# Implementation and Effectiveness Monitoring of

# Wetland Best Management Practices on

# The Tongass National Forest

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**Newly Constructed Road through a Forested Wetland on the Logjam Project Area.**

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## Introduction and Background

The Tongass National Forest Monitoring Plan (2008) includes a wetland implementation and effectiveness monitoring question. The wetland question stated in chapter six of the Forest plan is:

- Were the wetland conservation practices implemented and effective to avoid and/or minimize impacts to wetlands to the extent practicable?

Wetland Standards and guidelines are provided on page 4-88 of the forest plan. The standards and guidelines incorporate the State approved BMPs in FSH 2509.22 and the 15 baseline provisions from 33 CFR 323.4. The 15 baseline provisions are incorporated in BMP 12.5 (FSH 2509.22).

Prior to 2010 routine BMP implementation monitoring documented whether or not BMP 12.5 was prescribed or implemented and qualitatively assesses if the amount of roads and vegetative disturbance in wetlands are minimized and if borrow sources are located in upland areas. Quality control of routine BMP implementation monitoring is conducted by and interdisciplinary team on a random sample of sites. The random site selection may or may not include sites with wetland impacts. Annual forest monitoring also documents acres of wetland loss at the forest scale based on a GIS query. On 2010 the Tongass NF began using National BMP monitoring forms that focus on whether or not sediment is entering a water body. The national forms do not include a wetland assessment question. Routine BMP monitoring since 2010 does not assess Region 10 BMP 12.5.

In 2006 the 1997 Tongass forest plan wetland monitoring question was reviewed and a method was designed to qualitatively assess the implementation and effectiveness of the standards and guidelines in avoiding and minimizing impacts to wetlands. This question review and protocol development was documented by Landwehr (2006). The wetlands monitoring report for fiscal year 2006 (Landwehr, 2007) was the first report written using these new monitoring protocols. A report written in November 2008 documented findings from field data collected from five road segments in the summer of 2008. This wetland monitoring (above and beyond routine BMP implementation monitoring) is on a two-year cycle. FY 2010 was the next scheduled field data collection year but due to other budget priorities the field data collection was not funded until 2011.

This report is focused on the implementation and effectiveness of the 15 federal baseline provisions in avoiding and minimizing impacts to wetlands. The Appendix will include brief discussions of wetland avoidance at the project scale and wetland classification at each of the sites monitored.

## Purpose and Need

There is a need to answer the 2008 forest plan wetland monitoring question. There is a need to display how well implementation of standards and guidelines (baseline provisions) avoid and/or minimize impacts to wetlands. There is a need to understand and clearly articulate the impacts of forest roads on wetland hydrology, and specifically the conversion of wetlands to uplands.

## Objectives

- Determine if wetland conservation practices were implemented and qualitatively assess the effectiveness of those practices in avoiding and minimizing impacts to wetlands.
- Describe the extent of physical and hydrologic impacts to the wetland from each road segment.
- Determine if existing wetland classification schemes adequately describe Tongass wetlands.

## Methods

The methods for the revised wetland implementation and effectiveness monitoring are detailed in the *Proposed Wetland Monitoring Protocol* document (Landwehr 2006). Briefly the methods are as follows.

1) Using the standard forms, qualitatively assess the implementation and effectiveness of each of the 15 Federal Baseline Provisions (Wetland BMPs) described in 33 CFR 323 (4).
2) Assess physical impacts to the wetland soils by measuring the area of disturbed soil.
3) Document soil and vegetation conditions and use literature to estimate hydrologic effects to the wetland beyond the disturbed soil corridor.
4) Determine wetland status and classify soil and vegetation based on existing wetland classification schemes (Appendix A).

In FY 2011 wetland monitoring was conducted by an interdisciplinary team consisting of Tongass soil scientists and ecologists. The Corps of Engineers was invited but could not attend due to other priority projects.

### Site Selection

Road Segments across wetlands were identified by asking each of the Tongass Ranger Districts to identify areas harvested in 2009 and 2010. The harvested stands were identified in GIS and determination made if new roads were associated with the harvest and if the roads crossed wetlands. This process identified harvested timber on four districts, however the harvest on Wrangell district included rely constructed roads that were monitored in 2006. Very small lengths of road were constructed through wetlands on the Petersburg district. Both Thorne bay and Craig Ranger Districts had several new road segments across wetlands, however the Craig roads were on Suemez Island and the roads were put in storage following harvest so that helicopter access would be required to access the impacted wetlands. This monitoring project did not include funds for helicopter access so the Thorne Bay District-Logjam Timber Sale roads through wetlands were chosen.

Individual road segments across wetlands were identified using soil maps, National Wetland Inventory maps, orthophotography, project implementation maps and the road maps in GIS.  Due to small areas and questionable wetland status road segments were field verified before monitoring began. Field verification identified several segments that were non-wetland. Only three newly constructed road segments presented measureable monitoring opportunities. Those three segments were included in the monitoring.

In 2008 one 17 year old road segment was monitored and there was a desire to continue to monitor BMP performance over longer time periods. The literature review for the 2007 and 2008 wetland monitoring reports indicates that changes to wetland hydrology and vegetation may not manifest themselves for up to 30 years following drainage (Holden et. al. 2006). Therefore there is a desire to include several older road segments in this monitoring. The Logjam Timber Sale lies on central Prince of Wales Island and timber harvest in this area dates back to the 1960s and includes some of the oldest roaded timber harvest in Southeast Alaska. Using harvest dates, road and wetland maps, three additional road segments more than 30 years old were selected for monitoring in 2011.

## Results and Discussion

In August 2011 six road segments constructed through wetlands on the Thorne Bay Ranger District were measured for physical wetland impacts and standard forms completed to assess the implementation and effectiveness of the 15 Baseline Provisions. The total length of the six road segments was 7,650 feet (2.33 km). The six road segments occurred on two different project areas. The Logjam Project Area is located south and west of Sweetwater Lake, about 11 miles southwest of the City of Coffman Cove. The Little Ratz road is located on Clarence Strait about 15 miles southeast of the City of Coffman Cove. All of the old road segments, including the Little Ratz road were constructed as part of the long-term sale project which spanned a time from 1954 to 1997.

Three of the six roads segments were "new" construction all new construction was completed between 2009 and 2011. All of the new road segments were placed in storage or decommissioned following project activities. All of the new segments are temporary roads and decommissioning involves removing drainage structures and installing waterbars.

For the three "old" road segments the 3036 road was constructed prior to 1981, the 3035100 was constructed prior to 1979 and the Little Ratz 30 road was constructed about 1964. The Little Ratz road segment is in a decommissioned status and has been since the late 1960s when logging was completed in that area. Measurements from the old road segments provided insights as to BMP performance over a longer time scale.

The Logjam Project Area roads are located through wetlands within the Central Prince of Wales Lowlands subsection. Elevations of the wetlands in this area range from 200 to 1,000 feet. The lowlands are dominated by drumlins and till plains. The low hills have been heavily rounded by glaciation. The soils are dominantly underlain by dense till at varying depths. Of the six soil pits dug along the five road segments located in this area, 5 of them were poorly drained with more than a meter of peat. One of the soil pits included a somewhat poorly drained soil that was less than 50 centimeters deep over dense till. That particular soil does not classify as a hydric soil although similar soils that are hydric are located on the same hillslope.

The decommissioned road at Little Ratz is located less than 100 feet above sea level. The area is located at the mouth of a small glaciated valley. The site may be an uplifted marine beach or uplifted river floodplain terrace. The soils consist of more than a meter of very poorly drained peat over stratified gravels and organic materials.

**Assessment of the application of the 15 Federal wetland baseline provisions**
The 15 federal wetland baseline provisions (Wetland BMPs) are described in 33 CFR 323 (4). Criteria to measure or qualitatively evaluate each of the 15 Baseline Provisions have been developed. See Appendix B, Monitoring Forms, for a list of the criteria by baseline provision.

The 15 baseline provisions can be grouped into three categories; 1) wetland avoidance provisions, 2) provisions to minimize impacts to wetlands, and 3) provisions to mitigate impacts to wetlands. Eight of the 15 provisions are written to avoid wetlands in general or wetlands with specific characteristics (i.e. waterfowl breeding areas). Six of the provisions are focused on minimizing impacts to wetlands from roads. One of the provisions is written to mitigate impacts from temporary fills. This section describes the implementation and effectiveness of each baseline provision.

*Baseline Provisions to avoid wetlands (BPs 1, 2, 8, 9, 10, 11, 12, & 13)*
The Baseline Provisions to avoid wetlands are as follows:

- BP1 Permanent roads (for farming or forestry activities) temporary access roads (for mining, forestry or farm purposes), and skid trails (for logging) shall be held to the minimum feasible number, width, and total length consistent with the purpose of the specific farming, silviculture, or mining operations, and local topographic, and climatic conditions, project purpose and site conditions.
- BP 2 All roads, temporary and permanent, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharge of dredged or fill materials into waters of the US.
- BP 8 Borrow material shall be taken from upland sources whenever feasible.
- BP 9 The discharge shall not take, or jeopardize the continued existence of a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species.
- BP 10 Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands shall be avoided if practical alternatives exist.
- BP 11 The discharge shall not be located in the vicinity of a public water supply intake.
- BP 12 The discharge shall not occur in areas of concentrated shellfish production.
- BP 13 The discharge shall not occur in a component of the National Wild and Scenic River system.

