic dosing of the canal with copper sulfate which leads to excessively high levels of dissolved copper for short periods of time. This necessitates the WTPs to shut down their water intakes until levels of copper return to acceptable levels. This situation is manageable and is being accomplished through close coordination and good communication between SID and the individual WTPs. It nonetheless interrupts and complicates WTP operations and creates a risk of excessive copper entering the WTP.

Table 1. Summary of Primary Seasonal Water Quality Issues Experienced by Water Users.

Winter	Spring	Summer	Fall
High turbidity Low alkalinity	High turbidity Low alkalinity	Weed control High organics High hardness	Cleanout operations Interrupted supply Weed control High organics High solids High Fe & Mn High Cl demand High treatment costs

These issues are amplified immediately upstream of checks

Figure E-10.1.1 Waterman WTP intake (milepost 23.50).

Figure E-10.1.2 North Bay Regional (NBR) WTP intake (milepost 16.85).

Figure E-10.1.3 Cement Hill WTP intake (milepost 19.61).

Figure E-10.1.4 Vacaville Plant intake (milepost 12.84).

Figure E-10.1.5 Green Valley Conduit (milepost 32.33).

Figure E-10.1.6 Terminal Reservoir (milepost 33.53).

Figure E-10.1.7 Easily suspendable fluid-like deposits in PSC.

[redacted]

Figure E-10.1.8 Sediment deposits in Lake Solano in front of PSC headworks.

Figure E-10.1.9 PSC headworks trash screens.

Appendix E-10.2

SOLANO COUNTY WATER AGENCY

MEMORANDUM

TO: **David Okita, Thomas Pate, Bob MacArthur (NHC)**

FROM: **Alex Rabidoux**

DATE: **November 16, 2007**

SUBJECT: **PSC Cleanout Operations – WTP Shutdowns**

During the 2007 PSC cleanout operations, both the Waterman WTP and Cement Hill WTP have had serious problems treating the cleanout residual water and have had to shut down several times. A brief summary of the problems that the WTPs are facing is presented below.

Waterman WTP (Contact – Denise Drum):
The Waterman WTP has experienced water quality problems with the PSC cleanout over the last several years. The water quality problems have arisen since SID was stopped from using the sluice gates (such as McCoy) to empty out the dirty slugs of water from the cleanout operations. For the 2007 PSC cleanout, the Waterman WTP has had to shutdown 5 times due to water quality problems. Over the next 2 weeks, the plant has 4 scheduled shut downs and water treatment personnel expect they will have to shut down 2 more times due to poor water quality. In 2005, the plant had to shut down 13 times in 30 days. The WTP shutdowns this year have been due to a high concentration of dissolved organic matter, iron, and manganese as well as high levels of color and odor. The turbidity has actually been low, with the highest level reaching 12 NTU. According to Denise, the water has had the color of tea, which is an indication of a high concentration of dissolved organic matter, which is very difficult for the plant to treat. The Waterman WTP has tried to treat the PSC cleanout residual water, but due to the high levels of dissolved organic matter and the high chlorine demand, the TTHM production is too high. Additionally, the Waterman WTP uses preozonation to reduce the concentrations of organic matter into the plant, but even with preozonation the WTP cannot treat the cleanout residual water.

P.O. Box 349, Elmira, California 95625
(707) 451-6090, FAX (707) 451-6099

SOLANO WATER
• WASTE NOT • WANT NOT •

NBR WTP

The NBR WTP has been using 100% NBA water to avoid water quality problems with the PSC cleanout. Nevertheless, the NBR WTP cannot physically serve all of Fairfield, which is why the Waterman WTP cannot be shut down for longer than 24 hrs.

Cement Hill WTP (Contact – Carol Ramirez)

The Cement Hill WTP serves Suisun City and is a Joint Powers Authority between the City of Suisun and SID. During October 22-23 the Cement Hill WTP had to shut down due to poor water quality, similar to the Waterman WTP. However, this was the first time that the Cement Hill WTP had to shut down due to PSC cleanout operations outside of their check. Similar to the Waterman WTP, the water quality had high concentrations of dissolved organic matter, low turbidity, and had the color of brown tea. The Cement Hill WTP was forced to use the emergency inter-tie with the City of Fairfield for 28 hrs. The emergency inter-tie worked as designed.

In conclusion, during the PSC cleanout operations the PSC water quality can be unreliable and challenging for the WTPs to treat. The high concentration of dissolved organic matter and high chlorine demand appears to be the single largest problem for the WTPs.

FILE: S-11D

Appendix E-10.3

MEMO to SCWA November 21, 2007

PSC Water Quality During Cleanout Operations

Northwest Hydraulic Consultants (NHC) is conducting PSC cleanout monitoring and is preparing estimates of "pre-cleanout sediment accumulations" in the PSC. Once cleanout operations are completed and the canal is refilled, we will return to the canal and estimate the amount of residual sediment left after cleanout. NHC collected bottom material samples during cleanout operations and will send selected samples to a laboratory for materials characterization. Results from these tasks will be summarized in a brief 2007 PSC Canal Cleanout Report and compared with last year's results summarized in the 2006 Canal Cleanout Report.

During this year's cleanout several of the water treatment plants observed elevated turbidity, color, odor, high concentrations of Fe and Mg and other water quality and water treatment problems (see MEMO from Alex Rabidoux, 11-16-07). On Monday November 19th, NHC collected 12 water samples from the PSC in the vicinity of on-going cleanout operations (in the Serpas, Burton and McCoy checks). A listing of these samples is provided in Table 1. These samples were taken to the NBR Water Treatment Plant and stored in their refrigerator until SCWA, NHC and the water users decide what water quality analyses should be conducted on these samples. Photos of cleanout operations and water sampling conducted by NHC on November 19th are provided below.

NHC, SCWA and the water treatment plants need to discuss what water quality tests should be conducted on the samples that were recently collected. Sufficient analyses should be conducted to be able to identify major Baseline water quality conditions being experienced during cleanout operations. These data along with data collected last year and this year by individual treatment plants should be gathered and summarized in order to identify (1) key constituents in the bottom deposits that lead to significant water treatment problems during cleanout, and (2) other key indicator constituents that may need to be assessed further (this year or during future monitoring) if future canal wasteway permits are to be sought. Results from these preliminary lab analyses will provide important information about likely water quality issues we are presently dealing with and what additional tasks and information may be required if SCWA decides to consider other cleanout, prevention or treatment strategies.

Therefore, NHC recommends that we meet to discuss the following items:

1. What water quality tests should be conducted on the 12 samples listed in Table 1? Can the water treatment plants conduct those tests in their labs?
2. What "next steps" are needed by SCWA to better address their concerns and questions regarding canal cleanout strategies? As an example: Mention was made that SCWA may wish to evaluate opportunities to re-initiate usage of the McCoy wasteway.
3. Define possible future tasks (scopes and costs), develop schedules
4. Prioritize on-going and possible future tasks to meet urgent and/or overall objectives of SCWA, SID and water users.

Please refer to Table 1, Figures 1-5 and to the brief discussion on page 4 of other observations associated with aquatic vegetation and organic detritus found in the canal.

Figure E-10.3.1 Photo of Bobcat scooping up vegetation and settled materials in PSC during 2007 cleanout operations.

Figure E-10.3.2 Photo of Long-Reach backhoe removing vegetation of settled materials from canal and placing it along the bank to dry.

Figure E-10.3.3 Bobcats working in the canal collect materials and dump them into a large bucket that is hoisted out of the canal and deposited in drying basins next to the canal.

Figure E-10.3.4 Water sample being collected next to Waterman Treatment Plant Intake on November 19, 2007.

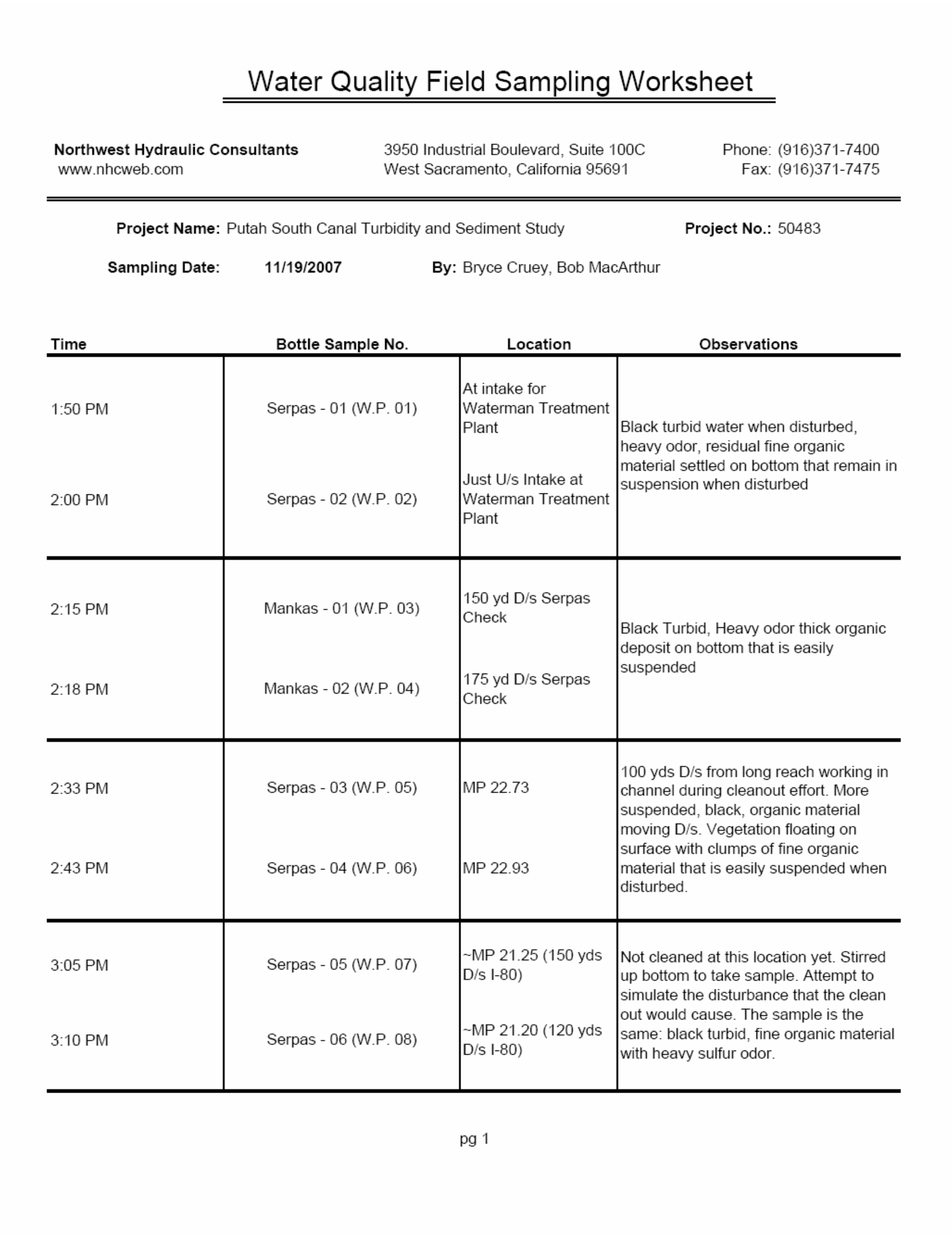
Figure E-10.3.5 Water samples from canal during cleanout. Bottle on the right was just collected; sample on the left had settled for about 30 minutes. Both contain high concentrations of organic materials with little or no sediment.

Observations Related to Vegetation and Residual Organic Materials in the PSC

Because of the low density and fine, floc-like characteristics, these materials shown in Figure 5 are easily suspended into the water column during cleanout and are very difficult to collect and remove from the canal using traditional mechanical means. Increasing growth of aquatic vegetation along with the requirement to discontinue the use of "wasteways" may be contributing to the net accumulation of these kinds of materials in the canal. Residual deposits of these materials after cleanout are likely to contain viable fragments of vegetation, seeds and rhizomes that may lay dormant through the winter months and sprout into new aquatic plants in the spring. Therefore, these materials are not only difficult to remove from the canal, but are capable of rapid re-growth in the spring if they remain in the canal. Decaying organic material deposits left on the canal bottoms are likely to harbor other mico- and macro-organisms that aid in the breakdown of vegetative materials into other dissolved and particulate forms of material. These biological processes may lead to the development of high concentrations of dissolved forms of Fe and Mg that greatly affect chemical treatment processes at the water treatment plants. Observed spikes in pH and elevated concentrations of Fe and Mg during cleanout may be related to these processes.

NHC recommends that we (SCWA and NHC) obtain input from the water treatment plants to determine what data they have to help quantify these problems and to discuss possible alternative strategies to mitigate these problems.

Table 1



Water Quality Field Sampling Worksheet

Northwest Hydraulic Consultants
www.nhcweb.com

3950 Industrial Boulevard, Suite 100C
West Sacramento, California 95691

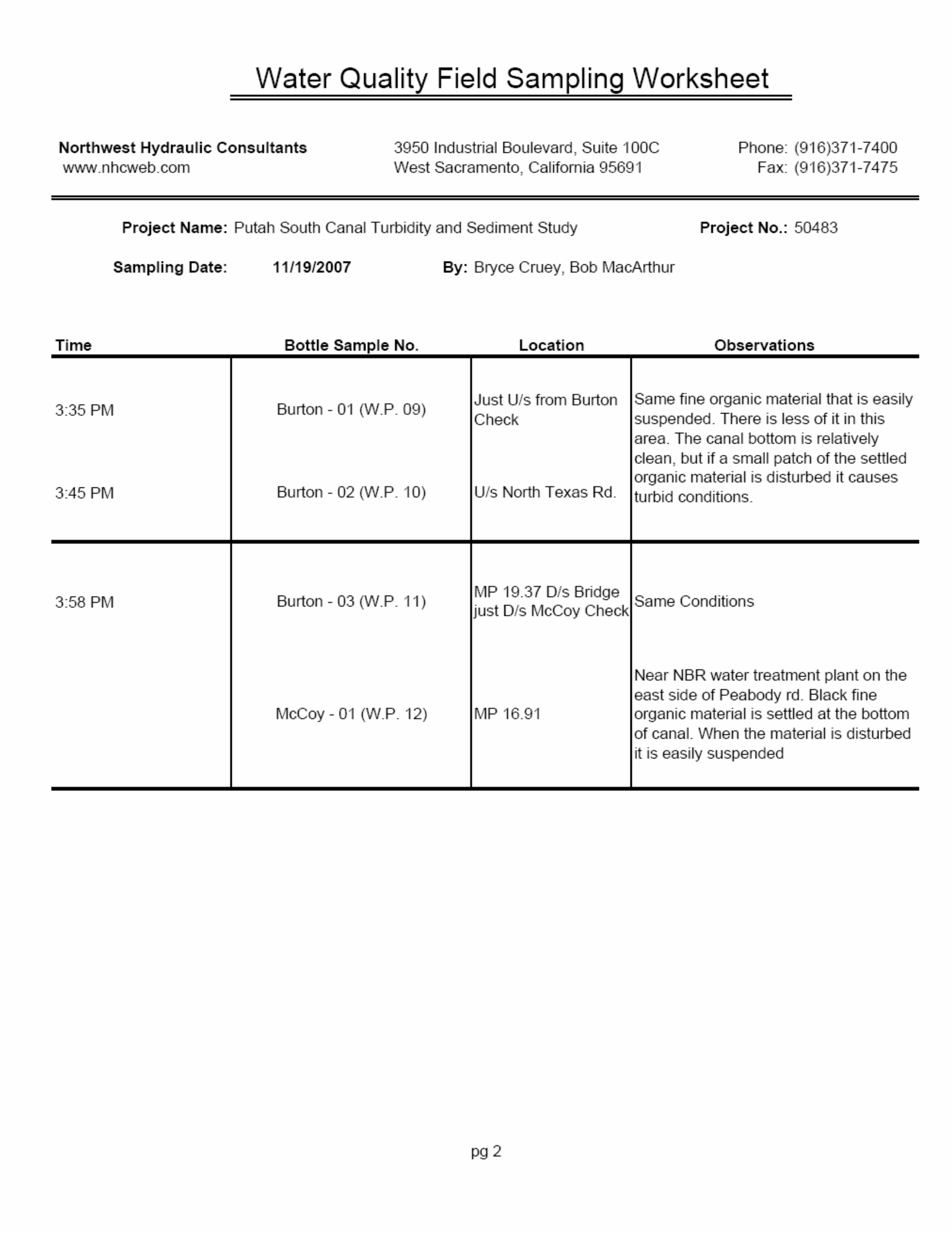
Phone: (916)371-7400
Fax: (916)371-7475

Project Name: Putah South Canal Turbidity and Sediment Study **Project No.:** 50483