BPs 1, 2, and 8 applied to all the road segments reviewed in FY 2011. BP 10 applied to 3 of the road segments due to fish stream crossings. Based on the associated NEPA documents, BPs 9, 11, 12, and 13 did not apply to any of the road segments monitored in 2011.

*Baseline Provision 1*

Baseline provision 1 speaks to avoiding wetlands to the extent possible. BP 1 requires minimum length, width, and number consistent with project purposes. The IDT assessed the minimum length and number criteria of BP 1 based on road card information and independent analysis of the orthophotography, topographic maps, and site specific conditions. The IDT also measured road surface widths to ensure that the road was within the minimum and maximum specified width for the project.

All of the new road segments and one of the old road segments were rated fully implemented for baseline provision 1. Primarily due to topographic constraints, road grade requirements and other environmental factors the road segments could not be located outside of the wetland while meeting project objectives. The length of the road segments through wetlands was the minimum amount necessary to meet project objectives. Two of the old road segments were rated as departures. On the 3035100 road segment there were no obvious avoidance opportunities but due to resurfacing and straightening of curves the average width of the running surface was 18 feet which is more than required for the maximum design vehicle (truck and lowboy trailer). The 30 road at Little Ratz had a running surface that averaged 17 feet wide at 6 cross sections. This road surface is wider than the minimum necessary for the design vehicle. On the six road segments monitored, the average road surface width measured at 49 cross sections was 15.75 feet. The design width for forest roads is 14 feet plus 2 feet for overage. Four of the six road segments monitored in 2011 were within specifications for minimum standard forest roads designed for silvicultural purposes.

Due to the low hills terrain of the Central Prince of Wales Till Lowlands wetland avoidance is particularly difficult when accessing timber stands. The timber tends to occur on the low hills and the low hills are often entirely surrounded by wetlands. Wetland avoidance is easier in the vicinity of the Little Ratz road segment, but in this case the wetland was logged and the road was a primary access route so that avoiding the wetland would not have met the desired specification for longitudinal curves.

A detailed wetland avoidance analysis was provided on the Logjam FEIS road cards and a wetland avoidance section was included in the FEIS. The NEPA documents for the old road segments are unavailable and the Ratz Road segment predates the Clean Water Act and National Environmental Policy Act. No NEPA or wetland avoidance was required at the time the 30 road at Little Ratz was constructed.

Implementation of baseline provision 1 is the most effective way to avoid impacts to wetlands. Due to the preponderance of wetlands on the Logjam Project Area road construction to access timber stands will often have to cross wetlands. Some commercially valuable timber stands are located within forested wetlands, as is the case with the 3000381 road segment monitored in 2011. Due to high costs, helicopter yarding of all Tongass timber is not practicable. Accessing timber stands with roads is often necessary to meet project objectives.

With the exception of the wide road running surfaces on two of the road segments monitored, baseline provision 1 as applied, is effective at avoiding and minimizing road construction in wetlands. Road cards should continue to document wetland avoidance and rationale for non-avoidance at the road segment scale. NEPA documents should continue to provide a road-wetland avoidance discussion at the project scale.

*Baseline Provision 2*

Baseline provision 2 (BP 2) describes avoiding impacts to wetlands by locating roads sufficiently far from streams or other water bodies. Baseline provision 2 was assessed using orthophotography, topographic maps, stream maps, and site observations. The measure of implementation of BP 2 is based on maximum distance from lakes and ponds. Road/stream crossings should be at or near 90 degrees to minimize the discharge of fill materials into the waters of the US.

BP 2 was fully implemented at all six road segments. Small streams are prevalent in most landscapes on the Tongass National Forest. All road segments crossed small streams and at or near right angles. The temporary road into unit 577-35 parallels a class one stream for a portion of its length, but the road was located outside the designated stream buffer and the change analysis found the location would be an adequate distance from the stream.

In many areas of the United States wetlands are synonymous with or at least in close proximity to, bodies of open water or streams. In temperate rain forests or boreal forests broad expanses of palustrine wetlands with no surface water are common. Based on measurements in 2006, 2008 and 2011 conducted as part of this monitoring, distance from water bodies (BP2) does not appear to be an effective provision to minimize the discharge of dredged or fill materials into waters of the US.

*Baseline Provision 8*

Due to the prevalence of wetlands on the Tongass National Forest borrow sources are often located in wetland areas. Rock used to construct five of the six road segments monitored was taken from borrow pits located in nearby upland areas. In these cases upland borrow sources were feasible. Baseline provision 8 was fully implemented.

On the 2057 temporary road segment the rock pit is located in upland, but is bounded by wetland on two sides of the pit. Some oversize rocks and fly rock were placed in wetlands down slope of the pit. It is unclear if the rocks were from the original pit development or from the pit expansion rock used to construct the 2057 temporary road. Baseline Provision 8 was implemented, but the pit development could probably have been done in a way that completely avoided wetlands at this site.

*Baseline Provision 9*
Baseline Provision 9 addresses avoidance of critical wetland habitat for threatened and endangered species. BP 9 was "not applicable" at all of the road segments monitored in 2006, 2008, or 2011. Since no Threatened or Endangered Species reside on the Tongass National Forest the assessment of BP 9 could be dropped from this monitoring.

*Baseline provision 10*
Baseline provision 10 addresses avoidance of breeding and nesting areas for migratory waterfowl and spawning areas. To assess BP 10 the litmus test is the wildlife analysis in the NEPA document and the presence or absence of fish bearing streams. If the analysis mentioned breeding and nesting areas for migratory waterfowl or spawning areas BP 10 would apply. If fish streams are crossed BP 10 would apply. Fish bearing streams were crossed by 3 of the road segments monitored in 2011. On the 3000381 road a bridge was used to cross a fish stream and the bridge was removed after the sale. The harvest unit is nearly surrounded by fish streams, so a crossing was necessary to access the unit. The crossing could not be avoided. The 3000381 road was rated fully implemented for BP 10. There was no way to avoid crossing a fish stream while still accessing the unit.

On the 3036 road a Class II fish stream was crossed near the south end of the wetland segment. The fish pipe crossings on this road had been removed, however new pipes would be installed next summer during the fish timing window. Assuming the pipe replacement will result in a crossing that passes fish, BP 10 will be fully implemented on the 3036 road. Without the pipe the crossing meets the intent of BP 10. There is no way to avoid crossing the stream while accessing the harvest beyond the stream.

On the decommissioned road at Little Ratz harbor the road was decommissioned, in part because of the presence of fish streams and beaver ponds that could be avoided by re-locating the road upslope. The new road location does not provide access to the stand previously harvested, but once riparian and beach buffers are installed, reconstruction outside the wetland area will be able to provide access. BP 10 was fully implemented while meeting project objectives.

*Baseline Provision 11*
Baseline Provision 11 addresses proximity to public water supplies. The State of Alaska maintains a map of public water supplies. The NEPA document and State maintained map were used to determine if public water supplies occurred downstream of the road segments monitored. None of the six road segments monitored in 2011 are in watersheds used for public water supply. On all six road segments BP 11 was found to be "not applicable". Public water supplies were not located in the vicinity of the six road segments monitored.

*Baseline Provision 12*
Baseline provision 12 addresses avoidance of areas of concentrated shellfish production. Maps and local knowledge were used to identify areas of mariculture operations or important natural shellfish production areas. All of the road segments monitored in FY 2011 are located in palustrine wetlands more than 1,000 feet (most are more than a mile)

from saltwater and many miles from any mariculture or "important" shellfish production areas. On all six road segments BP 12 was rated as "not applicable".

There may be circumstances on the Tongass where BP 12 applies. BP 12 should remain on the forms for those circumstances.

*Baseline Provision 13*
Baseline provision 13 seeks to avoid discharges in components of the National Wild and Scenic River System. Forest Plan maps include the components of the National Wild and Scenic River System. None of the road segments monitored in FY 2011 are located in or upstream of a component of the National Wild and Scenic River System. On all six road segments BP 13 was rated as "not applicable".

*Baseline provisions to minimize impacts to wetlands*
The Baseline provisions to minimize impacts to wetlands are as follows:

- BP 3 The road fill shall be bridged, culverted, or otherwise designed to prevent the restriction of expected flood flows.
- BP 4 The fill shall be properly stabilized and maintained during and following construction to prevent erosion.
- BP 5 Discharges of dredged or fill material into waters of the US to construct a road fill shall be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within waters of the US that lie outside the lateral boundaries of the fill itself.
- BP 6 In designing, constructing, and maintaining roads, vegetative disturbance on waters of the US shall be kept to a minimum.
- BP 7 The design, construction, and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.
- BP 14 The discharge of material shall consist of suitable material free of toxic pollutants in toxic amounts.

*Baseline Provision 3*
Baseline Provision 3 addresses the need to design roads through wetlands so that the road passes the expected flood flows. Due to costs all culverts greater than 36 inches in diameter on National Forest Systems roads in Region 10 are designed for a 25 year storm event and are planned with a life span of 25 years. Bridges are planned to pass a 50 year storm event. Implementation and effectiveness of BP 3 was assessed in the field by looking for evidence of erosion at culvert inlets and outlets, evidence of erosion or water flowing over the road prism, evidence of partially or fully plugged culverts, and evidence of ditchline erosion or water ponding in the ditchline.

On four of the six road segments monitored in 2011 BP 3 was rated as fully implemented. The reasons for a departure for BP 3 on the 3036 road was evidence of road surface erosion where water flowing on the surface of the wetland flowed down the road surface and back into the inboard ditch. The erosion on the 3036 road only occurs during very wet periods when surface flow occurs in the wetland. It was not clear if the erosion occurred during specific snow and ice conditions last winter or was a recurring event. A cross drain culvert could be installed at this site to prevent future erosion of the road surface. It was interesting to note that only one culvert was installed in 1,778 feet of wetland crossed by the 3036 road segment. Permeable shot rock fill had been passing wetland acrotelm water flow and surface water flow for over 30 years at this site.

On the decommissioned 30 road at Little Ratz harbor a plugged or dammed log culvert forced a small stream down the inboard ditch for about a hundred feet before it crossed the road surface eroding it. Beaver have also modified this stream where it now crossed the road is a beaver pond. Ponding also occurred adjacent to the 30 road where beaver had dammed the cross drains dug in the road fill. Proper decommissioning should have removed the log culvert. Larger cross drains may have reduced the influence beaver were able to have at this site.

Implementation of Baseline Provision 3 on the road segments monitored indicates effective passage of flood flows within 4 of the 6 wetlands monitored. The departure on the 3036 road could be considered minor. The departure on the 30 road is a bit more substantial. The log culvert should have been removed at this site. The road fill is stable at this time. No active beaver cuttings were identified at this site, so beaver influence may be fading.

Notes from the 2006 and 2008 monitoring indicate that most flow through palustrine wetlands can be maintained by placing drainage structures at preferential flow points in the wetland. When roads are constructed from coarse "shot" rock materials the roads generally remain permeable to sheet flow. Placing drainage structures away from preferential flow points generally does not enhance the movement of water through the wetland. Surface flow across sloping wetlands may be intercepted by the inside ditch of a road, however research on the Tongass NF indicates that the diversion of surface flow from the wetland may have little effect on wetland vegetation and wetland soil hydrology adjacent to the road (Kahklen and Moll 1999, McGee 2000). See the *Hydrologic Impacts to wetlands* section page 13 for detail.

When fully implemented Baseline Provision 3 appears to be effective at passing design flows on the road segments monitored. Care should be taken when decommissioning or storing roads for the long-term to ensure passage of water at preferential flow paths, no matter how small. If beaver influence is anticipated, cross drains should have a greater cross sectional area to pass additional flow and make it harder for beaver to form dams at the road crossing.

*Baseline Provision 4*

Baseline provision 4 requires stabilization of fills to prevent erosion during and after construction. The IDT assessed BP 4 by looking for erosion features like rills or gullies or slumping of the road fill. Sediment accumulated in the ditch or down-slope of the fill also indicates erosion is occurring. The IDT also looked for vegetation establishment on the road fill and cut-banks. Stabilization of fills on the six road segments monitored was good and the IDT rated BP 4 as fully implemented. It is unclear if the decommissioned road at Little Ratz Harbor was ever seeded, but it had adequate vegetation to prevent erosion on the day of investigation.

On the 2057 temp road there were areas of mineral soil exposed in the cutbank with little or no vegetation.  Erosion was not evident at this site.

Observations on the road segments where mineral soil cut-banks were exposed suggest that a stand of grass can prevent erosion. BP 4 as applied on the road segments monitored in 2011 is effective at preventing erosion.

*Baseline Provision 5*

Baseline provision 5 seeks to minimize the encroachment of equipment outside the lateral boundaries of the fill. BP 5 is assessed on-site by looking for evidence of equipment operation outside the boundaries of the fill or clearing limits, and by assessing the number of turnouts against the design criteria. On all six road segments there was no evidence of equipment operation outside the fill or clearing limits.

On five of the six road segments BP 5 was rated as fully implemented.  The 2057 temporary road was rated as a departure because one turnout was excessively large and 10 yard pile of excavated material was stacked adjacent to the road in the wetland. The distance between turnouts was similar to contract specifications for all road segments.

**Figure 1. Ten yard pile of fill placed in wetland adjacent to the road prism.**

On the decommissioned 30 road at Little Ratz harbor and on the 3035100 the road surface was found to be wider than the design criteria (see discussion of baseline provision 1) resulting in additional fill placed in wetlands.

When fully implemented, BP 5 appears effective at minimizing the encroachment of equipment in wetlands.  To reach full implementation more attention should be placed on avoiding placement of unwanted fill in wetlands. The turnout on the 2057 road was not as large those identified in previous monitoring efforts. Contract specifications include a minimum size for turnouts but not a maximum size. A maximum turnout size could be incorporated into contract specifications if turnout size is repeatedly excessive.

*Baseline Provision 6*
Baseline provision 6 requires minimizing vegetation disturbance when designing, constructing, and maintaining roads in waters of the US. To assess BP 6 contract clearing widths were reviewed and clearing width flagging was reviewed in the field. On the three "new" road segments clearing width flags were still present. Vegetative disturbance outside the clearing width or timber harvest unit would have been a departure from the plan. At all six road segments monitored no timber was cut outside of the clearing widths marked for road construction or outside the harvest unit if the harvest unit was in forested wetland. BP 6 was rated fully successful on all six road segments. The clearing widths provided in the road construction contract specifications are the minimum needed for the road design and for safety reasons. When fully implemented, BP 6 is effective at minimizing vegetative disturbance in waters of the US.

*Baseline Provision 7*
Baseline provision 7 requires that the design, construction, and maintenance of road crossing structures not disrupt the movement of aquatic life inhabiting the water body. For fish bearing streams on the Tongass, the State of Alaska and the Tongass National Forest have agreed on minimum design criteria to pass fish.

To assess BP 7 the IDT first determined if the road segment crossed any fish bearing streams. Three of the segments monitored crossed fish bearing streams and all were rated as fully implemented and effective for BP 7. On the 3000381 specified road a fish stream was crossed with a log stringer bridge and the bridge removed following harvest. On the 3036 old road the fish stream culvert had been removed and fish passage did not appear to be a concern with the current streambed. When this culvert is replaced during fish timing next summer it is assumed it will pass fish. On the decommissioned 30 road at Little Ratz there are 3 fish stream crossings, all of which have had some beaver influence. Although one log culvert is plugged, the stream is currently passing fish through a beaver pond and ditchline. Due to low gradients the IDT assumed that fish passage will continue at this site.

The Tongass NF has a separate inventory to identify stream crossing structures that do not pass fish. Given this fact and the detailed hydrologic criteria needed to assess fish passage, assessment of BP 7 may not be appropriate for a wetland monitoring IDT.

*Baseline Provision 14*
Baseline provision 14 addresses the need to use clean fill, free of toxic pollutants in toxic amounts. Baseline provision 14 was assessed by looking at the road fill, looking for sheens of oil, trash, or iron staining that may be a sign of acid rock drainage. At all six road segments clean shot rock fill was used and there was no evidence of pollution. .

BP 14 was rated as fully implemented at each of the six road segments monitored. BP 14 appears to be effective at preventing the introduction of toxic pollutants in toxic amounts.

*Baseline Provisions to mitigate wetland impacts*

*Baseline Provision 15*
Baseline provision 15 requires that all temporary fills be removed in their entirety and the area restored to its original elevation. During construction of forest service system roads it is rare to use temporary fills except perhaps for the installation of major stream crossing structures. On all six road segments monitored in 2008 no temporary fills were used and BP 15 was found to be not applicable.

**Assessment of Wetland Impacts**
Physical impacts to wetlands were assessed by collecting physical measurements of impacts on the soil resource. Wetland hydrology impacts beyond the physical impact area were assessed by gathering soils data, road drainage (ditch, culvert and stream crossing) data, landform and landscape position data, and through a literature review of the effects of roads and ditches on wetlands with similar soils, slopes, precipitation, and landscape positions. The assessment of wetland impacts is divided into three sections; physical impacts, hydrologic impacts and biologic impacts.

*Physical Impacts to wetlands*
Physical impacts to wetland soils from road construction were measured with evenly spaced road cross section measurements and a longitudinal measurement. On long road segments (more than 1,000 lineal feet) ten cross section measurements were taken. On short road segments (less than 1,000 lineal feet) at least five cross section measurements were taken.

Road surface width and slope of the ground traversed dictates the width of the road fill. Road fill widths averaged between 18 and 37 feet. The average for all 49 cross sections is 24 feet (7.3 meters).

Disturbed soil widths averaged 28.6 feet (8.8 meters) at the 49 road cross sections measured in 2011. The six road sections totaled 7,650 lineal feet (2,332 meters) of road in wetlands. The total wetland area physically impacted by the five road segments is 5.2 acres (2.0 hectares). Five of the six road segments involved mostly overlay construction on side slopes that averaged less than 10 percent gradient. For this reason the average disturbed soil width for the segments monitored in 2011 is significantly less than the average widths documented in either the 2007 or 2008 report.

Two road segments had some cut and fill sub-grade construction on sloping ground (2057 temporary and 3035100). Disturbed soil widths were wider for roads on sloping ground.