Sampling Date: **11/19/2007** **By:** Bryce Cruey, Bob MacArthur

Time	Bottle Sample No.	Location	Observations
1:50 PM	Serpas - 01 (W.P. 01)	At intake for Waterman Treatment Plant	Black turbid water when disturbed, heavy odor, residual fine organic material settled on bottom that remain in suspension when disturbed
2:00 PM	Serpas - 02 (W.P. 02)	Just U/s Intake at Waterman Treatment Plant	
2:15 PM	Mankas - 01 (W.P. 03)	150 yd D/s Serpas Check	Black Turbid, Heavy odor thick organic deposit on bottom that is easily suspended
2:18 PM	Mankas - 02 (W.P. 04)	175 yd D/s Serpas Check	
2:33 PM	Serpas - 03 (W.P. 05)	MP 22.73	100 yds D/s from long reach working in channel during cleanout effort. More suspended, black, organic material moving D/s. Vegetation floating on surface with clumps of fine organic material that is easily suspended when disturbed.
2:43 PM	Serpas - 04 (W.P. 06)	MP 22.93	
3:05 PM	Serpas - 05 (W.P. 07)	~MP 21.25 (150 yds D/s I-80)	Not cleaned at this location yet. Stirred up bottom to take sample. Attempt to simulate the disturbance that the clean out would cause. The sample is the same: black turbid, fine organic material with heavy sulfur odor.
3:10 PM	Serpas - 06 (W.P. 08)	~MP 21.20 (120 yds D/s I-80)	

pg 1



Water Quality Field Sampling Worksheet

Northwest Hydraulic Consultants
www.nhcweb.com

3950 Industrial Boulevard, Suite 100C
West Sacramento, California 95691

Phone: (916)371-7400
Fax: (916)371-7475

Project Name: Putah South Canal Turbidity and Sediment Study **Project No.:** 50483

Sampling Date: **11/19/2007** **By:** Bryce Cruey, Bob MacArthur

Time	Bottle Sample No.	Location	Observations
3:35 PM	Burton - 01 (W.P. 09)	Just U/s from Burton Check	Same fine organic material that is easily suspended. There is less of it in this area. The canal bottom is relatively clean, but if a small patch of the settled organic material is disturbed it causes turbid conditions.
3:45 PM	Burton - 02 (W.P. 10)	U/s North Texas Rd.	
3:58 PM	Burton - 03 (W.P. 11)	MP 19.37 D/s Bridge just D/s McCoy Check	Same Conditions
	McCoy - 01 (W.P. 12)	MP 16.91	Near NBR water treatment plant on the east side of Peabody rd. Black fine organic material is settled at the bottom of canal. When the material is disturbed it is easily suspended

Appendix E-10.4

SOLANO COUNTY WATER AGENCY

MEMORANDUM

TO: **File S-20 (Solano Project – Water Quality)**

FROM: **Alex Rabidoux**

DATE: **January 23, 2008**

SUBJECT: PSC Cleanout and McCoy Basin Water Quality

Purpose:
The purpose of this memo is to summarize the sampling effort done by Northwest Hydraulic Consultants (NHC) and the Solano County Water Agency (SCWA) on November 19-26, 2007.

Background:
One of the biggest challenges with the Putah South Canal (PSC) water quality is cleaning of the canal. The cleanout process usually takes about 1 month and occurs at the end of the irrigation season which is usually October 15th. During the cleanout process, water treatment plants need to shut down when their canal check is being cleaned because (a) the water level is below the water treatment plant's (WTP's) intake and (b) poor water quality. However, over the last few years the water treatment plants have had to shut down numerous times do to poor water quality coming from upstream checks that were being cleaned. These shutdowns have caused city water supplies to be stretched, especially for the City of Fairfield. Historically, spillways such as the McCoy, Sweeney Creek, Suisun Creek, and others were used to flush out residual sediments and poor water quality during the cleanout process. Several of the spillways such as Sweeney and Suisun, drained directly into natural streams. With increased environmental regulation and awareness, use of the spillways has stopped. The McCoy spillway, unlike several others, does not drain directly into a natural stream. Instead the McCoy spillway drains into the McCoy Basin, a dilapidated settling pond which was designed to act as a settling basin for canal operations. The McCoy Basin then drains into an urbanized channel within the City of Fairfield which eventually drains into the Suisun Marsh. To help with PSC cleanout operations and maintain better water quality in the canal, there is an interest by SCWA to see if the McCoy Basin could be put back into operation. Unfortunately, since the McCoy basin has been inactive for almost ten years, there are some substantial environmental issues and permitting which will have to be dealt with.

P.O. Box 349, Elmira, California 95625
(707) 451-6090, FAX (707) 451-6099

To help SCWA better understand the issue, a series of grab samples were taken along the PSC in the McCoy, Burton, Serpas, and Mankas checks during the 2007 cleanout operation as well as in the McCoy Basin. The reason for collecting the samples was to (a) determine baseline conditions in the PSC during the canal cleanout, (b) determine baseline conditions of the PSC canal cleanout water if the solids were allowed to settle out, and (c) determine baseline conditions of the McCoy Basin. The baseline water quality conditions will allow policy makers at SCWA to determine if the McCoy Basin Project is even feasible.

Collection:
A total of 12 samples were collected by NHC on November 19, 2007 along the McCoy, Burton, Serpas, and Mankas checks. The sampling time, location, and comments by NHC are shown in Table 1 below. On November 26, 2007 a total of 3 samples were collected at the McCoy Basin. A description of the samples, date, and location are shown in Table 2.

Analysis:
Samples were analyzed by the North Bay Regional (NBR) laboratory in Fairfield and by Analytical Science in Petaluma. The constituents that each laboratory analyzed are listed below in Table 3. The PSC samples were first analyzed by the NBR laboratory and the excess sample solution was analyzed by Analytical Science. The PSC samples were then split into two samples at the Analytical Science laboratory. One set of samples were left to settle over 24 hrs and the decant solution was then analyzed. The other split sample was analyzed without decanting. The purpose of analyzing the original sample and the decant sample, was to identify the level of improvement in water quality by settling out the solids. However, do to limited sample volumes, Analytical Science was only able to perform a limited amount of the analyses on the decant solution. The McCoy Basin samples were not decanted, as the samples were of much higher water quality. The McCoy Basin samples were also collected a week later than the PSC samples, and were analyzed by Analytical Science only.

Results:
All of the constituents are plotted in Figures 1 – 14. For each constituent the sample names are shown along the x-axis starting with *McCoy 01* and ending with *McCoyB. (NE)*. The samples are plotted spatially along the canal, such that *McCoy 01* is at the most upstream end of the canal, followed by *Burton 03* all the way down to *Mankas 02*. The last 3 samples (*Air Base Pkway*, *McCoy B.(N)*, and *McCoy B. (NE)* are actually in the McCoy Basin, but are shown at the very end of the chart to visually separate them from the PSC samples. The results section is broken up into nutrients, metals, physical properties, and sediments and the plots are discussed in greater detail.

a.) Nutrients (phosphorus, nitrogen):
For phosphorus (shown in Figure 1), *Serpas 03 – 06* have very high concentrations in comparison to the other samples. The 4 highest samples have phosphorus concentrations ranging from 13-41 mg/L, while the remaining phosphorus concentrations range from 0.3-2.2 mg/L. All of the decant phosphorus concentrations are considerably lower than

their respective unsettled concentrations. The decant phosphorus concentrations range from 0.0-1.9 mg/L. The McCoy Basin samples have lower phosphorus concentrations than the PSC samples ranging from 0.0-0.3 mg/L.

For nitrogen analysis, total nitrogen, total Kjeldahl nitrogen (TKN), nitrite, nitrate, and ammonia concentrations were analyzed. Plots of total nitrogen, all 5 nitrogen related compounds, and TKN are shown in Figures 2-4 respectively. The nitrate, nitrite, and ammonia concentrations were essentially negligible while the TKN concentration was equal to the total nitrogen concentration. The results indicate that most of the nitrogen found in the PSC and McCoy Basin samples is from organic compounds. *Serpas 03 – 06* have the highest total nitrogen and TKN concentrations while the McCoy Basin samples have the lowest. For *Serpas 03 – 06* total nitrogen and TKN concentrations ranged from 77-250 mg/L, the other PSC samples range from 1.7-29 mg/L, and the McCoy Basin samples range from 0.8-1.4 mg/L. The decant solution was analyzed for TKN only, and the results are very similar to those for phosphorus. The decant solution had smaller TKN concentrations then the original sample by almost one order of magnitude. The *Serpas 03 – 06* decant concentrations ranged from 2.5-6.0 mg/L while the remaining PSC decant samples ranged from 0.35-1.2 mg/L.

b.) Metals (copper, iron, manganese, mercury)

For copper (shown in Figure 5), *Serpas 03 – 06* had the highest concentrations ranging from 32-73 mg/L, while the remaining PSC samples varied from 0.89-10.6 mg/L. The PSC decant solutions had considerably smaller copper concentrations ranging from 0.0-0.48 mg/L. The McCoy Basin copper concentrations were below the laboratory detection limits. The PSC decant and McCoy Basin copper concentrations all are below the EPA National Secondary Drinking Water Regulation of 1.0 mg/L of copper.

For manganese (shown in Figure 6), *Serpas 03 – 06* again had the highest concentrations ranging from 5.3-12.2 mg/L while the other PSC samples varied from 0.16-1.3 mg/L of manganese. The PSC decant solutions, similar to the copper, had considerably smaller concentrations. PSC decant manganese concentrations varied from 0.0-1.1 mg/L. The McCoy Basin manganese concentrations varied from 0.02-0.14 mg/L.

For iron (shown in Figure 7), *Serpas 03 – 06* again had the highest concentrations ranging from 376-739 mg/L while the remaining PSC samples varied from 5.0-80.1 mg/L of iron. The decant PSC samples had considerably smaller iron concentrations ranging from 0.8-14 mg/L. The McCoy Basin iron concentrations were smaller than the original PSC samples and ranged from 0.18-4.0 mg/L.

For mercury (shown in Figure 8), *Serpas 03 – 06* had the highest concentrations ranging from 2.4-4.6 μg/L. The remaining PSC samples had mercury concentrations ranging from 0-0.65 μg/L. The McCoy Basin mercury concentrations were below the laboratory detection limits. The National Primary Drinking Water Regulation for mercury is 2 μg/L, which all of the samples are below, except *Serpas 03 – 06*. The decant solution was not analyzed for mercury, but if the results follow the same pattern as all of the other constituents above, it is very likely that the *Serpas 03 – 06* decant solutions would fall well under the 2 μg/L drinking water regulation for mercury.

c.) Physical Properties (Turbidity, pH, Color, Alkalinity)
For pH (shown in Figure 9), the PSC samples ranged from 6.8-7.8, while the McCoy Basin samples varied from 8.3-8.8. The *Serpas 03 – 06* samples had slightly lower pH values than the other samples indicating they were slightly acidic while most of the other samples and especially the McCoy Basin samples were more basic.

For color (shown in Figure 10), *Serpas 03 – 06* had the highest readings ranging from 64,500-190,600 color units while the remaining PSC samples had color values from 2,400-16,450. The McCoy Basin color values were considerably less than the PSC samples ranging from 50-70 color units. The PSC decant solution was not analyzed for color.

For turbidity (shown in Figure 11), *Serpas 03 – 06* had the highest values ranging from 8,950-20,650 NTU while the remaining PSC samples varied from 490-5,650 NTU. The PSC decant samples had considerably smaller turbidities, with the *Serpas 03 – 06* decant samples ranging from 45-150 NTU and the remaining PSC decant samples ranging from 9.8-17 NTU. The McCoy Basin samples had turbidities between 3.8-66 NTU, which were less than the original PSC samples.

For alkalinity (shown in Figure 12), *Serpas 03 – 06* had the highest values ranging from 375-1270 mg/L as $CaCO_3$. The remaining PSC samples had alkalinity values of 148-194 mg/L as $CaCO_3$. The McCoy Basin alkalinities were very similar to the PSC with values ranging from 110-260 mg/L as $CaCO_3$. The PSC decant solution was not analyzed for alkalinity.

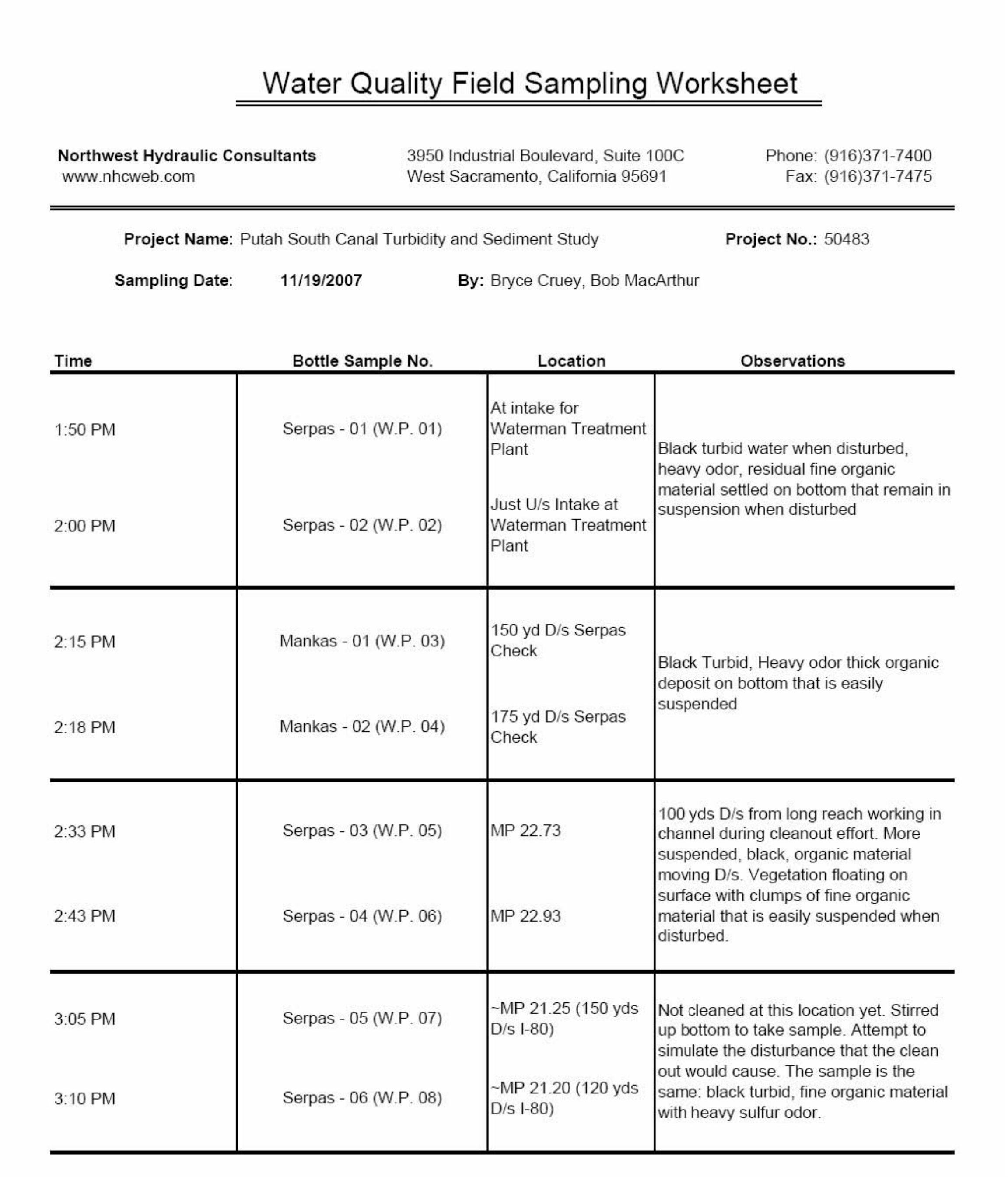
d.) Sediment/Misc.
Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) were analyzed for the PSC and McCoy Basin samples, but not on the PSC decant solution. A plot of both TSS and TDS for all of the samples is shown in Figure 13. For TSS, *Serpas 03 – 06* had the highest values ranging from 24,000-71,000 mg/L while the remaining PSC samples varied from 740-5,400 mg/L. The McCoy Basin samples had the lowest TSS values ranging from 0-78 mg/L. The TDS concentration for the PSC samples ranged from 190-420 mg/L and from 120-480 mg/L for the McCoy Basin samples. The results indicate that the PSC samples have a much higher fraction of solids in the suspended state (particles greater than 2 μm) as opposed to the dissolved state. The result helps to verify why the decant solutions have considerably smaller nutrient and metal concentrations than the original sample. For the McCoy Basin, the samples have a higher TDS compared to TSS concentration, indicating that most of the material is in the dissolved state. This conclusion makes sense, as the McCoy Basin is a settling pond designed to reduce suspended material from the water column.