**Figure 2. Overlay road construction through a forested wetland on the 577-35 temporary road segment. Disturbed soil widths averaged less than 23 feet through this wetland.**

The new construction road segments monitored in 2011 were from the Logjam FEIS NEPA document. The Logjam FEIS anticipated a 40 foot wide disturbed soil corridor. The NEPA documents for the older road construction are not available or did not estimate the area of wetland soils disturbed.

The average disturbed soil width of 29 feet measured in 2011 is less than that anticipated in the Logjam NEPA document, due primarily to gentler slopes of wetlands encountered in the Logjam Project Area. The 2006 and 2008 monitoring found average disturbed soil corridor widths of 45.5 and 41.9 respectively. The 40 foot width is still a good estimate for disturbed soil corridor widths on most project areas.

*Hydrologic Impacts to wetlands*

One of the goals of the 15 federal baseline provisions is to assure that the flow and circulation of waters within wetlands is not diminished. The implementation of the 15 federal baseline provisions and the ability of the road to pass expected flood flows of the wetland is discussed above in the assessment baseline provision 3. This section discusses probable impacts to wetland hydrology beyond the disturbed soil corridor.

Hydrologic impacts to wetlands as a result of road construction can occur within the disturbed soil corridor and beyond the disturbed soil corridor. Within the disturbed soil corridor wetland soils are excavated, buried, and/or compacted. Water movement over and through soils within the disturbed soil corridor will be altered.

At portions of three of the six road sites monitored in 2011 the wetlands consisted of shallow (less than 50 cm) to moderately deep (50 to 100 cm) poorly drained mineral and organic soils over bedrock. The water table in these soils is perched and if the site is sloping the water table is seasonal. These sites are similar to those monitored in 2006 and the 2007 report (Landwehr 2007) contains a detailed discussion of the potential hydrologic impacts beyond the disturbed road corridor on similar soils and landscape settings.

In summary, hydrologic effects to the wetland beyond the disturbed road corridor is generally limited within 3 to 5 meters of the road cut-bank or toe-of-fill. In southeast Alaska this limited effect is due primarily to the low hydraulic conductivity of the peat and the relatively high amount of rainfall through the year. In sloping areas the road prism and ditches will intercept surface runoff from wetlands and generally increase soil drainage near the road cut-slopes. Due to the low hydraulic conductivity of the peat and the high amounts of precipitation, the wetland soils beyond the disturbed road corridor will continue to classify as wetlands. The affected areas may be dryer or wetter for portions of the growing season, but precipitation is adequate to maintain wetland soil hydrology and vegetation conditions. McGee (2000) provides a more detailed discussion of this effect.

Portions of all of the road segments monitored in 2011 cross deep peat wetlands. The depth of the peat to underlying mineral soil varied from just over a meter to just over 3 meters. The 2008 report discussed the hydrologic impacts from road construction across deep peat wetlands.

In summary the hydrologic impact of Tongass forest roads on deep peat, gentle slope wetlands (bogs and forested wetlands) is likely less extensive than that summarized by Landwehr (2007) for shallow peat wetlands on steeper slopes. Saturation in deep peat soils is often maintained by the low hydraulic conductivity of the peat. In deep peat wetlands preferential flow paths in the peat form soil pipes that allow the wetland to process excess water without surface erosion. These soil pipes can be crushed by road construction and the result can be saturation of the site and increased water on the surface of the wetland. It can take many years for these changed hydrologic conditions to manifest themselves. This is one of the reasons we chose to include 30 year old roads in our 2011 monitoring effort. The effect of crushed soil pipes may have been the reason surface water is now present for part of the year on the 3036 old road segment monitored in 2011. At most sites there was no evidence of impeded drainage as a result of road construction across deep peat wetlands we monitored. The mostly overlay construction on deep peat wetlands result in very few areas of very short (less than 50 cm high) cut-slopes in the peat. Under these circumstances the hydrologic impacts to the wetland beyond the road prism appear negligible. (See Landwehr 2008 for more details.)

In 2011 several of the road segments monitored were built on wetland with peat depths of 1 to 2 meters over alluvial soil material or dense till. For those road segments built on peat wetlands underlain by dense till the hydrologic impacts beyond the road corridor are similar to those effects described for the shallow peat wetlands. Kahklen and Moll (1999) monitored hydrologic effect of road constructed across a wetland underlain by dense till. The effects are similar to described for shallow peatlands. (See Landwehr 2007 for more details.)

For the two wetlands with 1 to 2 meters of peat over stratified sands and gravels (577-35 temporary road and the 30 road at Little Ratz harbor) the hydrologic impacts to wetlands beyond the disturbed road corridor would likely be even less than those described for deep peat wetlands. When stratified sand and gravels underlie the peat at depths of one to two meters saturation is achieved through an apparent water table. If the overlying peat has low hydraulic conductivity the site can act like a deep peat wetland. An apparent water table changes in depth with seasonal rainfall, but is relatively constant within it depth of change as long as the wetland is not ditched to an outlet. Soil pipes are less likely to form in the peat and where they form they are tied to the underlying ground water table. Coarse, permeable shot rock may entirely displace the peat over the alluvial gravels, but the water table will not change and the wetland beyond the disturbed soil corridor will experience negligible change in water table or flow and circulation of water due to the permeable substratum. If the overlying peat has very slow hydraulic conductivity the influence of the underlying water table will be less.

Beaver can have a major influence on the hydrologic regime of wetlands by changing water table depths over localized areas. The wetland and uplands around the decommissioned 30 road at Little Ratz Harbor experienced a change in water table depth following beaver activity in the area. The wetland under and adjacent to the decommissioned 30 road appears to be wetter than indicated by the pre-construction and pre-harvest air photos. Portions of the site that were forested 50 years ago are no longer supporting coniferous vegetation because of beaver ponds and raised water tables. In this case a wetter wetland had a negative effect on the forest vegetation and beneficial effect on the sedge vegetation at the site. Based on site conditions and our monitoring of similar sites without beaver activity, we estimate that the road had little to do with changing water tables at the site. The timber harvest may have created vegetation more suitable for beaver colonization, but the effects of the road on the hydrology of the site appear negligible.

**Figure 3. This once forested wetland along the decommissioned 30 road segment was converted to sedge wetland by beaver influence following timber harvest and road construction.**

<u>*Biologic Impacts to Wetlands*</u>
Biologic impacts include wildlife habitat assessed at the landscape scale and plant habitat assessed at the site scale. The Logjam NEPA documents discussed the effects of roads and timber harvest on the wildlife habitat, fish habitat, and sensitive plant habitat on the project area. Fish were present in streams draining three of the road segments monitored in 2011. For the 3000381 fish stream crossing all mitigation measures were followed and the log stringer bridge removed after haul was complete.

On the 3036 road the fish stream crossing structure was removed but will be replaced during the next fish timing window. We assume it will be replaced with a structure that will pass fish.

On the decommissioned 30 road at Little Ratz Harbor fish are currently able to pass the three road crossing sites, including the one structure that was left in place. No mitigation or treatments are planned for the decommissioned road at Little Ratz, so if water tables drop following cessation of beaver activity, there may be fish passage issues. Given the size of the stream and the proximity to non-fish habitat just upstream, the effects on fish are non-existent at this time. The beaver ponds may have increased the amount of habitat at this site.

Wildlife habitat is a concern in the wetlands and surrounding forested areas. The Logjam NEPA documents identified road management options to address hunter access/wildlife concerns. The three new roads monitored in 2011 were already put in storage. The Ratz road was decommissioned. Only the 3035100 and 3036 roads remain open and drivable.

On highly acidic bogs the use of nutrient rich rock such as limestone would likely change the chemical composition of the bog in contact with and immediately adjacent to the road. The 3036 road was constructed from limestone rock about 30 years ago. The IDT noticed maidenhair fern adjacent to one of the muskeg ponds several meters downslope of the road prism. Informal testing of the surface pH indicated an elevated pH (7+) up to 10 meters from the road prism. The natural surface pH in the bog is about 4.5. With the exception of the maidenhair fern the elevated pH appeared to have little effect of the vegetation composition or growth down slope of the road prism. Future work should include a more formal monitoring effort to determine the extent and magnitude of the effect of elevated pH on vegetation and wetland function. Acid loving plants rooted in the surface (like sundew) may not tolerate changes to a more basic rooting medium.

Reed canary grass (Phalaris arundinacea) can be somewhat invasive in nutrient rich non-forested wetlands. For this reason reed canary grass is no longer used to stabilize road ditches, cut and fill slopes. Reed canary grass was identified at the 35 year-old road segment monitored at Little Ratz Harbor. Reed canary grass was present on the road prism, typically on the beaver dams, but very limited on the rest of the road segment monitored. It is unknown if reed canary grass was planted on the road following harvest. At some point in the future the reed canary grass may invade the fen wetland. At this time it has not.

## Summary and Conclusions

This monitoring qualitatively assessed the implementation and effectiveness of the 15 Federal Baseline Provisions. The baseline provisions can be separated into three groups 1) Provisions to avoid impacts to wetlands, 2) Provisions to minimize impacts to wetlands, and 3) Provisions to mitigate impacts to wetlands. The assessment indicates that the wetlands were avoided to the extent practicable while meeting project goals and objectives.