For Total Organic Carbon (shown in Figure 14), *Serpas 03 – 06* had the highest concentration values ranging from 53.7-106.4 mg/L while the rest of the PSC had values ranging from 0.8-26 mg/L. The PSC decant samples ranged from 2.2-5.9 mg/L. The original PSC samples that had very high values of TOC had much smaller concentration for the decant solution. However, several PSC samples such as *Burton 02*, *Burton 01*, and *Serpas 01*which had relatively low TOC concentrations did not see a dramatic decrease in TOC for the decant solutions.

Conclusion:

The results of the water quality data show that PSC cleanout water contains high concentrations of nutrients, metals, organic carbon as well as high values of color, turbidity, and alkalinity. The PSC samples *Serpas 03 – 06* consistently had the highest concentrations for most of the constituents analyzed. These samples also best represent actual PSC cleanout operations, especially since *Serpas 03 – 04* was sampled 100 yds downstream of the PSC cleanout operations. However, allowing PSC water to settle for at least 24 hrs provides a dramatic improvement in almost all of the water quality constituents, as shown by the PSC decant samples. In conclusion, projects such as the McCoy Basin or others that would allow PSC cleanout water to be settled out or taken out of the PSC system would have a positive impact on PSC water quality. The results of the data will also allow NHC and SCWA to make a more informed decision on how to improve water quality along the PSC, determine the feasibility of the McCoy Basin project, and/or come up with alternative solutions in how to improve PSC water quality.

Table 1 – NHC Water Quality Field Sampling Worksheet



Water Quality Field Sampling Worksheet

Northwest Hydraulic Consultants
www.nhcweb.com

3950 Industrial Boulevard, Suite 100C
West Sacramento, California 95691

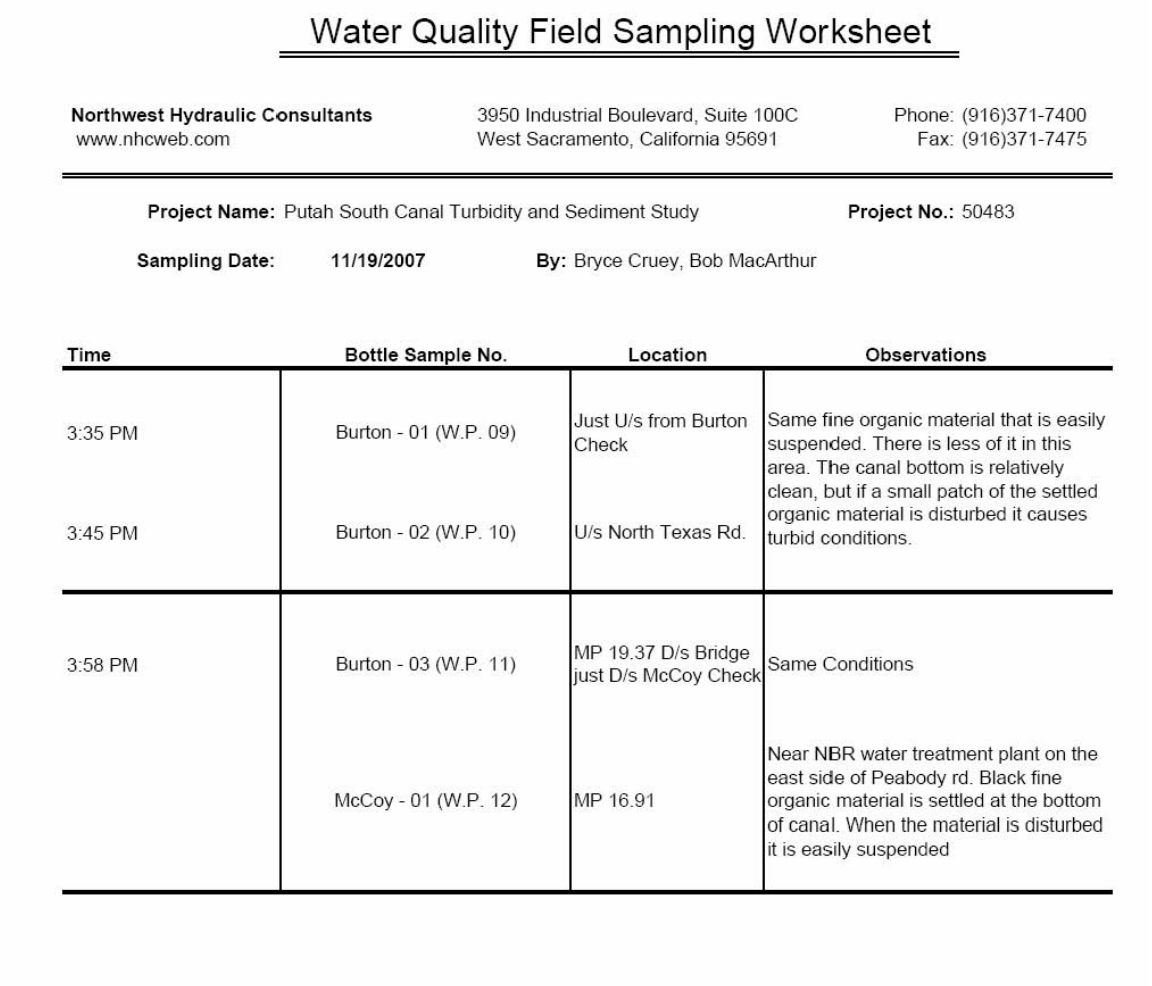
Phone: (916)371-7400
Fax: (916)371-7475

Project Name: Putah South Canal Turbidity and Sediment Study **Project No.:** 50483

Sampling Date: **11/19/2007** **By:** Bryce Cruey, Bob MacArthur

Time	Bottle Sample No.	Location	Observations
1:50 PM	Serpas - 01 (W.P. 01)	At intake for Waterman Treatment Plant	Black turbid water when disturbed, heavy odor, residual fine organic material settled on bottom that remain in suspension when disturbed
2:00 PM	Serpas - 02 (W.P. 02)	Just U/s Intake at Waterman Treatment Plant	
2:15 PM	Mankas - 01 (W.P. 03)	150 yd D/s Serpas Check	Black Turbid, Heavy odor thick organic deposit on bottom that is easily suspended
2:18 PM	Mankas - 02 (W.P. 04)	175 yd D/s Serpas Check	
2:33 PM	Serpas - 03 (W.P. 05)	MP 22.73	100 yds D/s from long reach working in channel during cleanout effort. More suspended, black, organic material moving D/s. Vegetation floating on surface with clumps of fine organic material that is easily suspended when disturbed.
2:43 PM	Serpas - 04 (W.P. 06)	MP 22.93	
3:05 PM	Serpas - 05 (W.P. 07)	~MP 21.25 (150 yds D/s I-80)	Not cleaned at this location yet. Stirred up bottom to take sample. Attempt to simulate the disturbance that the clean out would cause. The sample is the same: black turbid, fine organic material with heavy sulfur odor.
3:10 PM	Serpas - 06 (W.P. 08)	~MP 21.20 (120 yds D/s I-80)	

Table 1 (cont.) – NHC Water Quality Field Sampling



Water Quality Field Sampling Worksheet

Northwest Hydraulic Consultants
www.nhcweb.com

3950 Industrial Boulevard, Suite 100C
West Sacramento, California 95691

Phone: (916)371-7400
Fax: (916)371-7475

Project Name: Putah South Canal Turbidity and Sediment Study **Project No.:** 50483

Sampling Date: **11/19/2007** **By:** Bryce Cruey, Bob MacArthur

Time	Bottle Sample No.	Location	Observations
3:35 PM	Burton - 01 (W.P. 09)	Just U/s from Burton Check	Same fine organic material that is easily suspended. There is less of it in this area. The canal bottom is relatively clean, but if a small patch of the settled organic material is disturbed it causes turbid conditions.
3:45 PM	Burton - 02 (W.P. 10)	U/s North Texas Rd.	
3:58 PM	Burton - 03 (W.P. 11)	MP 19.37 D/s Bridge just D/s McCoy Check	Same Conditions
	McCoy - 01 (W.P. 12)	MP 16.91	Near NBR water treatment plant on the east side of Peabody rd. Black fine organic material is settled at the bottom of canal. When the material is disturbed it is easily suspended

Table 2 – SCWA Water Quality Field Sampling

Sample Time	Sample ID	Location
11/26/2007 16:15	ABPW0711261615G01	McCoy Basin outlet at the DS side of AirBase Parkway.
11/26/2007 16:30	MC_NORTH0711261630G01	North end of McCoy Basin at the shoreline.
11/26/2007 16:45	MC_NEAST0711261645G01	North east end of McCoy Basin at the shoreline.

Table 3 – Water Quality Constituents by Laboratory

Constituents	North Bay Regional	Analytical Science	
		Orginal	Decant
Phosphorus		X	X
Total Nitrogen		X	
Total Kjeldahl Nitrogen (TKN)		X	X
Nitrate $(NO_3)^-$		X	
Nitrite $(NO_2)^-$		X	
Ammonia (NH_3)		X	
Total Suspended Solids (TSS)		X	
Total Dissolved Solid (TDS)		X	
Turbidity	[1]X	[2]X	X
Total Organic Carbon (TOC)	[1]X	[2]X	X
pH	[1]X	[2]X	
Color	[1]X	[2]X	
Alkalinity	[1]X	[2]X	
Copper (Cu)	[1]X	[2]X	X
Iron (Fe)	[1]X	[2]X	X
Manganese (Mn)	[1]X	[2]X	X
Mercury (Hg)		X	

[1] Only the PSC samples were analyzed

[2] Only the McCoy Basin samples were analyzed

Figure 1:

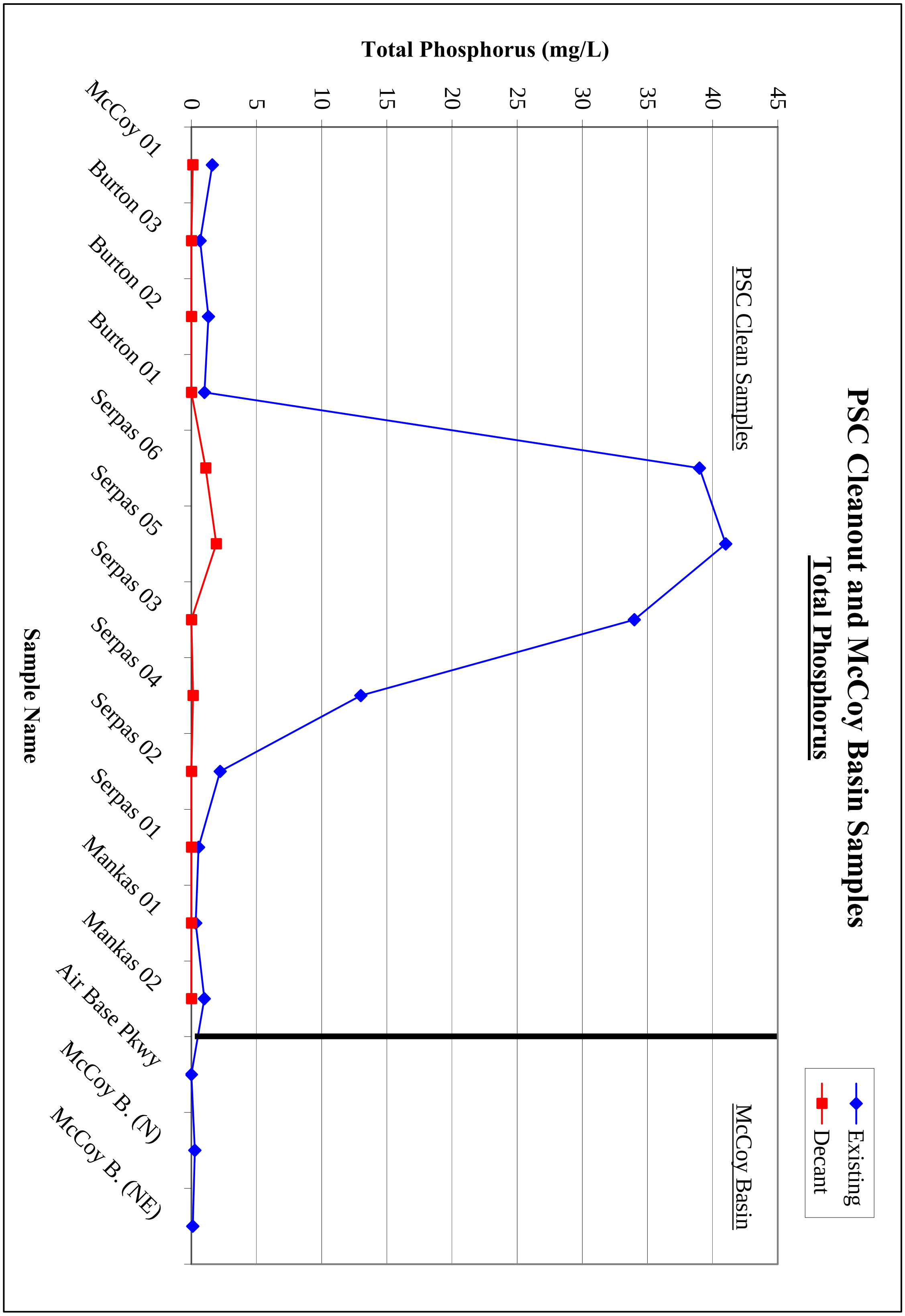

PSC Cleanout and McCoy Basin Samples
Total Phosphorus
Total Phosphorus (mg/L)
0
5
10
15
20
25
30
35
40
45
PSC Clean Samples
McCoy Basin
Existing
Decant
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 2:

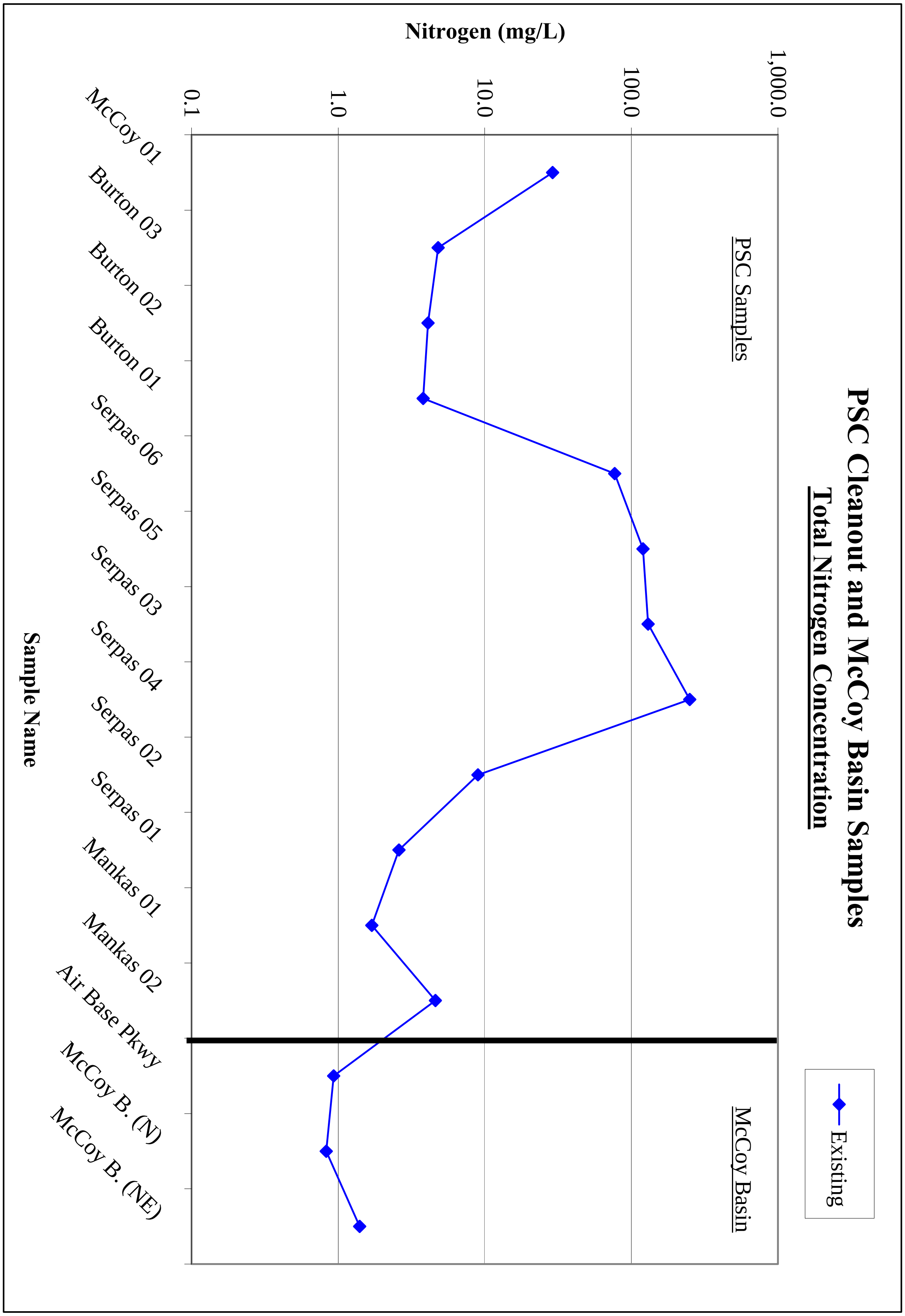

PSC Cleanout and McCoy Basin Samples
Total Nitrogen Concentration
Nitrogen (mg/L)
0.1
1.0
10.0
100.0
1,000.0
PSC Samples
McCoy Basin
Existing
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 3:

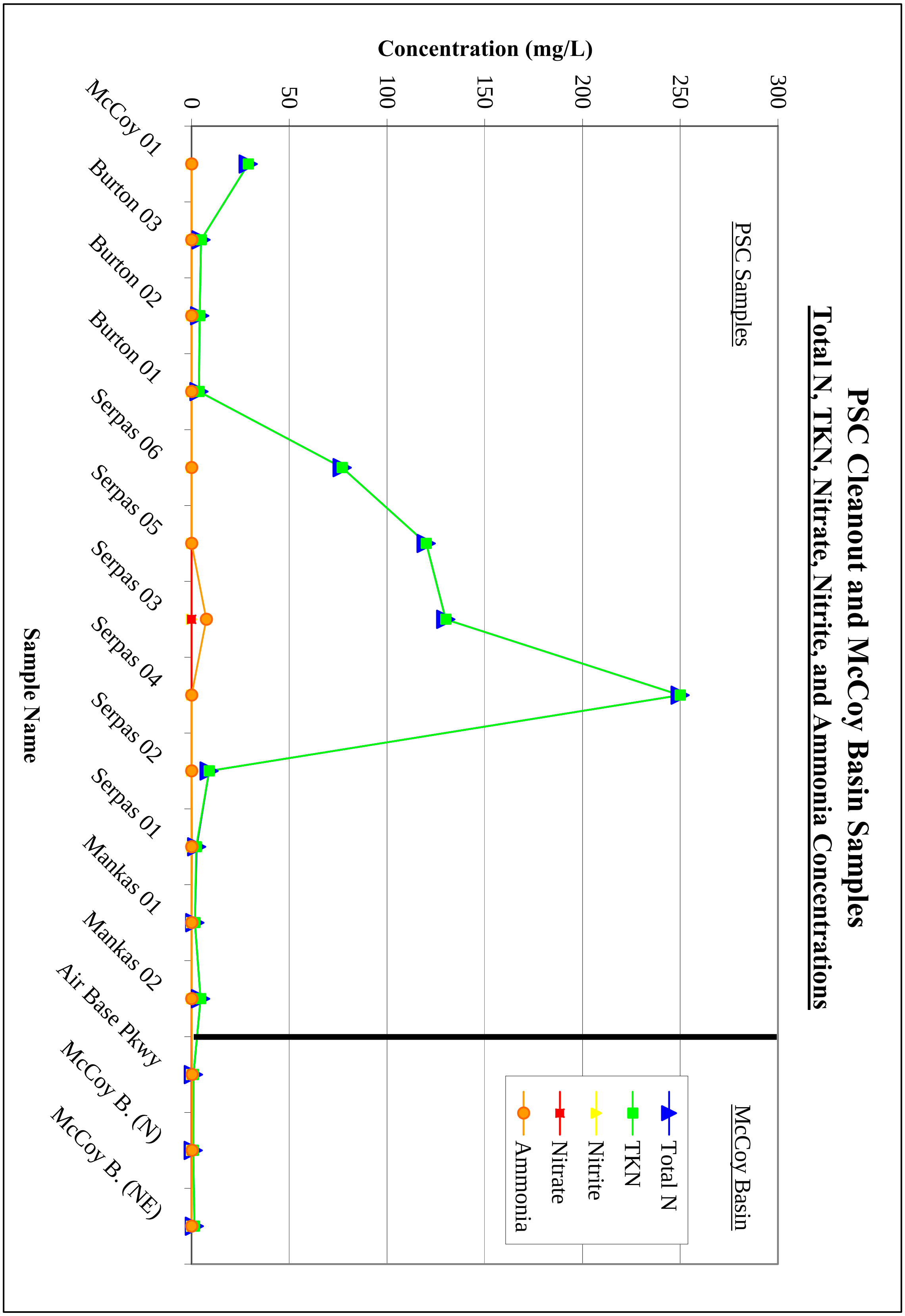

PSC Cleanout and McCoy Basin Samples
Total N, TKN, Nitrate, Nitrite, and Ammonia Concentrations
PSC Samples
McCoy Basin
Concentration (mg/L)
0
50
100
150
200
250
300
Sample Name
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Total N
TKN
Nitrite
Nitrate
Ammonia

Figure 4:

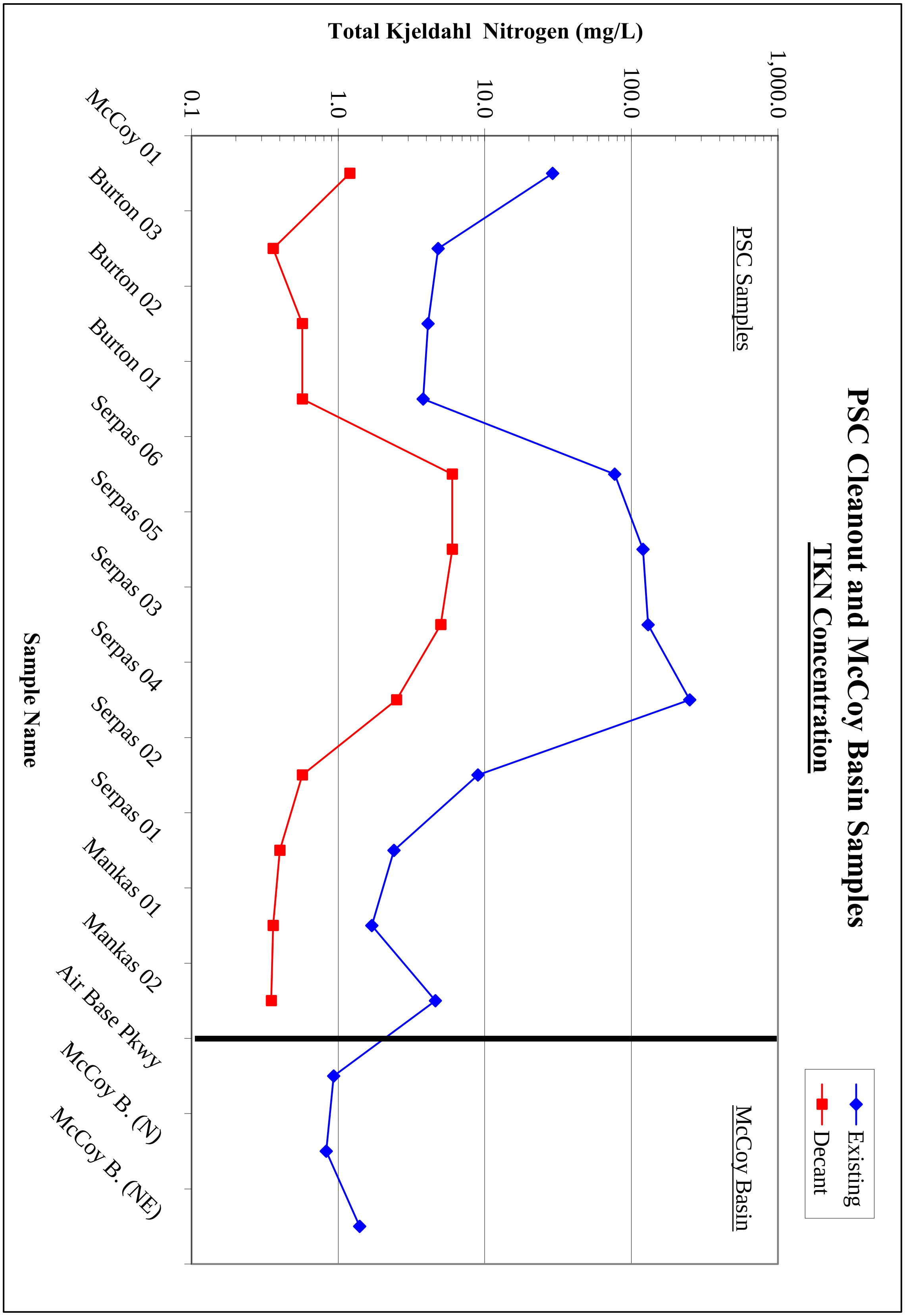

PSC Cleanout and McCoy Basin Samples
TKN Concentration
Total Kjeldahl Nitrogen (mg/L)
0.1
1.0
10.0
100.0
1,000.0
PSC Samples
McCoy Basin
Existing
Decant
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 5:

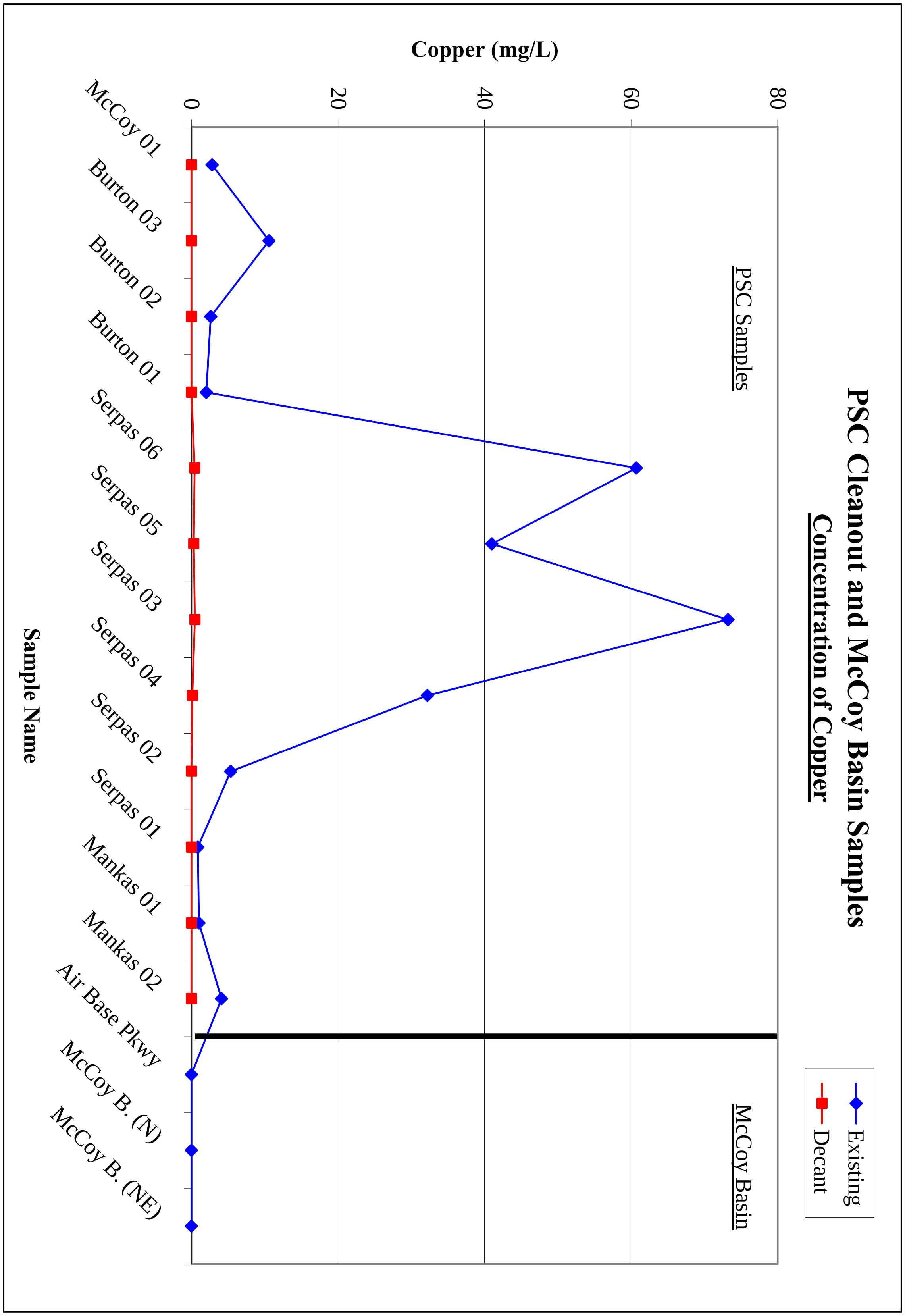

PSC Cleanout and McCoy Basin Samples
Concentration of Copper
Copper (mg/L)
0
20
40
60
80
PSC Samples
McCoy Basin
Existing
Decant
Sample Name
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)

Figure 6:

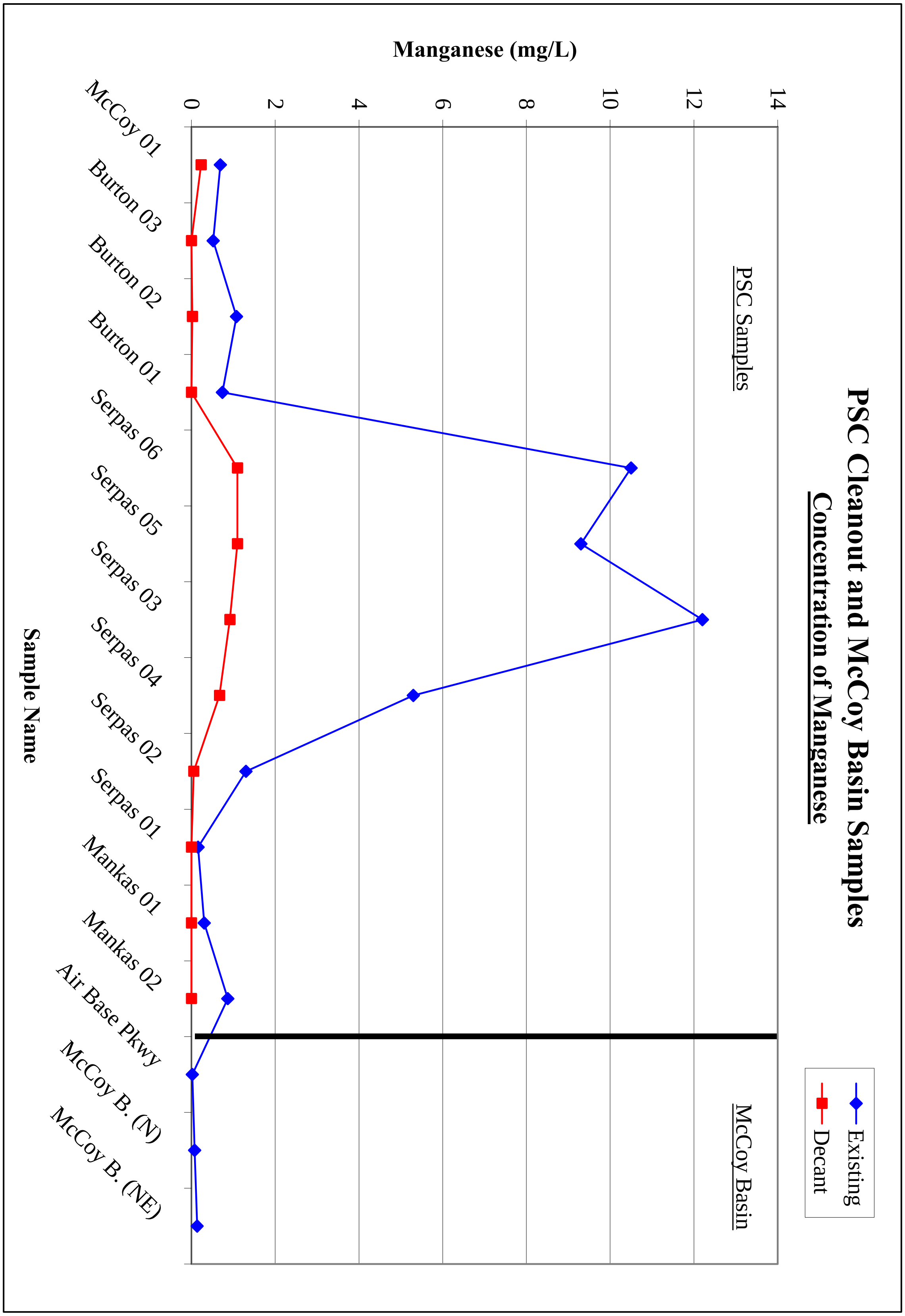

PSC Cleanout and McCoy Basin Samples
Concentration of Manganese
Manganese (mg/L)
0
2
4
6
8
10
12
14
PSC Samples
McCoy Basin
Existing
Decant
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 7:

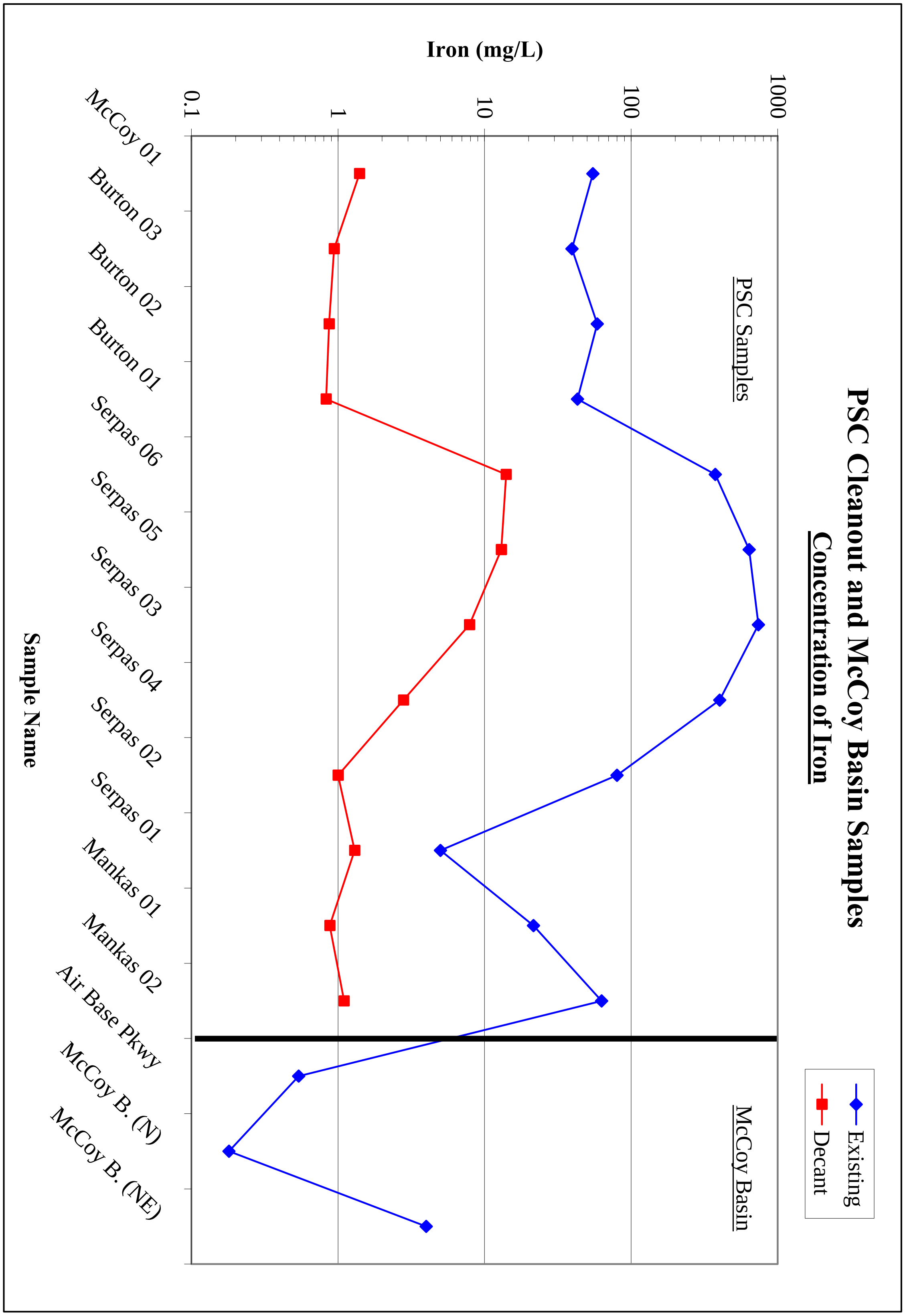

PSC Cleanout and McCoy Basin Samples
Concentration of Iron
Iron (mg/L)
0.1
1
10
100
1000
PSC Samples
McCoy Basin
Existing
Decant
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 8:

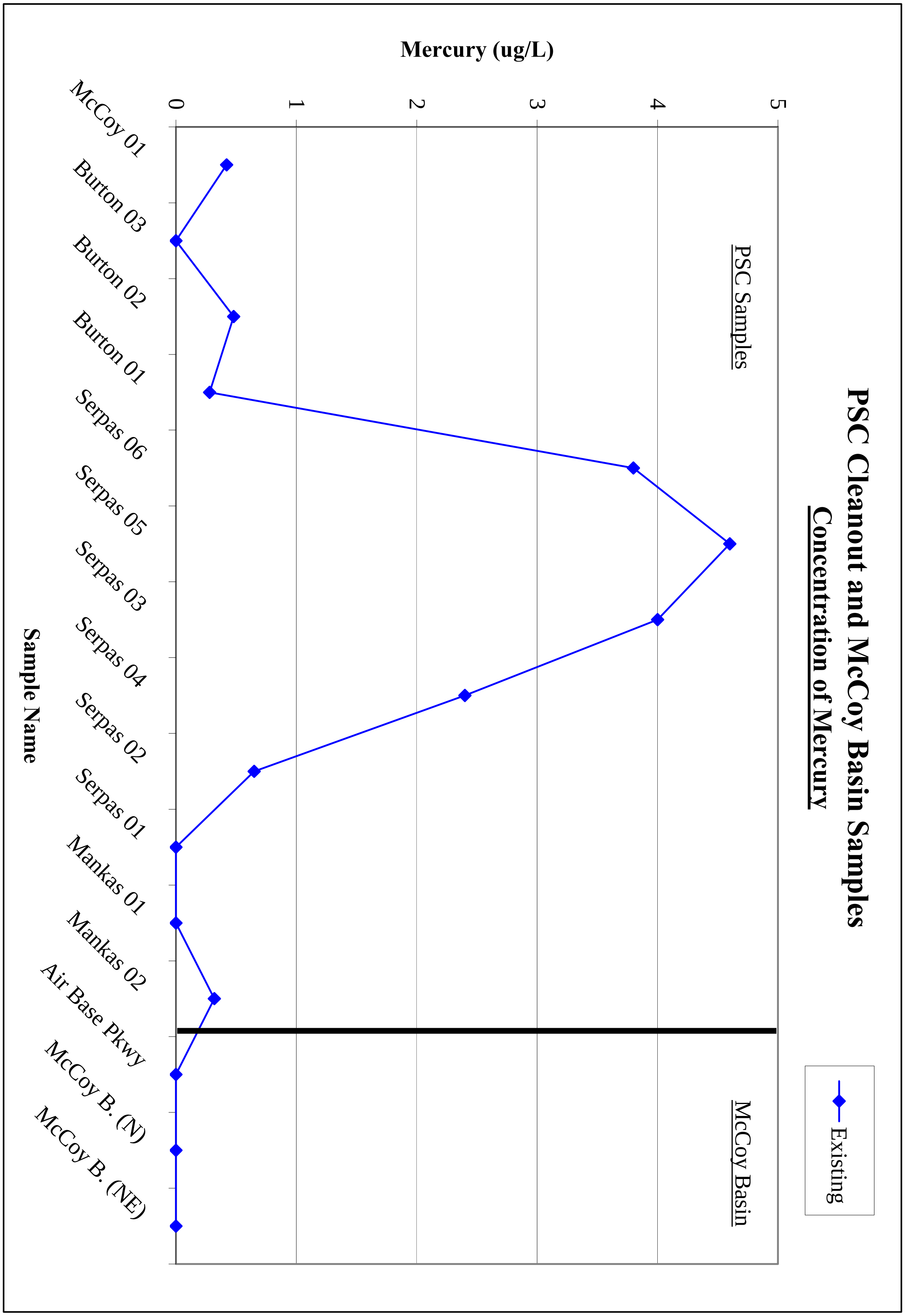

PSC Cleanout and McCoy Basin Samples
Concentration of Mercury
Mercury (ug/L)
0
1
2
3
4
5
PSC Samples
McCoy Basin
Existing
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 9:

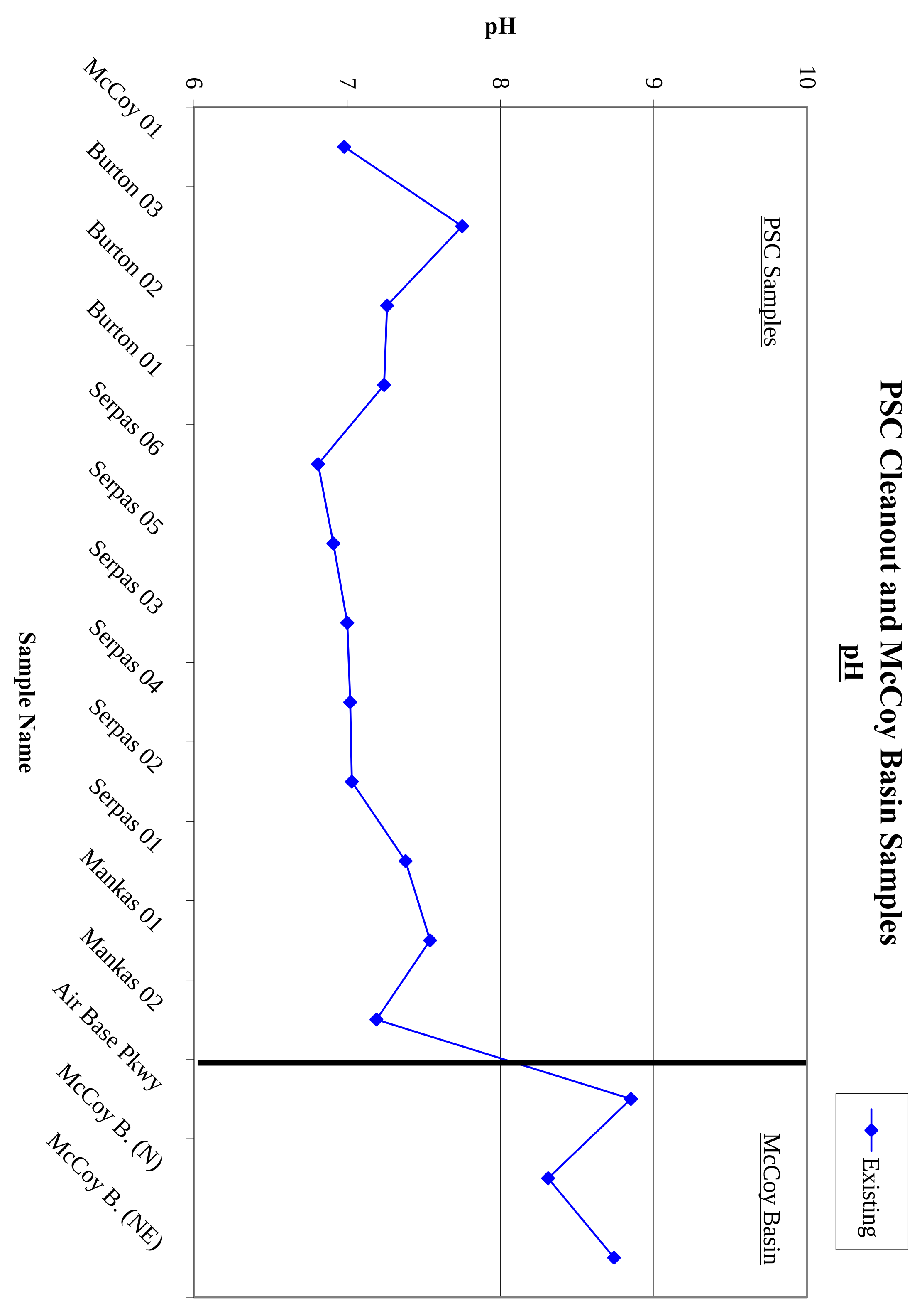

PSC Cleanout and McCoy Basin Samples
pH
pH
6
7
8
9
10
PSC Samples
McCoy Basin
Existing
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 10:

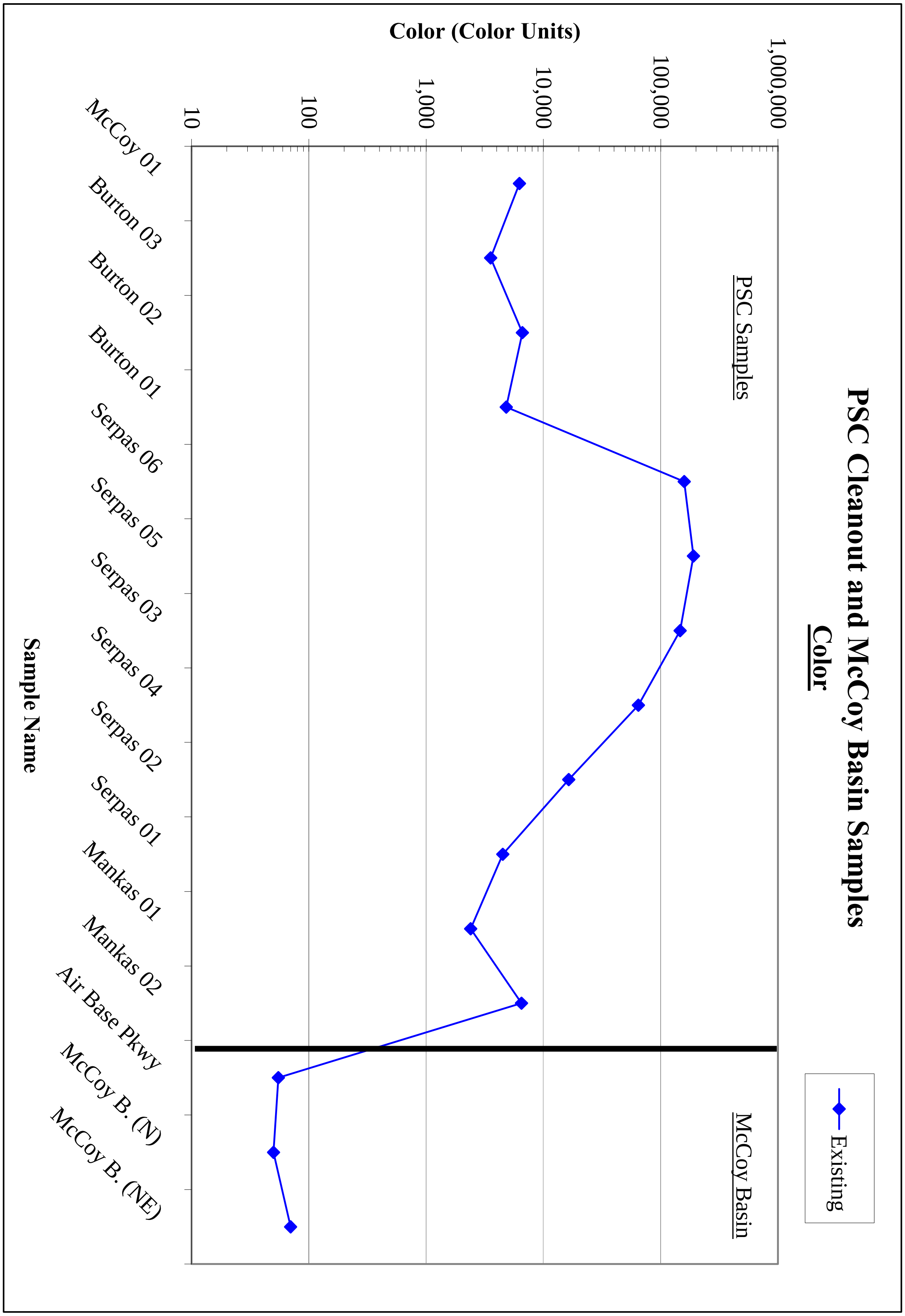

PSC Cleanout and McCoy Basin Samples
Color
Color (Color Units)
10
100
1,000
10,000
100,000
1,000,000
PSC Samples
McCoy Basin
Existing
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 11:

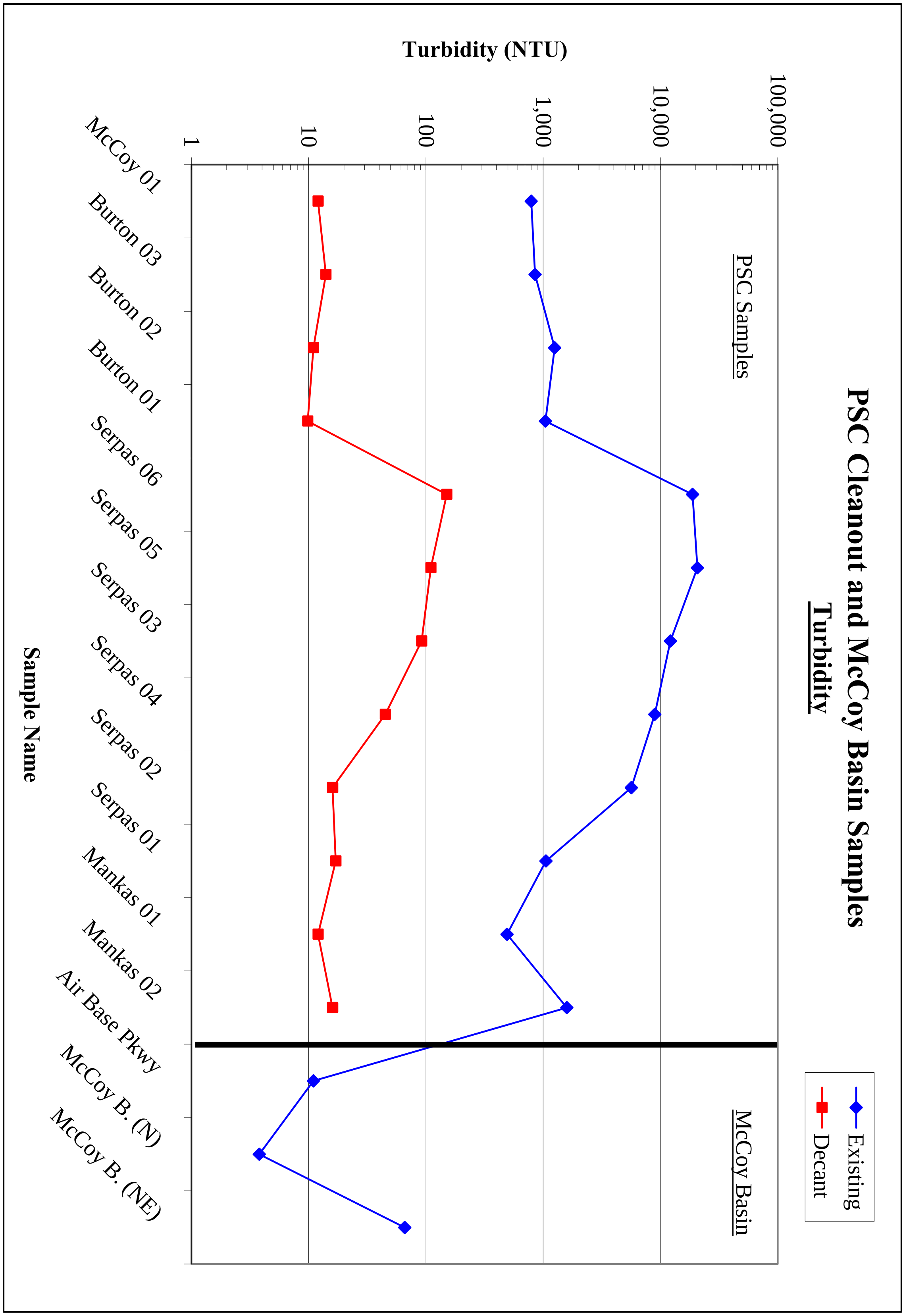

PSC Cleanout and McCoy Basin Samples
Turbidity
Existing
Decant
PSC Samples
McCoy Basin
Turbidity (NTU)
100,000
10,000
1,000
100
10
1
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 12:

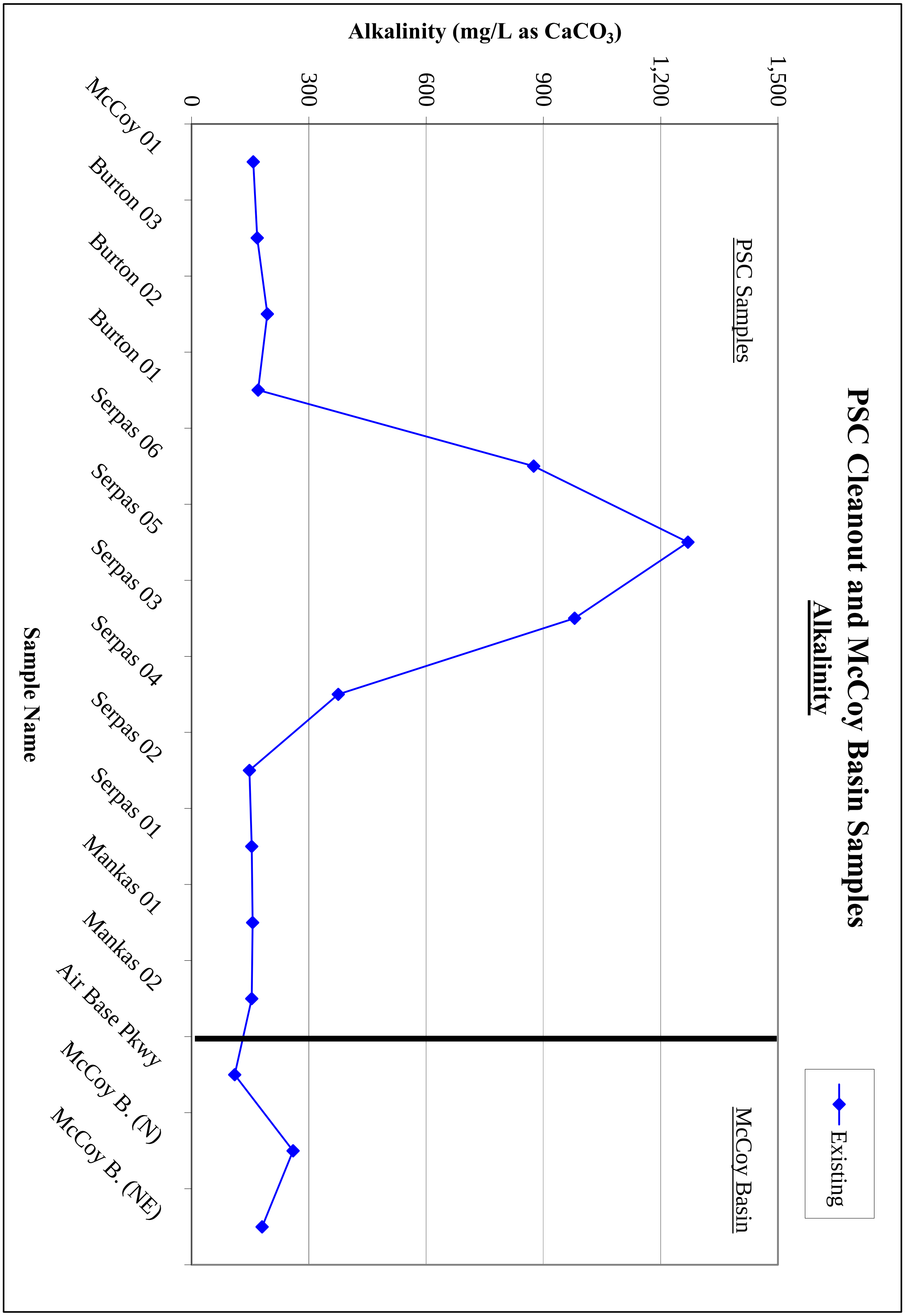

PSC Cleanout and McCoy Basin Samples
Alkalinity
Alkalinity (mg/L as CaCO3)
0
300
600
900
1,200
1,500
PSC Samples
McCoy Basin
Existing
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 13:

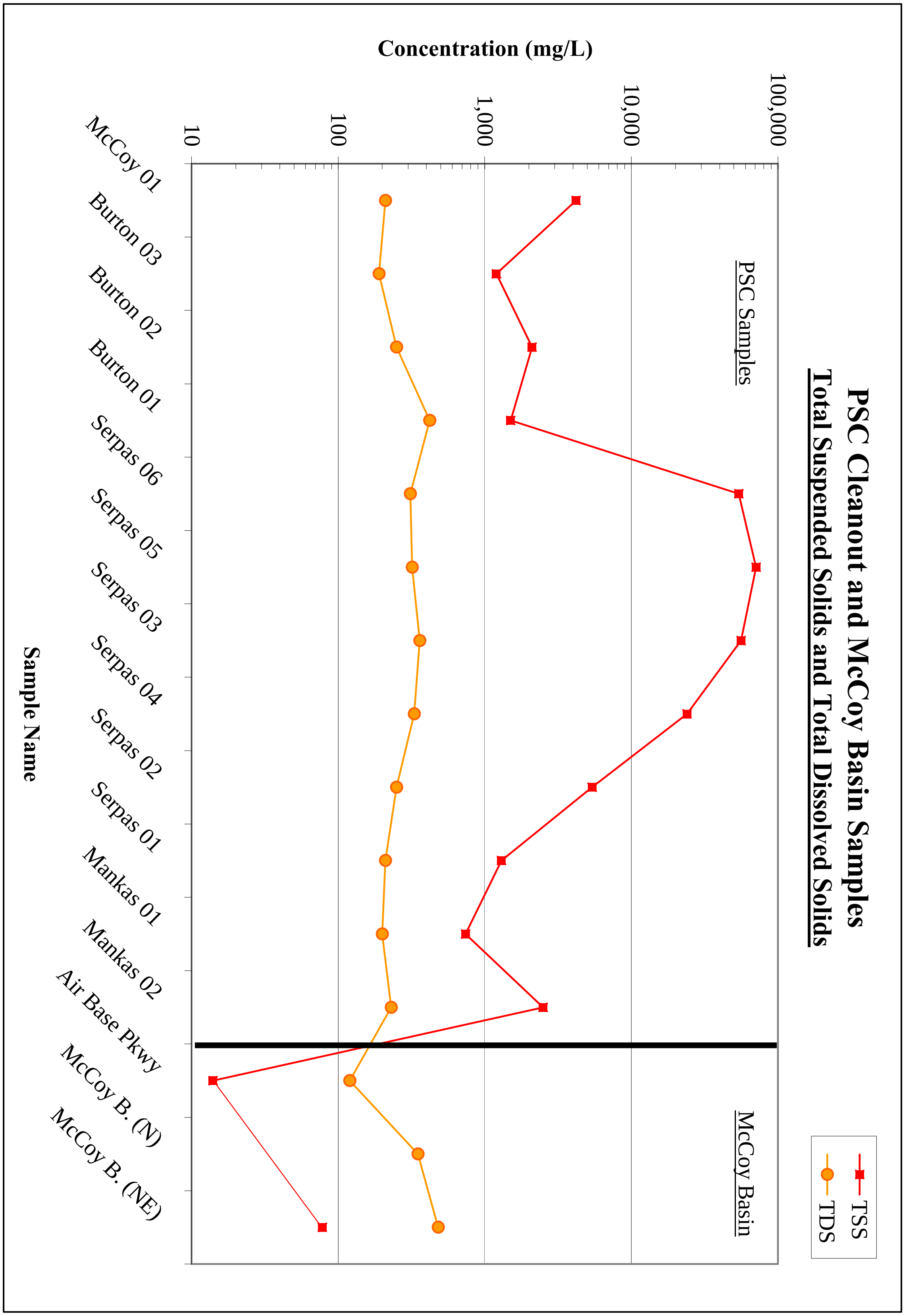
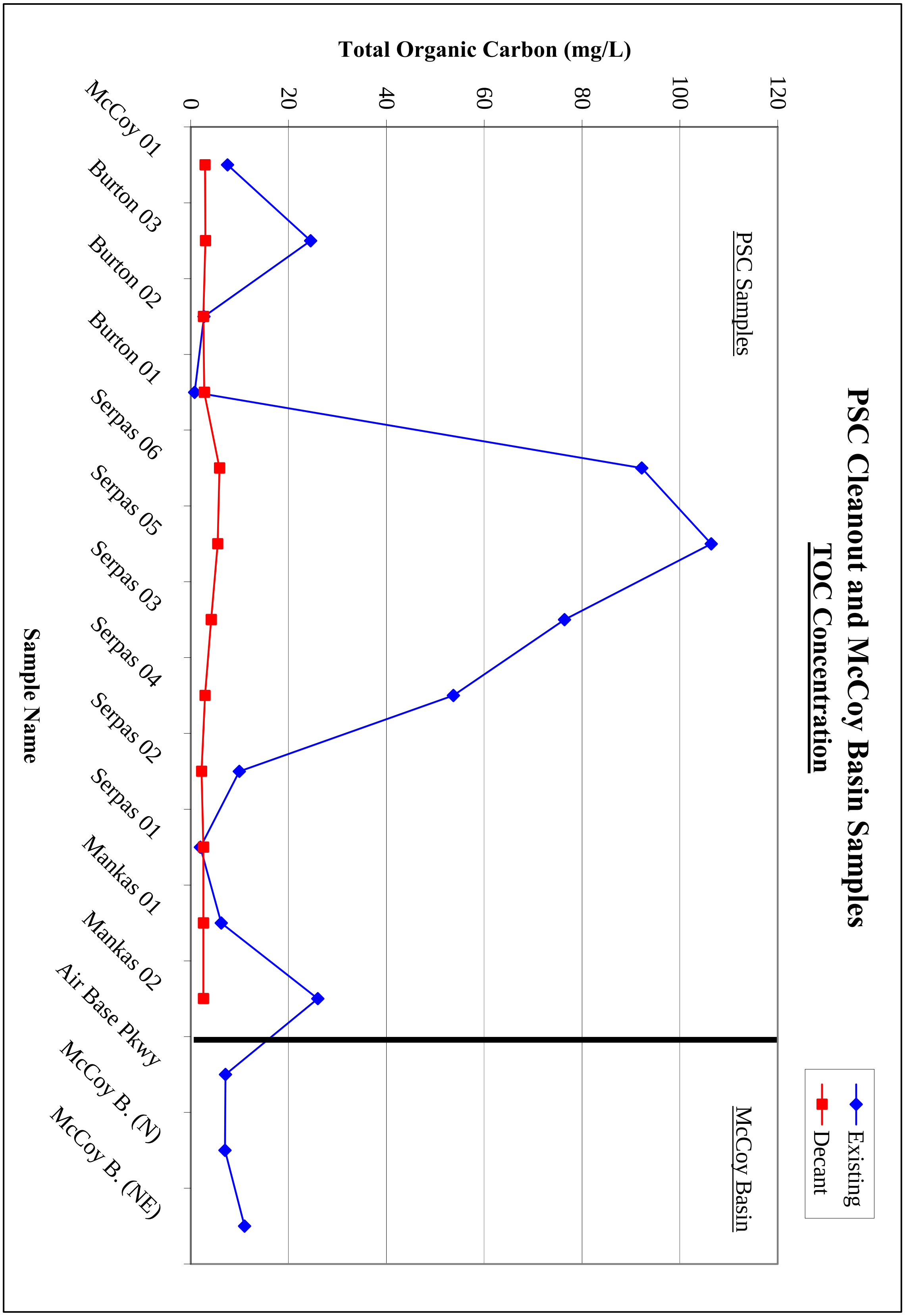