The assessment also indicates that impacts to wetlands were minimized to the extent practicable. Departures from full implementation occurred for baseline provisions 1, 3, 4, 5 and 8. Minor improvements could be made in the areas of road drainage, grass seeding, minimizing running surface width (especially on resurfaced roads) and minimizing turnout size and rock pit size in wetlands. Drainage improvements can be made when the road is put in storage. In the 2006 monitoring several large turnouts were identified in wetlands. The 2008 monitoring found only one unduly large turnout in wetlands. The 2011 monitoring found 2 turnouts in wetlands that could have been smaller. The turnouts identified in 2011 were smaller than those identified in 2006. Limiting the size of turnouts has not been necessary as a contract provision in the past. Since large turnouts in wetlands have been found in multiple locations it may be appropriate to have a contract specification listing a maximum size of turnouts in wetlands.

Physical impacts to wetland soils were relatively easy to quantify. The disturbed soil corridor associated with the road segments monitored averaged 28.6 feet (8.7 meters) in width. The disturbed corridor widths measured in 2011were significantly less than those measured in the 2006 and 2008. The reason is more overlay road construction was monitored in 2011 than in 2006 or 2008. The average disturbed soil corridor width from 3 years of monitoring is 37.2 feet (n = 115 cross sections). A disturbed soil corridor width of 40 feet would be an appropriate for future estimates of physical impacts to wetlands on most project areas. On flatter slopes the width will likely be less. On steeper side slopes the width will likely be more.

The literature review in conjunction with the soil, slope, precipitation, and landscape position data collected at the monitoring sites have allowed us to estimate the hydrologic impacts to wetlands outside the disturbed soil corridor. The hydrologic impacts to wetland soils and vegetation will be very limited (typically less than 3 to 5 meters) beyond the physically disturbed soil corridor associated with the road. This estimate best applies to sloping peatlands and mineral soils. The hydrologic effects from road construction on flat slopes and deeper peat wetlands will likely be less. Based on the literature, the hydrologic and vegetation changes beyond the disturbed soil corridor will not result in a change in status from wetland to upland.

Observations along the 30 year-old 3036 and 3035100 roads indicate little change to the wetland drainage and vegetation. These are relatively low volume roads constructed with coarse textured, durable materials. Roads constructed from finer textured materials, or less durable materials would be less permeable and may have farther ranging impacts to wetland drainage. Continuing to monitor new road construction will not provide insights to subtle drainage effects that take years to manifest themselves. This monitoring included 3 road segments that were 30 or more years old. On the decommissioned 30 road wetland drainage had been altered, primarily by a plugged log culvert and beaver dam construction. On the 3036 road there was evidence of water accessing and eroding the road surface during high flows. It is difficult to tell if this a legacy effect of road construction or a function of snow and ice conditions during the winter. Excavation of an old road prism in a wetland may help understand the effect of the road on soil hydrologic function. On the 3035100 road there was evidence of water flowing through the road prism rock even after 30 years had passed.

Beaver dam construction also changed the soil moisture status and vegetation along the decommissioned 30 road. A wetland that was forested and logged in 1964-65 is no longer forested and supports sedge vegetation.

On the 3036 road segment a maidenhair fern was noted in a muskeg pond down slope of the road. Informal testing of surface pH indicated an elevated pH up to ten meters down slope of the 3036 road. The 3036 road was constructed of limestone 30 years ago. The natural surface pH of the shore pine bog was about 4.5. The elevated pH was in excess of

7.  More formal sampling and testing need to be completed to understand the magnitude and extent of the elevated pH levels associated with limestone roads. Subtle vegetation changes may be occurring and more may occur in the future as a result of elevated pH levels.

A retrospective wetland vegetation study similar to Glaser's (2000) work may help elucidate the extent of wetland hydrology and vegetation change associated with roads more than 30 years old. For old roads preconstruction aerial photos may help identify vegetation change associated with road construction.

## Recommendations

If timber harvest and road construction in wetlands continues at the current pace, the number of road segments monitored could be reduced. The monitoring of the 15 federal baseline provisions has found a very high rate of implementation and minimization of impacts to wetlands. If monitoring of new roads is continued a team of wetland scientists that include the Corps of Engineers and EPA should be used.

Continue to measure the physical wetland impacts with the parameters described in this report. Continue to incorporate wetland literature to define hydrologic impacts beyond the disturbed soil corridor.

There is a need to understand the chemical effect of limestone roads through wetlands. A small pilot study sampling perhaps 5 wetlands with ph at 3 depths and 10 or meters upslope and down slope from the road prism would help define the chemical effect. Vegetation micro plots should be used in conjunction with the soil chemistry sites. The roads suggested should be 30 or more years old.

Both the 2007 and 2008 report suggested retrospective monitoring of older roads through wetlands. The 2011 monitoring included three 30-year road segments through wetlands. Both the 3036 road and the 3035100 indicate limited physical impacts to the wetland beyond the road corridor. On the 3036 road elevated pH was identified well beyond the road prism. On the 30 road beaver activity changed wetland hydrology and biologic function by converting the site from forested wetland to sedge dominated wetland. This report reiterates the need for monitoring the effects of older roads through wetlands.

Consider conducting a retrospective wetland vegetation study similar to Glaser's (1999) work to determine the extent of wetland vegetation change associated with roads more than 30 years old. Use preconstruction aerial photos to assist in determining the extent of vegetation change associated with road construction.

Consider examining soils under old road prisms in wetlands for indicators of compaction, crushed soil pipes, subsidence and deformation associated with the road prism.

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# Appendix A

**Wetland Avoidance a the Project Scale**
The 2006 wetland monitoring protocol (Landwehr 2006) provided a rationale for, and recommended documenting wetland avoidance at the project scale. Previous project level NEPA documents discussed wetland avoidance at the road segment scale. The Annual Monitoring and Evaluation Report for the Tongass discussed wetland avoidance at the forest scale. When the 2007 report (Landwehr 2007) was written no NEPA documents on the forest had incorporated a discussion of wetland avoidance at the project scale. As of this writing the Tongass has produced several timber sale NEPA documents that discuss wetland avoidance at both the road segment scale and the project area scale. Those documents include the Scratchings Timber Sale on Suemez Island on the Craig Ranger District, the Iyouktug Project Area on the Hoonah Ranger District, the Logjam Project Area on the Thorne bay Ranger district and the Central Kupreanof Project on the Petersburg Ranger District.

**Wetlands Classification Crosswalk**
Existing wetland classification systems were used to classify wetlands along the six road segments constructed across wetlands. The Wetlands of British Columbia classification system (Mackenzie and Moran 2004) is the most detailed of the classification systems and it fit the wetlands on the five of the six sites pretty well. None of the existing wetland classification systems perfectly fit the wetlands encountered along the road segments monitored. Each of the wetland classification systems documents different characteristics of the wetland.

The wetland classification system that best fits the forest's purposes depends on the interpretation the forest wishes to derive from the classification system. For purposes of assessing the effectiveness of the 15 Federal Baseline Provisions in preserving wetland functions the classification system should focus on hydrologic characteristics of wetlands and vegetation characteristics of wetlands. Hydrologic characteristics should include precipitation characteristics, runoff characteristics, soil permeability, available water holding capacity, pH, conductivity, and landscape position. Vegetation characteristics should include enough detail about species composition and abundance to correlate vegetation with hydrologic function. At a minimum the classification system needs to be a tool that is easily understandable for the public and personnel from cooperating agencies. The 2007 wetland monitoring report provided a brief discussion of each of the classification systems and the functions they quantify. Table 1 provides the wetland name by classification system and road segment number for the wetland sites monitored on the Thorne Bay ranger District in 2011.

**Table 1.** Wetland classification by road segment number.

| Road Segment Number | NWI classification | Wetland habitat type | Wetlands of British Columbia | Canadian Wetland System | Soil Series |
|---|---|---|---|---|---|
| 2057 temporary road | PFO4/EM1B | FES | WB10 and Ws55 | Treed Sloping Bog/Slope fen | Kina and Wadleigh |
| 3000381 and temp | FO4B | FW | WS54 | Treed Bog | Kina |
| 577-35 temporary | PFO4B | FW | WS54 | Treed Bog/slope fen | Kushneahin |
| 3036 old | PF04/EM1B | FW and EM | Wb10 | Treed sloping bog | Wadleigh and Kina |
| 3035100 old | PFO4/EM1B | FES | Wb07 | Treed sloping Bog | Kina |
| 30 Rd @ Little Ratz, Old decommissioned | PEM1/SS1B | FW and EM | Wf01 | Domed bog and Floodplain Swamp | Kina |

The National Wetlands Inventory (NWI) Classification (Cowardin 1979) is a nation-wide classification system that provides a very coarse descriptor of wetland vegetation and hydrology. The NWI classification has four components, system, subsystem, class, and subclass. A NWI code of PFO4B equates to a Palustrine Forested Needle-leaved Evergreen wetland on saturated soils. Modifiers can be used to more accurately describe the water regime, water chemistry, soil or other special circumstances. The NWI is a nation-wide system that is easily communicated to other agencies and interested publics. NWI maps are available for most of the Tongass. The drawback to using NWI is that it lacks the detail necessary to differentiate between wetland types at all but a very coarse scale. NWI does not provide good descriptors for estimating wetland hydrologic or habitat functions. Four different NWI wetland types have been identified at the 16 sites monitored since 2006. (Table 2).

The wet-hab wetland mapping system was derived from a need for a wetland map for the 1997 Tongass Forest Plan revision (DeMeo and Loggy 1989). The wetland habitat-type is an interpretation of soil and vegetation data. The wet-hab types provides more detail on wetland vegetation than the NWI, but still lacks detail regarding landscape position and vegetation community. Like NWI, the wet-hab does not provide the descriptors necessary for estimating hydrologic function or detailed habitat functions. Seven different wet-hab types have been identified among 16 sites monitored since 2006.

The Wetlands of British Columbia Classification (Mackenzie and Moran 2004) provided the most detail regarding plant communities and landscape position. For the wetlands monitored in 2006 the Wetlands of BC did not provide a direct fit for any of the plant communities documented along the four road segments monitored. For the 2008 sites the wetlands of BC provided a very close fit for the Chrome, Cobble, and Luck Lake wetlands. For the wetlands monitored in 2011 the wetlands of BC fit well on five of six sites. On several road segments two or more wetland plant communities were recognized. The level of vegetation detail is the highest of any of the classification systems discussed, but this system does not make a strong linkage between vegetation and hydrologic function. Eight different wetland of BC have been identified among 16 sites monitored since 2006.

The Wetlands of Canada Classification System (National Wetlands Working Group 1988) is a hierarchical classification based on surface features, soils, water source, and vegetation type. The vegetation type is based solely on life form class. This system provides the highest level of detail regarding landscape position and topographic form but still lacks enough detail to estimate wetland hydrologic and habitat functions.

Only three different soil series were represented on the six sites measured in 2011 (Table 1). Soil mapping matched the soil series found on most of the road segments measured in 2011. Several of the Kina soils had mineral soil contacts below 1 meter, which could be recognized as a different series. The soil survey on the central and northern Prince of Wales Island is the oldest third order soil survey in Alaska. Later surveys identified more soil series with similar classifications to those mapped on central Prince of Wales. Where accurate, the soil series provided necessary detail regarding soil permeability, available water holding capacity, and soil depth. These details are important for determining how water resides in the soil and how water moves through the soil. The soil series did not provide adequate information on landscape position to document hydrologic effects of a road crossing on the wetland. The soil series provided only cursory vegetation information. Eight different soil series have been identified among the 16 sites monitored since 2006.

The non-forest wetlands classification system currently being developed for the Tongass National Forest will eventually provide a wetland classification system specific to Tongass wetlands. The classification system needs to incorporate the criteria needed to make the desired interpretations. Specifically soil information, vegetation information, and landscape position need to be incorporated in the classification of wetlands. Until the Tongass specific classification system is developed, we suggest continuing to refine the crosswalk between the existing classification/mapping systems for the wetlands encountered during biennial monitoring trips. This data will continue to provide insight into needed wetland interpretations and the data (wetland characteristics) necessary to support the interpretations.

All of the road segments through wetlands monitored in FY 2011 were constructed as part of timber sale projects. For the newly constructed segments the wetlands were identified on the road cards for the project. Lengths of roads through wetlands were estimated in the road card narratives. Estimated lengths of roads through wetlands on the road cards were similar to the lengths of road implemented.  Wetlands were avoided to the extent practicable, given project objectives.

Both soil maps and NWI maps provided a reasonable guide to wetlands along the road segments monitored. Both maps appeared to over-estimate the amount the amount of the polygon that was wetland. The Logjam EIS discussed wetland avoidance on the road cards and at the project scale in the EIS.

**Table 2. Summary of wetland plot data from wetland-Road monitoring project.**

Three cycles, field data from 2006, 2008, and 2011 October, 2011

| Monitored segment | Date Monitored | Soil | Cowardin | Wet hab | Wetlands of BC | Notes |
|---|---|---|---|---|---|---|
| 2057 | 8/22/2011 | Wadleigh and Kina | PFO4B/EM1B | FW and EM | Ws55 and Wb10 | St. nicholas in forested type too. |
| 3000381 | 8/23/2011 | Kina | PFO4B | FW and EM | Ws54 | 120 cm to till |
| 3036 | 8/23/2011 | Kina/Kushneahin | PFO4B | FW and EM | Wb10 | 140 cm to till |
| 3035-100 | 8/24/2011 | Kina | PFO4B/EM1B | SE | Wb07 | Nothing really fit for wetlands of BC but came closest to WB07 and WB10 |
| 577-35 | 8/24/2011 | Kushneahin | PFO4B | FW | Ws54 | |
| Ratz 30 Road | 8/25/2011 | Kina | PEM1/SSF1b | MS | Wf01 | |
| 3000 190B | 7/10/2008 | Kina | PFO4B/EM1B | FW and EM | Ws54 or Ws55 | did not cleanly fit either |
| 3000338 | 7/9/2008 | Grindall | PEM1B | MT, EM | Wf51 | no sphagnum in plot but around the edge |
| 2030-2 | 7/9/2008 | Euic Kina | PEM1B | FEF | Wb53 | |
| 3030115 | 7/7/2008 | Nakwasina | PFO4B/EM1B complex, 90% PFO on road | FEF | Ws55 | |
| 2030300 | 7/8/2008 | Nakwasina | PFO4B/EM1B | FEF | Ws55 | |
| 52033 #2 | 9/27/2006 | Sunnyhay | PFO4/EM1B | FEF | Ws55 | no skunk cabbage, occasional marsh marigold and sedges |
| 6594 | 9/26/2006 | St. Nicholas | PfO4B | FW | Ws55 | complex of two soils |
| 6594 | 9/26/2006 | Niblack | PEM1B | EM | Wf50 | complex of two soils |
| 52033 #3 | 9/27/2006 | Sunnyhay, Nt. Nicholas, Tolstoi | PFO4B/EM1B | FES | Wb53 | |
| 520332-5 | 9/28/2006 | Kina | PEM1B | MS | WB53 | |

# Appendix B

## Wetland Implementation and Effectiveness Monitoring Forms

## And Wetland Impact Monitoring Form.

# Road Wetland BMP Implementation Monitoring Form

| | | | | | |
|---|---|---|---|---|---|
| **Date Monitored:** | **ER/ COR Name:** | | **Road Construction Contract:** | | **Date Monitored** |
| **Road #:** | **Timber Sale:** | | **EIS/EA:** | | **District:** |
| **Air photo number and notes:** | | | | | |
| Township/Range/1/4 section | Milepost | | GPS coordinates | | |
| **Wetland Information** | | | | | |
| Length of road through wetland: | | | | | |
| Cowardin Classification: | | | | | |
| Soil Series: | | | | Landform or landscape position: | |
| Wetland Habitat Type: | | | | | |
| Wetlands of Canada Type: | | | | | |
| Wetland Acres in Road Corridor: | | | | | |
| Soil pH surface: | | Soil pH @ 50 cm: | | Soil pH @ 20cm above impermeable layer:<br>Depth: | |
| Number of drainage structures of road in wetland: | | | | | |
| Size and channel type of any associated streams: | | | | | |

| |
|---|
| Standing water present in wetland? |

## Wetland Road BP Implementation Monitoring Form

1 BP rating (rate after road final): F = BP fully implemented; D = Departure from full BP implementation; N = BP not implemented

2 Departure occurred during Site Evaluation (SE), Environmental Analysis (EA), Contract (CT), Lay Out (LO), Administration (AD)

| Item Monitored | Applies | BP Rating [1] | Corrective Action | Corrective Action Implemented | Departure Occurred[2] | Comments (PRINT!) |
|---|---|---|---|---|---|---|
| BP-1- permanent roads (for farming or forestry activities) temporary access roads (for mining, forestry, or farm purposes), and skid trails (for logging) held to minimum feasible number, width, and total length consistent with the purpose of specific farming, silviculture, or mining operations, and local topographic and climatic conditions, project purpose and site conditions.<br>- Any obvious avoidance opportunities based on local conditions, road card data or project wetland map? (BMP 14.2 & 14.3)<br>-Does width of road surface match design criteria?<br>-Measure road surface width, road fill width, and disturbed soil width (top of cut to toe of fill) document on this form.<br>-Do implemented road miles through wetlands on this project match the planned road miles through wetlands.<br>-Was this wetland identified on the road card? | yes/ no | | yes/ no no | | | |
| BP-2 -All roads, temporary and permanent, shall be located a sufficiently far from streams or other waterbodies (except for portions of such roads which must cross water bodies) to minimize discharge of dredged or fill materials into waters of the US.<br>-Measure or estimate distance to the nearest water body.<br>-Could the distance have been greater while still meeting project objectives? (BMP 14.2 & 14.3) | yes/ no | | yes/no | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| -Is 100 feet a sufficient distance for a road from a water body?<br>-Forest Plan Riparian S&G applied? | | | | | | |

**Wetland Road BP Implementation Monitoring Form**

1 BP rating (rate after road final): F = BP fully implemented; D = Departure from full BP implementation; N = BP not implemented