PSC Cleanout and McCoy Basin Samples
Total Suspended Solids and Total Dissolved Solids
Concentration (mg/L)
10
100
1,000
10,000
100,000
PSC Samples
McCoy Basin
TSS
TDS
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Figure 14:


PSC Cleanout and McCoy Basin Samples
TOC Concentration
Total Organic Carbon (mg/L)
0
20
40
60
80
100
120
PSC Samples
McCoy Basin
Existing
Decant
McCoy 01
Burton 03
Burton 02
Burton 01
Serpas 06
Serpas 05
Serpas 03
Serpas 04
Serpas 02
Serpas 01
Mankas 01
Mankas 02
Air Base Pkwy
McCoy B. (N)
McCoy B. (NE)
Sample Name

Appendix E-10.5

PSC Cleanout Water Quality (A. Rabidoux)

PSC Cleanout – Water Quality

- Samples collected by NHC in the PSC during the 2007 Cleanout Event

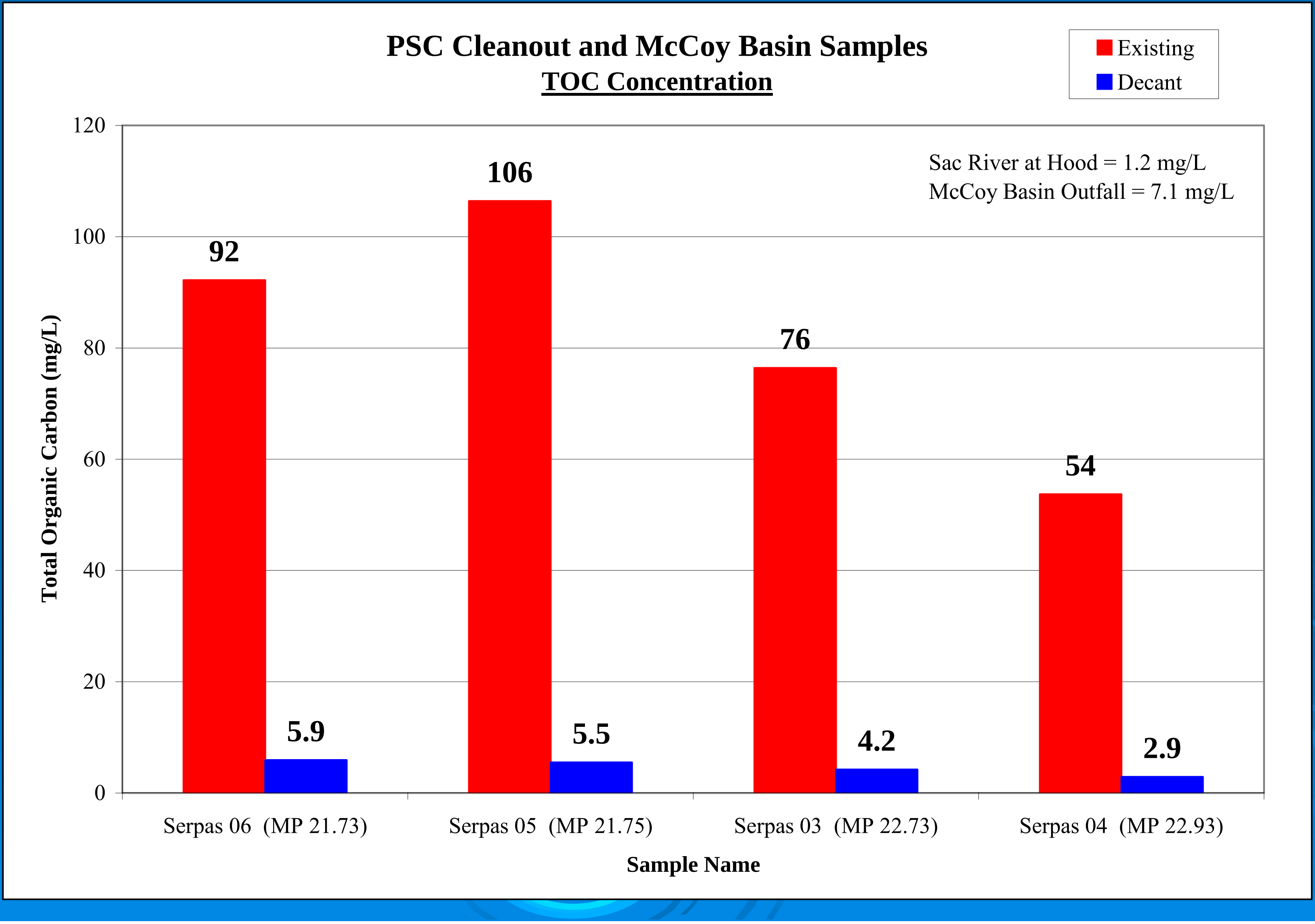
- Samples collected by SCWA in the McCoy Basin for comparison (future study)

- The samples were analyzed by the NBR and Analytical Sciences laboratory
  - The samples were split into two samples

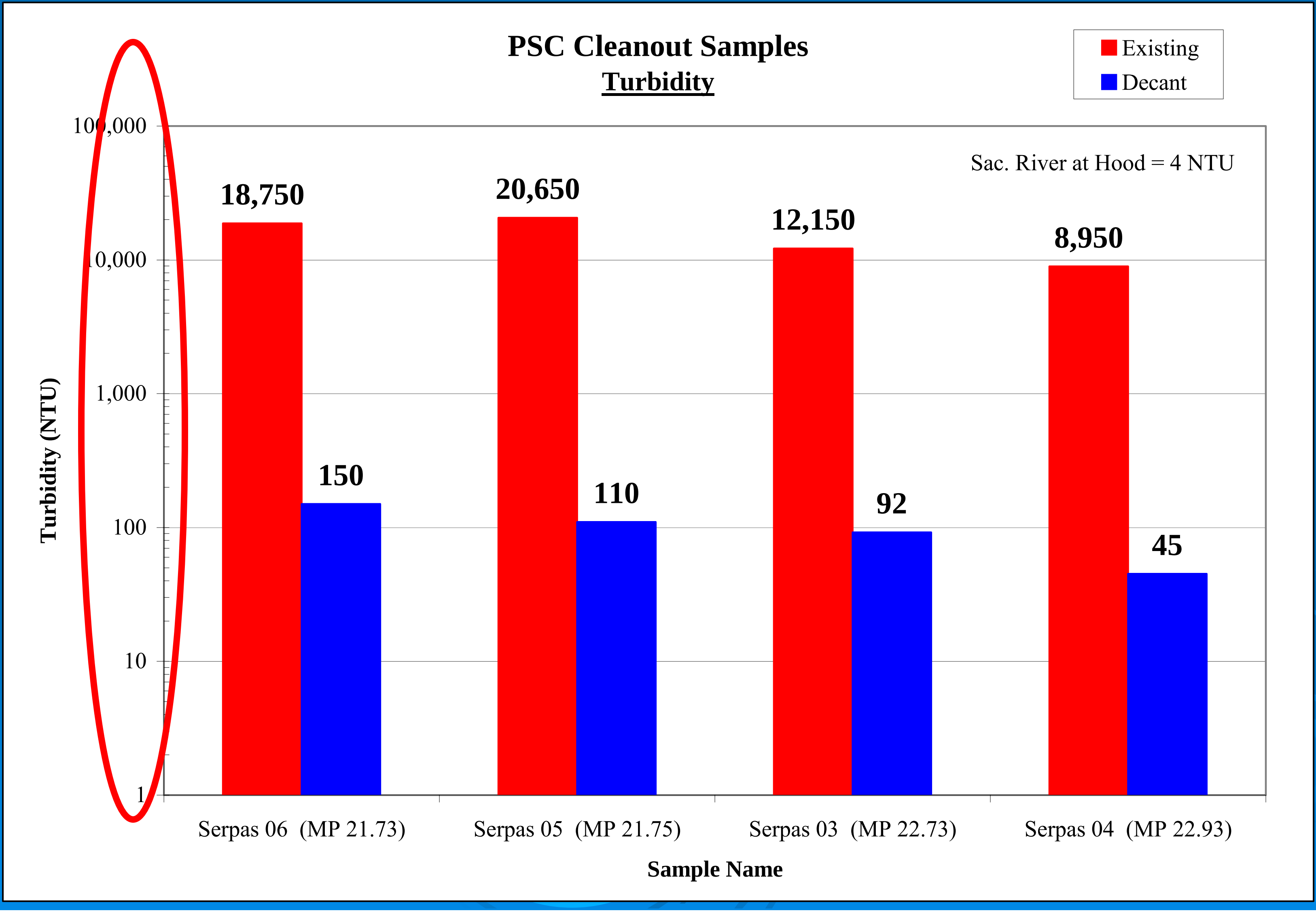
  (a) Original solution

  (b) Decant solution (sample settled for 24 hrs, clean liquid)