2 Departure occurred during Site Evaluation (SE), Environmental Analysis (EA), Contract (CT), Lay Out (LO), Administration (AD)

| Item Monitored | Applies | BP Rating 1 | Corrective Action | Corrective Action Implemented | Departure Occurred 2 | Comments (PRINT!) |
|---|---|---|---|---|---|---|
| BP-8 -Borrow material shall be taken from upland sources whenever feasible.<br>-Is borrow source located in wetlands or did the development of the borrow source impact wetlands?<br>-Was there a practicable option to locating the borrow source in wetlands? (BMP 12.5) | yes/ no | | yes/no | | | |
| BP-9 -The discharge shall not take, or jeopardize the continued existence of, a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species.<br>- Are threatened or endangered species individuals or critical habitat present at the site?<br>-Any T&E habitats identified on the project area? (Review the project NEPA) | yes/ no | | yes/ no no | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| BP-10 - Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands shall be avoided if practical alternatives exist.<br>-Are spawning areas or nesting areas for migratory waterfowl present at the site?<br>-Were breeding or nesting areas for waterfowl a concern at this site in the NEPA analysis? | yes/<br>no | | yes/no | | | |

**Wetland Road BP Implementation Monitoring Form**

[1] BP rating (rate after road final): F = BP fully implemented; D = Departure from full BP implementation; N = BP not implemented

[2] Departure occurred during Site Evaluation (SE), Environmental Analysis (EA), Contract (CT), Lay Out (LO), Administration (AD)

| Item Monitored | Applies | BP Rating [1] | Corrective Action | Corrective Action Implemented | Departure Occurred[2] | Comments (PRINT!) |
|---|---|---|---|---|---|---|
| BP-11 - The discharge shall not be located in the proximity of a public water supply intake.<br>-Is there a public water supply intake downstream of the wetland? How Far?<br>-Is there a visible or quantifiable impact to the public water supply from the management activity? Explain.<br>-Also a forest plan standard. | yes/ no | | yes/no | | | |
| BP-12- The discharge shall not occur in areas of concentrated shellfish production.<br>- Is the wetland in an area of concentrated shellfish production?<br>-Is there a visible or quantifiable impact to the shellfish production from the management activity? | yes/ no | | yes/ no no | | | |
| BP-13-The discharge shall not occur in a component of the National Wild and Scenic River system.<br>-Is the discharge in a component of the National Wild and Scenic River System? | yes/ no | | yes/no | | | |

## Wetland Road BP Implementation Monitoring Form

[1] BP rating (rate after road final): F = BP fully implemented; D = Departure from full BP implementation; N = BP not implemented

[2] Departure occurred during Site Evaluation (SE), Environmental Analysis (EA), Contract (CT), Lay Out (LO), Administration (AD)

| Item Monitored | Applies | BMP Rating [1] | Corrective Action | Corrective Action Implemented | Departure Occurred[2] | Comments (PRINT!) |
|---|---|---|---|---|---|---|
| BP-3 -The road fill shall be bridged, culverted, or otherwise designed to prevent the restriction of expected flood flows.<br>-Is there evidence of flood flow restriction at the site? (evidence of water moving across the road, eroded ditchlines, erosion of culvert inlets or outlets) (BMPs 14.9, 14.14, &14.17)<br>-Are culverts adequate and designed for expected flood flows?<br>-Will fill disrupt the flow of water enough to alter soil drainage at the site? (BMPs 14.3 & 14.9)<br>- Will the management activity result in headcutting that will eventually change the soil drainage in the wetland? (BMPs 14.3 & 14.9) | yes/ no | | yes/no | | | |
| BMP WET-4 -. The fill shall be properly stabilized and maintained during and following construction to prevent erosion.<br>- Is there evidence of fill erosion at the site? (BMPs 12.7, 14.5 & 14.8)<br>-Are ditchlines seeded? (BMPs 12.7, 14.5 & 14.8)<br>-Are rock walls or ditchblocks or other erosion control structures in place as needed? (BMPs 13.11, 13.14, & 14.5)<br>-Were suspension requirements met in harvest units? (BMP 13.9)<br>-Have disturbed areas been revegetated? (BMP 12.17)<br>-Was an erosion control plan used? (BMPs 12.7, 14,5, & 14.8) | yes/ no | | yes/ no no | | | |

## Wetland Road BP Implementation Monitoring Form

[1] BP rating (rate after road final): F = BP fully implemented; D = Departure from full BP implementation; N = BP not implemented

[2] Departure occurred during Site Evaluation (SE), Environmental Analysis (EA), Contract (CT), Lay Out (LO), Administration (AD)

| Item Monitored | Applies | BP Rating [1] | Corrective Action | Corrective Action Implemented | Departure Occurred[2] | Comments (PRINT!) |
|---|---|---|---|---|---|---|
| BP-5 – Discharges of dredged or fill material into waters of the US to construct a road fill shall be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within waters of the US that lie outside the lateral boundaries of the fill itself.<br>-Is there excess fill or excess turnouts in wetlands?<br>-Measure width of road surface – Does it match the design criteria? (BMPs 14.2, 14.3 & 14.20)<br>Was end-haul material placed in wetlands? Was there a practicable alternative? (BMP 14.19) | yes/ no | | yes/no | | | |
| BP-6 – In designing, constructing, and maintaining roads, vegetative disturbance on waters of the US shall be kept to a minimum.<br>-Measure vegetative clearing width. Does the clearing width match the design criteria? (BMPs 12.5, 14.2 & 14.3)<br>-Could the clearing width have been less?<br>-What about harvest units in forested wetlands? | yes/ no | | yes/no | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| BP-7 –The design, construction, and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.<br>-Culverts functional? (BMP 14.9)<br>-Fish passage? (BMPs 14.14 & 14.17)<br>-FS and ADF&G concurrence details implemented? (BMPs 14.14 & 14.17)<br>-Timing guidelines met for fish stream crossings? (BMP 14.6)<br>-Effectiveness is evaluated forest-wide. | yes/ no | | yes/ no no | | | |

**Wetland Road BP Implementation Monitoring Form**

[1] BP rating (rate after road final): F = BP fully implemented; D = Departure from full BP implementation; N = BP not implemented

[2] Departure occurred during Site Evaluation (SE), Environmental Analysis (EA), Contract (CT), Lay Out (LO), Administration (AD)

| Item Monitored | Applies | BP Rating [1] | Corrective Action | Corrective Action Implemented | Departure Occurred[2] | Comments (PRINT!) |
|---|---|---|---|---|---|---|
| BP-14 – The discharge of material shall consist of suitable material free of toxic pollutants in toxic amounts.<br>-Is the fill clean shot rock? (BMP 12.5)<br>-Is there evidence of oil or other pollutants in the wetland? (BMPs 12.8 & 12.9) | yes/ no | | yes/no | | | |
| BP-15 – All temporary fills shall be removed in their entirety and the area restored to its original elevation.<br>-Is there a temporary fill placed in the wetland?<br>-Was the fill completely or partially removed? (BMP 14.24)<br>- Was there a practicable alternate site for fill disposal? (BMP 14.19)<br>-Can the fill be practicably removed? (BMP 14.24)<br>. | yes/ no | | yes/no | | | |

# Road/wetland Impact Monitoring Form

<table>
<tr><td>Date Monitored:</td><td>ER/ COR Name:</td><td>Road Construction Contract:</td><td>District:</td></tr>
<tr><td>Road #:</td><td>Timber Sale:</td><td>EIS/EA:</td><td>Road gradient through wetland:</td></tr>
<tr><td colspan="2">Width of disturbed soil corridor (top of cut to toe of fill):</td><td colspan="2">Road location, edge of wetland, middle of wetland</td></tr>
<tr><td>Width of road fill every 100 feet:</td><td>Length of road through wetland:</td><td colspan="2">Number of turnouts in wetland:<br>Number of turnouts minimized?</td></tr>
<tr><td colspan="4">Size of wetland (acres):</td></tr>
<tr><td colspan="4">Width of hydrologic effects from road (based on Kahklen and Moll 1999):<br>Does this width match the width estimated in the NEPA document?</td></tr>
<tr><td colspan="4">Percent of wetland impacted by road and hydrologic effect:</td></tr>
<tr><td colspan="4">Cross drainage and culverts at each end of wetland and a preferential flow points?</td></tr>
<tr><td colspan="4">Is there evidence of the ditchline carrying water away from the wetland?</td></tr>
<tr><td colspan="4">Is road inhibiting water flow?  Water ponding on side of road?</td></tr>
<tr><td colspan="4">Wetland habitat-type:<br>Is this wetland scare or rare in this project area</td></tr>
<tr><td colspan="4">Narrative describing impacts:</td></tr>
</table>

| Landform or landscape position: |
| --- |
| |

# Appendix C Data from wetland-road segments monitored in 2011

**Road-Wetland Impact Monitoring data**

October, 2011

| Road and segment number | Contract Name | Ranger District | Cross section number | Width of road running surface (ft) | Width of road fill (ft) | Width of disturbed soil corridor (ft) | Slope hill at cross section (%) | Estimated Hydrologic Impact (ft) | Length of road segment through wetland (ft) | Number and size of turnouts | Road gradient through wetland | Total impact (Acres) | Size of wetland polygon (Acres) | Percent of wetland polygon impacted. | Number of culverts | Culverts at preferential flow points? | Is ditchline eroding or carrying water away from wetland? | Is road prism causing ponding of water? | Soil Series at Site. | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2057 temp | Diesel/Logjam | TNB | 1 | 15 | 23 | 23 | 11 | | 1937 | 25 by 50 | 7 | 1.3 ac. | 81.1 | 1.60% | 0 | culverts | No | No | Wadleigh | Seven cross drains and waterbars. One of which is not deep enough but was not ponding water. 70% of wetland is FW and Scrub/shrub and the rest Emergent muskeg, some short sedge and some tall sedge. Water flowign thru fill in one spot. Forested soil pit was borderline hydric, wetter sites in the vicinity. St. Nicholas soils also present. |
| 2057 temp | Diesel/Logjam | TNB | 2 | 15 | 22 | 23 | 11 | | | 18 by 34 | 5 | | | | | pulled | | | kina | |
| 2057 temp | Diesel/Logjam | TNB | 3 | 15 | 23 | 29 | 11 | | | | 5 | | | | | 7 crossdrains | | | | |
| 2057 temp | Diesel/Logjam | TNB | 4 | 24 | 30 | 35 | 13 | | | | 8 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 5 | 17 | 24 | 43 | 31 | | | | 12 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 6 | 15 | 27 | 23 | 8 | | | | 2 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 7 | 13 | 23 | 36 | 22 | | | | 2 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 8 | 15 | 22 | 41 | 16 | | | | 5 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 9 | 14 | 23 | 23 | 4 | | | | 4 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 10 | 14 | 20 | 23 | 2 | | | | 3 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 11 | 15 | 23 | 22 | 3 | | | | 5 | | | | | | | | | |
| 2057 temp | Diesel/Logjam | TNB | 12 | 14 | 23 | 27 | n/a | | | | n/a | | | | | | | | | |
| | | | **Ave.** | **15.5** | **23.6** | **29.0** | 12 | | | | **5.3** | | | | | | | | | |
| 3000381 temp | Diesel/Logjam | THB | 1 | 14 | 20 | 20 | 10 | | 1387 | 1/2 not | 8 | 0.7 | 10389.5 | 0.006% | 0 | yes | No | No | Kushneahin | Wetland includes a Class IV stream in a clearcut. All pipes pulled and waterbars and cross drains installed. Wetland Polygon PFO4b is large and includes many other roads and much upland in the polygon. At the site the wetland was probably less than 10 acres. Forested wetland on a Kina soil. Road collects hillslope water for about 100 feet and delivers it to the stream |
| 3000381 temp | Diesel/Logjam | THB | 2 | 15 | 18 | 19 | 8 | | | neasured | 2 | | | | | culverts | | | | |
| 3000381 temp | Diesel/Logjam | THB | 3 | 14 | 26 | 26 | 4 | | | | 8 | | | | | pulled | | | | |
| 3000381 temp | Diesel/Logjam | THB | 4 | 15 | 22 | 20 | 11 | | | | 2 | | | | | 3 waterbars | | | | |
| 3000381 temp | Diesel/Logjam | THB | 5 | 14 | 20 | 22 | 11 | | | | 5 | | | | | | | | | |
| 3000381 temp | Diesel/Logjam | THB | 6 | 14 | 18 | 18 | 13 | | | | 7 | | | | | | | | | |
| | | | **Ave.** | **15.1** | **20.7** | **20.8** | **9.5** | | | | **5.3** | | | | | | | | | |
| 577-35 temp | Slake/Logjam | THB | 1 | 14 | 20 | 20 | 2 | | 1153 | 19 by 32 | 4 | 0.61 | 9470 | 0.006 | 0 | yes | Yes | No | Kushneahin | Wetland goes from Scrub forested to sedgy open areas. Fish stream to the west of the road. Small non-streams near the POB. Five cross drains all flowing water and water flowing thru the road prism in two spots. No ponding of water except in cross drains. Wetland polygon is large but has many roads thru it. |
| 577-35 temp | Slake/Logjam | THB | 2 | 15 | 20 | 20 | 2 | | | | 1 | | | | | culverts | | | | |
| 577-35 temp | Slake/Logjam | THB | 3 | 14 | 21 | 21 | 3 | | | | 4 | | | | | pulled | | | | |
| 577-35 temp | Slake/Logjam | THB | 4 | 15 | 24 | 24 | 4 | | | | 5 | | | | | | | | | |
| 577-35 temp | Slake/Logjam | THB | 5 | 14 | 20 | 20 | 2 | | | | 4 | | | | | | | | | |
| 577-35 temp | Slake/Logjam | THB | 6 | 14 | 20 | 20 | 1 | | | | 3 | | | | | | | | | |
| 577-35 temp | Slake/Logjam | THB | 7 | 13 | 22 | 31 | 2 | | | | 1 | | | | | | | | | |
| 577-35 temp | Slake/Logjam | THB | 8 | 14 | 22 | 26 | 1 | | | | 1 | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3036, 30yr old | Long-term | THB | 1 | 15 | 26 | 31 | 2 | 1778 | 24 by 36 | 1 | 1.26 ac. | 9470 | 0.01% | 1 | No culverts | No | No | Kina | 30 year old road has no culverts in the wetland. The wetland is bog with shorepine for about 400 feet and thena FW UPL mosaic for more than a 1000 feet. Noted a pH shift downslope of the road fill. pH remained over 7 for up to 10 meters downslope awhen parent pH above the road and further below was 4.5. One maidenhair fern noted downslope of road. More testing needed. Limestone road. hydrologic effects were negligible or not apparent beyond the road fill or disturbed road corridor. lack of culverts indicates flow thru or under the road. Some erosion noted on road surface where water flows out of wetland and down road in one area. |
| 3036, 30yr old | Long-term | THB | 2 | 13 | 21 | 22 | 3 | | 27 by 28 | 6 | | | | | except at | | | | |
| 3036, 30yr old | Long-term | THB | 3 | 15 | 27 | 29 | 5 | | | 6 | | | | | Class II | | | | |
| 3036, 30yr old | Long-term | THB | 4 | 14 | 25 | 34 | 4 | | | 3 | | | | | currently | | | | |
| 3036, 30yr old | Long-term | THB | 5 | 13 | 24 | 33 | 2 | | | 4 | | | | | pulled | | | | |
| 3036, 30yr old | Long-term | THB | 6 | 15 | 27 | 37 | 4 | | | 5 | | | | | | | | | |
| 3036, 30yr old | Long-term | THB | 7 | 23 | 23 | 39 | 17 | | | 5 | | | | | | | | | |
| 3036, 30yr old | Long-term | THB | 8 | 14 | 22 | 35 | 2 | | | 5 | | | | | | | | | |
| 3036, 30yr old | Long-term | THB | 9 | 14 | 26 | 32 | 27 | | | 6 | | | | | | | | | |
| 3036, 30yr old | Long-term | THB | 10 | 13 | 34 | 27 | 7 | | | 3 | | | | | | | | | |
| 3036, 30yr old | Long-term | THB | 11 | 13 | 25 | 28 | 4 | | | 2 | | | | | | | | | |
| 3036, 30yr old | Long-term | THB | 12 | | 22 | 23 | 2 | | | | | | | | | | | | |
| | | | **Ave.** | **14.7** | **25.2** | **30.8** | **6.6** | | | **4.2** | | | | | | | | | |
| 35100 30+ yr | Long-term | THB | 1 | 16 | 29 | 29 | 2 | 829 | 0 | 7 | 0.61 | 42 | 1.45% | 1 | Yes | No | No | Kina | Road constructed pre 1979. Shore pine and cedar-hemlock FW. Road is wider than specs due to resurfacig and straightening of curves. Fill rock is covered with mosses, small hemlock and lodgepole. One 24 inch culvert with some water flowing through the fill, perhaps could have used two culverts, Class 4 but fish not far away. |
| 35100 30+ yr | Long-term | THB | 2 | 17 | 28 | 28 | 4 | | | 4 | | | | | | | | | |
| 35100 30+ yr | Long-term | THB | 3 | 24 | 37 | 37 | 17 | | | 3 | | | | | | | | | |
| 35100 30+ yr | Long-term | THB | 4 | 19 | 29 | 38 | 14 | | | 3 | | | | | | | | | |
| 35100 30+ yr | Long-term | THB | 5 | 17 | 28 | 28 | 7 | | | 1 | | | | | | | | | |
| | | | **Ave.** | **18.6** | **30.2** | **32** | **8.8** | | | **3.6** | | | | | | | | | |
| 0RD Little Rat | Long-term | THB | 1 | 13 | 23 | 34 | 2 | 566 | 0 | 0 | 0.47 | 10 | 4.56% | 0 | culverts | No | Yes | Kina | Road constructed pre 1964. Ditches on road collect and pond water. At south end of wetland road collects upland hilslope water and delivers it to the wetland. The water eventually washes across road eroding it. Beaver have also used the road for dam construction, in one place beaver dammed a dug cross drain. a portion of the wetland has been converted from productive forested wetland to non-forested wetland. may be more wetland in the area than before the road. |
| 35100 30+ yr | Long-term | THB | 2 | 15 | 27 | 43 | 1 | | | 0.5 | | | | | pulled | | | | |
| 35100 30+ yr | Long-term | THB | 3 | 18 | 27 | 33 | 1 | | | 0.5 | | | | | 2 cross | | | | |
| 35100 30+ yr | Long-term | THB | 4 | 19 | 25 | 39 | 1 | | | 2 | | | | | drains | | | | |
| 35100 30+ yr | Long-term | THB | 5 | 17 | 28 | 39 | 5 | | | 5 | | | | | | | | | |
| | | | 6 | 17 | 21 | 26 | 4 | | | 3 | | | | | | | | | |
| | | | **Ave.** | **16.5** | **25.2** | **35.7** | **2.3** | | | **1.8** | | | | | | | | | |