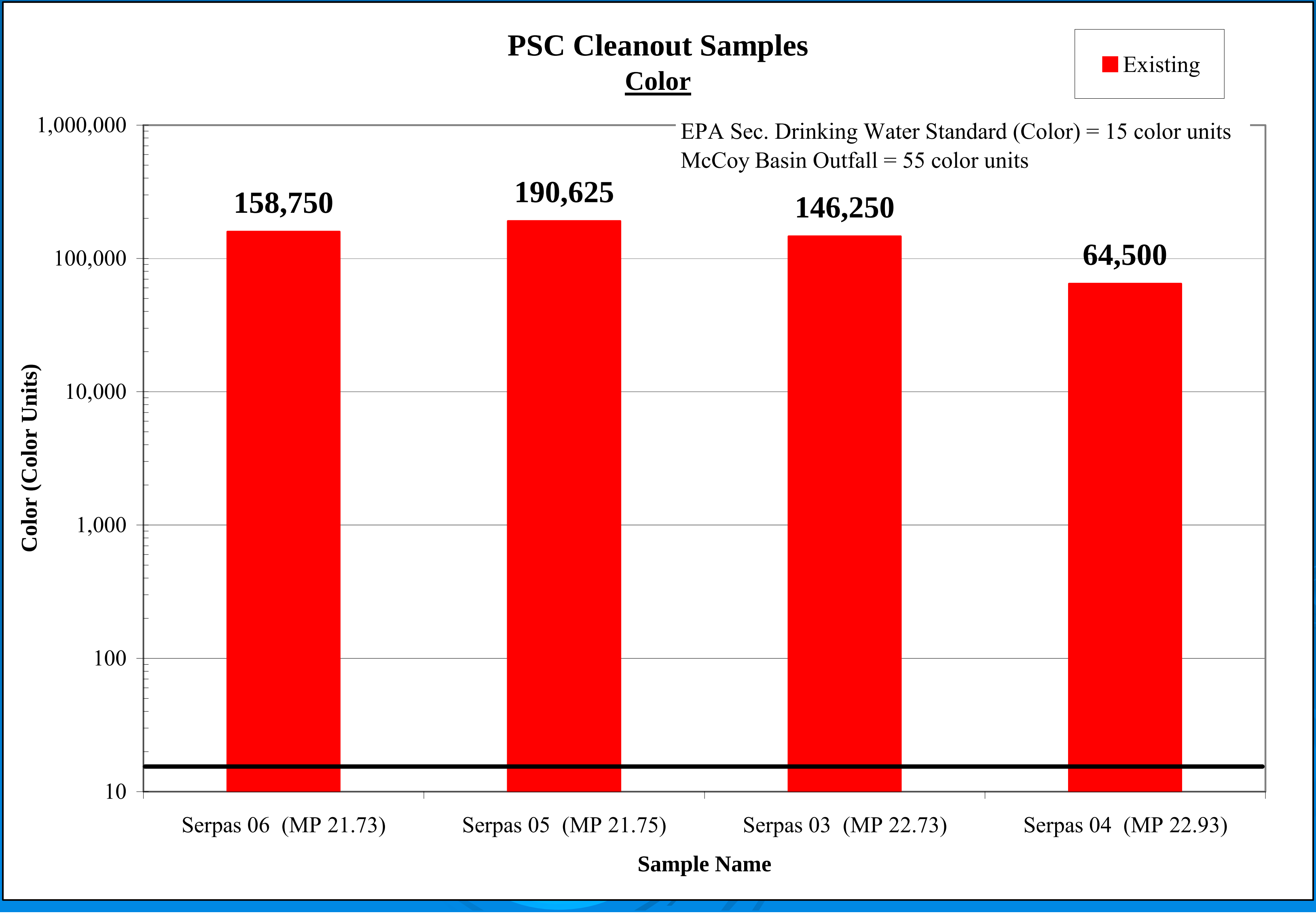
PSC Cleanout – Water Quality



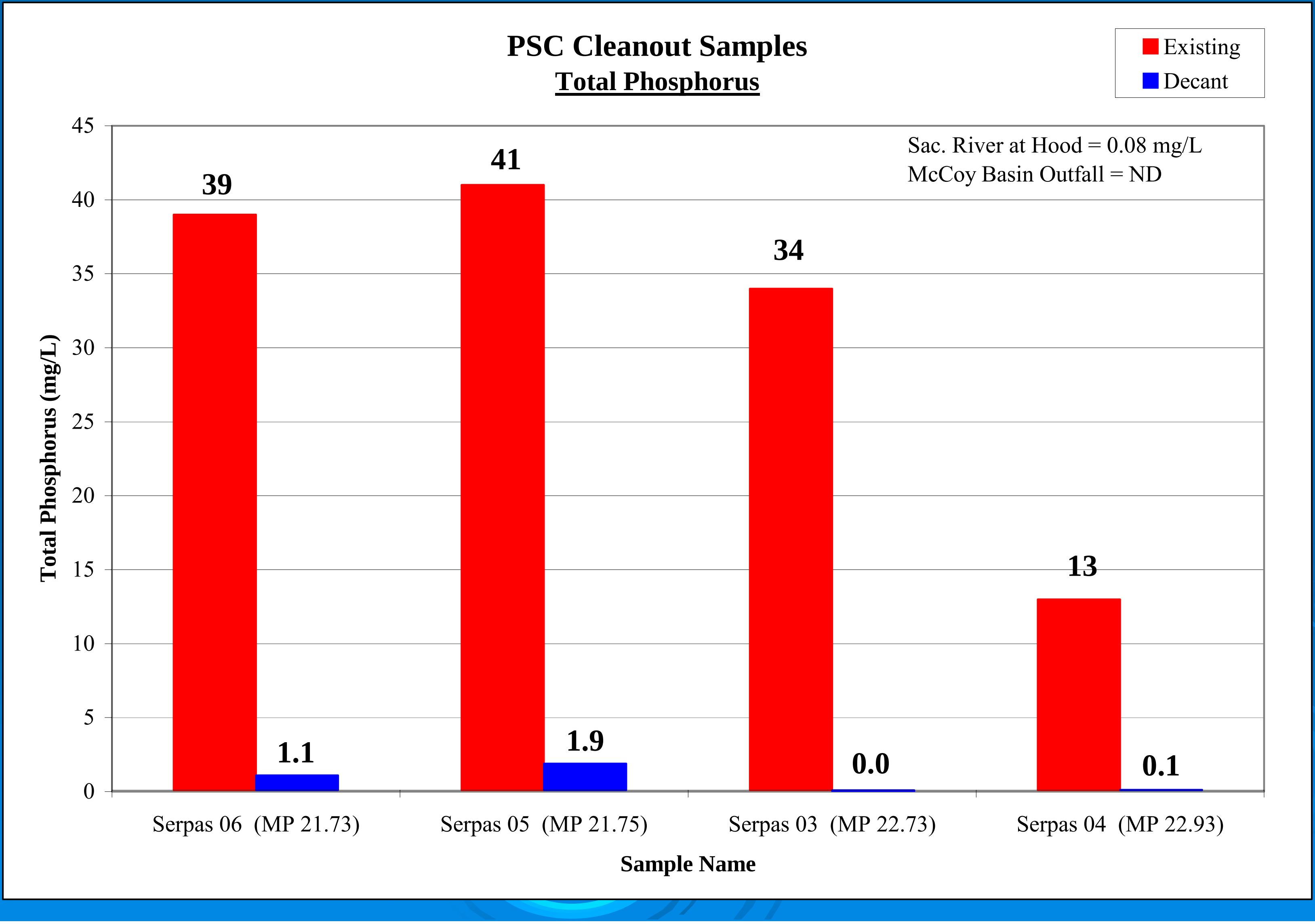
PSC Cleanout – Water Quality



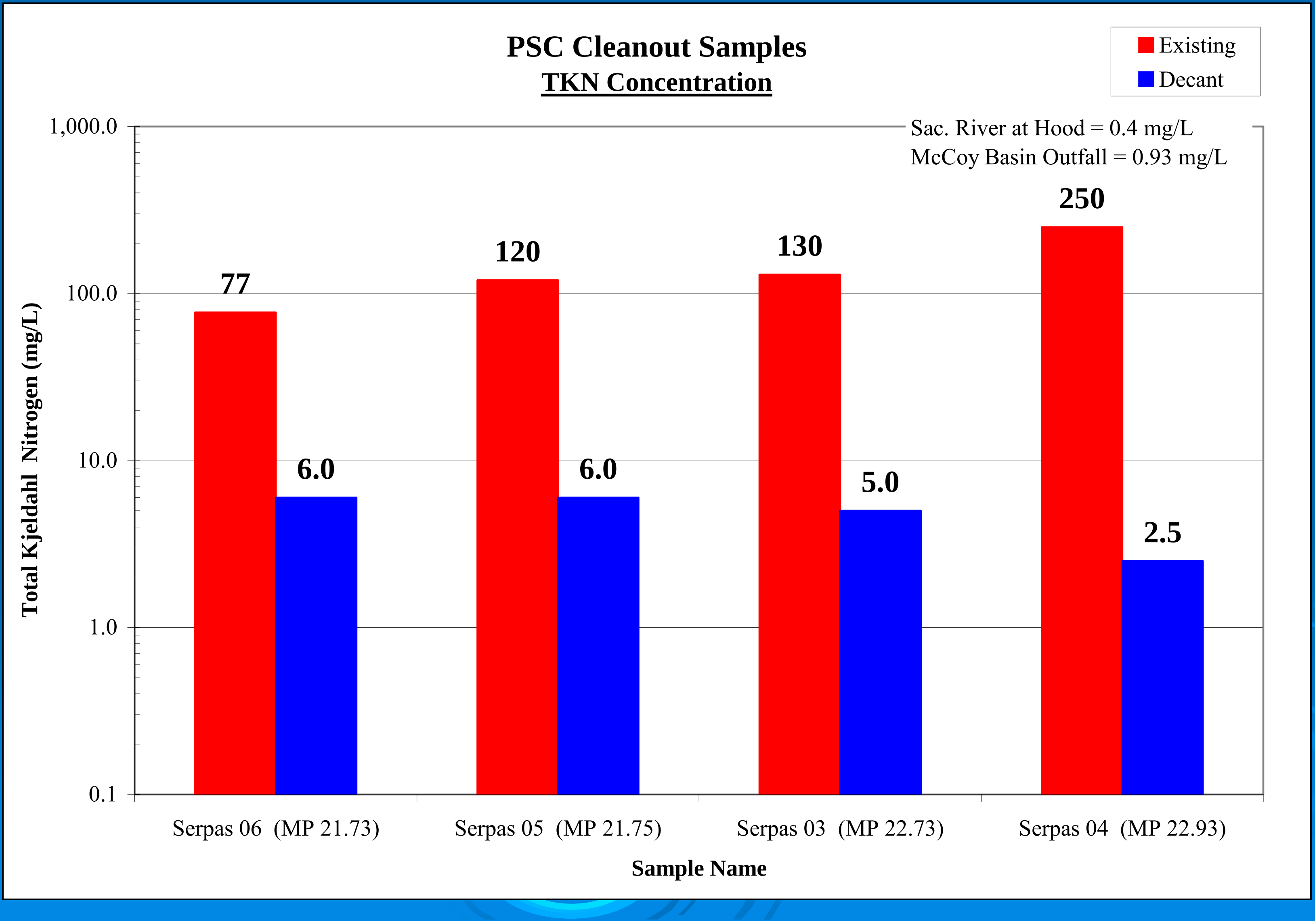
PSC Cleanout – Water Quality



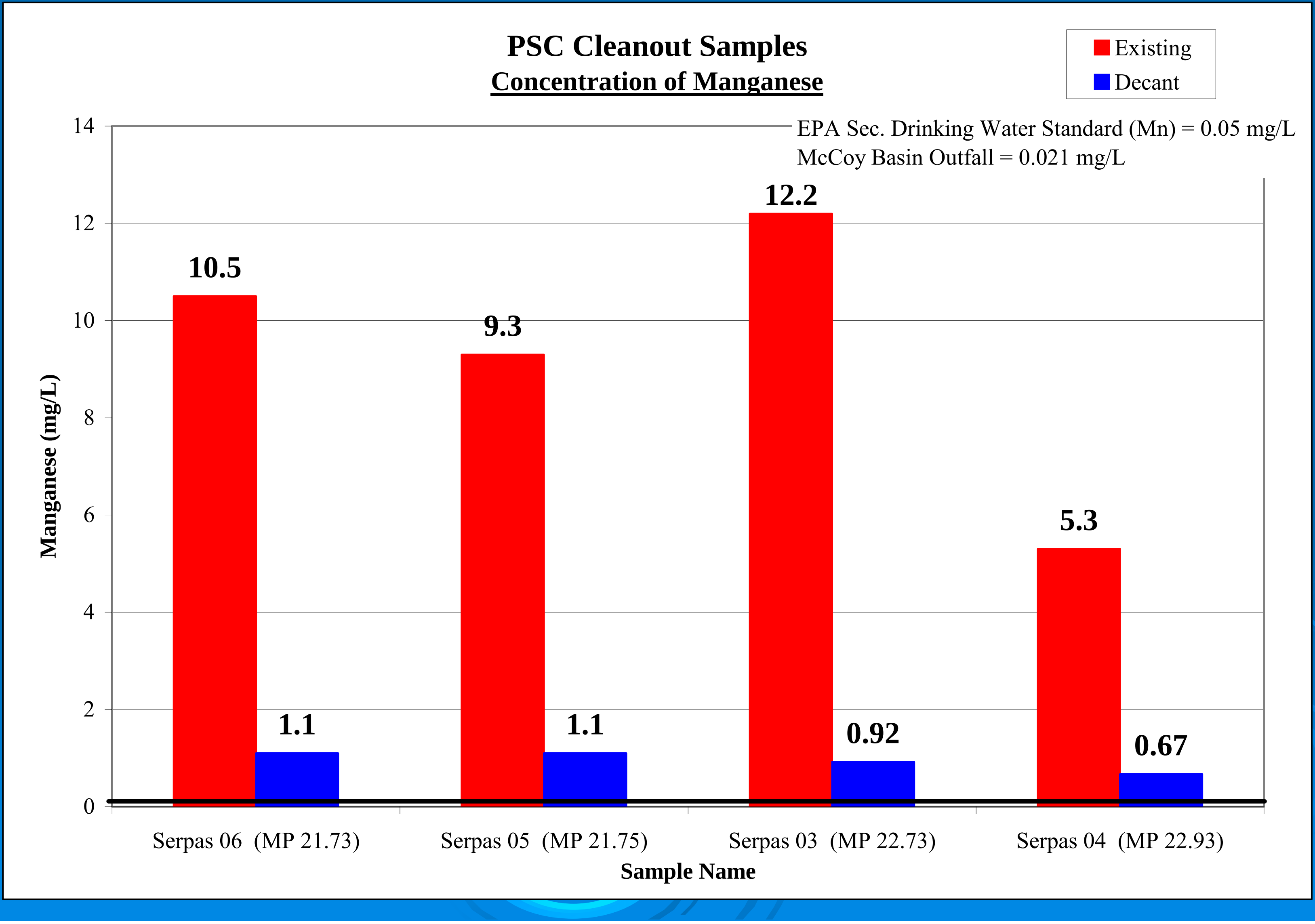
PSC Cleanout – Water Quality



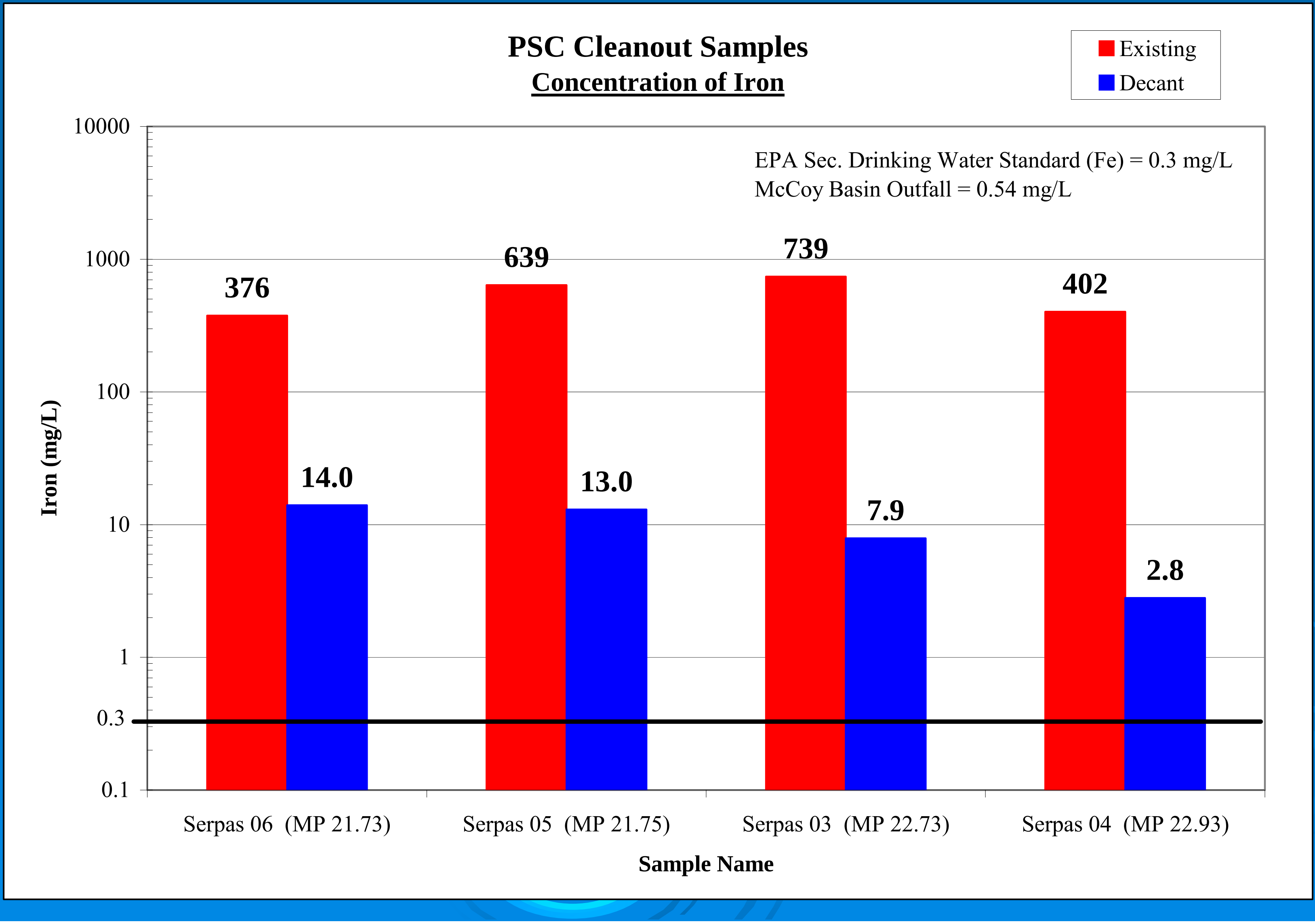
PSC Cleanout – Water Quality



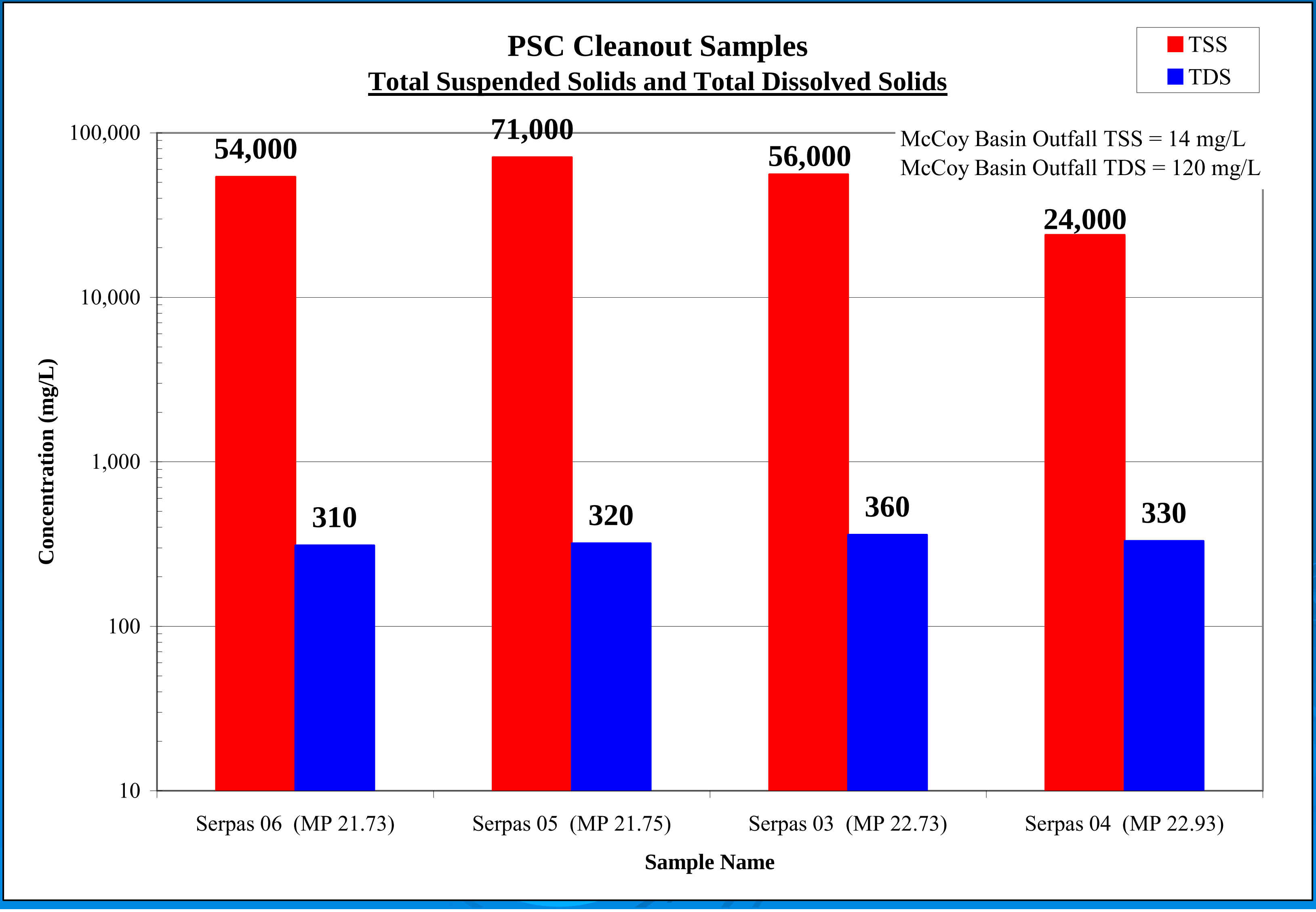
PSC Cleanout – Water Quality



PSC Cleanout – Water Quality



PSC Cleanout – Water Quality



PSC Cleanout – Water Quality

- PSC Cleanout Samples had high concentrations of nutrients, organics, color, TSS, TOC, Fe, Mn
    - The water cannot be used for municipal use
- Decanting the samples reduced the concentrations by 1-2 orders of magnitude
    - Settling basins could be very helpful, still left with disposal problem of what to do with the solids material
- The cleanout residual has poor water quality ➔ promotes aquatic vegetation ➔ leads to more fine particle / residual material (Viscous Cycle)

PSC Cleanout – Water Quality

Goals

1.) To better understand how sediment enters into the PSC and under what conditions

2.) Better understand the impact of aquatic vegetation and how to control it

3.) Begin working on ways to reduce sediment into the PSC

4.) Determine ways to improve the PSC Cleanout, to more effectively remove the fine sediments